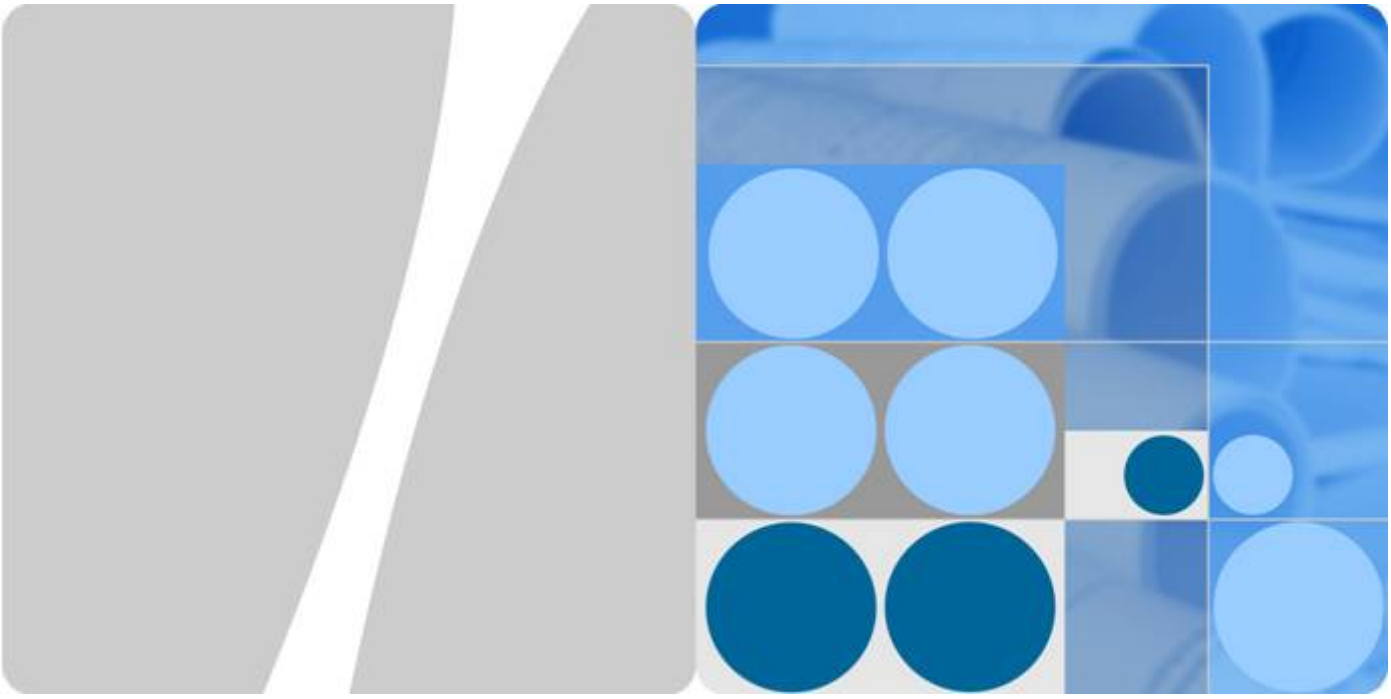


MapReduce Service

Component Operation Guide

Date 2024-11-30

Contents

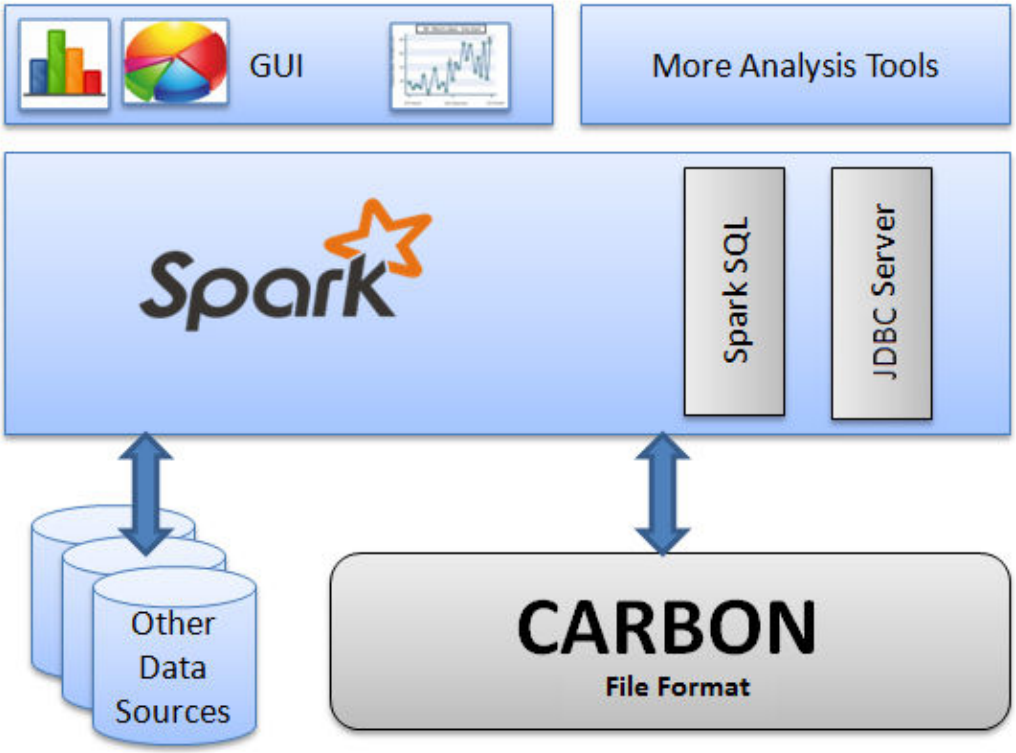
1 Using CarbonData

1.1 Overview

1.1.1 CarbonData Overview

CarbonData is a new Apache Hadoop native data-store format. CarbonData allows faster interactive queries over PetaBytes of data using advanced columnar storage, index, compression, and encoding techniques to improve computing efficiency. In addition, CarbonData is also a high-performance analysis engine that integrates data sources with Spark.

Figure 1-1 Basic architecture of CarbonData



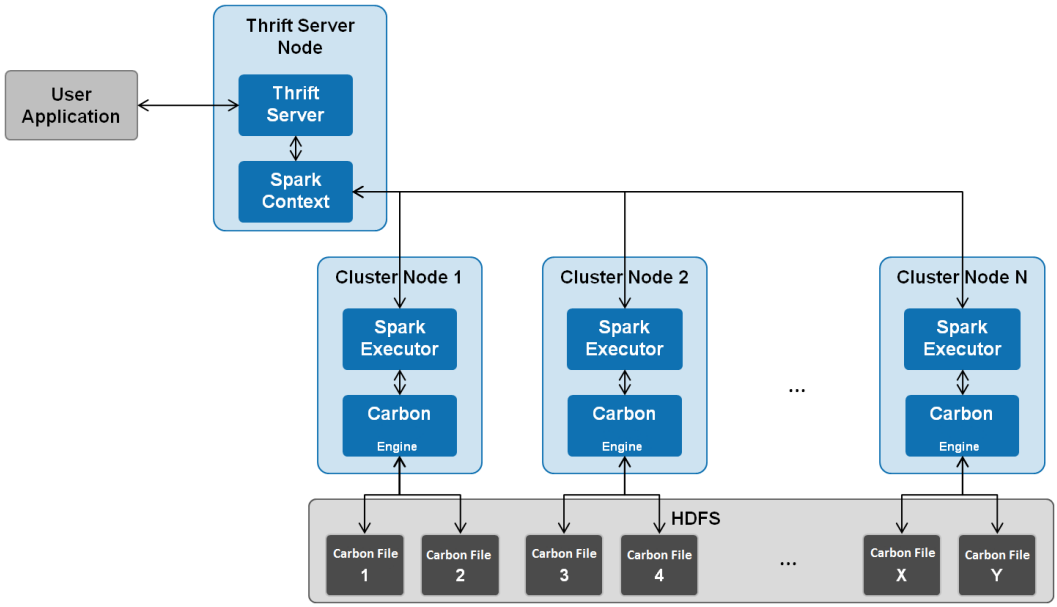
The purpose of using CarbonData is to provide quick response to ad hoc queries of big data. Essentially, CarbonData is an Online Analytical Processing (OLAP) engine, which stores data by using tables similar to those in Relational Database Management System (RDBMS). You can import more than 10 TB data to tables created in CarbonData format, and CarbonData automatically organizes and stores data using the compressed multi-dimensional indexes. After data is loaded to CarbonData, CarbonData responds to ad hoc queries in seconds.

CarbonData integrates data sources into the Spark ecosystem and you can query and analyze the data using Spark SQL. You can also use the third-party tool JDBCServer provided by Spark to connect to SparkSQL.

Topology of CarbonData

CarbonData runs as a data source inside Spark. Therefore, CarbonData does not start any additional processes on nodes in clusters. CarbonData engine runs inside the Spark executor.

Figure 1-2 Topology of CarbonData



Data stored in CarbonData Table is divided into several CarbonData data files. Each time when data is queried, CarbonData Engine reads and filters data sets. CarbonData Engine runs as a part of the Spark Executor process and is responsible for handling a subset of data file blocks.

Table data is stored in HDFS. Nodes in the same Spark cluster can be used as HDFS data nodes.

CarbonData Features

- SQL: CarbonData is compatible with Spark SQL and supports SQL query operations performed on Spark SQL.
- Simple Table dataset definition: CarbonData allows you to define and create datasets by using user-friendly Data Definition Language (DDL) statements. CarbonData DDL is flexible and easy to use, and can define complex tables.

- Easy data management: CarbonData provides various data management functions for data loading and maintenance. CarbonData supports bulk loading of historical data and incremental loading of new data. Loaded data can be deleted based on load time and a specific loading operation can be undone.
- CarbonData file format is a columnar store in HDFS. This format has many new column-based file storage features, such as table splitting and data compression. CarbonData has the following characteristics:
  - Stores data along with index: Significantly accelerates query performance and reduces the I/O scans and CPU resources, when there are filters in the query. CarbonData index consists of multiple levels of indices. A processing framework can leverage this index to reduce the task that needs to be schedules and processed, and it can also perform skip scan in more finer grain unit (called blocklet) in task side scanning instead of scanning the whole file.
  - Operable encoded data: Through supporting efficient compression, CarbonData can query on compressed/encoded data. The data can be converted just before returning the results to the users, which is called late materialized.
  - Support for various use cases with one single data format: like interactive OLAP-style query, sequential access (big scan), and random access (narrow scan).

Key Technologies and Advantages of CarbonData

- Quick query response: CarbonData features high-performance query. The query speed of CarbonData is 10 times of that of Spark SQL. It uses dedicated data formats and applies multiple index technologies and multiple push-down optimizations, providing quick response to TB-level data queries.
- Efficient data compression: CarbonData compresses data by combining the lightweight and heavyweight compression algorithms. This significantly saves 60% to 80% data storage space and the hardware storage cost.

1.1.2 Main Specifications of CarbonData

Main Specifications of CarbonData

Table 1-1 Main Specifications of CarbonData

Entity	Tested Value	Test Environment
Number of tables	10000	3 nodes. 4 vCPUs and 20 GB memory for each executor. Driver memory: 5 GB, 3 executors. Total columns: 107 String: 75 Int: 13 BigInt: 7 Timestamp: 6 Double: 6
Number of table columns	2000	3 nodes. 4 vCPUs and 20 GB memory for each executor. Driver memory: 5 GB, 3 executors.
Maximum size of a raw CSV file	200 GB	17 cluster nodes. 150 GB memory and 25 vCPUs for each executor. Driver memory: 10 GB, 17 executors.
Number of CSV files in each folder	100 folders. Each folder has 10 files. The size of each file is 50 MB.	3 nodes. 4 vCPUs and 20 GB memory for each executor. Driver memory: 5 GB, 3 executors.
Number of load folders	10000	3 nodes. 4 vCPUs and 20 GB memory for each executor. Driver memory: 5 GB, 3 executors.

The memory required for data loading depends on the following factors:

- Number of columns
- Column values
- Concurrency (configured using **carbon.number.of.cores.while.loading**)
- Sort size in memory (configured using **carbon.sort.size**)
- Intermediate cache (configured using **carbon.graph.rowset.size**)

Data loading of an 8 GB CSV file that contains 10 million records and 300 columns with each row size being about 0.8 KB requires about 10 GB executor memory.

That is, set **carbon.sort.size** to **100000** and retain the default values for other parameters.

Table Specifications

Table 1-2 Table specifications

Entity	Tested Value
Number of secondary index tables	10
Number of composite columns in a secondary index table	5
Length of column name in a secondary index table (unit: character)	120
Length of a secondary index table name (unit: character)	120
Cumulative length of all secondary index table names + column names in an index table* (unit: character)	3800**

NOTE

- * Characters of column names in an index table refer to the upper limit allowed by Hive or the upper limit of available resources.
- ** Secondary index tables are registered using Hive and stored in HiveSERDEPROPERTIES in JSON format. The value of **SERDEPROPERTIES** supported by Hive can contain a maximum of 4,000 characters and cannot be changed.

1.2 Common CarbonData Parameters

Configure all common CarbonData parameters.

Parameters in the carbon.properties File

Configure CarbonData parameters on the server or client based on the actual application scenario.

- Server: Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Spark**. Click **Configurations** then **All Configurations**, click **JDBCServer(Role)**, and select **Customization**. Then, add CarbonData parameters in **spark.carbon.customized.configs**.
- Client: Log in to the client node and configure related parameters in the *{Client installation directory}*/**Spark/spark/conf/carbon.properties** file.

Table 1-3 System configurations in carbon.properties

Parameter	Default Value	Description
carbon.ddl.base.hdfs.url	hdfs://hacluster/opt/data	HDFS relative path from the HDFS base path, which is configured in **fs.defaultFS**. The path configured in **carbon.ddl.base.hdfs.url** will be appended to the HDFS path configured in **fs.defaultFS**. If this path is configured, you do not need to pass the complete path while dataload. For example, if the absolute path of the CSV file is **hdfs://10.18.101.155:54310/data/cnbc/2016/xyz.csv**, the path **hdfs://10.18.101.155:54310** will come from property **fs.defaultFS** and you can configure **/data/cnbc/** as **carbon.ddl.base.hdfs.url**. During data loading, you can specify the CSV path as **/2016/xyz.csv**.
carbon.badRecords.location	-	Storage path of bad records. This path is an HDFS path. The default value is **Null**. If bad records logging or bad records operation redirection is enabled, the path must be configured by the user.
carbon.bad.records.action	fail	The following are four types of actions for bad records: **FORCE**: Data is automatically corrected by storing the bad records as NULL. **REDIRECT**: Bad records are written to the CSV file in **carbon.badRecords.location** instead of being loaded. **IGNORE**: Bad records are neither loaded nor written to the CSV file. **FAIL**: Data loading fails if any bad records are found.
carbon.update.sync.folder	/tmp/carbondata	Specifies the **modifiedTime.mdt** file path. You can set it to an existing path or a new path. **NOTE** If you set this parameter to an existing path, ensure that all users can access the path and the path has the 777 permission.

Parameter	Default Value	Description
carbon.enable.bad record.action.redir ect	false	Specifies whether to enable the REDIRECT mode to handle bad records during data loading. When it is enabled, bad records in source files will be recorded in a CSV file generated in a specified storage location each time data is loaded. CSV injection may occur when such CSV files are opened in Windows.
carbon.enable.par titiondata.trash	false	After this function is enabled, the **ALTER DROP PARTITION** operation moves the deleted partition data to the carbon trash.
carbon.enable.sho w.mv.for.showtabl es	false	If this parameter is set to **true**, materialized views are filtered out when the **show tables** command is executed. If this parameter is set to **true** when there are a large number of tables, the execution of the **show tables** command will take a long time.
carbon.enable.dro ptable.remove.stal eentry	true	If this parameter is set to **true**, obsolete records of the table will be deleted from the cache when the **drop table** command is executed. If this parameter is set to **true** when there are a large number of databases, the execution of the **drop table** command will take a long time.
carbon.enable.mul ti.version.table.sta tus	false	Whether to enable versioning management of tablestatus files. If this parameter is set to **true**, a tablestatus file is generated each time a load, insert, or IUD operation is performed. **NOTE** If JDBCServer and the client are both used to load data to a table, ensure that this feature is enabled or disabled for both of them at the same time.
carbon.tablestatus .multi.version.file.c oun	3	This parameter is available only when **carbon.enable.multi.version.table.sta tus** is set to **true**. This parameter indicates the default number of the latest tablestatus files to be retained. Old tablestatus files that exceed the value of this parameter will be deleted.

Table 1-4 Performance configurations in **carbon.properties**

Parameter	Default Value	Description
Data Loading Configuration		
carbon.sort.file.write.buffer.size	16384	CarbonData sorts data and writes it to a temporary file to limit memory usage. This parameter controls the size of the buffer used for reading and writing temporary files. The unit is bytes. The value ranges from 10240 to 10485760.
carbon.graph.rowset.size	100,000	Rowset size exchanged in data loading graph steps. The value ranges from 500 to 1,000,000.
carbon.number.of.cores.while.loading	6	Number of cores used during data loading. The greater the number of cores, the better the compaction performance. If the CPU resources are sufficient, you can increase the value of this parameter.
carbon.sort.size	500000	Number of records to be sorted
carbon.enableXXHash	true	Hashmap algorithm used for hashkey calculation
carbon.number.of.cores.block.sort	7	Number of cores used for sorting blocks during data loading
carbon.max.driver.lru.cache.size	-1	Maximum size of LRU caching for data loading at the driver side. The unit is MB. The default value is **-1**, indicating that there is no memory limit for the caching. Only integer values greater than 0 are accepted.
carbon.max.executor.lru.cache.size	-1	Maximum size of LRU caching for data loading at the executor side. The unit is MB. The default value is **-1**, indicating that there is no memory limit for the caching. Only integer values greater than 0 are accepted. If this parameter is not configured, the value of **carbon.max.driver.lru.cache.size** is used.

Parameter	Default Value	Description
carbon.merge.sort.prefetch	true	Whether to enable prefetch of data during merge sort while reading data from sorted temp files in the process of data loading
carbon.update.persist.enable	true	Configuration to enable the dataset of RDD/dataframe to persist data. Enabling this will reduce the execution time of UPDATE operation.
enable.unsafe.sort	true	Whether to use unsafe sort during data loading. Unsafe sort reduces the garbage collection during data load operation, resulting in better performance. The default value is **true**, indicating that unsafe sort is enabled.
enable.offheap.sort	true	Whether to use off-heap memory for sorting of data during data loading
offheap.sort.chunk.size.inmb	64	Size of data chunks to be sorted, in MB. The value ranges from 1 to 1024.
carbon.unsafe.working.memory.in.mb	512	Size of the unsafe working memory. This will be used for sorting data and storing column pages. The unit is MB. Memory required for data loading: carbon.number.of.cores.while.loading [default value is 6] x Number of tables to load in parallel x offheap.sort.chunk.size.inmb [default value is 64 MB] + carbon.blockletgroup.size.in.mb [default value is 64 MB] + Current compaction ratio [64 MB/3.5] = Around 900 MB per table Memory required for data query: (SPARK_EXECUTOR_INSTANCES. [default value is 2] x (carbon.blockletgroup.size.in.mb [default value: 64 MB] + carbon.blockletgroup.size.in.mb [default value = 64 MB x 3.5) x Number of cores per executor [default value: 1]) = ~ 600 MB

Parameter	Default Value	Description
carbon.sort.inmemory.storage.size.in.mb	512	Size of the intermediate sort data to be kept in the memory. Once the specified value is reached, the system writes data to the disk. The unit is MB.
sort.inmemory.size.inmb	1024	Size of the intermediate sort data to be kept in the memory. Once the specified value is reached, the system writes data to the disk. The unit is MB. If **carbon.unsafe.working.memory.in.mb** and **carbon.sort.inmemory.storage.size.in.mb** are configured, you do not need to set this parameter. If this parameter has been configured, 20% of the memory is used for working memory **carbon.unsafe.working.memory.in.mb**, and 80% is used for sort storage memory **carbon.sort.inmemory.storage.size.in.mb**. **NOTE** The value of **spark.yarn.executor.memoryOverhead** configured for Spark must be greater than the value of **sort.inmemory.size.inmb** configured for CarbonData. Otherwise, Yarn might stop the executor if off-heap access exceeds the configured executor memory.
carbon.blockletgroup.size.in.mb	64	The data is read as a group of blocklets which are called blocklet groups. This parameter specifies the size of each blocklet group. Higher value results in better sequential I/O access. The minimum value is 16 MB. Any value less than 16 MB will be reset to the default value (64 MB). The unit is MB.
enable.inmemory.merge.sort	false	Whether to enable **inmemorymerge sort**.
use.offheap.in.query.processing	true	Whether to enable **offheap** in query processing.

Parameter	Default Value	Description
carbon.load.sort.scope	local_sort	Sort scope for the load operation. There are two types of sort: **batch_sort** and **local_sort**. If **batch_sort** is selected, the loading performance is improved but the query performance is reduced. **NOTE** local_sort conflicts with DDL operations on partitioned tables and they cannot be used at the same time. In addition, local_sort does not significantly improve the performance of partitioned tables. You are advised not to enable this feature on partitioned tables.
carbon.batch.sort.size.inmb	-	Size of data to be considered for batch sorting during data loading. The recommended value is less than 45% of the total sort data. The unit is MB. **NOTE** If this parameter is not set, its value is about 45% of the value of **sort.inmemory.size.inmb** by default.
enable.unsafe.columnpage	true	Whether to keep page data in heap memory during data loading or query to prevent garbage collection bottleneck.
carbon.use.local.dir	false	Whether to use Yarn local directories for multi-disk data loading. If this parameter is set to **true**, Yarn local directories are used to load multi-disk data to improve data loading performance.
carbon.use.multiple.temp.dir	false	Whether to use multiple temporary directories for storing temporary files to improve data loading performance.
carbon.load.datamaps.parallel.db_name.table_name	N/A	The value can be **true** or **false**. You can set the database name and table name to improve the first query performance of the table.
Compaction Configuration		
carbon.number.of.cores.while.compacting	2	Number of cores to be used while compacting data. The greater the number of cores, the better the compaction performance. If the CPU resources are sufficient, you can increase the value of this parameter.

Parameter	Default Value	Description
carbon.compaction.level.threshold	4,3	This configuration is for minor compaction which decides how many segments to be merged. For example, if this parameter is set to **2,3**, minor compaction is triggered every two segments. **3** is the number of level 1 compacted segments which is further compacted to new segment. The value ranges from 0 to 100.
carbon.major.compaction.size	1024	Major compaction size. Sum of the segments which is below this threshold will be merged. The unit is MB.
carbon.horizontal.compaction.enable	true	Whether to enable/disable horizontal compaction. After every DELETE and UPDATE statement, horizontal compaction may occur in case the incremental (DELETE/ UPDATE) files becomes more than specified threshold. By default, this parameter is set to **true**. You can set this parameter to **false** to disable horizontal compaction.
carbon.horizontal.update.compaction.threshold	1	Threshold limit on number of UPDATE delta files within a segment. In case the number of delta files goes beyond the threshold, the UPDATE delta files within the segment becomes eligible for horizontal compaction and are compacted into single UPDATE delta file. By default, this parameter is set to **1**. The value ranges from **1** to **10000**.
carbon.horizontal.delete.compaction.threshold	1	Threshold limit on number of DELETE incremental files within a block of a segment. In case the number of incremental files goes beyond the threshold, the DELETE incremental files for the particular block of the segment becomes eligible for horizontal compaction and are compacted into single DELETE incremental file. By default, this parameter is set to **1**. The value ranges from **1** to **10000**.
Query Configuration		

Parameter	Default Value	Description
carbon.number.of.cores	4	Number of cores to be used during query
carbon.limit.block.distribution.enable	false	Whether to enable the CarbonData distribution for limit query. The default value is **false**, indicating that block distribution is disabled for query statements that contain the keyword limit. For details about how to optimize this parameter, see **Configurations for Performance Tuning**.
carbon.custom.block.distribution	false	Whether to enable Spark or CarbonData block distribution. By default, the value is **false**, indicating that Spark block distribution is enabled. To enable CarbonData block distribution, change the value to **true**.
carbon.infilter.subquery.pushdown.enable	false	If this is set to **true** and a Select query is triggered in the filter with subquery, the subquery is executed and the output is broadcast as IN filter to the left table. Otherwise, SortMergeSemiJoin is executed. You are advised to set this to **true** when IN filter subquery does not return too many records. For example, when the IN clause subquery returns 10,000 or fewer records, enabling this parameter will display query results faster. Example: ***select * from flow_carbon_256b where cus_no in (select cus_no from flow_carbon_256b where dt>='20260101' and dt<='20260701' and txn_bk='tk_1' and txn_br='tr_1') limit 1000;***
carbon.scheduler.minRegisteredResourcesRatio	0.8	Minimum resource (executor) ratio needed for starting the block distribution. The default value is **0.8**, indicating that 80% of the requested resources are allocated for starting block distribution.
carbon.dynamicAllocation.schedulerTimeout	5	Maximum time that the scheduler waits for executors to be active. The default value is **5** seconds, and the maximum value is **15** seconds.

Parameter	Default Value	Description
enable.unsafe.in.query.processing	true	Whether to use unsafe sort during query. Unsafe sort reduces the garbage collection during query, resulting in better performance. The default value is **true**, indicating that unsafe sort is enabled.
carbon.enable.vector.reader	true	Whether to enable vector processing for result collection to improve query performance
carbon.query.show.datamaps	true	**SHOW TABLES** lists all tables, including the primary table and datamaps. To filter out the datamaps, set this parameter to **false**.
Secondary Index Configuration		
carbon.secondary.index.creation.threads	1	Number of threads to concurrently process segments during secondary index creation. This property helps fine-tuning the system when there are a lot of segments in a table. The value ranges from 1 to 50.
carbon.si.lookup.partialstring	true	• When the parameter value is **true**, it includes indexes started with, ended with, and contained. • When the parameter value is **false**, it includes only secondary indexes started with.
carbon.si.segment.merge	true	Enabling this property merges **.carbondata** files inside the secondary index segment. The merging will happen after the load operation. That is, at the end of the secondary index table load, small files are checked and merged. **NOTE** Table Block Size is used as the size threshold for merging small files.

Table 1-5 Other configurations in **carbon.properties**

Parameter	Default Value	Description
Data Loading Configuration		

Parameter	Default Value	Description
carbon.lock.type	HDFSLOCK	Type of lock to be acquired during concurrent operations on a table. There are following types of lock implementation: • **LOCALLOCK**: Lock is created on local file system as a file. This lock is useful when only one Spark driver (or JDBCServer) runs on a machine. • **HDFSLOCK**: Lock is created on HDFS file system as a file. This lock is useful when multiple Spark applications are running and no ZooKeeper is running on a cluster.
carbon.sort.intermediate.files.limit	20	Minimum number of intermediate files. After intermediate files are generated, sort and merge the files. For details about how to optimize this parameter, see **Configurations for Performance Tuning**.
carbon.csv.read.buffersize.byte	1048576	Size of CSV reading buffer
carbon.merge.sort.reader.thread	3	Maximum number of threads used for reading intermediate files for final merging.
carbon.concurrent.lock.retries	100	Maximum number of retries used to obtain the concurrent operation lock. This parameter is used for concurrent loading.
carbon.concurrent.lock.retry.timeout.sec	1	Interval between the retries to obtain the lock for concurrent operations.
carbon.lock.retries	3	Maximum number of retries to obtain the lock for any operations other than import.
carbon.lock.retry.timeout.sec	5	Interval between the retries to obtain the lock for any operation other than import.

Parameter	Default Value	Description
carbon.tempstore.location	/opt/Carbon/TempStoreLoc	Temporary storage location. By default, the **System.getProperty("java.io.tmpdir")** method is used to obtain the value. For details about how to optimize this parameter, see the description of **carbon.use.local.dir** in **Configurations for Performance Tuning**.
carbon.load.log.counter	500000	Data loading records count in logs
SERIALIZATION_NULL_FORMAT	\N	Value to be replaced with NULL
carbon.skip.empty.line	false	Setting this property will ignore the empty lines in the CSV file during data loading.
carbon.load.datamaps.parallel	false	Whether to enable parallel datamap loading for all tables in all sessions. This property will improve the time to load datamaps into memory by distributing the job among executors, thus improving query performance.
Merging Configuration		
carbon.numberof.preserve.segments	0	If you want to preserve some number of segments from being compacted, then you can set this configuration. For example, if **carbon.numberof.preserve.segments** is set to **2**, the latest two segments will always be excluded from the compaction. No segments will be preserved by default.
carbon.allowed.compaction.days	0	This configuration is used to control on the number of recent segments that needs to be merged. For example, if this parameter is set to **2**, the segments which are loaded in the time frame of past 2 days only will get merged. Segments which are loaded earlier than 2 days will not be merged. This configuration is disabled by default.

Parameter	Default Value	Description
carbon.enable.auto.load.merge	false	Whether to enable compaction along with data loading.
carbon.merge.index.in.segment	true	This configuration enables to merge all the CarbonIndex files (**.carbonindex**) into a single MergeIndex file (**.carbonindexmerge**) upon data loading completion. This significantly reduces the delay in serving the first query.
carbon.enable.compact.autoclean	false	If this parameter is set to **true**, the **clean files** command is invoked to delete obsolete files after segments are compacted.
Query Configuration		
max.query.execution.time	60	Maximum time allowed for one query to be executed. The unit is minute.
carbon.enableMinMax	true	MinMax is used to improve query performance. You can set this to **false** to disable this function.
carbon.lease.recovery.retry.count	5	Maximum number of attempts that need to be made for recovering a lease on a file. Minimum value: **1** Maximum value: **50**
carbon.lease.recovery.retry.interval	1000 (ms)	Interval or pause time after a lease recovery attempt is made on a file. Minimum value: **1000** (ms) Maximum value: **10000** (ms)

spark-defaults.conf parameters

- Log in to the client node and configure the parameters listed in **Table 1-6** in the *{Client installation directory}***/Spark/spark/conf/spark-defaults.conf** file.

Table 1-6 Spark configuration reference in **spark-defaults.conf**

Parameter	Default Value	Description
spark.driver.memory	4G	Memory to be used for the driver process. SparkContext has been initialized. **NOTE** In client mode, do not use SparkConf to set this parameter in the application because the driver JVM has been started. To configure this parameter, configure it in the **--driver-memory** command-line option or in the default property file.
spark.executor.memory	4 GB	Memory to be used for each executor process.
spark.sql.crossJoin.enabled	true	If the query contains a cross join, enable this property so that no error is thrown. In this case, you can use a cross join instead of a join for better performance.

- Configure the following parameters in the **spark-defaults.conf** file on the Spark driver.
  - In spark-sql mode: Log in to the Spark client node and configure the parameters listed in **Table 1-7** in the *{Client installation directory}***/Spark/spark/conf/spark-defaults.conf** file.

Table 1-7 Parameters in spark-sql mode

Parameter	Value	Description
spark.driver.extraJavaOptions	-Dlog4j.configuration=file:/opt/client/Spark/spark/conf/log4j.properties -Djetty.version=x.y.z -Dzookeeper.server.principal=zookeeper/hadoop.*<System domain name>* -Djava.security.krb5.conf=/opt/client/KrbClient/kerberos/var/krb5kdc/krb5.conf -Djava.security.auth.login.config=/opt/client/Spark/spark/conf/jaas.conf -Dorg.xerial.snappy.tempdir=/opt/client/Spark/tmp -Dcarbon.properties.filepath=/opt/client/Spark/spark/conf/carbon.properties -Djava.io.tmpdir=/opt/client/Spark/tmp	The default value **/opt/client/Spark/spark** indicates **CLIENT_HOME** of the client and is added to the end of the value of **spark.driver.extraJavaOptions**. This parameter is used to specify the path of the **carbon.properties**file in Driver. **NOTE** Spaces next to equal marks (=) are not allowed.
spark.sql.session.state.builder	org.apache.spark.sql.hive.FIHiveACLSessionStateBuilder	Session state constructor.
spark.carbon.sqlastbuilder.classname	org.apache.spark.sql.hive.CarbonInternalSqlAstBuilder	AST constructor.

Parameter	Value	Description
spark.sql.catalog.class	org.apache.spark.sql.hive.HiveACLExternalCatalog	Hive External catalog to be used. This parameter is mandatory if Spark ACL is enabled.
spark.sql.hive.implementation	org.apache.spark.sql.hive.HiveACLClientImpl	How to call the Hive client. This parameter is mandatory if Spark ACL is enabled.
spark.sql.hiveClient.isolation.enabled	false	This parameter is mandatory when Spark ACL is enabled.

- In JDBCServer: Log in to the node where JDBCServer is installed and configure the parameters listed in **Table 1-8** in the **{BIGDATA_HOME}/FusionInsight_Spark_*/*_JDBCServer/etc/spark-defaults.conf** file.

Table 1-8 Parameter description

Parameter	Value	Description
spark.driver.extraJavaOptions	-Xloggc:${SPARK_LOG_DIR}/indexserver-omm-%p-gc.log -XX:+PrintGCDetails -XX:-OmitStackTraceInFastThrow -XX:+PrintGCTimeStamps -XX:+PrintGCDateStamps -XX:MaxDirectMemorySize=512M -XX:MaxMetaspaceSize=512M -XX:+UseGCLogFileRotation -XX:NumberOfGCLogFiles=20 -XX:GCLogFileSize=10M -XX:OnOutOfMemoryError='kill -9 %p' -Djetty.version=x.y.z -Dorg.xerial.snappy.tempdir=${BIGDATA_HOME}/tmp/spark/JDBCServer/snappy_tmp -Djava.io.tmpdir=${BIGDATA_HOME}/tmp/spark/JDBCServer/io_tmp -Dcarbon.properties.filepath=${SPARK_CONF_DIR}/carbon.properties -Djdk.tls.ephemeralDHKeySize=2	The default value **${SPARK_CONF_DIR}** depends on a specific cluster and is added to the end of the value of the **spark.driver.extraJavaOptions** parameter. This parameter is used to specify the path of the **carbon.properties** file in Driver. **NOTE** Spaces next to equal marks (=) are not allowed.

Parameter	Value	Description
	048 -Dspark.ssl.keyStore=${SPARK_CONF_DIR}/child.keystore #{java_stack_prefer}	
spark.sql.session.state.builder	org.apache.spark.sql.hive.FIHiveACLSessionStateBuilder	Session state constructor.
spark.carbon.sqlastbuilder.classname	org.apache.spark.sql.hive.CarbonInternalSqlAst-Builder	AST constructor.
spark.sql.catalog.class	org.apache.spark.sql.hive.HiveACLExternalCatalog	Hive External catalog to be used. This parameter is mandatory if Spark ACL is enabled.
spark.sql.hive.implementation	org.apache.spark.sql.hive.HiveACLClientImpl	How to call the Hive client. This parameter is mandatory if Spark ACL is enabled.
spark.sql.hiveClient.isolation.enabled	false	This parameter is mandatory if Spark ACL is enabled.

1.3 CarbonData Operation Guide

1.3.1 CarbonData Quick Start

This section describes how to create CarbonData tables, load data, and query data. This quick start provides operations based on the Spark Beeline client. If you want to use Spark shell, wrap the queries with **spark.sql()**.

The following describes how to load data from a CSV file to a CarbonData table.

Table 1-9 CarbonData Quick Start

Operation	Description
Preparing a CSV File	Prepare the CSV file to be loaded to the CarbonData Table.
Connecting to CarbonData	Connect to CarbonData before performing any operations on CarbonData.
Creating a CarbonData Table	Create a CarbonData table to load data and perform query operations.
Loading Data to a CarbonData Table	Load data from CSV to the created table.
Querying Data from a CarbonData Table	Perform query operations such as filters and groupby.

Preparing a CSV File

1. Prepare a CSV file named **test.csv** on the local PC. An example is as follows:

   ```
   13418592122,1001, MAC address, 2017-10-23 15:32:30,2017-10-24 15:32:30,62.50,74.56
   13418592123 1002, MAC address, 2017-10-23 16:32:30,2017-10-24 16:32:30,17.80,76.28
   13418592124,1003, MAC address, 2017-10-23 17:32:30,2017-10-24 17:32:30,20.40,92.94
   13418592125 1004, MAC address, 2017-10-23 18:32:30,2017-10-24 18:32:30,73.84,8.58
   13418592126,1005, MAC address, 2017-10-23 19:32:30,2017-10-24 19:32:30,80.50,88.02
   13418592127 1006, MAC address, 2017-10-23 20:32:30,2017-10-24 20:32:30,65.77,71.24
   13418592128,1007, MAC address, 2017-10-23 21:32:30,2017-10-24 21:32:30,75.21,76.04
   13418592129,1008, MAC address, 2017-10-23 22:32:30,2017-10-24 22:32:30,63.30,94.40
   13418592130, 1009, MAC address, 2017-10-23 23:32:30,2017-10-24 23:32:30,95.51,50.17
   13418592131,1010, MAC address, 2017-10-24 00:32:30,2017-10-25 00:32:30,39.62,99.13
   ```

2. Use WinSCP to import the CSV file to the directory of the node where the client is installed, for example, **/opt**.
3. If Kerberos authentication is enabled for the cluster, log in to FusionInsight Manager, choose **System** > **Permission** > **User**, and add the human-machine user **sparkuser**, and user groups **hadoop** (primary) and **hive**.
4. Run the following commands to go to the client installation directory, load environment variables, and authenticate the user.

   cd *Client installation directory*

   source ./bigdata_env

   source ./Spark/component_env

   kinit sparkuser
5. Run the following command to upload the CSV file to the **/data** directory of the HDFS.

   hdfs dfs -put /opt/test.csv /data/

Connecting to CarbonData

- Use Spark SQL or Spark shell to connect to Spark and run Spark SQL commands.
- Start JDBCServer and use a JDBC client (for example, Spark Beeline) to connect to JDBCServer.

Run the following commands:

cd ./Spark/spark/bin

./spark-beeline

Creating a CarbonData Table

After connecting Spark Beeline with the JDBCServer, create a CarbonData table to load data and perform query operations. Run the following commands to create a simple table:

create table x1 (imei string, deviceInformationId int, mac string, productdate timestamp, updatetime timestamp, gamePointId double, contractNumber double) STORED AS carbondata TBLPROPERTIES ('SORT_COLUMNS'='imei,mac');

The command output is as follows:

```
+---------+
| Result  |
+---------+
+---------+
No rows selected (1.093 seconds)
```

Loading Data to a CarbonData Table

After you have created a CarbonData table, you can load the data from CSV to the created table.

Run the following command with required parameters to load data from CSV. The column names of the CarbonData table must match the column names of the CSV file.

LOAD DATA inpath 'hdfs://hacluster/data/*test.csv***' into table** ***x1*** **options('DELIMITER'=',', 'QUOTECHAR'='"','FILEHEADER'='imei, deviceinformationid,mac, productdate,updatetime, gamepointid,contractnumber');**

test.csv is the CSV file prepared in **Preparing a CSV File** and **x1** is the table name.

The CSV example file is as follows:

```
13418592122,1001, MAC address, 2017-10-23 15:32:30,2017-10-24 15:32:30,62.50,74.56
13418592123 1002,  MAC address, 2017-10-23 16:32:30,2017-10-24 16:32:30,17.80,76.28
13418592124,1003, MAC address, 2017-10-23 17:32:30,2017-10-24 17:32:30,20.40,92.94
13418592125 1004,  MAC address, 2017-10-23 18:32:30,2017-10-24 18:32:30,73.84,8.58
13418592126,1005, MAC address, 2017-10-23 19:32:30,2017-10-24 19:32:30,80.50,88.02
13418592127 1006,  MAC address, 2017-10-23 20:32:30,2017-10-24 20:32:30,65.77,71.24
13418592128,1007, MAC address, 2017-10-23 21:32:30,2017-10-24 21:32:30,75.21,76.04
13418592129,1008, MAC address, 2017-10-23 22:32:30,2017-10-24 22:32:30,63.30,94.40
13418592130, 1009, MAC address, 2017-10-23 23:32:30,2017-10-24 23:32:30,95.51,50.17
13418592131,1010, MAC address, 2017-10-24 00:32:30,2017-10-25 00:32:30,39.62,99.13
```

The command output is as follows:

```
+-------------+
|Segment ID  |
+-------------+
|0           |
+-------------+
No rows selected (3.039 seconds)
```

Querying Data from a CarbonData Table

After a CarbonData table is created and the data is loaded, you can perform query operations as required. Some query operations are provided as examples.

- **Obtaining the number of records**

  Run the following command to obtain the number of records in the CarbonData table:

  select count(*) from x1;

- **Querying with the groupby condition**

  Run the following command to obtain the **deviceinformationid** records without repetition in the CarbonData table:

  select deviceinformationid,count (distinct deviceinformationid) from x1 group by deviceinformationid;

- **Querying with Filter**

  Run the following command to obtain specific **deviceinformationid** records:

  select * from x1 where deviceinformationid='1010';

Using CarbonData on Spark-shell

If you need to use CarbonData on a Spark-shell, you need to create a CarbonData table, load data to the CarbonData table, and query data in CarbonData as follows:

```
spark.sql("CREATE TABLE x2(imei string, deviceInformationId int, mac string, productdate timestamp, updatetime timestamp, gamePointId double, contractNumber double) STORED AS carbondata")
spark.sql("LOAD DATA inpath 'hdfs://hacluster/data/x1_without_header.csv' into table x2 options('DELIMITER'=',', 'QUOTECHAR'='\"','FILEHEADER'='imei, deviceinformationid,mac, productdate,updatetime, gamepointid,contractnumber')")
spark.sql("SELECT * FROM x2").show()
```

1.3.2 CarbonData Table Management

1.3.2.1 About CarbonData Table

Overview

In CarbonData, data is stored in entities called tables. CarbonData tables are similar to RDBMS tables. RDBMS data is stored in a table consisting of rows and columns. CarbonData tables store structured data, and have fixed columns and data types.

Supported Data Types

CarbonData tables support the following data types:

- Int
- String
- BigInt
- Smallint

- Char
- Varchar
- Boolean
- Decimal
- Double
- TimeStamp
- Date
- Array
- Struct
- Map

The following table describes supported data types and their respective values range.

Table 1-10 CarbonData data types

Data Type	Value Range
Int	4-byte signed integer ranging from -2,147,483,648 to 2,147,483,647. **NOTE** If a non-dictionary column is of the **int** data type, it is internally stored as the **BigInt** type.
String	100,000 characters **NOTE** If the **CHAR** or **VARCHAR** data type is used in **CREATE TABLE**, the two data types are automatically converted to the String data type. If a column contains more than 32,000 characters, add the column to the **LONG_STRING_COLUMNS** attribute of the **tblproperties** table during table creation.
BigInt	64-bit value ranging from -9,223,372,036,854,775,808 to 9,223,372,036,854,775,807
SmallInt	–32,768 to 32,767
Char	A to Z and a to z
Varchar	A to Z, a to z, and 0 to 9
Boolean	**true** or **false**
Decimal	The default value is (10,0) and maximum value is (38,38). **NOTE** When query with filters, append **BD** to the number to achieve accurate results. For example, **select * from carbon_table where num = 1234567890123456.22BD**.
Double	64-bit value ranging from 4.9E-324 to 1.7976931348623157E308

Data Type	Value Range
TimeStamp	The default format is **yyyy-MM-dd HH:mm:ss**.
Date	The **DATE** data type is used to store calendar dates. The default format is **yyyy-MM-DD**.
Array<data_type>	N/A **NOTE** Currently, only two layers of complex types can be nested.
Struct<col_name: data_type COMMENT col_comment, ...>	
Map<primitive_type, data_type>	

1.3.2.2 Creating a CarbonData Table

Scenario

A CarbonData table must be created to load and query data. You can run the **Create Table** command to create a table. This command is used to create a table using custom columns.

Creating a Table with Self-Defined Columns

Users can create a table by specifying its columns and data types.

Sample command:

CREATE TABLE *IF NOT EXISTS productdb.productSalesTable (*

productNumber Int,

productName String,

storeCity String,

storeProvince String,

productCategory String,

productBatch String,

saleQuantity Int,

revenue Int)

STORED AS *carbondata*

TBLPROPERTIES (

'table_blocksize'='128');

The following table describes parameters of preceding commands.

Table 1-11 Parameter description

Parameter	Description
productSalesTable	Table name. The table is used to load data for analysis. The table name consists of letters, digits, and underscores (_).
productdb	Database name. The database maintains logical connections with tables stored in it to identify and manage the tables. The database name consists of letters, digits, and underscores (_).
productName storeCity storeProvince procuctCategory productBatch saleQuantity revenue	Columns in the table. The columns are service entities for data analysis. The column name (field name) consists of letters, digits, and underscores (_).
table_blocksize	Indicates the block size of data files used by the CarbonData table, in MB. The value ranges from **1** to **2048**. The default value is **1024**. If **table_blocksize** is too small, a large number of small files will be generated when data is loaded. This may affect the performance of HDFS. If **table_blocksize** is too large, during data query, the amount of block data that matches the index is large, and some blocks contain a large number of blocklets, affecting read concurrency and lowering query performance. You are advised to set the block size based on the data volume. For example, set the block size to 256 MB for GB-level data, 512 MB for TB-level data, and 1024 MB for PB-level data.

NOTE

- Measurement of all Integer data is processed and displayed using the **BigInt** data type.
- CarbonData parses data strictly. Any data that cannot be parsed is saved as **null** in the table. For example, if the user loads the **double** value (3.14) to the BigInt column, the data is saved as **null**.
- The Short and Long data types used in the **Create Table** command are shown as Smallint and BigInt in the **DESCRIBE** command, respectively.
- You can run the **DESCRIBE** command to view the table data size and table index size.

Operation Result

Run the command to create a table.

1.3.2.3 Deleting a CarbonData Table

Scenario

You can run the **DROP TABLE** command to delete a table. After a CarbonData table is deleted, its metadata and loaded data are deleted together.

Procedure

Run the following command to delete a CarbonData table:

Run the following command:

DROP TABLE *[IF EXISTS] [db_name.]table_name;*

Once this command is executed, the table is deleted from the system. In the command, **db_name** is an optional parameter. If **db_name** is not specified, the table named **table_name** in the current database is deleted.

Example:

DROP TABLE *productdb.productSalesTable;*

Run the preceding command to delete the **productSalesTable** table from the **productdb** database.

Operation Result

Deletes the table specified in the command from the system. After the table is deleted, you can run the **SHOW TABLES** command to check whether the table is successfully deleted. For details, see **SHOW TABLES**.

1.3.2.4 Modify the CarbonData Table

SET and UNSET

When the **SET** command is executed, the new properties overwrite the existing ones.

- SORT SCOPE

  The following is an example of the **SET SORT SCOPE** command:

  ALTER TABLE *tablename* **SET TBLPROPERTIES('SORT_SCOPE'**=*'no_sort'*)

  After running the **UNSET SORT SCOPE** command, the default value **NO_SORT** is adopted.

  The following is an example of the **UNSET SORT SCOPE** command:

  ALTER TABLE *tablename* **UNSET TBLPROPERTIES('SORT_SCOPE'**)
- SORT COLUMNS

  The following is an example of the **SET SORT COLUMNS** command:

  ALTER TABLE *tablename* **SET TBLPROPERTIES('SORT_COLUMNS'**=*'column1'*)

After this command is executed, the new value of **SORT_COLUMNS** is used. Users can adjust the **SORT_COLUMNS** based on the query results, but the original data is not affected. The operation does not affect the query performance of the original data segments which are not sorted by new **SORT_COLUMNS**.

The **UNSET** command is not supported, but the **SORT_COLUMNS** can be set to empty string instead of using the **UNSET** command.

ALTER TABLE *tablename* **SET TBLPROPERTIES('SORT_COLUMNS'**= '')

NOTE

- The later version will enhance custom compaction to resort the old segments.
- The value of **SORT_COLUMNS** cannot be modified in the streaming table.
- If the **inverted index** column is removed from **SORT_COLUMNS**, **inverted index** will not be created in this column. However, the old configuration of **INVERTED_INDEX** will be kept.

1.3.3 CarbonData Table Data Management

1.3.3.1 Loading Data

Scenario

After a CarbonData table is created, you can run the **LOAD DATA** command to load data to the table for query. Once data loading is triggered, data is encoded in CarbonData format and files in multi-dimensional and column-based format are compressed and copied to the HDFS path of CarbonData files for quick analysis and queries. The HDFS path can be configured in the **carbon.properties** file. For details, see **Common CarbonData Parameters**.

1.3.3.2 Deleting Segments

Scenario

If you want to modify and reload the data because you have loaded wrong data into a table, or there are too many bad records, you can delete specific segments by segment ID or data loading time.

NOTE

The segment deletion operation only deletes segments that are not compacted. You can run the **CLEAN FILES** command to clear compacted segments.

Deleting a Segment by Segment ID

Each segment has a unique ID. This segment ID can be used to delete the segment.

Step 1 Obtain the segment ID.

Command:

SHOW SEGMENTS FOR Table *dbname.tablename LIMIT number_of_loads;*

Example:

SHOW SEGMENTS FOR TABLE *carbonTable;*

Run the preceding command to show all the segments of the table named **carbonTable**.

SHOW SEGMENTS FOR TABLE *carbonTable LIMIT 2;*

Run the preceding command to show segments specified by *number_of_loads*.

The command output is as follows:

```
+-----+----------+--------------------------+------------------+------------+------------+-------------+--------------+--
+
| ID  | Status |     Load Start Time      | Load Time Taken  | Partition  | Data Size  | Index Size  | File Format  |
+-----+----------+--------------------------+------------------+------------+------------+-------------+--------------+--
+
| 3   | Success  | 2020-09-28 22:53:26.336  | 3.726S           | {}         | 6.47KB     | 3.30KB      | columnar_v3  |
| 2   | Success  | 2020-09-28 22:53:01.702  | 6.688S           | {}         | 6.47KB     | 3.30KB      | columnar_v3  |
+-----+----------+--------------------------+------------------+------------+------------+-------------+--------------+--
+
```

NOTE

The output of the **SHOW SEGMENTS** command includes ID, Status, Load Start Time, Load Time Taken, Partition, Data Size, Index Size, and File Format. The latest loading information is displayed in the first line of the command output.

Step 2 Run the following command to delete the segment after you have found the Segment ID:

Command:

DELETE FROM TABLE tableName WHERE SEGMENT.ID IN (load_sequence_id1, load_sequence_id2, ...);

Example:

DELETE FROM TABLE carbonTable WHERE SEGMENT.ID IN (1,2,3);

For details, see **DELETE SEGMENT by ID**.

----End

Deleting a Segment by Data Loading Time

You can delete a segment based on the loading time.

Command:

DELETE FROM TABLE db_name.table_name WHERE SEGMENT.STARTTIME BEFORE date_value;

Example:

DELETE FROM TABLE carbonTable WHERE SEGMENT.STARTTIME BEFORE '2017-07-01 12:07:20';

The preceding command can be used to delete all segments before 2017-07-01 12:07:20.

For details, see **DELETE SEGMENT by DATE**.

Result

Data of corresponding segments is deleted and is unavailable for query. You can run the **SHOW SEGMENTS** command to display the segment status and check whether the segment has been deleted.

NOTE

- Segments are not physically deleted after the execution of the **DELETE SEGMENT** command. Therefore, if you run the **SHOW SEGMENTS** command to check the status of a deleted segment, it will be marked as **Marked for Delete**. If you run the **SELECT * FROM tablename** command, the deleted segment will be excluded.
- The deleted segment will be deleted physically only when the next data loading reaches the maximum query execution duration, which is configured by the **max.query.execution.time** parameter. The default value of the parameter is 60 minutes.
- If you want to forcibly delete a physical segment file, run the **CLEAN FILES** command.

  Example:

  CLEAN FILES FOR TABLE table1;

  This command will physically delete the segment file in the **Marked for delete** state.

  If this command is executed before the time specified by **max.query.execution.time** arrives, the query may fail. **max.query.execution.time** indicates the maximum time allowed for a query, which is set in the **carbon.properties** file.

1.3.3.3 Combining Segments

Scenario

Frequent data access results in a large number of fragmented CarbonData files in the storage directory. In each data loading, data is sorted and indexing is performed. This means that an index is generated for each load. With the increase of data loading times, the number of indexes also increases. As each index works only on one loading, the performance of index is reduced. CarbonData provides loading and compression functions. In a compression process, data in each segment is combined and sorted, and multiple segments are combined into one large segment.

Prerequisites

Multiple data loadings have been performed.

Operation Description

There are three types of compaction: Minor, Major, and Custom.

- Minor compaction:

  In minor compaction, you can specify the number of loads to be merged. If **carbon.enable.auto.load.merge** is set, minor compaction is triggered for every data load. If any segments are available to be merged, then compaction will run parallel with data load.

  There are two levels in minor compaction:

  – Level 1: Merging of the segments which are not yet compacted

  - Level 2: Merging of the compacted segments again to form a larger segment

- Major compaction:

  Multiple segments can be merged into one large segment. You can specify the compaction size so that all segments below the size will be merged. Major compaction is usually done during the off-peak time.

- Custom compaction:

  In Custom compaction, you can specify the IDs of multiple segments to merge them into a large segment. The IDs of all the specified segments must exist and be valid. Otherwise, the compaction fails. Custom compaction is usually done during the off-peak time.

For details, see **ALTER TABLE COMPACTION**.

Table 1-12 Compaction parameters

Parameter	Default Value	Application Type	Description
carbon.enable.auto.load.merge	false	Minor	Whether to enable compaction along with data loading. **true**: Compaction is automatically triggered when data is loaded. **false**: Compaction is not triggered when data is loaded.
carbon.compaction.level.threshold	4,3	Minor	This configuration is for minor compaction which decides how many segments to be merged. For example, if this parameter is set to **2,3**, minor compaction is triggered every two segments and segments form a single level 1 compacted segment. When the number of compacted level 1 segments reach 3, compaction is triggered again to merge them to form a single level 2 segment. The compaction policy depends on the actual data size and available resources. The value ranges from 0 to 100.

Parameter	Default Value	Application Type	Description
carbon.major.compaction.size	1024 MB	Major	The major compaction size can be configured using this parameter. Sum of the segments which is below this threshold will be merged. For example, if this parameter is set to 1024 MB, and there are five segments whose sizes are 300 MB, 400 MB, 500 MB, 200 MB, and 100 MB used for major compaction, only segments whose total size is less than this threshold are compacted. In this example, only the segments whose sizes are 300 MB, 400 MB, 200 MB, and 100 MB are compacted.
carbon.numberof.preserve.segments	0	Minor/ Major	If you want to preserve some number of segments from being compacted, then you can set this configuration. For example, if **carbon.numberof.preserve.segments** is set to **2**, the latest two segments will always be excluded from the compaction. By default, no segments are reserved.
carbon.allowed.compaction.days	0	Minor/ Major	This configuration is used to control on the number of recent segments that needs to be compacted. For example, if this parameter is set to **2**, the segments which are loaded in the time frame of past 2 days only will get merged. Segments which are loaded earlier than 2 days will not be merged. This configuration is disabled by default.
carbon.number.of.cores.while.compacting	2	Minor/ Major	Number of cores to be used while compacting data. The greater the number of cores, the better the compaction performance. If the CPU resources are sufficient, you can increase the value of this parameter.

Parameter	Default Value	Application Type	Description
carbon.merge.index.in.segment	true	SEGMENT_INDEX	If this parameter is set to **true**, all the Carbon index (.carbonindex) files in a segment will be merged into a single Index (.carbonindexmerge) file. This enhances the first query performance.

Reference

You are advised not to perform minor compaction on historical data. For details, see **How to Avoid Minor Compaction for Historical Data?**.

1.3.4 CarbonData Data Migration

Scenario

If you want to rapidly migrate CarbonData data from a cluster to another one, you can use the CarbonData backup and restoration commands. This method does not require data import in the target cluster, reducing required migration time.

Prerequisites

The Spark client has been installed in a directory, for example, **/opt/client**, in two clusters. The source cluster is cluster A, and the target cluster is cluster B.

Procedure

Step 1 Log in to the node where the client is installed in cluster A as a client installation user.

Step 2 Run the following commands to configure environment variables:

source /opt/client/bigdata_env

source /opt/client/Spark/component_env

Step 3 If the cluster is in security mode, run the following command to authenticate the user. In normal mode, skip user authentication.

kinit *carbondatauser*

carbondatauser indicates the user of the original data. That is, the user has the read and write permissions for the tables.

NOTE

You must add the user to the **hadoop** (primary group) and **hive** groups, and associate it with the **System_administrator** role.

Step 4 Run the following command to connect to the database and check the location for storing table data on HDFS:

spark-beeline

desc formatted *Name of the table containing the original data*;

Location in the displayed information indicates the directory where the data file resides.

Step 5 Log in to the node where the client is installed in cluster B as a client installation user and configure the environment variables:

source /opt/client/bigdata_env

source /opt/client/Spark/component_env

Step 6 If the cluster is in security mode, run the following command to authenticate the user. In normal mode, skip user authentication.

kinit *carbondatauser2*

carbondatauser2 indicates the user that uploads data.

NOTE

You must add the user to the **hadoop** (primary group) and **hive** groups, and associate it with the **System_administrator** role.

Step 7 Run the **spark-beeline** command to connect to the database.

Step 8 Does the database that maps to the original data exist?

- If yes, go to **Step 9**.
- If no, run the **create database** *Database name* command to create a database with the same name as that maps to the original data and go to **Step 9**.

Step 9 Copy the original data from the HDFS directory in cluster A to that in cluster B.

When uploading data in cluster B, ensure that the upload directory has the directories with the same names as the database and table in the original directory and the upload user has the permission to write data to the upload directory. After the data is uploaded, the user has the permission to read and write the data.

For example, if the original data is stored in **/user/carboncadauser/warehouse/db1/tb1**, the data can be stored in **/user/carbondatauser2/warehouse/db1/tb1** in the new cluster.

1. Run the following command to download the original data to the **/opt/backup** directory of cluster A:

   hdfs dfs -get /user/carboncadauser/warehouse/db1/tb1 /opt/backup

2. Run the following command to copy the original data of cluster A to the **/opt/backup** directory on the client node of cluster B.

   scp /opt/backup root@*IP address of the client node of cluster B*:**/opt/backup**

3. Run the following command to upload the data copied to cluster B to HDFS:

   hdfs dfs -put /opt/backup /user/carbondatauser2/warehouse/db1/tb1

Step 10 In the client environment of cluster B, run the following command to generate the metadata associated with the table corresponding to the original data in Hive:

REFRESH TABLE *$dbName.$tbName;*

$dbName indicates the database name, and *$tbName* indicates the table name.

Step 11 If the original table contains an index table, perform **Step 9** and **Step 10** to migrate the index table directory from cluster A to cluster B.

Step 12 Run the following command to register an index table for the CarbonData table (skip this step if no index table is created for the original table):

REGISTER INDEX TABLE *$tableName* ON *$maintable*;

$tableName indicates the index table name, and *$maintable* indicates the table name.

----End

1.4 CarbonData Performance Tuning

1.4.1 Tuning Guide

Query Performance Tuning

There are various parameters that can be tuned to improve the query performance in CarbonData. Most of the parameters focus on increasing the parallelism in processing and optimizing system resource usage.

- Spark executor count: Executors are basic entities of parallelism in Spark. Raising the number of executors can increase the amount of parallelism in the cluster. For details about how to configure the number of executors, see the Spark documentation.
- Executor core: The number of concurrent tasks that an executor can run are controlled in each executor. Increasing the number of executor cores will add more concurrent processing tasks to improve performance.
- HDFS block size: CarbonData assigns query tasks by allocating different blocks to different executors for processing. HDFS block is the partition unit. CarbonData maintains a global block level index in Spark driver, which helps to reduce the quantity of blocks that need to be scanned for a query. Higher block size means higher I/O efficiency and lower global index efficiency. Reversely, lower block size means lower I/O efficiency, higher global index efficiency, and greater memory consumption.
- Number of scanner threads: Scanner threads control the number of parallel data blocks that are processed by each task. By increasing the number of scanner threads, you can increase the number of data blocks that are processed in parallel to improve performance. The **carbon.number.of.cores** parameter in the **carbon.properties** file is used to configure the number of scanner threads. For example, **carbon.number.of.cores = 4**.
- B-Tree caching: The cache memory can be optimized using the B-Tree least recently used (LRU) caching. In the driver, the B-Tree LRU caching configuration helps free up the cache by releasing table segments which are

not accessed or not used. Similarly, in the executor, the B-Tree LRU caching configuration will help release table blocks that are not accessed or used. For details, see the description of **carbon.max.driver.lru.cache.size** and **carbon.max.executor.lru.cache.size** in **Table 1-4**.

CarbonData Query Process

When CarbonData receives a table query task, for example query for table A, the index data of table A will be loaded to the memory for the query process. When CarbonData receives a query task for table A again, the system does not need to load the index data of table A.

When a query is performed in CarbonData, the query task is divided into several scan tasks, namely, task splitting based on HDFS blocks. Scan tasks are executed by executors on the cluster. Tasks can run in parallel, partially parallel, or in sequence, depending on the number of executors and configured number of executor cores.

Some parts of a query task can be processed at the individual task level, such as **select** and **filter.** Some parts of a query task can be processed at the individual task level, such as **group-by**, **count**, and **distinct count**.

Some operations cannot be performed at the task level, such as **Having Clause** (filter after grouping) and **sort**. Operations which cannot be performed at the task level or can be only performed partially at the task level require data (partial results) transmission across executors on the cluster. The transmission operation is called shuffle.

The more the tasks are, the more data needs to be shuffled. This affects query performance.

The number of tasks is depending on the number of HDFS blocks and the number of blocks is depending on the size of each block. You are advised to configure proper HDFS block size to achieve a balance among increased parallelism, the amount of data to be shuffled, and the size of aggregate tables.

Relationship Between Splits and Executors

If the number of splits is less than or equal to the executor count multiplied by the executor core count, the tasks are run in parallel. Otherwise, some tasks can start only after other tasks are complete. Therefore, ensure that the executor count multiplied by executor cores is greater than or equal to the number of splits. In addition, make sure that there are sufficient splits so that a query task can be divided into sufficient subtasks to ensure concurrency.

Configuring Scanner Threads

The scanner threads property decides the number of data blocks to be processed. If there are too many data blocks, a large number of small data blocks will be generated, affecting performance. If there are few data blocks, the parallelism is poor and the performance is affected. Therefore, when determining the number of scanner threads, you are advised to consider the average data size within a partition and select a value that makes the data block not small. Based on experience, you are advised to divide a single block size (unit: MB) by 250 and use the result as the number of scanner threads.

The number of actual available vCPUs is an important factor to consider when you want to increase the parallelism. The number of vCPUs that conduct parallel computation must not exceed 75% to 80% of actual vCPUs.

The number of vCPUs is approximately equal to:

Number of parallel tasks x Number of scanner threads. Number of parallel tasks is the smaller value of number of splits or executor count x executor cores.

Data Loading Performance Tuning

Tuning of data loading performance is different from that of query performance. Similar to query performance, data loading performance depends on the amount of parallelism that can be achieved. In case of data loading, the number of worker threads decides the unit of parallelism. Therefore, more executors mean more executor cores and better data loading performance.

To achieve better performance, you can configure the following parameters in HDFS.

Table 1-13 HDFS configuration

Parameter	Recommended Value
dfs.datanode.drop.cache.behind.reads	false
dfs.datanode.drop.cache.behind.writes	false
dfs.datanode.sync.behind.writes	true

Compression Tuning

CarbonData uses a few lightweight compression and heavyweight compression algorithms to compress data. Although these algorithms can process any type of data, the compression performance is better if the data is ordered with similar values being together.

During data loading, data is sorted based on the order of columns in the table to achieve good compression performance.

Since CarbonData sorts data in the order of columns defined in the table, the order of columns plays an important role in the effectiveness of compression. If the low cardinality dimension is on the left, the range of data partitions after sorting is small and the compression efficiency is high. If a high cardinality dimension is on the left, a range of data partitions obtained after sorting is relatively large, and compression efficiency is relatively low.

Memory Tuning

CarbonData provides a mechanism for memory tuning where data loading depends on the columns needed in the query. Whenever a query command is received, columns required by the query are fetched and data is loaded for those columns in memory. During this operation, if the memory threshold is reached, the

least used loaded files are deleted to release memory space for columns required by the query.

1.4.2 Suggestions for Creating CarbonData Tables

Scenario

This section provides suggestions based on more than 50 test cases to help you create CarbonData tables with higher query performance.

Table 1-14 Columns in the CarbonData table

Column name	Data type	Cardinality	Attribution
msname	String	30 million	dimension
BEGIN_TIME	bigint	10,000	dimension
host	String	1 million	dimension
dime_1	String	1,000	dimension
dime_2	String	500	dimension
dime_3	String	800	dimension
counter_1	numeric(20,0)	NA	measure
...	...	NA	measure
counter_100	numeric(20,0)	NA	measure

Procedure

- If the to-be-created table contains a column that is frequently used for filtering, for example, this column is used in more than 80% of filtering scenarios,

  implement optimization as follows:

  Place this column in the first column of **sort_columns**.

  For example, if **msname** is used most frequently as a filter criterion in a query, it is placed in the first column. Run the following command to create a table. The query performance is good if **msname** is used as the filter criterion.

  ```
  create table carbondata_table(
     msname String,
     ...
     )STORED AS carbondata TBLPROPERTIES ('SORT_COLUMS'='msname');
  ```

- If the to-be-created table has multiple columns which are frequently used to filter the results,

  implement optimization as follows:

  Create an index for the columns.

  For example, if **msname**, **host**, and **dime_1** are frequently used columns, the **sort_columns** column sequence is "dime_1-> host-> msname..." based on cardinality. Run the following command to create a table. The following

command can improve the filtering performance of **dime_1**, **host**, and **msname**.

```
create table carbondata_table(
    dime_1 String,
    host String,
    msname String,
    dime_2 String,
    dime_3 String,
    ...
    )STORED AS carbondata
TBLPROPERTIES ('SORT_COLUMS'='dime_1,host,msname');
```

- If the frequency of each column used for filtering is similar,

  implement optimization as follows:

  sort_columns is sorted in ascending order of cardinality.

  Run the following command to create a table:

  ```
  create table carbondata_table(
      Dime_1 String,
      BEGIN_TIME bigint,
      HOST String,
      msname String,
      ...
      )STORED AS carbondata
  TBLPROPERTIES ('SORT_COLUMS'='dime_2,dime_3,dime_1, BEGIN_TIME,host,msname');
  ```

- Create tables in ascending order of cardinalities. Then create secondary indexes for columns with more cardinalities. The statement for creating an index is as follows:

  ```
  create index carbondata_table_index_msidn on tablecarbondata_table (
  msname String) as 'carbondata' PROPERTIES ('table_blocksize'='128');
  create index carbondata_table_index_host on tablecarbondata_table (
  host String) as 'carbondata' PROPERTIES ('table_blocksize'='128');
  ```

- For columns of measure type, not requiring high accuracy, the numeric (20,0) data type is not required. You are advised to use the double data type to replace the numeric (20,0) data type to enhance query performance.

  The result of performance analysis of test-case shows reduction in query execution time from 15 to 3 seconds, thereby improving performance by nearly 5 times. The command for creating a table is as follows:

  ```
  create table carbondata_table(
      Dime_1 String,
      BEGIN_TIME bigint,
      HOST String,
      msname String,
      counter_1 double,
      counter_2 double,
      ...
      counter_100 double,
      )STORED AS carbondata
  ;
  ```

- If values (**start_time** for example) of a column are incremental:

  For example, if data is loaded to CarbonData every day, **start_time** is incremental for each load. In this case, it is recommended that the **start_time** column be put at the end of **sort_columns**, because incremental values are efficient in using min/max index. The command for creating a table is as follows:

  ```
  create table carbondata_table(
      Dime_1 String,
      HOST String,
      msname String,
      counter_1 double,
  ```

```
counter_2 double,
BEGIN_TIME bigint,
...
counter_100 double,
)STORED AS carbondata
TBLPROPERTIES ( 'SORT_COLUMS'='dime_2,dime_3,dime_1..BEGIN_TIME');
```

1.4.3 Configurations for Performance Tuning

Scenario

This section describes the configurations that can improve CarbonData performance.

Procedure

Table 1-15 and **Table 1-16** describe the configurations about query of CarbonData.

Table 1-15 Number of tasks started for the shuffle process

Parameter	spark.sql.shuffle.partitions
Configuration File	spark-defaults.conf
Function	Data query
Scenario Description	Number of tasks started for the shuffle process in Spark
Tuning	You are advised to set this parameter to one to two times as much as the executor cores. In an aggregation scenario, reducing the number from 200 to 32 can reduce the query time by two folds.

Table 1-16 Number of executors and vCPUs, and memory size used for CarbonData data query

Parameter	spark.executor.cores spark.executor.instances spark.executor.memory
Configuration File	spark-defaults.conf
Function	Data query
Scenario Description	Number of executors and vCPUs, and memory size used for CarbonData data query

Tuning	In the bank scenario, configuring 4 vCPUs and 15 GB memory for each executor will achieve good performance. The two values do not mean the more the better. Configure the two values properly in case of limited resources. If each node has 32 vCPUs and 64 GB memory in the bank scenario, the memory is not sufficient. If each executor has 4 vCPUs and 12 GB memory, Garbage Collection may occur during query, time spent on query from increases from 3s to more than 15s. In this case, you need to increase the memory or reduce the number of vCPUs.

Table 1-17, **Table 1-18**, and **Table 1-19** describe the configurations for CarbonData data loading.

Table 1-17 Number of vCPUs used for data loading

Parameter	carbon.number.of.cores.while.loading
Configuration File	carbon.properties
Function	Data loading
Scenario Description	Number of vCPUs used for data processing during data loading in CarbonData
Tuning	If there are sufficient CPUs, you can increase the number of vCPUs to improve performance. For example, if the value of this parameter is changed from 2 to 4, the CSV reading performance can be doubled.

Table 1-18 Whether to use Yarn local directories for multi-disk data loading

Parameter	carbon.use.local.dir
Configuration File	carbon.properties
Function	Data loading
Scenario Description	Whether to use Yarn local directories for multi-disk data loading
Tuning	If this parameter is set to **true**, CarbonData uses local Yarn directories for multi-table load disk load balance, improving data loading performance.

Table 1-19 Whether to use multiple directories during loading

Parameter	carbon.use.multiple.temp.dir
Configuration File	carbon.properties
Function	Data loading
Scenario Description	Whether to use multiple temporary directories to store temporary sort files
Tuning	If this parameter is set to **true**, multiple temporary directories are used to store temporary sort files during data loading. This configuration improves data loading performance and prevents single points of failure (SPOFs) on disks.

Table 1-20 describes the configurations for CarbonData data loading and query.

Table 1-20 Number of vCPUs used for data loading and query

Parameter	carbon.compaction.level.threshold
Configuration File	carbon.properties
Function	Data loading and query
Scenario Description	For minor compaction, specifies the number of segments to be merged in stage 1 and number of compacted segments to be merged in stage 2.
Tuning	Each CarbonData load will create one segment, if every load is small in size, it will generate many small files over a period of time impacting the query performance. Configuring this parameter will merge the small segments to one big segment which will sort the data and improve the performance. The compaction policy depends on the actual data size and available resources. For example, a bank loads data once a day and at night when no query is performed. If resources are sufficient, the compaction policy can be 6 or 5.

Table 1-21 Whether to enable data pre-loading when the index cache server is used

Parameter	carbon.indexserver.enable.prepriming
Configuration File	carbon.properties
Function	Data loading

Scenario Description	Enabling data pre-loading during the use of the index cache server can improve the performance of the first query.
Tuning	You can set this parameter to **true** to enable the pre-loading function. The default value is **false**.

1.5 CarbonData Access Control

The following table provides details about Hive ACL permissions required for performing operations on CarbonData tables.

Prerequisites

Carbon-related parameters listed in **Table 1-7** or **Table 1-8** have been configured.

Hive ACL permissions

Table 1-22 Hive ACL permissions required for CarbonData table-level operations

Scenario	Required Permission
DESCRIBE TABLE	SELECT (of table)
SELECT	SELECT (of table)
EXPLAIN	SELECT (of table)
CREATE TABLE	CREATE (of database)
CREATE TABLE As SELECT	CREATE (on database), INSERT (on table), RW on data file, and SELECT (on table)
LOAD	INSERT (of table) RW on data file
DROP TABLE	OWNER (of table)
DELETE SEGMENTS	DELETE (of table)
SHOW SEGMENTS	SELECT (of table)
CLEAN FILES	DELETE (of table)
INSERT OVERWRITE / INSERT INTO	INSERT (of table) RW on data file and SELECT (of table)
CREATE INDEX	OWNER (of table)
DROP INDEX	OWNER (of table)
SHOW INDEXES	SELECT (of table)
ALTER TABLE ADD COLUMN	OWNER (of table)
ALTER TABLE DROP COLUMN	OWNER (of table)

Scenario	Required Permission
ALTER TABLE CHANGE DATATYPE	OWNER (of table)
ALTER TABLE RENAME	OWNER (of table)
ALTER TABLE COMPACTION	INSERT (on table)
FINISH STREAMING	OWNER (of table)
ALTER TABLE SET STREAMING PROPERTIES	OWNER (of table)
ALTER TABLE SET TABLE PROPERTIES	OWNER (of table)
UPDATE CARBON TABLE	UPDATE (of table)
DELETE RECORDS	DELETE (of table)
REFRESH TABLE	OWNER (of main table)
REGISTER INDEX TABLE	OWNER (of table)
SHOW PARTITIONS	SELECT (on table)
ALTER TABLE ADD PARTITION	OWNER (of table)
ALTER TABLE DROP PARTITION	OWNER (of table)

NOTE

- If tables in the database are created by multiple users, the **Drop database** command fails to be executed even if the user who runs the command is the owner of the database.
- In a secondary index, when the parent table is triggered, **insert** and **compaction** are triggered on the index table. If you select a query that has a filter condition that matches index table columns, you should provide selection permissions for the parent table and index table.
- The LockFiles folder and lock files created in the LockFiles folder will have full permissions, as the LockFiles folder does not contain any sensitive data.
- If you are using ACL, ensure you do not configure any path for DDL or DML which is being used by other process. You are advised to create new paths.

  Configure the path for the following configuration items:

  1) carbon.badRecords.location

  2) Db_Path and other items during database creation
- For Carbon ACL in a non-security cluster, **hive.server2.enable.doAs** in the **hive-site.xml** file must be set to **false**. Then the query will run as the user who runs the hiveserver2 process.

1.6 CarbonData Syntax Reference

1.6.1 DDL

1.6.1.1 CREATE TABLE

Function

This command is used to create a CarbonData table by specifying the list of fields along with the table properties.

Syntax

CREATE TABLE *[IF NOT EXISTS] [db_name.]table_name*

[(col_name data_type, ...)]

STORED AS *carbondata*

[TBLPROPERTIES (property_name=property_value, ...)];

Additional attributes of all tables are defined in **TBLPROPERTIES**.

Parameter Description

Table 1-23 CREATE TABLE parameters

Parameter	Description
db_name	Database name that contains letters, digits, and underscores (_).
col_name data_type	List with data types separated by commas (,). The column name contains letters, digits, and underscores (_). **NOTE** When creating a CarbonData table, do not use tupleId, PositionId, and PositionReference as column names because columns with these names are internally used by secondary index commands.
table_name	Table name of a database that contains letters, digits, and underscores (_).
STORED AS	The **carbondata** parameter defines and creates a CarbonData table.
TBLPROPERTIES	List of CarbonData table properties.

Precautions

Table attributes are used as follows:

- Block size

  The block size of a data file can be defined for a single table using **TBLPROPERTIES**. The larger one between the actual size of the data file and the defined block size is selected as the actual block size of the data file in

HDFS. The unit is MB. The default value is 1024 MB. The value ranges from 1 MB to 2048 MB. If the value is beyond the range, the system reports an error.

Once the block size reaches the configured value, the write program starts a new block of CarbonData data. Data is written in multiples of the page size (32,000 records). Therefore, the boundary is not strict at the byte level. If the new page crosses the boundary of the configured block, the page is written to the new block instead of the current block.

TBLPROPERTIES('table_blocksize'='128')

NOTE

- If a small block size is configured in the CarbonData table while the size of the data file generated by the loaded data is large, the block size displayed in HDFS is different from the configured value. This is because when data is written to a local block file for the first time, even though the size of the to-be-written data is larger than the configured value of the block size, data will still be written into the block. Therefore, the actual value of block size in HDFS is the larger value between the size of the data to be written and the configured block size.
- If **block.num** is less than the parallelism, the blocks are split into new blocks so that new blocks.num is greater than parallelism and all cores can be used. This optimization is called block distribution.

- **SORT_SCOPE** specifies the sort scope during table creation. There are four types of sort scopes:
  - **GLOBAL_SORT**: It improves query performance, especially for point queries. *TBLPROPERTIES('SORT_SCOPE'='GLOBAL_SORT')*
  - **LOCAL_SORT**: Data is sorted locally (task-level sorting).

    NOTE

    LOCAL_SORT conflicts with DDL operations on partitioned tables and they cannot be used at the same time. In addition, LOCAL_SORT does not significantly improve the performance of partitioned tables. You are advised not to enable this feature on partitioned tables.
  - **NO_SORT**: The default sorting mode is used. Data is loaded in unsorted manner, which greatly improves loading performance.
- SORT_COLUMNS

  This table property specifies the order of sort columns.

  TBLPROPERTIES('SORT_COLUMNS'='column1, column3')

  NOTE

  - If this attribute is not specified, no columns are sorted by default.
  - If this property is specified but with empty argument, then the table will be loaded without sort. For example, *('SORT_COLUMNS'='')*.
  - **SORT_COLUMNS** supports the string, date, timestamp, short, int, long, byte, and boolean data types.
- RANGE_COLUMN

  This property is used to specify a column to partition the input data by range. Only one column can be configured. During data import, you can use **global_sort_partitions** or **scale_factor** to avoid generating small files.

  TBLPROPERTIES('RANGE_COLUMN'='column1')
- LONG_STRING_COLUMNS

The length of a common string cannot exceed 32,000 characters. To store a string of more than 32,000 characters, set **LONG_STRING_COLUMNS** to the target column.

TBLPROPERTIES('LONG_STRING_COLUMNS'='column1, column3')

NOTE

LONG_STRING_COLUMNS can be set only for columns of the STRING, CHAR, or VARCHAR type.

Scenarios

Creating a Table by Specifying Columns

The **CREATE TABLE** command is the same as that of Hive DDL. The additional configurations of CarbonData are provided as table properties.

CREATE TABLE *[IF NOT EXISTS] [db_name.]table_name*

[(col_name data_type , ...)]

STORED AS *carbondata*

[TBLPROPERTIES (property_name=property_value, ...)];

Examples

CREATE TABLE *IF NOT EXISTS productdb.productSalesTable (*

productNumber Int,

productName String,

storeCity String,

storeProvince String,

productCategory String,

productBatch String,

saleQuantity Int,

revenue Int)

STORED AS carbondata

TBLPROPERTIES (

'table_blocksize'='128',

'SORT_COLUMNS'='productBatch, productName')

System Response

A table will be created and the success message will be logged in system logs.

1.6.1.2 CREATE TABLE As SELECT

Function

This command is used to create a CarbonData table by specifying the list of fields along with the table properties.

Syntax

CREATE TABLE *[IF NOT EXISTS] [db_name.]table_name* ***STORED AS carbondata*** *[TBLPROPERTIES (key1=val1, key2=val2, ...)] AS select_statement;*

Parameter Description

Table 1-24 CREATE TABLE parameters

Parameter	Description
db_name	Database name that contains letters, digits, and underscores (_).
table_name	Table name of a database that contains letters, digits, and underscores (_).
STORED AS	Used to store data in CarbonData format.
TBLPROPERTIES	List of CarbonData table properties. For details, see **Precautions**.

Precautions

N/A

Examples

CREATE TABLE ctas_select_parquet ***STORED AS*** carbondata as select * from parquet_ctas_test;

System Response

This example will create a Carbon table from any Parquet table and load all the records from the Parquet table.

1.6.1.3 DROP TABLE

Function

This command is used to delete an existing table.

Syntax

DROP TABLE *[IF EXISTS] [db_name.]table_name;*

Parameter Description

Table 1-25 DROP TABLE parameters

Parameter	Description
db_name	Database name. If this parameter is not specified, the current database is selected.
table_name	Name of the table to be deleted

Precautions

In this command, **IF EXISTS** and **db_name** are optional.

Example

DROP TABLE IF EXISTS productDatabase.productSalesTable;

System Response

The table will be deleted.

1.6.1.4 SHOW TABLES

Function

SHOW TABLES command is used to list all tables in the current or a specific database.

Syntax

SHOW TABLES *[IN db_name];*

Parameter Description

Table 1-26 SHOW TABLE parameters

Parameter	Description
IN db_name	Name of the database. This parameter is required only when tables of this specific database are to be listed.

Usage Guidelines

IN db_Name is optional.

Examples

SHOW TABLES IN ProductDatabase;

System Response

All tables are listed.

1.6.1.5 ALTER TABLE COMPACTION

Function

The **ALTER TABLE COMPACTION** command is used to merge a specified number of segments into a single segment. This improves the query performance of a table.

Syntax

ALTER TABLE*[db_name.]table_name COMPACT 'MINOR/MAJOR/SEGMENT_INDEX';*

ALTER TABLE*[db_name.]table_name COMPACT 'CUSTOM' WHERE SEGMENT.ID IN (id1, id2, ...);*

Parameter Description

Table 1-27 ALTER TABLE COMPACTION parameters

Parameter	Description
db_name	Database name. If this parameter is not specified, the current database is selected.
table_name	Table name.
MINOR	Minor compaction. For details, see **Combining Segments**.
MAJOR	Major compaction. For details, see **Combining Segments**.
SEGMENT_INDEX	This configuration enables you to merge all the CarbonData index files (**.carbonindex**) inside a segment to a single CarbonData index merge file (**.carbonindexmerge**). This enhances the first query performance. For more information, see **Table 1-12**.
CUSTOM	Custom compaction. For details, see **Combining Segments**.

Precautions

N/A

Examples

ALTER TABLE ProductDatabase COMPACT 'MINOR';

ALTER TABLE ProductDatabase COMPACT 'MAJOR';

ALTER TABLE ProductDatabase COMPACT 'SEGMENT_INDEX';

ALTER TABLE ProductDatabase COMPACT 'CUSTOM' WHERE SEGMENT.ID IN (0, 1);

System Response

ALTER TABLE COMPACTION does not show the response of the compaction because it is run in the background.

If you want to view the response of minor and major compactions, you can check the logs or run the ***SHOW SEGMENTS*** command.

Example:

```
+------+------------+--------------------------+------------------+------------+------------+-------------+--------------
+--+
|  ID  |   Status   |     Load Start Time      | Load Time Taken  | Partition  | Data Size  | Index Size  | File
Format  |
+------+------------+--------------------------+------------------+------------+------------+-------------+--------------
+--+
| 3    | Success    | 2020-09-28 22:53:26.336  | 3.726S           | {}         | 6.47KB     | 3.30KB      | columnar_v3  |
| 2    | Success    | 2020-09-28 22:53:01.702  | 6.688S           | {}         | 6.47KB     | 3.30KB      | columnar_v3  |
| 1    | Compacted  | 2020-09-28 22:51:15.242  | 5.82S            | {}         | 6.50KB     | 3.43KB      |
columnar_v3  |
| 0.1  | Success    | 2020-10-30 20:49:24.561  | 16.66S           | {}         | 12.87KB    | 6.91KB      | columnar_v3
|
| 0    | Compacted  | 2020-09-28 22:51:02.6    | 6.819S           | {}         | 6.50KB     | 3.43KB      | columnar_v3
|
+------+------------+--------------------------+------------------+------------+------------+-------------+--------------
+--+
```

In the preceding information:

- **Compacted** indicates that data has been compacted.
- **0.1** indicates the compacting result of segment 0 and segment 1.

The compact operation does not incur any change to other operations.

Compacted segments, such as segment 0 and segment 1, become useless. To save space, before you perform other operations, run the ***CLEAN FILES*** command to delete compacted segments. For more information about the **CLEAN FILES** command, see **CLEAN FILES**.

1.6.1.6 TABLE RENAME

Function

This command is used to rename an existing table.

Syntax

ALTER TABLE *[db_name.]table_name* **RENAME TO** *new_table_name*;

Parameter Description

Table 1-28 RENAME parameters

Parameter	Description
db_name	Database name. If this parameter is not specified, the current database is selected.
table_name	Current name of the existing table
new_table_name	New name of the existing table

Precautions

- Parallel queries (using table names to obtain paths for reading CarbonData storage files) may fail during this operation.
- The secondary index table cannot be renamed.

Example

ALTER TABLE *carbon* **RENAME TO** *carbondata*;

ALTER TABLE *test_db.carbon* **RENAME TO** *test_db.carbondata*;

System Response

The new table name will be displayed in the CarbonData folder. You can run **SHOW TABLES** to view the new table name.

1.6.1.7 ADD COLUMNS

Function

This command is used to add a column to an existing table.

Syntax

ALTER TABLE *[db_name.]table_name* **ADD COLUMNS** *(col_name data_type,...)* **TBLPROPERTIES***(''COLUMNPROPERTIES.columnName.shared_column'='sharedFolder.sharedColumnName,...', 'DEFAULT.VALUE.COLUMN_NAME'='default_value')*;

Parameter Description

Table 1-29 ADD COLUMNS parameters

Parameter	Description
db_name	Database name. If this parameter is not specified, the current database is selected.

Parameter	Description
table_name	Table name.
col_name data_type	Name of a comma-separated column with a data type. It consists of letters, digits, and underscores (_). **NOTE** When creating a CarbonData table, do not name columns as tupleId, PositionId, and PositionReference because they will be used in UPDATE, DELETE, and secondary index commands.

Precautions

- Only **shared_column** and **default_value** are read. If any other property name is specified, no error will be thrown and the property will be ignored.
- If no default value is specified, the default value of the new column is considered null.
- If filter is applied to the column, new columns will not be added during sort. New columns may affect query performance.

Examples

- **ALTER TABLE** *carbon* **ADD COLUMNS** *(a1 INT, b1 STRING)*;
- **ALTER TABLE** *carbon* **ADD COLUMNS** *(a1 INT, b1 STRING)* **TBLPROPERTIES***('COLUMNPROPERTIES.b1.shared_column'='sharedFolder.b1')*;
- ALTER TABLE *carbon* **ADD COLUMNS** *(a1 INT, b1 STRING)* **TBLPROPERTIES***('DEFAULT.VALUE.a1'='10')*;

System Response

The newly added column can be displayed by running the **DESCRIBE** command.

1.6.1.8 DROP COLUMNS

Function

This command is used to delete one or more columns from a table.

Syntax

ALTER TABLE *[db_name.]table_name* **DROP COLUMNS** *(col_name, ...)*;

Parameter Description

Table 1-30 DROP COLUMNS parameters

Parameter	Description
db_name	Database name. If this parameter is not specified, the current database is selected.
table_name	Table name.
col_name	Name of a column in a table. Multiple columns are supported. It consists of letters, digits, and underscores (_).

Precautions

After a column is deleted, at least one key column must exist in the schema. Otherwise, an error message is displayed, and the column fails to be deleted.

Examples

Assume that the table contains four columns named a1, b1, c1, and d1.

- Delete a column:
  ALTER TABLE *carbon* **DROP COLUMNS** *(b1)*;
  ALTER TABLE *test_db.carbon* **DROP COLUMNS** *(b1)*;
- Delete multiple columns:
  ALTER TABLE *carbon* **DROP COLUMNS** *(b1,c1)*;
  ALTER TABLE *test_db.carbon* **DROP COLUMNS** *(b1,c1)*;

System Response

If you run the **DESCRIBE** command, the deleted columns will not be displayed.

1.6.1.9 CHANGE DATA TYPE

Function

This command is used to change the data type from INT to BIGINT or decimal precision from lower to higher.

Syntax

ALTER TABLE *[db_name.]table_name* **CHANGE** *col_name col_name changed_column_type*;

Parameter Description

Table 1-31 CHANGE DATA TYPE parameters

Parameter	Description
db_name	Name of the database. If this parameter is left unspecified, the current database is selected.
table_name	Name of the table.
col_name	Name of columns in a table. Column names contain letters, digits, and underscores (_).
changed_column_type	The change in the data type.

Usage Guidelines

- Change of decimal data type from lower precision to higher precision will only be supported for cases where there is no data loss.

  Example:

  - **Invalid scenario** - Change of decimal precision from (10,2) to (10,5) is not valid as in this case only scale is increased but total number of digits remain the same.
  - **Valid scenario** - Change of decimal precision from (10,2) to (12,3) is valid as the total number of digits are increased by 2 but scale is increased only by 1 which will not lead to any data loss.
- The allowed range is 38,38 (precision, scale) and is a valid upper case scenario which is not resulting in data loss.

Examples

- Changing data type of column a1 from INT to BIGINT.

  ALTER TABLE *test_db.carbon* **CHANGE** *a1 a1 BIGINT*;
- Changing decimal precision of column a1 from 10 to 18.

  ALTER TABLE *test_db.carbon* **CHANGE** *a1 a1 DECIMAL(18,2)*;

System Response

By running DESCRIBE command, the changed data type for the modified column is displayed.

1.6.1.10 REFRESH TABLE

Function

This command is used to register Carbon table to Hive meta store catalogue from exisiting Carbon table data.

Syntax

REFRESH TABLE *db_name.table_name*;

Parameter Description

Table 1-32 REFRESH TABLE parameters

Parameter	Description
db_name	Name of the database. If this parameter is left unspecified, the current database is selected.
table_name	Name of the table.

Usage Guidelines

- The new database name and the old database name should be same.
- Before executing this command the old table schema and data should be copied into the new database location.
- If the table is aggregate table, then all the aggregate tables should be copied to the new database location.
- For old store, the time zone of the source and destination cluster should be same.
- If old cluster used HIVE meta store to store schema, refresh will not work as schema file does not exist in file system.

Examples

REFRESH TABLE *dbcarbon.productSalesTable*;

System Response

By running this command, the Carbon table will be registered to Hive meta store catalogue from exisiting Carbon table data.

1.6.1.11 REGISTER INDEX TABLE

Function

This command is used to register an index table with the primary table.

Syntax

REGISTER INDEX TABLE *indextable_name* ON *db_name.maintable_name*;

Parameter Description

Table 1-33 REFRESH INDEX TABLE parameters

Parameter	Description
db_name	Database name. If this parameter is not specified, the current database is selected.
indextable_name	Index table name.
maintable_name	Primary table name.

Precautions

Before running this command, run **REFRESH TABLE** to register the primary table and secondary index table with the Hive metastore.

Examples

create database productdb;

use productdb;

CREATE TABLE productSalesTable(a int,b string,c string) stored as carbondata;

create index productNameIndexTable on table productSalesTable(c) as 'carbondata';

insert into table productSalesTable select 1,'a','aaa';

create database productdb2;

Run the **hdfs** command to copy **productSalesTable** and **productNameIndexTable** in the **productdb** database to the **productdb2** database.

refresh table productdb2.productSalesTable ;

refresh table productdb2.productNameIndexTable ;

explain select * from productdb2.productSalesTable where c = 'aaa'; / The query command does not use an index table.

REGISTER INDEX TABLE productNameIndexTable ON productdb2.productSalesTable;

explain select * from productdb2.productSalesTable where c = 'aaa'; // The query command uses an index table.

System Response

By running this command, the index table will be registered to the primary table.

1.6.2 DML

1.6.2.1 LOAD DATA

Function

This command is used to load user data of a particular type, so that CarbonData can provide good query performance.

NOTE

Only the raw data on HDFS can be loaded.

Syntax

LOAD DATA *INPATH 'folder_path' INTO TABLE [db_name.]table_name OPTIONS(property_name=property_value, ...);*

Parameter Description

Table 1-34 LOAD DATA parameters

Parameter	Description
folder_path	Path of the file or folder used for storing the raw CSV data.
db_name	Database name. If this parameter is not specified, the current database is used.
table_name	Name of a table in a database.

Precautions

The following configuration items are involved during data loading:

- **DELIMITER**: Delimiters and quote characters provided in the load command. The default value is a comma (**,**).

  OPTIONS('DELIMITER'=',' , 'QUOTECHAR'='"')

  You can use **'DELIMITER'='\t'** to separate CSV data using tabs.

  OPTIONS('DELIMITER'='\t')

  CarbonData also supports **\001** and **\017** as delimiters.

  NOTE

  When the delimiter of CSV data is a single quotation mark ('), the single quotation mark must be enclosed in double quotation marks (" "). For example, 'DELIMITER'= "'".

- **QUOTECHAR**: Delimiters and quote characters provided in the load command. The default value is double quotation marks (**"**).

  OPTIONS('DELIMITER'=',' , 'QUOTECHAR'='"')

- **COMMENTCHAR**: Comment characters provided in the load command. During data loading, if there is a comment character at the beginning of a line, the line is regarded as a comment line and data in the line will not be loaded. The default value is a pound key (#).

OPTIONS('COMMENTCHAR'='#')

- **FILEHEADER**: If the source file does not contain any header, add a header to the **LOAD DATA** command.

  OPTIONS('FILEHEADER'='column1,column2')

- **ESCAPECHAR**: Is used to perform strict verification of the escape character on CSV files. The default value is backslash (\).

  OPTIONS('ESCAPECHAR'='\')

  NOTE

  Enter **ESCAPECHAR** in the CSV data. **ESCAPECHAR** must be enclosed in double quotation marks (" "). For example, "a\b".

- Bad records handling:

  In order for the data processing application to provide benefits, certain data integration is required. In most cases, data quality problems are caused by data sources.

  Methods of handling bad records are as follows:

  – Load all of the data before dealing with the errors.

  – Clean or delete bad records before loading data or stop the loading when bad records are found.

  There are many options for clearing source data during CarbonData data loading, as listed in **Table 1-35**.

Table 1-35 Bad Records Logger

Configuration Item	Default Value	Description
BAD_RECORDS_LOGGER_ENABLE	false	Whether to create logs with details about bad records

Configuration Item	Default Value	Description
BAD_RECORDS_ACTION	FAIL	The four types of actions for bad records are as follows: ● **FORCE**: Auto-corrects the data by storing the bad records as NULL. ● **REDIRECT**: Bad records cannot be loaded and written to the CSV file in **BAD_RECORD_PATH**. This mode is disabled by default. To enable it, set **carbon.enable.badrecord.action.redirect** to **true**. ● **IGNORE**: Bad records are neither loaded nor written to the CSV file. ● **FAIL**: Data loading fails if any bad records are found. **NOTE** In loaded data, if all records are bad records, **BAD_RECORDS_ACTION** is invalid and the load operation fails.
IS_EMPTY_DATA_BAD_RECORD	false	Whether empty data of a column to be considered as bad record or not. If this parameter is set to **false**, empty data ("",', or,) is not considered as bad records. If this parameter is set to **true**, empty data is considered as bad records.
BAD_RECORD_PATH	-	HDFS path where bad records are stored. The default value is **Null**. If bad records logging or bad records operation redirection is enabled, the path must be configured by the user.

Example:

LOAD DATA INPATH *'filepath.csv'* **INTO TABLE** *tablename*
OPTIONS('BAD_RECORDS_LOGGER_ENABLE'='true',
'BAD_RECORD_PATH'='hdfs://hacluster/tmp/carbon',
'BAD_RECORDS_ACTION'='REDIRECT',
'IS_EMPTY_DATA_BAD_RECORD'='false');

NOTE

If **REDIRECT** is used, CarbonData will add all bad records into a separate CSV file. However, this file must not be used for subsequent data loading because the content may not exactly match the source record. You must clean up the source record for further data ingestion. This option is used to remind you which records are bad.

- **MAXCOLUMNS**: (Optional) Specifies the maximum number of columns parsed by a CSV parser in a line.

  OPTIONS('MAXCOLUMNS'='400')

Table 1-36 MAXCOLUMNS

Name of the Optional Parameter	Default Value	Maximum Value
MAXCOLUMNS	2000	20000

Table 1-37 Behavior chart of MAXCOLUMNS

MAXCOLUMNS Value	Number of Columns in the File Header	Final Value Considered
Not specified in Load options	5	2000
Not specified in Load options	6000	6000
40	7	Max (column count of file header, MAXCOLUMNS value)
22000	40	20000
60	Not specified in Load options	Max (Number of columns in the first line of the CSV file, MAXCOLUMNS value)

NOTE

There must be sufficient executor memory for setting the maximum value of **MAXCOLUMNS Option**. Otherwise, data loading will fail.

- If **SORT_SCOPE** is set to **GLOBAL_SORT** during table creation, you can specify the number of partitions to be used when sorting data. If this parameter is not set or is set to a value less than **1**, the number of map tasks is used as the number of reduce tasks. It is recommended that each reduce task process 512 MB to 1 GB data.

  OPTIONS('GLOBAL_SORT_PARTITIONS'='2')

NOTE

To increase the number of partitions, you may need to increase the value of **spark.driver.maxResultSize**, as the sampling data collected in the driver increases with the number of partitions.

- **DATEFORMAT**: Specifies the date format of the table.

  OPTIONS('DATEFORMAT'='dateFormat')

  NOTE

  Date formats are specified by date pattern strings. The date pattern letters in Carbon are same as in JAVA.

- **TIMESTAMPFORMAT**: Specifies the timestamp of a table.
- *OPTIONS('TIMESTAMPFORMAT'='timestampFormat')*
- **SKIP_EMPTY_LINE**: Ignores empty rows in the CSV file during data loading.

  OPTIONS('SKIP_EMPTY_LINE'='TRUE/FALSE')

- **Optional: SCALE_FACTOR**: Used to control the number of partitions for **RANGE_COLUMN**, **SCALE_FACTOR**. The formula is as follows:

  ```
  splitSize = max(blocklet_size, (block_size - blocklet_size)) * scale_factor
  numPartitions = total size of input data / splitSize
  ```

  The default value is **3**. The value ranges from **1** to **300**.

  OPTIONS('SCALE_FACTOR'='10')

  NOTE

  - If **GLOBAL_SORT_PARTITIONS** and **SCALE_FACTOR** are used at the same time, only **GLOBAL_SORT_PARTITIONS** is valid.
  - The compaction on **RANGE_COLUMN** will use **LOCAL_SORT** by default.

    LOCAL_SORT conflicts with DDL operations on partitioned tables and they cannot be used at the same time. In addition, LOCAL_SORT does not significantly improve the performance of partitioned tables. You are advised not to enable this feature on partitioned tables.

Scenarios

To load a CSV file to a CarbonData table, run the following statement:

LOAD DATA *INPATH 'folder path' INTO TABLE tablename OPTIONS(property_name=property_value, ...);*

Examples

The data in the **data.csv** file is as follows:

```
ID,date,country,name,phonetype,serialname,salary
4,2014-01-21 00:00:00,xxx,aaa4,phone2435,ASD66902,15003
5,2014-01-22 00:00:00,xxx,aaa5,phone2441,ASD90633,15004
6,2014-03-07 00:00:00,xxx,aaa6,phone294,ASD59961,15005
```

CREATE TABLE carbontable(ID int, date Timestamp, country String, name String, phonetype String, serialname String,salary int) STORED AS carbondata;

LOAD DATA *inpath 'hdfs://hacluster/tmp/data.csv' INTO table carbontable*

options('DELIMITER'=',');

System Response

Success or failure will be recorded in the driver logs.

1.6.2.2 UPDATE CARBON TABLE

Function

This command is used to update the CarbonData table based on the column expression and optional filtering conditions.

Syntax

- Syntax 1:

  UPDATE <CARBON TABLE> SET (column_name1, column_name2, ... column_name n) = (column1_expression , column2_expression , column3_expression ... column n_expression) [WHERE { <filter_condition> }];

- Syntax 2:

  UPDATE <CARBON TABLE> SET (column_name1, column_name2,) = (select sourceColumn1, sourceColumn2 from sourceTable [WHERE { <filter_condition> }]) [WHERE { <filter_condition> }];

Parameter Description

Table 1-38 UPDATE parameters

Parameter	Description
CARBON TABLE	Name of the CarbonData table to be updated
column_name	Target column to be updated
sourceColumn	Column value of the source table that needs to be updated in the target table
sourceTable	Table from which the records are updated to the target table

Precautions

Note the following before running this command:

- The UPDATE command fails if multiple input rows in the source table are matched with a single row in the target table.
- If the source table generates empty records, the UPDATE operation completes without updating the table.
- If rows in the source table do not match any existing rows in the target table, the UPDATE operation completes without updating the table.
- UPDATE is not allowed in the table with secondary index.
- In a subquery, if the source table and target table are the same, the UPDATE operation fails.

- The UPDATE operation fails if the subquery used in the UPDATE command contains an aggregate function or a GROUP BY clause.

  For example, **update t_carbn01 a set (a.item_type_code, a.profit) = (select b.item_type_cd, sum(b.profit) from t_carbn01b b where item_type_cd =2 group by item_type_code);**.

  In the preceding example, aggregate function **sum(b.profit)** and GROUP BY clause are used in the subquery. As a result, the UPDATE operation will fail.

- If the **carbon.input.segments** property has been set for the queried table, the UPDATE operation fails. To solve this problem, run the following statement before the query:

  Syntax:

  SET carbon.input.segments. <database_name>. <table_name>=*;

Examples

- Example 1:

  update carbonTable1 d set (d.column3,d.column5) = (select s.c33 ,s.c55 from sourceTable1 s where d.column1 = s.c11) where d.column1 = 'country' exists(select * from table3 o where o.c2 > 1);

- Example 2:

  update carbonTable1 d set (c3) = (select s.c33 from sourceTable1 s where d.column1 = s.c11) where exists(select * from iud.other o where o.c2 > 1);

- Example 3:

  update carbonTable1 set (c2, c5) = (c2 + 1, concat(c5 , "y"));

- Example 4:

  update carbonTable1 d set (c2, c5) = (c2 + 1, "xyx") where d.column1 = 'india';

- Example 5:

  update carbonTable1 d set (c2, c5) = (c2 + 1, "xyx") where d.column1 = 'india' and exists(select * from table3 o where o.column2 > 1);

System Response

Success or failure will be recorded in the driver log and on the client.

1.6.2.3 DELETE RECORDS from CARBON TABLE

Function

This command is used to delete records from a CarbonData table.

Syntax

DELETE FROM CARBON_TABLE [WHERE expression];

Parameter Description

Table 1-39 DELETE RECORDS parameters

Parameter	Description
CARBON TABLE	Name of the CarbonData table in which the DELETE operation is performed

Precautions

- If a segment is deleted, all secondary indexes associated with the segment are deleted as well.
- If the **carbon.input.segments** property has been set for the queried table, the DELETE operation fails. To solve this problem, run the following statement before the query:

  Syntax:

  SET carbon.input.segments. <database_name>.<table_name>=*;

Examples

- Example 1:

  delete from columncarbonTable1 d where d.column1 = 'country';
- Example 2:

  delete from dest where column1 IN ('country1', 'country2');
- Example 3:

  delete from columncarbonTable1 where column1 IN (select column11 from sourceTable2);
- Example 4:

  delete from columncarbonTable1 where column1 IN (select column11 from sourceTable2 where column1 = 'xxx');
- Example 5:

  delete from columncarbonTable1 where column2 >= 4;

System Response

Success or failure will be recorded in the driver log and on the client.

1.6.2.4 INSERT INTO CARBON TABLE

Function

This command is used to add the output of the SELECT command to a Carbon table.

Syntax

INSERT INTO [CARBON TABLE] [select query];

Parameter Description

Table 1-40 INSERT INTO parameters

Parameter	Description
CARBON TABLE	Name of the CarbonData table to be inserted
select query	SELECT query on the source table (CarbonData, Hive, and Parquet tables are supported)

Precautions

- A table has been created.
- You must belong to the data loading group in order to perform data loading operations. By default, the data loading group is named **ficommon**.
- CarbonData tables cannot be overwritten.
- The data type of the source table and the target table must be the same. Otherwise, data in the source table will be regarded as bad records.
- The **INSERT INTO** command does not support partial success. If bad records exist, the command fails.
- When you insert data of the source table to the target table, you cannot upload or update data of the source table.

  To enable data loading or updating during the INSERT operation, set the following parameter to **true**.

  carbon.insert.persist.enable=**true**

  By default, the preceding parameters are set to **false**.

  NOTE

  Enabling this property will reduce the performance of the INSERT operation.

Example

create table carbon01(a int,b string,c string) stored as carbondata;

insert into table carbon01 values(1,'a','aa'),(2,'b','bb'),(3,'c','cc');

create table carbon02(a int,b string,c string) stored as carbondata;

INSERT INTO carbon02 select * from carbon01 where a > 1;

System Response

Success or failure will be recorded in the driver logs.

1.6.2.5 DELETE SEGMENT by ID

Function

This command is used to delete segments by the ID.

Syntax

DELETE FROM TABLE db_name.table_name WHERE SEGMENT.ID IN (segment_id1,segment_id2);

Parameter Description

Table 1-41 DELETE SEGMENT parameters

Parameter	Description
segment_id	ID of the segment to be deleted.
db_name	Database name. If the parameter is not specified, the current database is used.
table_name	The name of the table in a specific database.

Usage Guidelines

Segments cannot be deleted from the stream table.

Examples

DELETE FROM TABLE CarbonDatabase.CarbonTable WHERE SEGMENT.ID IN (0);

DELETE FROM TABLE CarbonDatabase.CarbonTable WHERE SEGMENT.ID IN (0,5,8);

System Response

Success or failure will be recorded in the CarbonData log.

1.6.2.6 DELETE SEGMENT by DATE

Function

This command is used to delete segments by loading date. Segments created before a specific date will be deleted.

Syntax

DELETE FROM TABLE db_name.table_name WHERE SEGMENT.STARTTIME BEFORE date_value;

Parameter Description

Table 1-42 DELETE SEGMENT by DATE parameters

Parameter	Description
db_name	Database name. If this parameter is not specified, the current database is used.
table_name	Name of a table in the specified database
date_value	Valid date when segments are started to be loaded. Segments before the date will be deleted.

Precautions

Segments cannot be deleted from the stream table.

Example

DELETE FROM TABLE db_name.table_name WHERE SEGMENT.STARTTIME BEFORE '2017-07-01 12:07:20';

STARTTIME indicates the loading start time of different loads.

System Response

Success or failure will be recorded in CarbonData logs.

1.6.2.7 SHOW SEGMENTS

Function

This command is used to list the segments of a CarbonData table.

Syntax

SHOW SEGMENTS FOR TABLE *[db_name.]table_name* **LIMIT** *number_of_loads;*

Parameter Description

Table 1-43 SHOW SEGMENTS FOR TABLE parameters

Parameter	Description
db_name	Database name. If this parameter is not specified, the current database is used.
table_name	Name of a table in the specified database
number_of_loads	Threshold of records to be listed

Precautions

None

Examples

create table carbon01(a int,b string,c string) stored as carbondata;

insert into table carbon01 select 1,'a','aa';

insert into table carbon01 select 2,'b','bb';

insert into table carbon01 select 3,'c','cc';

SHOW SEGMENTS FOR TABLE carbon01 LIMIT 2;

System Response

```
+-----+----------+--------------------------+------------------+------------+------------+-------------+--------------+--
+
| ID  |  Status  |     Load Start Time      | Load Time Taken  | Partition  | Data Size  | Index Size  | File Format  |
+-----+----------+--------------------------+------------------+------------+------------+-------------+--------------+--
+
| 3   | Success  | 2020-09-28 22:53:26.336  | 3.726S           | {}         | 6.47KB     | 3.30KB      | columnar_v3  |
| 2   | Success  | 2020-09-28 22:53:01.702  | 6.688S           | {}         | 6.47KB     | 3.30KB      | columnar_v3  |
+-----+----------+--------------------------+------------------+------------+------------+-------------+--------------+--
+
```

1.6.2.8 CREATE SECONDARY INDEX

Function

This command is used to create secondary indexes in the CarbonData tables.

Syntax

CREATE INDEX *index_name*

ON TABLE *[db_name.]table_name (col_name1, col_name2)*

AS *'carbondata'*

PROPERTIES *('table_blocksize'='256')*;

Parameter Description

Table 1-44 CREATE SECONDARY INDEX parameters

Parameter	Description
index_name	Index table name. It consists of letters, digits, and special characters (_).
db_name	Database name. It consists of letters, digits, and special characters (_).

Parameter	Description
table_name	Name of the database table. It consists of letters, digits, and special characters (_).
col_name	Name of a column in a table. Multiple columns are supported. It consists of letters, digits, and special characters (_).
table_blocksize	Block size of a data file. For details, see **•Block Size**.

Precautions

db_name is optional.

Examples

create table productdb.productSalesTable(id int,price int,productName string,city string) stored as carbondata;

CREATE INDEX productNameIndexTable on table productdb.productSalesTable (productName,city) as 'carbondata' ;

In this example, a secondary table named **productdb.productNameIndexTable** is created and index information of the provided column is loaded.

System Response

A secondary index table will be created. Index information related to the provided column will be loaded into the secondary index table. The success message will be recorded in system logs.

1.6.2.9 SHOW SECONDARY INDEXES

Function

This command is used to list all secondary index tables in the CarbonData table.

Syntax

SHOW INDEXES ON db_name.table_name;

Parameter Description

Table 1-45 SHOW SECONDARY INDEXES parameters

Parameter	Description
db_name	Database name. It consists of letters, digits, and special characters (_).

Parameter	Description
table_name	Name of the database table. It consists of letters, digits, and special characters (_).

Precautions

db_name is optional.

Examples

create table productdb.productSalesTable(id int,price int,productName string,city string) stored as carbondata;

CREATE INDEX productNameIndexTable on table productdb.productSalesTable (productName,city) as 'carbondata' ;

SHOW INDEXES ON productdb.productSalesTable;

System Response

All index tables and corresponding index columns in a given CarbonData table will be listed.

1.6.2.10 DROP SECONDARY INDEX

Function

This command is used to delete the existing secondary index table in a specific table.

Syntax

DROP INDEX *[IF EXISTS] index_name* **ON** *[db_name.]table_name*;

Parameter Description

Table 1-46 DROP SECONDARY INDEX parameters

Parameter	Description
index_name	Name of the index table. Table name contains letters, digits, and underscores (_).
db_Name	Name of the database. If the parameter is not specified, the current database is used.
table_name	Name of the table to be deleted.

Usage Guidelines

In this command, **IF EXISTS** and **db_name** are optional.

Examples

DROP INDEX *if exists productNameIndexTable* **ON** *productdb.productSalesTable*;

System Response

Secondary Index Table will be deleted. Index information will be cleared in CarbonData table and the success message will be recorded in system logs.

1.6.2.11 CLEAN FILES

Function

After the **DELETE SEGMENT** command is executed, the deleted segments are marked as the **delete** state. After the segments are merged, the status of the original segments changes to **compacted**. The data files of these segments are not physically deleted. If you want to forcibly delete these files, run the **CLEAN FILES** command.

However, running this command may result in a query command execution failure.

Syntax

CLEAN FILES FOR TABLE *[db_name.]table_name* ;

Parameter Description

Table 1-47 CLEAN FILES FOR TABLE parameters

Parameter	Description
db_name	Database name. It consists of letters, digits, and underscores (_).
table_name	Name of the database table. It consists of letters, digits, and underscores (_).

Precautions

None

Examples

Add Carbon configuration parameters.

```
carbon.clean.file.force.allowed = true
```

create table carbon01(a int,b string,c string) stored as carbondata;

insert into table carbon01 select 1,'a','aa';

insert into table carbon01 select 2,'b','bb';

delete from table carbon01 where segment.id in (0);

show segments for table carbon01;

CLEAN FILES FOR TABLE carbon01 options('force'='true');

show segments for table carbon01;

In this example, all the segments marked as **deleted** and **compacted** are physically deleted.

System Response

Success or failure will be recorded in the driver logs.

1.6.2.12 SET/RESET

Function

This command is used to dynamically add, update, display, or reset the CarbonData properties without restarting the driver.

Syntax

- Add or Update parameter value:

  SET *parameter_name=parameter_value*

  This command is used to add or update the value of **parameter_name**.
- Display property value:

  SET *parameter_name*

  This command is used to display the value of **parameter_name**.
- Display session parameter:

  SET

  This command is used to display all supported session parameters.
- Display session parameters along with usage details:

  SET -v

  This command is used to display all supported session parameters and their usage details.
- Reset parameter value:

  RESET

  This command is used to clear all session parameters.

Parameter Description

Table 1-48 SET parameters

Parameter	Description
parameter_name	Name of the parameter whose value needs to be dynamically added, updated, or displayed
parameter_value	New value of **parameter_name** to be set

Precautions

The following table lists the properties which you can set or clear using the SET or RESET command.

Table 1-49 Properties

Property	Description
carbon.options.bad.records.logger.enable	Whether to enable bad record logger.
carbon.options.bad.records.action	Operations on bad records, for example, force, redirect, fail, or ignore. For more information, see **•Bad record handling**.
carbon.options.is.empty.data.bad.record	Whether the empty data is considered as a bad record. For more information, see **Bad record handling**.
carbon.options.sort.scope	Scope of the sort during data loading.
carbon.options.bad.record.path	HDFS path where bad records are stored.
carbon.custom.block.distribution	Whether to enable Spark or CarbonData block distribution.
enable.unsafe.sort	Whether to use unsafe sort during data loading. Unsafe sort reduces the garbage collection during data loading, thereby achieving better performance.

Property	Description
carbon.si.lookup.partialstring	If this is set to **TRUE**, the secondary index uses the starts-with, ends-with, contains, and LIKE partition condition strings. If this is set to **FALSE**, the secondary index uses only the starts-with partition condition string.
carbon.input.segments	Segment ID to be queried. This property allows you to query a specified segment of a specified table. CarbonScan reads data only from the specified segment ID. Syntax: **carbon.input.segments. <database_name>. <table_name> = < list of segment ids >** If you want to query a specified segment in multi-thread mode, you can use **CarbonSession.threadSet** instead of the **SET** statement. Syntax: **CarbonSession.threadSet ("carbon.input.segments. <database_name>. <table_name>","< list of segment ids >");** **NOTE** You are advised not to set this property in the **carbon.properties** file because all sessions contain the segment list unless session-level or thread-level overwriting occurs.

Examples

- Add or Update:

  SET *enable.unsafe.sort=true*
- Display property value:

  SET *enable.unsafe.sort*
- Show the segment ID list, segment status, and other required details, and specify the segment list to be read:

  SHOW SEGMENTS FOR *TABLE carbontable1;*

  SET *carbon.input.segments.db.carbontable1 = 1, 3, 9;*
- Query a specified segment in multi-thread mode:

  CarbonSession.threadSet (*"carbon.input.segments.default.carbon_table_MulTI_THread", "1,3"*);

- Use **CarbonSession.threadSet** to query segments in a multi-thread environment (Scala code is used as an example):

```
def main(args: Array[String]) {
 Future
{              CarbonSession.threadSet("carbon.input.segments.default.carbon_table_MulTI_THread", "1")
     spark.sql("select count(empno) from carbon_table_MulTI_THread").show()
   }
}
```

- Reset:

  RESET

System Response

- Success will be recorded in the driver log.
- Failure will be displayed on the UI.

1.6.3 Operation Concurrent Execution

Before performing **DDL** and **DML** operations, you need to obtain the corresponding locks. See **Table 1-50** for details about the locks that need to be obtained for each operation. The check mark (√) indicates that the lock is required. An operation can be performed only after all required locks are obtained.

You can check whether any two operations can be executed concurrently by using the following method: The first two lines in **Table 1-50** indicate two operations. If no column in the two lines is marked with the check mark (√), the two operations can be executed concurrently. That is, if the columns with check marks (√) in the two lines do not exist, the two operations can be executed concurrently.

Table 1-50 List of obtaining locks for operations

Operation	METADATA_LOCK	COMPACTION_LOCK	DROP_TABLE_LOCK	DELETE_SEGMENT_LOCK	CLEAN_FILES_LOCK	ALTER_PARTITION_LOCK	UPDATE_LOCK	STREAMING_LOCK	CONCURRENT_LOAD_LOCK	SEGMENT_LOCK
CREATE TABLE	-	-	-	-	-	-	-	-	-	-
CREATE TABLE As SELECT	-	-	-	-	-	-	-	-	-	-
DROP TABLE	√	-	√	-	-	-	-	√	-	-

Operation	METADATA_LOCK	COMPACTION_LOCK	DROP_TABLE_LOCK	DELETE_SEGMENT_LOCK	CLEAN_FILES_LOCK	ALTER_PARTITION_LOCK	UPDATE_LOCK	STREAMING_LOCK	CONCURRENT_LOAD_LOCK	SEGMENT_LOCK
ALTER TABLE COMPACTION	-	√	-	-	-	-	√	-	-	-
TABLE RENAME	-	-	-	-	-	-	-	-	-	-
ADD COLUMNS	√	√	-	-	-	-	-	-	-	-
DROP COLUMNS	√	√	-	-	-	-	-	-	-	-
CHANGE DATA TYPE	√	√	-	-	-	-	-	-	-	-
REFRESH TABLE	-	-	-	-	-	-	-	-	-	-
REGISTER INDEX TABLE	√	-	-	-	-	-	-	-	-	-
REFRESH INDEX	-	√	-	-	-	-	-	-	-	-

Operation	METADATA_LOCK	COMPACTION_LOCK	DROP_TABLE_LOCK	DELETE_SEGMENT_LOCK	CLEAN_FILES_LOCK	ALTER_PARTITION_LOCK	UPDATE_LOCK	STREAMING_LOCK	CONCURRENT_LOAD_LOCK	SEGMENT_LOCK
LOAD DATA/ INSERT INTO	-	-	-	-	-	-	-	-	√	√
UPDATE CARBON TABLE	√	√	-	-	-	-	√	-	-	-
DELETE RECORDS from CARBON TABLE	√	√	-	-	-	-	√	-	-	-
DELETE SEGMENT by ID	-	-	-	√	√	-	-	-	-	-
DELETE SEGMENT by DATE	-	-	-	√	√	-	-	-	-	-
SHOW SEGMENTS	-	-	-	-	-	-	-	-	-	-

Operation	METADATA_LOCK	COMPACTION_LOCK	DROP_TABLE_LOCK	DELETE_SEGMENT_LOCK	CLEAN_FILES_LOCK	ALTER_PARTITION_LOCK	UPDATE_LOCK	STREAMING_LOCK	CONCURRENT_LOAD_LOCK	SEGMENT_LOCK
CREATE SECONDARY INDEX	√	√	-	√	-	-	-	-	-	-
SHOW SECONDARY INDEXES	-	-	-	-	-	-	-	-	-	-
DROP SECONDARY INDEX	√	-	√	-	-	-	-	-	-	-
CLEAN FILES	-	-	-	-	-	-	-	-	-	-
SET/RESET	-	-	-	-	-	-	-	-	-	-
Add Hive Partition	-	-	-	-	-	-	-	-	-	-
Drop Hive Partition	√	√	√	√	√	√	-	-	-	-
Drop Partition	√	√	√	√	√	√	-	-	-	-

Operation	METADATA_LOCK	COMPACTION_LOCK	DROP_TABLE_LOCK	DELETE_SEGMENT_LOCK	CLEAN_FILES_LOCK	ALTER_PARTITION_LOCK	UPDATE_LOCK	STREAMING_LOCK	CONCURRENT_LOAD_LOCK	SEGMENT_LOCK
Alter table set	√	√	-	-	-	-	-	-	-	-

1.6.4 API

This section describes the APIs and usage methods of Segment. All methods are in the org.apache.spark.util.CarbonSegmentUtil class.

The following methods have been abandoned:

```
/**
* Returns the valid segments for the query based on the filter condition
* present in carbonScanRdd.
*
* @param carbonScanRdd
* @return Array of valid segments
*/
@deprecated def getFilteredSegments(carbonScanRdd: CarbonScanRDD[InternalRow]): Array[String];
```

Usage Method

Use the following methods to obtain CarbonScanRDD from the query statement:

```
val df=carbon.sql("select * from table where age='12'")
val myscan=df.queryExecution.sparkPlan.collect {
case scan: CarbonDataSourceScan if scan.rdd.isInstanceOf[CarbonScanRDD[InternalRow]] => scan.rdd
case scan: RowDataSourceScanExec if scan.rdd.isInstanceOf[CarbonScanRDD[InternalRow]] => scan.rdd
}.head
val carbonrdd=myscan.asInstanceOf[CarbonScanRDD[InternalRow]]
```

Example:

```
CarbonSegmentUtil.getFilteredSegments(carbonrdd)
```

The filtered segment can be obtained by importing SQL statements.

```
/**
* Returns an array of valid segment numbers based on the filter condition provided in the sql
* NOTE: This API is supported only for SELECT Sql (insert into,ctas,.., is not supported)
*
* @param sql
* @param sparkSession
* @return Array of valid segments
* @throws UnsupportedOperationException because Get Filter Segments API supports if and only
* if only one carbon main table is present in query.
*/
def getFilteredSegments(sql: String, sparkSession: SparkSession): Array[String];
```

Example:

```
CarbonSegmentUtil.getFilteredSegments("select * from table where age='12'", sparkSession)
```

Import the database name and table name to obtain the list of segments to be merged. The obtained segments can be used as parameters of the getMergedLoadName function.

```
/**
* Identifies all segments which can be merged with MAJOR compaction type.
* NOTE: This result can be passed to getMergedLoadName API to get the merged load name.
*
* @param sparkSession
* @param tableName
* @param dbName
* @return list of LoadMetadataDetails
*/
def identifySegmentsToBeMerged(sparkSession: SparkSession,
tableName: String,
dbName: String) : util.List[LoadMetadataDetails];
```

Example:

```
CarbonSegmentUtil.identifySegmentsToBeMerged(sparkSession, "table_test","default")
```

Import the database name, table name, and obtain all segments which can be merged with CUSTOM compaction type. The obtained segments can be transferred as the parameter of the getMergedLoadName function.

```
/**
* Identifies all segments which can be merged with CUSTOM compaction type.
*  NOTE: This result can be passed to getMergedLoadName API to get the merged load name.
*
* @param sparkSession
* @param tableName
* @param dbName
* @param customSegments
* @return list of LoadMetadataDetails
* @throws UnsupportedOperationException if customSegments is null or empty.
* @throws MalformedCarbonCommandException if segment does not exist or is not valid
*/
def identifySegmentsToBeMergedCustom(sparkSession: SparkSession,
tableName: String,
dbName: String,
customSegments: util.List[String]): util.List[LoadMetadataDetails];
```

Example:

```
val customSegments = new util.ArrayList[String]()
customSegments.add("1")
customSegments.add("2")
CarbonSegmentUtil.identifySegmentsToBeMergedCustom(sparkSession, "table_test","default",
customSegments)
```

If a segment list is specified, the merged load name is returned.

```
/**
* Returns the Merged Load Name for given list of segments
*
* @param list of segments
* @return Merged Load Name
* @throws UnsupportedOperationException if list of segments is less than 1
*/
def getMergedLoadName(list: util.List[LoadMetadataDetails]): String;
```

Example:

```
val carbonTable = CarbonEnv.getCarbonTable(Option(databaseName), tableName)(sparkSession)
val loadMetadataDetails = SegmentStatusManager.readLoadMetadata(carbonTable.getMetadataPath)
CarbonSegmentUtil.getMergedLoadName(loadMetadataDetails.toList.asJava)
```

1.6.5 Spatial Indexes

Quick Example

```
create table IF NOT EXISTS carbonTable
(
```

```
COLUMN1    BIGINT,
LONGITUDE    BIGINT,
LATITUDE    BIGINT,
COLUMN2    BIGINT,
COLUMN3    BIGINT
)
STORED AS carbondata
TBLPROPERTIES
('SPATIAL_INDEX.mygeohash.type'='geohash','SPATIAL_INDEX.mygeohash.sourcecolumns'='longitude,
latitude','SPATIAL_INDEX.mygeohash.originLatitude'='39.850713','SPATIAL_INDEX.mygeohash.gridSize'='50','S
PATIAL_INDEX.mygeohash.minLongitude'='115.828503','SPATIAL_INDEX.mygeohash.maxLongitude'='720.000
000','SPATIAL_INDEX.mygeohash.minLatitude'='39.850713','SPATIAL_INDEX.mygeohash.maxLatitude'='720.0
00000','SPATIAL_INDEX'='mygeohash','SPATIAL_INDEX.mygeohash.conversionRatio'='1000000','SORT_COLU
MNS'='column1,column2,column3,latitude,longitude');
```

Introduction to Spatial Indexes

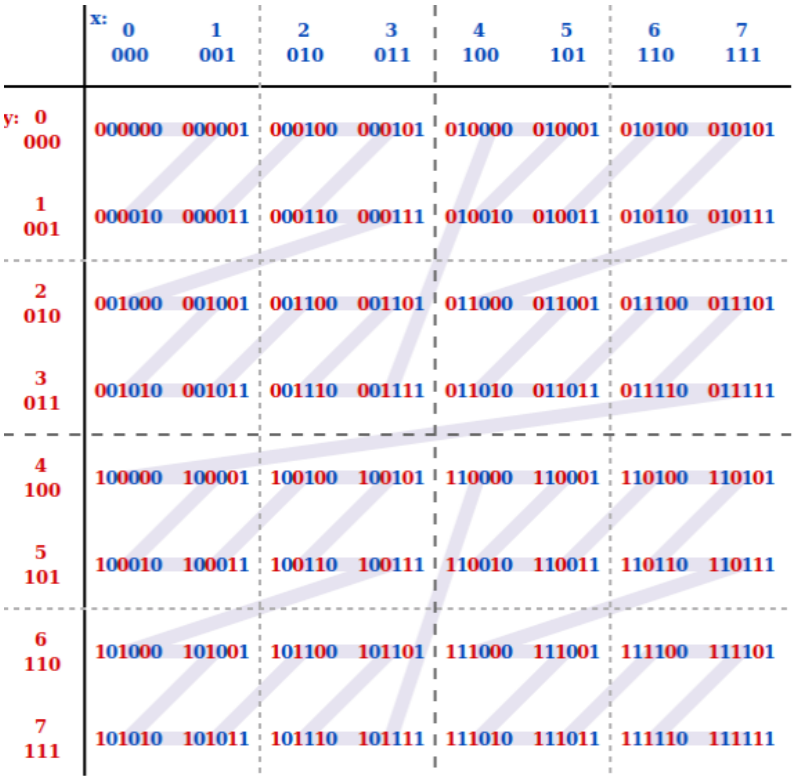
Spatial data includes multidimensional points, lines, rectangles, cubes, polygons, and other geometric objects. A spatial data object occupies a certain region of space, called spatial scope, characterized by its location and boundary. The spatial data can be either point data or region data.

- Point data: A point has a spatial extent characterized completely by its location. It does not occupy space and has no associated boundary. Point data consists of a collection of points in a two-dimensional space. Points can be stored as a pair of longitude and latitude.
- Region data: A region has a spatial extent with a location, and boundary. The location can be considered as the position of a fixed point in the region, such as its centroid. In two dimensions, the boundary can be visualized as a line (for finite regions, a closed loop). Region data contains a collection of regions.

Currently, only point data is supported, and it can be stored.

Longitude and latitude can be encoded as a unique GeoID. Geohash is a public-domain geocoding system invented by Gustavo Niemeyer. It encodes geographical locations into a short string of letters and digits. It is a hierarchical spatial data structure which subdivides the space into buckets of grid shape, which is one of the many applications of what is known as the Z-order curve, and generally the space-filling curve.

The Z value of a point in multiple dimensions is calculated by interleaving the binary representation of its coordinate value, as shown in the following figure. When Geohash is used to create a GeoID, data is sorted by GeoID instead of longitude and latitude. Data is stored by spatial proximity.



Creating a Table

GeoHash encoding:

```
create table IF NOT EXISTS carbonTable
(
...
`LONGITUDE`     BIGINT,
`LATITUDE`      BIGINT,
...
)
STORED AS carbondata
TBLPROPERTIES
('SPATIAL_INDEX.mygeohash.type'='geohash','SPATIAL_INDEX.mygeohash.sourcecolumns'='longitude,
latitude','SPATIAL_INDEX.mygeohash.originLatitude'='xx.xxxxxx','SPATIAL_INDEX.mygeohash.gridSize'='xx','SP
ATIAL_INDEX.mygeohash.minLongitude'='xxx.xxxxxx','SPATIAL_INDEX.mygeohash.maxLongitude'='xxx.xxxxxx'
,'SPATIAL_INDEX.mygeohash.minLatitude'='xx.xxxxxx','SPATIAL_INDEX.mygeohash.maxLatitude'='xxx.xxxxxx','
SPATIAL_INDEX'='mygeohash','SPATIAL_INDEX.mygeohash.conversionRatio'='1000000','SORT_COLUMNS'='co
lumn1,column2,column3,latitude,longitude');
```

SPATIAL_INDEX is a user-defined index handler. This handler allows users to create new columns from the table-structure column set. The new column name is the same as that of the handler name. The **type** and **sourcecolumns** properties of the handler are mandatory. Currently, the value of **type** supports only **geohash**. Carbon provides a default implementation class that can be easily used. You can extend the default implementation class to mount the customized implementation class of **geohash**. The default handler also needs to provide the following table properties:

- **SPATIAL_INDEX.*xxx*.originLatitude**: specifies the origin latitude. (**Double** type.)
- **SPATIAL_INDEX.*xxx*.gridSize**: specifies the grid length in meters. (**Int** type.)

- **SPATIAL_INDEX.*xxx*.minLongitude**: specifies the minimum longitude. (**Double** type.)
- **SPATIAL_INDEX.*xxx*.maxLongitude**: specifies the maximum longitude. (**Double** type.)
- **SPATIAL_INDEX.*xxx*.minLatitude**: specifies the minimum latitude. (**Double** type.)
- **SPATIAL_INDEX.*xxx*.maxLatitude**: specifies the maximum latitude. (**Double** type.)
- **SPATIAL_INDEX.*xxx*.conversionRatio**: used to convert the small value of the longitude and latitude to an integer. (**Int** type.)

You can add your own table properties to the handlers in the above format and access them in your custom implementation class. **originLatitude**, **gridSize**, and **conversionRatio** are mandatory. Other parameters are optional in Carbon. You can use the **SPATIAL_INDEX.*xxx*.class** property to specify their implementation classes.

The default implementation class can generate handler column values for **sourcecolumns** in each row and support query based on the **sourcecolumns** filter criteria. The generated handler column is invisible to users. Except the **SORT_COLUMNS** table properties, no DDL commands or properties are allowed to contain the handler column.

NOTE

- By default, the generated handler column is regarded as the sorting column. If **SORT_COLUMNS** does not contain any **sourcecolumns**, add the handler column to the end of the existing **SORT_COLUMNS**. If the handler column has been specified in **SORT_COLUMNS**, its order in **SORT_COLUMNS** remains unchanged.
- If **SORT_COLUMNS** contains any **sourcecolumns** but does not contain the handler column, the handler column is automatically inserted before **sourcecolumns** in **SORT_COLUMNS**.
- If **SORT_COLUMNS** needs to contain any **sourcecolumns**, ensure that the handler column is listed before the **sourcecolumns** so that the handler column can take effect during sorting.

GeoSOT encoding:

```
CREATE TABLE carbontable(
...
longitude DOUBLE,
latitude DOUBLE,
...)
STORED AS carbondata
TBLPROPERTIES ('SPATIAL_INDEX'='xxx',
'SPATIAL_INDEX.xxx.type'='geosot',
'SPATIAL_INDEX.xxx.sourcecolumns'='longitude, latitude',
'SPATIAL_INDEX.xxx.level'='21',
'SPATIAL_INDEX.xxx.class'='org.apache.carbondata.geo.GeoSOTIndex')
```

Table 1-51 Parameter description

Parameter	Description
SPATIAL_INDEX	Specifies the spatial index. Its value is the same as the column name.

Parameter	Description
SPATIAL_INDEX.xxx.type	(Mandatory) The value is set to **geosot**.
SPATIAL_INDEX.xxx.source columns	(Mandatory) Specifies the source columns for calculating the spatial index. The value must be two existing columns of the double type.
SPATIAL_INDEX.xxx.level	(Optional) Specifies the columns for calculating the spatial index. The default value is **17**, through which you can obtain an accurate result and improve the computing performance.
SPATIAL_INDEX.xxx.class	(Optional) Specifies the implementation class of GeoSOT. The default value is **org.apache.carbondata.geo.GeoSOTIndex**.

Example:

```
create table geosot(
timevalue bigint,
longitude double,
latitude double)
stored as carbondata
TBLPROPERTIES ('SPATIAL_INDEX'='mygeosot',
'SPATIAL_INDEX.mygeosot.type'='geosot',
'SPATIAL_INDEX.mygeosot.level'='21', 'SPATIAL_INDEX.mygeosot.sourcecolumns'='longitude, latitude');
```

Preparing Data

- Data file 1: **geosotdata.csv**

```
timevalue,longitude,latitude
1575428400000,116.285807,40.084087
1575428400000,116.372142,40.129503
1575428400000,116.187332,39.979316
1575428400000,116.337069,39.951887
1575428400000,116.359102,40.154684
1575428400000,116.736367,39.970323
1575428400000,116.720179,40.009893
1575428400000,116.346961,40.13355
1575428400000,116.302895,39.930753
1575428400000,116.288955,39.999101
1575428400000,116.17609,40.129953
1575428400000,116.725575,39.981115
1575428400000,116.266922,40.179415
1575428400000,116.353706,40.156483
1575428400000,116.362699,39.942444
1575428400000,116.325378,39.963129
```

- Data file 2: **geosotdata2.csv**

```
timevalue,longitude,latitude
1575428400000,120.17708,30.326882
1575428400000,120.180685,30.326327
1575428400000,120.184976,30.327105
1575428400000,120.189311,30.327549
1575428400000,120.19446,30.329698
1575428400000,120.186965,30.329133
1575428400000,120.177481,30.328911
1575428400000,120.169713,30.325614
1575428400000,120.164563,30.322243
1575428400000,120.171558,30.319613
1575428400000,120.176365,30.320687
```

```
1575428400000,120.179669,30.323688
1575428400000,120.181001,30.320761
1575428400000,120.187094,30.32354
1575428400000,120.193574,30.323651
1575428400000,120.186192,30.320132
1575428400000,120.190055,30.317464
1575428400000,120.195376,30.318094
1575428400000,120.160786,30.317094
1575428400000,120.168211,30.318057
1575428400000,120.173618,30.316612
1575428400000,120.181001,30.317316
1575428400000,120.185162,30.315908
1575428400000,120.192415,30.315871
1575428400000,120.161902,30.325614
1575428400000,120.164306,30.328096
1575428400000,120.197093,30.325985
1575428400000,120.19602,30.321651
1575428400000,120.198638,30.32354
1575428400000,120.165421,30.314834
```

Importing Data

The GeoHash default implementation class extends the customized index abstract class. If the handler property is not set to a customized implementation class, the default implementation class is used. You can extend the default implementation class to mount the customized implementation class of **geohash**. The methods of the customized index abstract class are as follows:

- **Init** method: Used to extract, verify, and store the handler property. If the operation fails, the system throws an exception and displays the error information.
- **Generate** method: Used to generate indexes. It generates an index for each row of data.
- **Query** method: Used to generate an index value range list for given input.

The commands for importing data are the same as those for importing common Carbon tables.

LOAD DATA inpath '/tmp/*geosotdata.csv*' INTO TABLE geosot OPTIONS ('DELIMITER'= ',');

LOAD DATA inpath '/tmp/*geosotdata2.csv*' INTO TABLE geosot OPTIONS ('DELIMITER'= ',');

NOTE

For details about **geosotdata.csv** and **geosotdata2.csv**, see **Preparing Data**.

Aggregate Query of Irregular Spatial Sets

Query statements and filter UDFs

- Filtering data based on polygon

  IN_POLYGON(pointList)

  UDF input parameter

Parameter	Type	Description
pointList	String	Enter multiple points as a string. Each point is presented as **longitude latitude**. Longitude and latitude are separated by a space. Each pair of longitude and latitude is separated by a comma (,). The longitude and latitude values at the start and end of the string must be the same.

UDF output parameter

Parameter	Type	Description
inOrNot	Boolean	Checks whether data is in the specified **polygon_list**.

Example:

```
select longitude, latitude from geosot where IN_POLYGON('116.321011 40.123503, 116.137676 39.947911, 116.560993 39.935276, 116.321011 40.123503');
```

- Filtering data based on the polygon list

  IN_POLYGON_LIST(polygonList, opType)

  UDF input parameters

Parameter	Type	Description
polygonList	String	Inputs multiple polygons as a string. Each polygon is presented as **POLYGON ((longitude1 latitude1, longitude2 latitude2, ...))**. Note that there is a space after **POLYGON**. Longitudes and latitudes are separated by spaces. Each pair of longitude and latitude is separated by a comma (,). The longitudes and latitudes at the start and end of a polygon must be the same. **IN_POLYGON_LIST** requires at least two polygons. Example: `POLYGON ((116.137676 40.163503, 116.137676 39.935276, 116.560993 39.935276, 116.137676 40.163503))`

Parameter	Type	Description
opType	String	Performs union, intersection, and subtraction on multiple polygons. Currently, the following operation types are supported: • OR: A U B U C (Assume that three polygons A, B, and C are input.) • AND: A ∩ B ∩ C

UDF output parameter

Parameter	Type	Description
inOrNot	Boolean	Checks whether data is in the specified **polygon_list**.

Example:

```
select longitude, latitude from geosot where IN_POLYGON_LIST('POLYGON ((120.176433 30.327431,120.171283 30.322245,120.181411 30.314540, 120.190509 30.321653,120.185188 30.329358,120.176433 30.327431)), POLYGON ((120.191603 30.328946,120.184179 30.327465,120.181819 30.321464, 120.190359 30.315388,120.199242 30.324464,120.191603 30.328946))', 'OR');
```

- Filtering data based on the polyline list

  IN_POLYLINE_LIST(polylineList, bufferInMeter)

  UDF input parameters

Parameter	Type	Description
polylineList	String	Inputs multiple polylines as a string. Each polyline is presented as **LINESTRING (longitude1 latitude1, longitude2 latitude2, ...)**. Note that there is a space after **LINESTRING**. Longitudes and latitudes are separated by spaces. Each pair of longitude and latitude is separated by a comma (,). A union will be output based on the data in multiple polylines. Example: `LINESTRING (116.137676 40.163503, 116.137676 39.935276, 116.260993 39.935276)`
bufferInMeter	Float	Polyline buffer distance, in meters. Right angles are used at the end to create a buffer.

UDF output parameter

Parameter	Type	Description
inOrNot	Boolean	Checks whether data is in the specified **polyline_list**.

Example:

```
select longitude, latitude from geosot where IN_POLYLINE_LIST('LINESTRING (120.184179 30.327465, 120.191603 30.328946, 120.199242 30.324464, 120.190359 30.315388)', 65);
```

- Filtering data based on the GeoID range list

  IN_POLYGON_RANGE_LIST(polygonRangeList, opType)

  UDF input parameters

Parameter	Type	Description
polygonRangeList	String	Inputs multiple rangeLists as a string. Each rangeList is presented as **RANGELIST (startGeoId1 endGeoId1, startGeoId2 endGeoId2, ...)**. Note that there is a space after **RANGELIST**. Start GeoIDs and end GeoIDs are separated by spaces. Each group of GeoID ranges is separated by a comma (,). Example: `RANGELIST (855279368848 855279368850, 855280799610 855280799612, 855282156300 855282157400)`
opType	String	Performs union, intersection, and subtraction on multiple rangeLists. Currently, the following operation types are supported: ● OR: A U B U C (Assume that three rangeLists A, B, and C are input.) ● AND: A ∩ B ∩ C

  UDF output parameter

Parameter	Type	Description
inOrNot	Boolean	Checks whether data is in the specified **polyRange_list**.

  Example:

```
select mygeosot, longitude, latitude from geosot where IN_POLYGON_RANGE_LIST('RANGELIST
(526549722865860608 526549722865860618, 532555655580483584 532555655580483594)', 'OR');
```

- Performing polygon query

  IN_POLYGON_JOIN(GEO_HASH_INDEX_COLUMN, POLYGON_COLUMN)

  Perform join query on two tables. One is a spatial data table containing the longitude, latitude, and GeoHashIndex columns, and the other is a dimension table that saves polygon data.

  During query, **IN_POLYGON_JOIN UDF**, **GEO_HASH_INDEX_COLUMN**, and **POLYGON_COLUMN** of the polygon table are used. **Polygon_column** specifies the column containing multiple points (longitude and latitude pairs). The first and last points in each row of the Polygon table must be the same. All points in each row form a closed geometric shape.

  UDF input parameters

Parameter	Type	Description
GEO_HASH_INDEX_COLUMN	Long	GeoHashIndex column of the spatial data table.
POLYGON_COLUMN	String	Polygon column of the polygon table, the value of which is represented by the string of polygon, for example, **POLYGON ((longitude1 latitude1, longitude2 latitude2, ...))**.

  Example:

```
CREATE TABLE polygonTable(
polygon string,
poiType string,
poiId String)
STORED AS carbondata;

insert into polygonTable select 'POLYGON ((120.176433 30.327431,120.171283 30.322245,
120.181411 30.314540,120.190509 30.321653,120.185188 30.329358,120.176433 30.327431))','abc','1';

insert into polygonTable select 'POLYGON ((120.191603 30.328946,120.184179 30.327465,
120.181819 30.321464,120.190359 30.315388,120.199242 30.324464,120.191603 30.328946))','abc','2';

select t1.longitude,t1.latitude from geosot t1
inner join
(select polygon,poiId from polygonTable where poitype='abc') t2
on in_polygon_join(t1.mygeosot,t2.polygon) group by t1.longitude,t1.latitude;
```

- Performing range_list query

  IN_POLYGON_JOIN_RANGE_LIST(GEO_HASH_INDEX_COLUMN, POLYGON_COLUMN)

  Use the **IN_POLYGON_JOIN_RANGE_LIST** UDF to associate the spatial data table with the polygon dimension table based on **Polygon_RangeList**. By using a range list, you can skip the conversion between a polygon and a range list.

  UDF input parameters

Parameter	Type	Description
GEO_HASH_INDEX_COLUMN	Long	GeoHashIndex column of the spatial data table.
POLYGON_COLUMN	String	Rangelist column of the Polygon table, the value of which is represented by the string of rangeList, for example, **RANGELIST (startGeoId1 endGeoId1, startGeoId2 endGeoId2, ...)**.

Example:

```
CREATE TABLE polygonTable(
polygon string,
poiType string,
poiId String)
STORED AS carbondata;

insert into polygonTable select 'RANGELIST (526546455897309184 526546455897309284,
526549831217315840 526549831217315850, 532555655580483534 532555655580483584)','xyz','2';

select t1.*
from geosot t1
inner join
(select polygon,poiId from polygonTable where poitype='xyz') t2
on in_polygon_join_range_list(t1.mygeosot,t2.polygon);
```

UDFs of spacial index tools

- Obtaining row number and column number of a grid converted from GeoID

  GeoIdToGridXy(geoId)

  UDF input parameter

Parameter	Type	Description
geoId	Long	Calculates the row number and column number of the grid based on GeoID.

  UDF output parameter

Parameter	Type	Description
gridArray	Array[Int]	Returns the grid row and column numbers contained in GeoID in array. The first digit indicates the row number, and the second digit indicates the column number.

  Example:

```
select longitude, latitude, mygeohash, GeoIdToGridXy(mygeohash) as GridXY from geoTable;
```

- Converting longitude and latitude to GeoID

  LatLngToGeoId(latitude, longitude oriLatitude, gridSize)

  UDF input parameters

Parameter	Type	Description
longitude	Long	Longitude. Note: The value is an integer after conversion.
latitude	Long	Latitude. Note: The value is an integer after conversion.
oriLatitude	Double	Origin latitude, required for calculating GeoID.
gridSize	Int	Grid size, required for calculating GeoID.

  UDF output parameter

Parameter	Type	Description
geoId	Long	Returns a number that indicates the longitude and latitude after coding.

  Example:

```
select longitude, latitude, mygeohash, LatLngToGeoId(latitude, longitude, 39.832277, 50) as geoId
from geoTable;
```

- Converting GeoID to longitude and latitude

  GeoIdToLatLng(geoId, oriLatitude, gridSize)

  UDF input parameters

Parameter	Type	Description
geoId	Long	Calculates the longitude and latitude based on GeoID.
oriLatitude	Double	Origin latitude, required for calculating the longitude and latitude.
gridSize	Int	Grid size, required for calculating the longitude and latitude.

NOTE

GeoID is generated based on the grid coordinates, which are the grid center. Therefore, the calculated longitude and latitude are the longitude and latitude of the grid center. There may be an error ranging from 0 degree to half of the grid size between the calculated longitude and latitude and the longitude and latitude of the generated GeoID.

UDF output parameter

Parameter	Type	Description
latitudeAndLongitude	Array[Double]	Returns the longitude and latitude coordinates of the grid center that represent the GeoID in array. The first digit indicates the latitude, and the second digit indicates the longitude.

Example:

```
select longitude, latitude, mygeohash, GeoIdToLatLng(mygeohash, 39.832277, 50) as LatitudeAndLongitude from geoTable;
```

- Calculating the upper-layer GeoID of the pyramid model

  ToUpperLayerGeoId(geoId)

  UDF input parameter

Parameter	Type	Description
geoId	Long	Calculates the upper-layer GeoID of the pyramid model based on the input GeoID.

  UDF output parameter

Parameter	Type	Description
geoId	Long	Returns the upper-layer GeoID of the pyramid model.

  Example:

```
select longitude, latitude, mygeohash, ToUpperLayerGeoId(mygeohash) as upperLayerGeoId from geoTable;
```

- Obtaining the GeoID range list using the input polygon

  ToRangeList(polygon, oriLatitude, gridSize)

  UDF input parameters

Parameter	Type	Description
polygon	String	Input polygon string, which is a pair of longitude and latitude. Longitude and latitude are separated by a space. Each pair of longitude and latitude is separated by a comma (,). The longitude and latitude at the start and end must be the same.
oriLatitude	Double	Origin latitude, required for calculating GeoID.
gridSize	Int	Grid size, required for calculating GeoID.

UDF output parameter

Parameter	Type	Description
geoIdList	Buffer[Array[Long]]	Converts polygons into GeoID range lists.

Example:

```
select ToRangeList('116.321011 40.123503, 116.137676 39.947911, 116.560993 39.935276, 116.321011 40.123503', 39.832277, 50) as rangeList from geoTable;
```

- Calculating the upper-layer longitude of the pyramid model

  ToUpperLongitude (longitude, gridSize, oriLat)

  UDF input parameters

Parameter	Type	Description
longitude	Long	Input longitude, which is a long integer.
gridSize	Int	Grid size, required for calculating longitude.
oriLatitude	Double	Origin latitude, required for calculating longitude.

  UDF output parameter

Parameter	Type	Description
longitude	Long	Returns the upper-layer longitude.

Example:

```
select ToUpperLongitude (-23575161504L, 50, 39.832277) as upperLongitude from geoTable;
```

- Calculating the upper-layer latitude of the pyramid model

  ToUpperLatitude(Latitude, gridSize, oriLat)

  UDF input parameters

Parameter	Type	Description
latitude	Long	Input latitude, which is a long integer.
gridSize	Int	Grid size, required for calculating latitude.
oriLatitude	Double	Origin latitude, required for calculating latitude.

  UDF output parameter

Parameter	Type	Description
Latitude	Long	Returns the upper-layer latitude.

  Example:

```
select ToUpperLatitude (-23575161504L, 50, 39.832277) as upperLatitude from geoTable;
```

- Converting longitude and latitude to GeoSOT

  LatLngToGridCode(latitude, longitude, level)

  UDF input parameters

Parameter	Type	Description
latitude	Double	Latitude.
longitude	Double	Longitude.
level	Int	Level. The value range is [0, 32].

  UDF output parameter

Parameter	Type	Description
geoId	Long	A number that indicates the longitude and latitude after GeoSOT encoding.

  Example:

```
select LatLngToGridCode(39.930753, 116.302895, 21) as geoId;
```

1.7 CarbonData Troubleshooting

1.7.1 Filter Result Is not Consistent with Hive when a Big Double Type Value Is Used in Filter

Symptom

When double data type values with higher precision are used in filters, incorrect values are returned by filtering results.

Possible Causes

When double data type values with higher precision are used in filters, values are rounded off before comparison. Therefore, values of double data type with different fraction part are considered same.

Troubleshooting Method

NA.

Procedure

To avoid this problem, use decimal data type when high precision data comparisons are required, such as financial applications, equality and inequality checks, and rounding operations.

Reference Information

NA.

1.7.2 Query Performance Deterioration

Symptom

The query performance fluctuates when the query is executed in different query periods.

Possible Causes

During data loading, the memory configured for each executor program instance may be insufficient, resulting in more Java GCs. When GC occurs, the query performance deteriorates.

Troubleshooting Method

On the Spark UI, the GC time of some executors is obviously higher than that of other executors, or all executors have high GC time.

Procedure

Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Spark**. Click **Configurations** then **All Configurations**, search for **spark.executor.memory** in the search box, and set it to a larger value.

Reference

None

1.8 CarbonData FAQ

1.8.1 Why Is Incorrect Output Displayed When I Perform Query with Filter on Decimal Data Type Values?

Question

Why is incorrect output displayed when I perform query with filter on decimal data type values?

For example:

select * from carbon_table where num = 1234567890123456.22;

Output:

```
+------+----------------------+--+
| name |        num           |
+------+----------------------+--+
| IAA  | 1234567890123456.22 |
| IAA  | 1234567890123456.21 |
+------+----------------------+--+
```

Answer

To obtain accurate output, append BD to the number.

For example:

select * from carbon_table where num = 1234567890123456.22BD;

Output:

```
+------+----------------------+--+
| name |        num           |
+------+----------------------+--+
| IAA  | 1234567890123456.22 |
+------+----------------------+--+
```

1.8.2 How to Avoid Minor Compaction for Historical Data?

Question

How to avoid minor compaction for historical data?

Answer

If you want to load historical data first and then the incremental data, perform following steps to avoid minor compaction of historical data:

1. Load all historical data.
2. Configure the major compaction size to a value smaller than the segment size of historical data.
3. Run the major compaction once on historical data so that these segments will not be considered later for minor compaction.
4. Load the incremental data.
5. You can configure the minor compaction threshold as required.

For example:

1. Assume that you have loaded all historical data to CarbonData and the size of each segment is 500 GB.
2. Set the threshold of major compaction property to **carbon.major.compaction.size** = **491520** (480 GB x 1024).
3. Run major compaction. All segments will be compacted because the size of each segment is more than configured size.
4. Perform incremental loading.
5. Configure the minor compaction threshold to **carbon.compaction.level.threshold** = **6,6**.
6. Run minor compaction. As a result, only incremental data is compacted.

1.8.3 How to Change the Default Group Name for CarbonData Data Loading?

Question

How to change the default group name for CarbonData data loading?

Answer

By default, the group name for CarbonData data loading is **ficommon**. You can perform the following operation to change the default group name:

1. Edit the **carbon.properties** file.
2. Change the value of the key **carbon.dataload.group.name** as required. The default value is **ficommon**.

1.8.4 Why Does INSERT INTO CARBON TABLE Command Fail?

Question

Why does the ***INSERT INTO CARBON TABLE*** command fail and the following error message is displayed?

```
Data load failed due to bad record
```

Answer

The ***INSERT INTO CARBON TABLE*** command fails in the following scenarios:

- If the data type of source and target table columns are not the same, the data from the source table will be treated as bad records and the ***INSERT INTO*** command fails.
- If the result of aggregation function on a source column exceeds the maximum range of the target column, then the ***INSERT INTO*** command fails.

  Solution:

  You can use the cast function on corresponding columns when inserting records.

  For example:

  a. Run the ***DESCRIBE*** command to query the target and source table.

     DESCRIBE *newcarbontable*;

     Result:

     ```
     col1 int
     col2 bigint
     ```

     DESCRIBE *sourcetable*;

     Result:

     ```
     col1 int
     col2 int
     ```

  b. Add the cast function to convert bigint value to integer.

     INSERT INTO *newcarbontable select col1, cast(col2 as integer) from sourcetable;*

1.8.5 Why Is the Data Logged in Bad Records Different from the Original Input Data with Escape Characters?

Question

Why is the data logged in bad records different from the original input data with escaped characters?

Answer

An escape character is a backslash (\) followed by one or more characters. If the input records contain escape characters such as \t, \b, \n, \r, \f, \', \", \\ , java will process the escape character '\' and the following characters together to obtain the escaped meaning.

For example, if the CSV data type **2010\\10,test** is inserted to String,int type, the value is treated as bad records, because **tes**t cannot be converted to int. The value logged in the bad records is **2010\10** because java processes **** as ****.

1.8.6 Why INSERT INTO/LOAD DATA Task Distribution Is Incorrect and the Opened Tasks Are Less Than the Available Executors when the Number of Initial Executors Is Zero?

Question

Why **INSERT INTO or LOAD DATA** task distribution is incorrect, and the openedtasks are less than the available executors when the number of initial executors is zero**?**

Answer

In case of INSERT INTO or LOAD DATA, CarbonData distributes one task per node. If the executors are not allocated from the distinct nodes then CarbonData will launch fewer tasks.

Solution:

Configure higher value for the executor memory and core so that the yarn can launch only one executor per node.

1. Configure the number of the Executor cores.
   - Configure the **spark.executor.cores** in **spark-defaults.conf** or the **SPARK_EXECUTOR_CORES** in **spark-env.sh** appropriately.
   - Add **--executor-cores NUM** parameter to configure the cores during use the spark-submit command.
2. Configure the Executor memory.
   - Configure the **spark.executor.memory** in **spark-defaults.conf** or the **SPARK_EXECUTOR_MEMORY** in **spark-env.sh** appropriately.
   - Add **--executor-memory MEM** parameter to configure the memory during use the spark-submit command.

1.8.7 Why Does CarbonData Require Additional Executors Even Though the Parallelism Is Greater Than the Number of Blocks to Be Processed?

Question

Why does CarbonData require additional executors even though the parallelism is greater than the number of blocks to be processed?

Answer

CarbonData block distribution optimizes data processing as follows:

1. Optimize data processing parallelism.

2. Optimize parallel reading of block data.

To optimize parallel processing and parallel read, CarbonData requests executors based on the locality of blocks so that it can obtain executors on all nodes.

If you are using dynamic allocation, you need to configure the following properties:

1. Set **spark.dynamicAllocation.executorIdleTimeout** to 15 minutes (or the average query time).
2. Set **spark.dynamicAllocation.maxExecutors** correctly. The default value **2048** is not recommended. Otherwise, CarbonData will request the maximum number of executors.
3. For a bigger cluster, set **carbon.dynamicAllocation.schedulerTimeout** to a value ranging from 10 to 15 seconds. The default value is 5 seconds.
4. Set **carbon.scheduler.minRegisteredResourcesRatio** to a value ranging from 0.1 to 1.0. The default value is **0.8**. Block distribution can be started as long as the value of **carbon.scheduler.minRegisteredResourcesRatio** is within the range.

1.8.8 Why Do I Fail to Create a Hive Table?

Question

Why do I fail to create a hive table?

Answer

Creating a Hive table fails, when source table or sub query has more number of partitions. The implementation of the query requires a lot of tasks, then the number of files will be output a lot, resulting OOM in Driver.

It can be solved by using ***distribute by*** on suitable cardinality(distinct values) column in the statement of Hive table creation.

distribute by clause limits number of hive table partitions. It considers cardinality of given column or **spark.sql.shuffle.partitions** which ever is minimal. For example, if **spark.sql.shuffle.partitions** is 200, but cardinality of column is 100, out files is 200, but the other 100 files are empty. So using very low cardinality column like 1 will cause data skew and will effect later query distribution.

So we suggest using the column with cardinality greater than **spark.sql.shuffle.partitions**. It can be greater than 2 to 3 times.

Example:

create table hivetable1 as select * from sourcetable1 distribute by col_age;

1.8.9 How Do I Logically Split Data Across Different Namespaces?

Question

How do I logically split data across different namespaces?

Answer

- Configuration:

  To logically split data across different namespaces, you must update the following configuration in the **core-site.xml** file of HDFS, Hive, and Spark.

  NOTE

  Changing the Hive component will change the locations of carbonstore and warehouse.

  - Configuration in HDFS
    - **fs.defaultFS**: Name of the default file system. The URI mode must be set to **viewfs**. When **viewfs** is used, the permission part must be **ClusterX**.
    - **fs.viewfs.mountable.ClusterX.homedir**: Home directory base path. You can use the getHomeDirectory() method defined in **FileSystem/FileContext** to access the home directory.
    - fs.viewfs.mountable.default.link.<dir_name>: ViewFS mount table.

    Example:

    ```
    <property>
    <name>fs.defaultFS</name>
    <value>viewfs://ClusterX/</value>
    </property>
    <property>
    <name>fs.viewfs.mounttable.ClusterX.link./folder1</name>
    <value>hdfs://NS1/folder1</value>
    </property>
    <property>
    <name>fs.viewfs.mounttable.ClusterX.link./folder2</name>
    <value>hdfs://NS2/folder2</value>
    </property>
    ```

  - Configurations in Hive and Spark

    fs.defaultFS: Name of the default file system. The URI mode must be set to **viewfs**. When **viewfs** is used, the permission part must be **ClusterX**.

- Syntax:

  LOAD DATA INPATH *'path to data' INTO TABLE table_name OPTIONS ('...');*

  NOTE

  When Spark is configured with the viewFS file system and attempts to load data from HDFS, users must specify a path such as **viewfs://** or a relative path as the file path in the **LOAD** statement.

- Example:
  - Sample viewFS path:

    LOAD DATA INPATH *'viewfs://ClusterX/dir/data.csv' INTO TABLE table_name OPTIONS ('...');*
  - Sample relative path:

    LOAD DATA INPATH *'/apps/input_data1.txt'* ***INTO TABLE*** *table_name*;

1.8.10 Why the UPDATE Command Cannot Be Executed in Spark Shell?

Question

Why the UPDATE command cannot be executed in Spark Shell?

Answer

The syntax and examples provided in this document are about Beeline commands instead of Spark Shell commands.

To run the UPDATE command in Spark Shell, use the following syntax:

- Syntax 1

  <carbon_context>.sql("UPDATE <CARBON TABLE> SET (column_name1, column_name2, ... column_name n) = (column1_expression , column2_expression , column3_expression ... column n_expression) [WHERE { <filter_condition> }];").show

- Syntax 2

  <carbon_context>.sql("UPDATE <CARBON TABLE> SET (column_name1, column_name2,) = (select sourceColumn1, sourceColumn2 from sourceTable [WHERE { <filter_condition> }]) [WHERE { <filter_condition> }];").show

Example:

If the context of CarbonData is **carbon**, run the following command:

carbon.sql("update carbonTable1 d set (d.column3,d.column5) = (select s.c33 ,s.c55 from sourceTable1 s where d.column1 = s.c11) where d.column1 = 'country' exists(select * from table3 o where o.c2 > 1);").show

1.8.11 How Do I Configure Unsafe Memory in CarbonData?

Question

How do I configure unsafe memory in CarbonData?

Answer

In the Spark configuration, the value of **spark.yarn.executor.memoryOverhead** must be greater than the sum of (**sort.inmemory.size.inmb** + **Netty offheapmemory required**), or the sum of (**carbon.unsafe.working.memory.in.mb** + **carbon.sort.inememory.storage.size.in.mb** + **Netty offheapmemory required**). Otherwise, if off-heap access exceeds the configured executor memory, Yarn may stop the executor.

If **spark.shuffle.io.preferDirectBufs** is set to **true**, the netty transfer service in Spark takes off some heap memory (around 384 MB or 0.1 x executor memory) from **spark.yarn.executor.memoryOverhead**.

For details, see **Configuring Executor Off-Heap Memory**.

1.8.12 Why Exception Occurs in CarbonData When Disk Space Quota is Set for Storage Directory in HDFS?

Question

Why exception occurs in CarbonData when Disk Space Quota is set for the storage directory in HDFS?

Answer

The data will be written to HDFS when you during create table, load table, update table, and so on. If the configured HDFS directory does not have sufficient disk space quota, then the operation will fail and throw following exception.

```
org.apache.hadoop.hdfs.protocol.DSQuotaExceededException:
The DiskSpace quota of /user/tenant is exceeded:
quota = 314572800 B = 300 MB but diskspace consumed = 402653184 B = 384 MB at
org.apache.hadoop.hdfs.server.namenode.DirectoryWithQuotaFeature.verifyStoragespaceQuota(DirectoryWithQuotaFeature.java:211) at
org.apache.hadoop.hdfs.server.namenode.DirectoryWithQuotaFeature.verifyQuota(DirectoryWithQuotaFeature.java:239) at
org.apache.hadoop.hdfs.server.namenode.FSDirectory.verifyQuota(FSDirectory.java:941) at
org.apache.hadoop.hdfs.server.namenode.FSDirectory.updateCount(FSDirectory.java:745)
```

If such exception occurs, configure a sufficient disk space quota for the tenant.

For example:

If the HDFS replication factor is 3 and HDFS default block size is 128 MB, then at least 384 MB (no. of block x block_size x replication_factor of the schema file = 1 x 128 x 3 = 384 MB) disk space quota is required to write a table schema file to HDFS.

NOTE

In case of fact files, as the default block size is 1024 MB, the minimum space required is 3072 MB per fact file for data load.

1.8.13 Why Does Data Query or Loading Fail and "org.apache.carbondata.core.memory.MemoryException: Not enough memory" Is Displayed?

Question

Why does data query or loading fail and "org.apache.carbondata.core.memory.MemoryException: Not enough memory" is displayed?

Answer

This exception is thrown when the out-of-heap memory required for data query and loading in the executor is insufficient.

In this case, increase the values of **carbon.unsafe.working.memory.in.mb** and **spark.yarn.executor.memoryOverhead**.

For details, see **How Do I Configure Unsafe Memory in CarbonData?**.

The memory is shared by data query and loading. Therefore, if the loading and query operations need to be performed at the same time, you are advised to set **carbon.unsafe.working.memory.in.mb** and **spark.yarn.executor.memoryOverhead** to a value greater than 2,048 MB.

The following formula can be used for estimation:

Memory required for data loading:

carbon.number.of.cores.while.loading [default value is 6] x Number of tables to load in parallel x offheap.sort.chunk.size.inmb [default value is 64 MB] + carbon.blockletgroup.size.in.mb [default value is 64 MB] + Current compaction ratio [64 MB/3.5])

= Around 900 MB per table

Memory required for data query:

(SPARK_EXECUTOR_INSTANCES. [default value is 2] x (carbon.blockletgroup.size.in.mb [default value: 64 MB] + carbon.blockletgroup.size.in.mb [default value = 64 MB x 3.5) x Number of cores per executor [default value: 1])

= ~ 600 MB

1.8.14 Why Do Files of a Carbon Table Exist in the Recycle Bin Even If the drop table Command Is Not Executed When Mis-deletion Prevention Is Enabled?

Question

Why do files of a Carbon table exist in the recycle bin even if the **drop table** command is not executed when mis-deletion prevention is enabled?

Answer

After the mis-deletion prevention is enabled for a Carbon table, calling a file deletion command will move the deleted files to the recycle bin.

The intermediate file **.carbonindex** is deleted duration the execution of the **insert** or **load** command. Therefore, the table files may exist in the recycle bin even through the **drop table** command is not executed.

If you run the **drop table** command, a table directory with a timestamp is generated. The files in the directory are complete.

1.8.15 How Do I Restore the Latest tablestatus File That Has Been Lost or Damaged When TableStatus Versioning Is Enabled?

Question

When the TableStatus versioning feature is enabled, how do I restore the latest **tablestatus** file if it is lost or damaged due to other exceptions?

Answer

Use the latest available **tablestatus** file to restore data in the following scenarios:

Scenario 1: The CarbonData data files and .segment files of the current batch are damaged and cannot be restored.

1. Log in to the client node and run the following commands to view the **tablestatus** file of the HDFS table and find the latest tablestatus version number:

   cd *Client installation path*

   source bigdata_env

   source Spark/component_env

   kinit *Component service user* (You do not need to run the **kinit** command for normal clusters.)

   hdfs dfs -ls /user/hive/warehouse/hrdb.db/car01/Metadata

   ```
   [root@192-168-64-146 Spark2x]# hdfs dfs -ls /user/hive/warehouse/hrdb.db/car01/Metadata
   Found 6 items
   -rw-r--r--   3 admintest hive        470 2022-11-21 15:41 /user/hive/warehouse/hrdb.db/car01/Metadata/schema
   drwxrwxr-x+  - admintest hive          0 2022-11-21 19:08 /user/hive/warehouse/hrdb.db/car01/Metadata/segments
   -rw-rw-r--+  3 admintest hive       1051 2022-11-21 15:52 /user/hive/warehouse/hrdb.db/car01/Metadata/tablestatus_1669017138012
   -rw-rw-r--+  3 admintest hive       1226 2022-11-21 19:07 /user/hive/warehouse/hrdb.db/car01/Metadata/tablestatus_1669028830530
   -rw-rw-r--+  3 admintest hive       1401 2022-11-21 19:07 /user/hive/warehouse/hrdb.db/car01/Metadata/tablestatus_1669028852132
   -rw-rw-r--+  3 admintest hive       1576 2022-11-21 19:08 /user/hive/warehouse/hrdb.db/car01/Metadata/tablestatus_1669028899548
   ```

   NOTE

   In the preceding figure, the **tablestatus_1669028899548** file of the current batch is damaged and the **tablestatus_1669028852132** file is required.

2. Go to Spark SQL and run the following command to change the value of **latestversion** to the latest version:

   alter table car01 set SERDEPROPERTIES ('latestversion'='1669082252132');

   ```
   spark-sql> alter table car01 set SERDEPROPERTIES ('latestversion'='1669028852132');
   Time taken: 0.513 seconds
   spark-sql> show create table car01;
   2022-11-21 19:15:14,825 | AUDIT | main | {"time":"November 21, 2022 7:15:14 PM CST","username":"admintest","opName":"S
   n.audit.logOperationStart(Auditor.java:74)
   2022-11-21 19:15:15,034 | AUDIT | main | {"time":"November 21, 2022 7:15:15 PM CST","username":"admintest","opName":"S
   e":"209 ms","table":"hrdb.car01","extraInfo":{}} | carbon.audit.logOperationEnd(Auditor.java:97)
   CREATE TABLE `hrdb`.`car01` (
     `a` INT,
     `b` STRING,
     `c` STRING)
   USING carbondata
   OPTIONS (
     `bad_record_path` '',
     `dbName` 'hrdb',
     `latestversion` '1669028852132',
     `indextableexists` 'true',
     `local_dictionary_enable` 'true',
   ```

   You need to exit the current session, reconnect to the session, and perform the query. This method has been used to restore customer data as much as

possible. Generally, segment data files on the live network cannot be restored in power-off scenarios.

Scenario 2: The CarbonData data files and .segment files of the current batch are complete and can be restored.

Use the TableStatusRecovery tool to restore non-partitioned tables. Log in to the Spark client node and run the following commands:

cd *Client installation path*

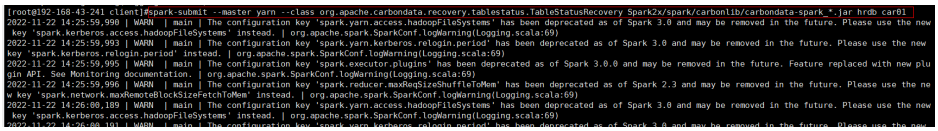
source bigdata_env

source Spark/component_env

kinit *Component service user* (You do not need to run the **kinit** command for normal clusters.)

spark-submit --master yarn --class org.apache.carbondata.recovery.tablestatus.TableStatusRecovery Spark/spark/carbonlib/carbondata-spark_*.jar *hrdb car01*

Parameter description: **hrdb car01** indicates the table name.



Restrictions on using TableStatusRecovery for restoration:

- After the merge, if the **tablestatus** file is lost or damaged, this tool cannot be used to restore the segments in the merge state because only the **tablestatus** file contains the segment merge information.
- After segments are deleted by ID or date, if the **tablestatus** file is lost or damaged, the deleted segment information cannot be restored because only the **tablestatus** file contains the segment deletion information.
- This tool cannot be used on materialized view tables.
- If the latest **tablestatus** file is faulty and query cannot be performed after using this tool for restoration, remove this latest file and use the previous **tablestatus** file for restoration.

2 Using ClickHouse

2.1 Using ClickHouse from Scratch

ClickHouse is a column-based database oriented to online analysis and processing. It supports SQL query and provides good query performance. The aggregation analysis and query performance based on large and wide tables is excellent, which is one order of magnitude faster than other analytical databases.

Prerequisites

The client has been installed in a directory, for example, **/opt/client**. The client directory in the following operations is only an example. Change it to the actual installation directory. Before using the client, download and update the client configuration file, and ensure that the active management node of Manager is available.

Procedure

Step 1 Log in to the node where the client is installed as the client installation user.

Step 2 Run the following command to go to the client installation directory:

cd /opt/client

Step 3 Run the following command to configure environment variables:

source bigdata_env

Step 4 If Kerberos authentication has been enabled for the current cluster, run the following command to authenticate the user. The current user must have the permission to create ClickHouse tables. If Kerberos authentication is disabled for the current cluster, skip this step.

kinit *Component service user*

Example: **kinit clickhouseuser**

Step 5 Run the client command of the ClickHouse component.

Run the **clickhouse -h** command to view the command help of ClickHouse.

The command output is as follows:

```
Use one of the following commands:
clickhouse local [args]
clickhouse client [args]
clickhouse benchmark [args]
clickhouse server [args]
clickhouse performance-test [args]
clickhouse extract-from-config [args]
clickhouse compressor [args]
clickhouse format [args]
clickhouse copier [args]
clickhouse obfuscator [args]
...
```

For MRS 3.1.2 or later, run the **clickhouse client** command to connect to the ClickHouse server.

- Command for using a non-SSL mode to log in to a ClickHouse cluster with Kerberos authentication disabled

  clickhouse client --host *IP address of the ClickHouse instance* **--port 9000 --user** *Username* **--password**

  Enter the user password.

- Using SSL for login when Kerberos authentication is enabled for the current cluster:

  There are no default users in clusters with Kerberos authentication enabled. You must create a user on FusionInsight Manager.

  clickhouse client --host *IP address of the ClickHouse instance* **--port 9440 --user** *Username* **--password --secure**

  Enter the user password.

Run the **quit;** command to exit the ClickHouse server connection.

Table 2-1 describes related parameters.

Table 2-1 Parameters of the **clickhouse client** command

Parameter	Description
--host	Host name of the server. The default value is **localhost**. You can use the host name or IP address of the node where the ClickHouse instance is located. **NOTE** You can log in to FusionInsight Manager and choose **Cluster** > **Services** > **ClickHouse** > **Instance** to obtain the service IP address of the ClickHouseServer instance.
--port	Port for connection. • If the SSL security connection is used, the default port number is **9440**, the parameter **--secure** must be carried. For details about the port number, search for the **tcp_port_secure** parameter in the ClickHouseServer instance configuration. • If non-SSL security connection is used, the default port number is **9000**, the parameter **--secure** does not need to be carried. For details about the port number, search for the **tcp_port** parameter in the ClickHouseServer instance configuration.

Parameter	Description
--user	Username. You can create a user on FusionInsight Manager and bind roles to it. ● If Kerberos authentication has been enabled for the current cluster (the cluster is in security mode) and the user authentication is successful, you do not need to carry the **--user** and **--password** parameters during your login to the client as the authenticated user. You must create a user with this name on Manager because there is no default user in the Kerberos cluster scenario. ● If Kerberos authentication has not been enabled for the current cluster (the cluster is in normal mode), you cannot use the ClickHouse user created on FusionInsight Manager if you need to specify the username and password when you log in to the client. You need to execute the **create user SQL** statement on the client to create a ClickHouse user. If you do not need to specify the username and password during your login to the client, the default user is used by default.
--password	Password. The default password is an empty string. This parameter is used together with the **--user** parameter. You can set a password when creating a user on Manager.
--query	Query to process when using non-interactive mode.
--database	Current default database. The default value is **default**, which is the default configuration on the server.
--multiline	If this parameter is specified, multiline queries are allowed. (**Enter** only indicates line feed and does not indicate that the query statement is complete.)
--multiquery	If this parameter is specified, multiple queries separated with semicolons (;) can be processed. This parameter is valid only in non-interactive mode.
--format	Specified default format used to output the result.
--vertical	If this parameter is specified, the result is output in vertical format by default. In this format, each value is printed on a separate line, which helps to display a wide table.
--time	If this parameter is specified, the query execution time is printed to **stderr** in non-interactive mode.
--stacktrace	If this parameter is specified, stack trace information will be printed when an exception occurs.
--config-file	Name of the configuration file.
--secure	If this parameter is specified, the server will be connected in SSL mode.

Parameter	Description
--history_file	Path of files that record command history.
--param_<name>	Query with parameters. Pass values from the client to the server.

----End

2.2 ClickHouse Permission Management

2.2.1 ClickHouse User and Permission Management

User Permission Model

ClickHouse user permission management enables unified management of users, roles, and permissions on each ClickHouse instance in the cluster. You can use the permission management module of the Manager UI to create users, create roles, and bind the ClickHouse access permissions. User permissions are controlled by binding roles to users.

Resource management: **Table 2-2** lists the resources supported by ClickHouse permission management.

Resource permissions: **Table 2-3** lists the resource permissions supported by ClickHouse.

Table 2-2 Permission management objects supported by ClickHouse

Resource	Integration	Remarks
Database	Yes (level 1)	-
Table	Yes (level 2)	-
View	Yes (level 2)	Same as tables

Table 2-3 Resource permission list

Resource	Available Permission	Remarks
Database	CREATE	CREATE DATABASE/TABLE/VIEW/DICTIONARY
Database	DELETE	DROP/TRUNCATE DATABASE/TABLE/VIEW/DICTIONARY

Resource	Available Permission	Remarks
Database	ADMIN	CREATE/SHOW/SELECT/INSERT/ ALTER/DROP/TRUNCATE/ OPTIMIZE/SYSTEM/dictGet
Table/View/Dictionary	READ	SELECT
Table/View/Dictionary	WRITE	INSERT
Table/View/Dictionary	DELETE	ALTER
Table/View/Dictionary	DELETE	DROP/TRUNCATE

Prerequisites

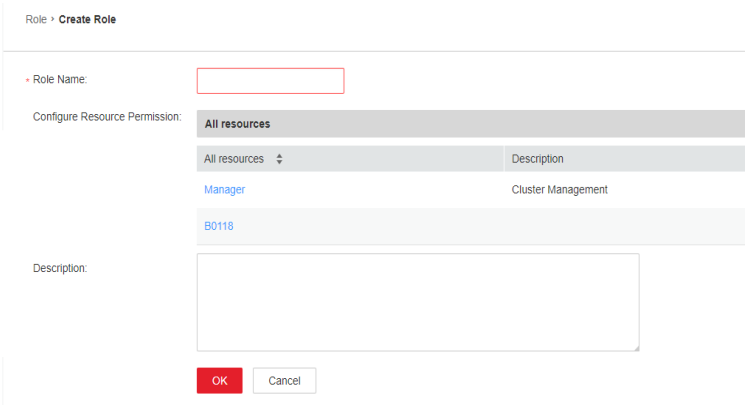
- The ClickHouse and Zookeeper services are running properly.
- The **ON CLUSTER** statement has been used to create a database or table in the cluster to ensure that the metadata of the database and table on each ClickHouse node is the same.

NOTE

After the permission is granted, it takes about 1 minute for the permission to take effect.

Adding the ClickHouse Role

Step 1 Log in to Manager and choose **System** > **Permission** > **Role**. On the **Role** page, click **Create Role**.



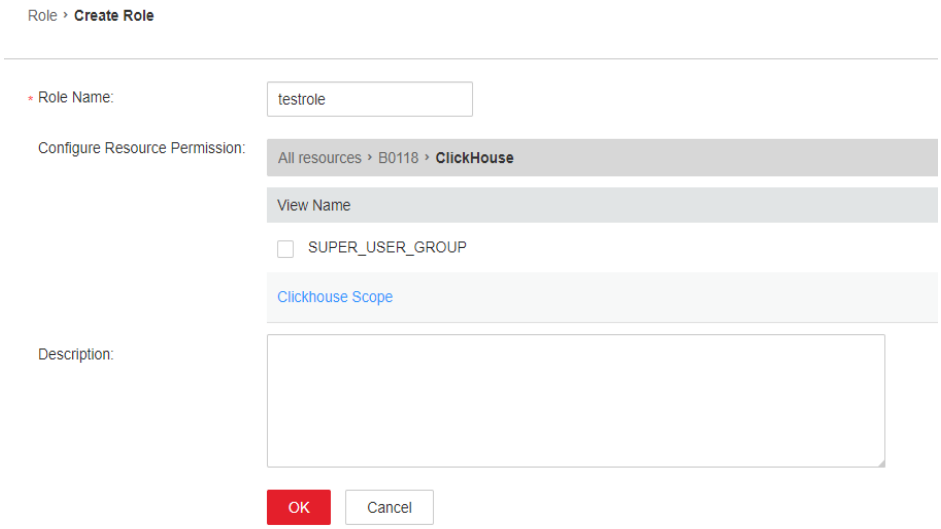
Step 2 On the **Create Role** page, specify **Role Name**. In the **Configure Resource Permission** area, click the cluster name. On the service list page that is displayed, click the ClickHouse service.

Determine whether to create a role with the ClickHouse administrator permissions based on service requirements.

NOTE

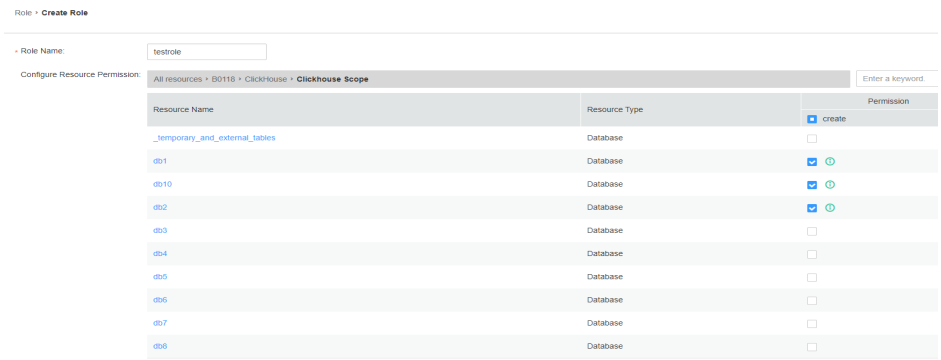
- The ClickHouse administrator has all the database operation permissions except the permissions to create, delete, and modify users and roles.
- Only the built-in user **clickhouse** of ClickHouse has the permission to manage users and roles.

- If yes, go to **Step 3**.
- If no, go to **Step 4**.



Step 3 Select **SUPER_USER_GROUP** and click **OK**.

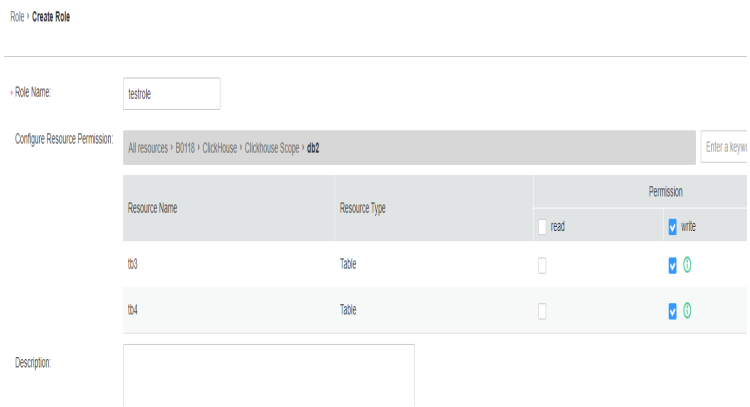
Step 4 Click **Clickhouse Scope**. The ClickHouse database resource list is displayed. If you select **create**, the role has the create permission on the database.



Determine whether to grant the permission based on the service requirements.

- If yes, click **OK**.
- If no, go to **Step 5**.

Step 5 Click the resource name and select the *Database resource name to be operated*. On the displayed page, select **READ** (SELECT permission) or **WRITE** (INSERT permission) based on service requirements, and click **OK**.



----End

Adding a User and Binding the ClickHouse Role to the User

Step 1 Log in to Manager and choose **System** > **Permission** > **User** and click **Create**.

Step 2 Select **Human-Machine** for **User Type** and set **Password** and **Confirm Password** to the password of the user.

NOTE

- Username: The username cannot contain hyphens (-). Otherwise, the authentication will fail.
- Password: The password cannot contain special characters $, ., and #. Otherwise, the authentication will fail.

Step 3 In the **Role** area, click **Add**. In the displayed dialog box, select a role with the ClickHouse permission and click **OK** to add the role. Then, click **OK**.

Step 4 Log in to the node where the ClickHouse client is installed and use the new username and password to connect to the ClickHouse service.

1. Run the following command to go to the client installation directory:

   cd /opt/*Client installation directory*

2. Run the following command to configure environment variables:

   source bigdata_env

3. Run the following commands to connect to ClickHouse. The commands require the permission to create ClickHouse tables. For details about how to obtain the permission, see **Adding the ClickHouse Role**.

   Cluster with Kerberos authentication enabled:

   clickhouse client --host *IP address of the ClickHouse instance***--user** *Username* **--password --port** 9440 **--secure**

   Enter the password.

   Cluster with Kerberos authentication disabled:

   clickhouse client --host *ClickHouse instance IP address* **--user***Username* **--multiline --port** *ClickHouse port number*

NOTE

- The **default** user is automatically used in the command for clusters that do not require Kerberos authentication. To specify other users, you can add a management user by using the function provided in the ClickHouse open source community, or use FusionInsight Manager to add a user with the ClickHouse permission.
- For the **default** user, run the following command:

  clickhouse client --host *ClickHouse instance IP address* **--user default --password --port** *ClickHouse port number*

  Enter the password.
- To obtain the IP address of the ClickHouse instance, log in to FusionInsight Manager, choose **Cluster** > **Services** > **ClickHouse**, and click the **Instance** tab.

----End

Granting Permissions Using the Client in Abnormal Scenarios

By default, the table metadata on each node of the ClickHouse cluster is the same. Therefore, the table information on a random ClickHouse node is collected on the permission management page of Manager. If the **ON CLUSTER** statement is not used when databases or tables are created on some nodes, the resource may fail to be displayed during permission management, and permissions may not be granted to the resource. To grant permissions on the local table on a single ClickHouse node, perform the following steps on the background client.

NOTE

The following operations are performed based on the obtained roles, database or table names, and IP addresses of the node where the corresponding ClickHouseServer instance is located.

- You can log in to FusionInsight Manager and choose **Cluster** > **Services** > **ClickHouse** > **Instance** to obtain the service IP address of the ClickHouseServer instance.
- The default system domain name is **hadoop.com**. Log in to FusionInsight Manager and choose **System** > **Permission** > **Domain and Mutual Trust**. The value of **Local Domain** is the system domain name. Change the letters to lowercase letters when running a command.

Step 1 Log in to the node where the ClickHouseServer instance is located as user **root**.

Step 2 Run the following command to obtain the path of the **clickhouse.keytab** file:

ls ${BIGDATA_HOME}/FusionInsight_ClickHouse_*/install/FusionInsight-ClickHouse-*/clickhouse/keytab/clickhouse.keytab

Step 3 Log in to the node where the client is installed as the client installation user.

Step 4 Run the following command to go to the client installation directory:

cd /opt/client

Step 5 Run the following command to configure environment variables:

source bigdata_env

For an MRS 3.1.0 cluster with Kerberos authentication enabled, additionally run the following command:

export CLICKHOUSE_SECURITY_ENABLED=true

Step 6 Run the following command to connect to the ClickHouseServer instance:

If Kerberos authentication is enabled for the current cluster, run the following command:

clickhouse client --host *IP address of the node where the ClickHouseServer instance is located* **--user clickhouse/hadoop.***<System domain name>* **--password** *clickhouse.keytab path obtained in* ***Step 2*** **--port** *ClickHouse port number* **--secure**

If Kerberos authentication is disabled for the current cluster, run the following command:

clickhouse client --host *IP address of the node where the ClickHouseServer instance is located* **--user clickhouse --port** *ClickHouse port number*

Step 7 Run the following statement to grant permissions to a database:

In the syntax for granting permissions, *DATABASE* indicates the name of the target database, and *role* indicates the target role.

GRANT [ON CLUSTER *cluster_name***]** *privilege* **ON** *{DATABASE|TABLE}* **TO** *{user | role]*

For example, grant user **testuser** the CREATE permission on database **t2**:

GRANT CREATE ON *m2* **to** *testuser***;**

Step 8 Run the following commands to grant permissions on the table or view. In the following command, *TABLE* indicates the name of the table or view to be operated, and *user* indicates the role to be operated.

Run the following command to grant the query permission on tables in a database:

GRANT SELECT ON *TABLE* **TO** *user;*

Run the following command to grant the write permission on tables in a database:

GRANT INSERT ON *TABLE* **TO** *user***;**

Step 9 Run the following command to exit the client:

quit;

----End

2.2.2 Changing the Passwords of Default and ClickHouse Users

After a ClickHouse cluster is created, you can use the ClickHouse client to connect to the ClickHouse server.

Set the passwords of default ClickHouse users **default** and **clickhouse** after creating a ClickHouse cluster in normal mode.

NOTE

- **default** and **clickhouse** are default internal administrators of a ClickHouse cluster in normal mode (with Kerberos authentication disabled).
- For a ClickHouse cluster in normal mode, if the default passwords of the default users **default** and **clickhouse** have been changed and the ClickHouseServer node is reinstalled, the passwords will be reset. You need to change the passwords again.

Configuring the Passwords of the Default ClickHouse User

Step 1 Log in to the node where ClickHouse is installed as user **root**, switch to user **omm**, and go to the **$BIGDATA_HOME/FusionInsight_ClickHouse_*/install/FusionInsight-ClickHouse-*/clickhouse/clickhouse_change_password** directory.

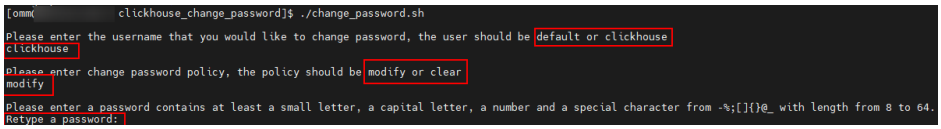
su - omm

cd $BIGDATA_HOME/FusionInsight_ClickHouse_*/install/FusionInsight-ClickHouse-*/clickhouse/clickhouse_change_password

Step 2 Run the following command to change the password of user **default** or **clickhouse**:

./change_password.sh

In the following figure, user **clickhouse** is used as an example. Enter **clickhouse** and its password as prompted, and wait until the password is changed.



NOTE

The password must meet the following complexity requirements:

- Contains 8 to 64 characters.
- Contains at least one lowercase letter, one uppercase letter, one number, and one special character (-%;[]{}@_).

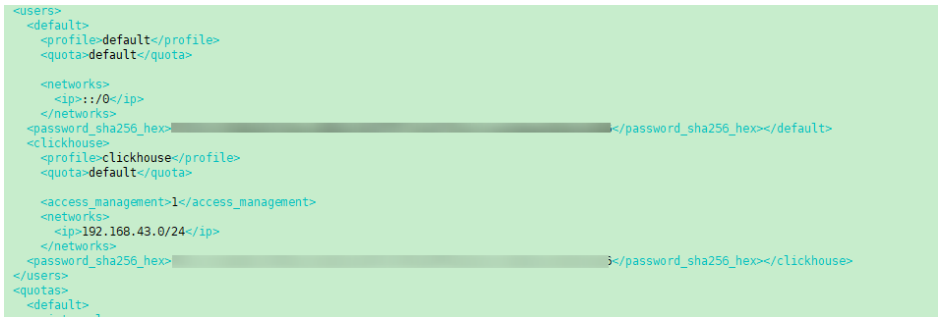
Step 3 Check the password change result.

Log in to the ClickHouse Server node and check the value of **password_sha256_hex** in the **${BIGDATA_HOME}/FusionInsight_ClickHouse_*/*_ClickHouseServer/etc/users.xml** file. The value is the new password.

cd ${BIGDATA_HOME}/*FusionInsight_ClickHouse_*/*_ClickHouseServer***/etc/**

vi users.xml

As shown in the following figure, the new password is stored in the **password_sha256_hex** file.



----End

2.2.3 Clearing the Passwords of the Default and ClickHouse Users

After a ClickHouse cluster in normal mode is created, set the passwords of default users **default** and **clickhouse**.

NOTE

- **default** and **clickhouse** are default internal administrators of a ClickHouse cluster in normal mode (with Kerberos authentication disabled).

Clearing the Passwords of the Default and ClickHouse Users

Step 1 Log in to FusionInsight Manager, choose **Cluster** > **Service** > **ClickHouse** > **Configurations** > **All Configurations**, search for **ALLOW_CLEAR_INTERNAL_ACCOUNT_PASSWORD**, and change the value to **true**.

Step 2 Log in to the node where ClickHouse is installed as user **root**, switch to user **omm**, and go to the **$BIGDATA_HOME/FusionInsight_ClickHouse_*/install/FusionInsight-ClickHouse-*/clickhouse/clickhouse_change_password** directory.

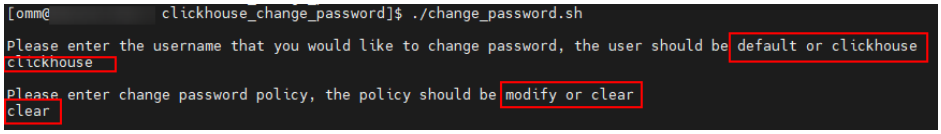
su - omm

cd $BIGDATA_HOME/FusionInsight_ClickHouse_*/install/FusionInsight-ClickHouse-*/clickhouse/clickhouse_change_password

Step 3 Run the following command to clear the password of user **default** or **clickhouse**:

./change_password.sh

In the following figure, user **clickhouse** is used as an example. Enter **clickhouse** and its password as prompted, and wait until the password is cleared.



Step 4 Verify that the password is cleared.

Log in to the ClickHouse Server node and check whether the value of **password** in the **${BIGDATA_HOME}/FusionInsight_ClickHouse_*/*_ClickHouseServer/etc/users.xml** file is empty.

cd ${BIGDATA_HOME}/*FusionInsight_ClickHouse_*/*_ClickHouseServer***/etc/**

vi users.xml

The following example shows an empty password.

```
<clickhouse>
  <profile>clickhouse</profile>
  <quota>default</quota>
  <password/>
  <access_management>1</access_management>
  <networks>
    <ip>192.168.67.0/24</ip>
  </networks>
</clickhouse>
```

----End

2.3 ClickHouse Table Engine Overview

Background

Table engines play a key role in ClickHouse to determine:

- Where to write and read data
- Supported query modes
- Whether concurrent data access is supported
- Whether indexes can be used
- Whether multi-thread requests can be executed
- Parameters used for data replication

This section describes MergeTree and Distributed engines, which are the most important and frequently used ClickHouse table engines.

MergeTree Family

Engines of the MergeTree family are the most universal and functional table engines for high-load tasks. They have the following key features:

- Data is stored by partition and block based on partitioning keys.
- Data index is sorted based on primary keys and the **ORDER BY** sorting keys.
- Data replication is supported by table engines prefixed with Replicated.
- Data sampling is supported.

When data is written, a table with this type of engine divides data into different folders based on the partitioning key. Each column of data in the folder is an independent file. A file that records serialized index sorting is created. This structure reduces the volume of data to be retrieved during data reading, greatly improving query efficiency.

- MergeTree

  Syntax for creating a table:

```
CREATE TABLE [IF NOT EXISTS] [db.]table_name [ON CLUSTER cluster]
(
   name1 [type1] [DEFAULT|MATERIALIZED|ALIAS expr1] [TTL expr1],
   name2 [type2] [DEFAULT|MATERIALIZED|ALIAS expr2] [TTL expr2],
   ...
   INDEX index_name1 expr1 TYPE type1(...) GRANULARITY value1,
   INDEX index_name2 expr2 TYPE type2(...) GRANULARITY value2
) ENGINE = MergeTree()
ORDER BY expr
[PARTITION BY expr]
[PRIMARY KEY expr]
[SAMPLE BY expr]
[TTL expr [DELETE|TO DISK 'xxx'|TO VOLUME 'xxx'], ...]
[SETTINGS name=value, ...]
```

Example:

```
CREATE TABLE default.test (
  name1 DateTime,
  name2 String,
  name3 String,
  name4 String,
  name5 Date,
  ...
) ENGINE = MergeTree()
PARTITION BY toYYYYMM(name5)
ORDER BY (name1, name2)
SETTINGS index_granularity = 8192
```

Parameters in the example are described as follows:

- **ENGINE = MergeTree()**: specifies the MergeTree engine.
- **PARTITION BY toYYYYMM(name4)**: specifies the partition. The sample data is partitioned by month, and a folder is created for each month.
- **ORDER BY**: specifies the sorting field. A multi-field index can be sorted. If the first field is the same, the second field is used for sorting, and so on.
- **index_granularity = 8192**: specifies the index granularity. One index value is recorded for every 8,192 data records.

If the data to be queried exists in a partition or sorting field, the data query time can be greatly reduced.

- ReplacingMergeTree

  Different from MergeTree, ReplacingMergeTree deletes duplicate entries with the same sorting key. ReplacingMergeTree is suitable for clearing duplicate data to save space, but it does not guarantee the absence of duplicate data. Generally, it is not recommended.

  Syntax for creating a table:

  ```
  CREATE TABLE [IF NOT EXISTS] [db.]table_name [ON CLUSTER cluster]
  (
     name1 [type1] [DEFAULT|MATERIALIZED|ALIAS expr1],
     name2 [type2] [DEFAULT|MATERIALIZED|ALIAS expr2],
     ...
  ) ENGINE = ReplacingMergeTree([ver])
  [PARTITION BY expr]
  [ORDER BY expr]
  [SAMPLE BY expr]
  [SETTINGS name=value, ...]
  ```

- SummingMergeTree

  When merging data parts in SummingMergeTree tables, ClickHouse merges all rows with the same primary key into one row that contains summed values for the columns with the numeric data type. If the primary key is composed in a way that a single key value corresponds to large number of

rows, storage volume can be significantly reduced and the data query speed can be accelerated.

Syntax for creating a table:

```
CREATE TABLE [IF NOT EXISTS] [db.]table_name [ON CLUSTER cluster]
(
    name1 [type1] [DEFAULT|MATERIALIZED|ALIAS expr1],
    name2 [type2] [DEFAULT|MATERIALIZED|ALIAS expr2],
    ...
) ENGINE = SummingMergeTree([columns])
[PARTITION BY expr]
[ORDER BY expr]
[SAMPLE BY expr]
[SETTINGS name=value, ...]
```

Example:

Create a SummingMergeTree table named **testTable**.

```
CREATE TABLE testTable
(
    id UInt32,
    value UInt32
)
ENGINE = SummingMergeTree()
ORDER BY id
```

Insert data into the table.

```
INSERT INTO testTable Values(5,9),(5,3),(4,6),(1,2),(2,5),(1,4),(3,8);
INSERT INTO testTable Values(88,5),(5,5),(3,7),(3,5),(1,6),(2,6),(4,7),(4,6),(43,5),(5,9),(3,6);
```

Query all data in unmerged parts.

```
SELECT * FROM testTable
┌─id─┬─value─┐
│  1 │     6 │
│  2 │     5 │
│  3 │     8 │
│  4 │     6 │
│  5 │    12 │
└────┴───────┘
┌─id─┬─value─┐
│  1 │     6 │
│  2 │     6 │
│  3 │    18 │
│  4 │    13 │
│  5 │    14 │
│ 43 │     5 │
│ 88 │     5 │
└────┴───────┘
```

If ClickHouse has not summed up all rows and you need to aggregate data by ID, use the **sum** function and **GROUP BY** statement.

```
SELECT id, sum(value) FROM testTable GROUP BY id
┌─id─┬─sum(value)─┐
│  4 │         19 │
│  3 │         26 │
│ 88 │          5 │
│  2 │         11 │
│  5 │         26 │
│  1 │         12 │
│ 43 │          5 │
└────┴────────────┘
```

Merge rows manually.

```
OPTIMIZE TABLE testTable
```

Query data in the **testTable** table again.

```
SELECT * FROM testTable
┌─id─┬─value─┐
```

```
┌─id─┬─sum(sum)─┐
│  1 │       12 │
│  2 │       11 │
│  3 │       26 │
│  4 │       19 │
│  5 │       26 │
│ 43 │        5 │
│ 88 │        5 │
└────┴──────────┘
```

SummingMergeTree uses the **ORDER BY** sorting keys as the condition keys to aggregate data. That is, if sorting keys are the same, data records are merged into one and the specified merged fields are aggregated.

Data is pre-aggregated only when merging is executed in the background, and the merging execution time cannot be predicted. Therefore, it is possible that some data has been pre-aggregated and some data has not been aggregated. Therefore, the **GROUP BY** statement must be used during aggregation.

- AggregatingMergeTree

  AggregatingMergeTree is a pre-aggregation engine used to improve aggregation performance. When merging partitions, the AggregatingMergeTree engine aggregates data based on predefined conditions, calculates data based on predefined aggregate functions, and saves the data in binary format to tables.

  Syntax for creating a table:

  ```
  CREATE TABLE [IF NOT EXISTS] [db.]table_name [ON CLUSTER cluster]
  (
     name1 [type1] [DEFAULT|MATERIALIZED|ALIAS expr1],
     name2 [type2] [DEFAULT|MATERIALIZED|ALIAS expr2],
     ...
  ) ENGINE = AggregatingMergeTree()
  [PARTITION BY expr]
  [ORDER BY expr]
  [SAMPLE BY expr]
  [TTL expr]
  [SETTINGS name=value, ...]
  ```

  Example:

  You do not need to set the AggregatingMergeTree parameter separately. When partitions are merged, data in each partition is aggregated based on the **ORDER BY** sorting key. You can set the aggregate functions to be used and column fields to be calculated by defining the AggregateFunction type, as shown in the following example:

  ```
  create table test_table (
  name1 String,
  name2 String,
  name3 AggregateFunction(uniq,String),
  name4 AggregateFunction(sum,Int),
  name5 DateTime
  ) ENGINE = AggregatingMergeTree()
  PARTITION BY toYYYYMM(name5)
  ORDER BY (name1,name2)
  PRIMARY KEY name1;
  ```

  When data of the AggregateFunction type is written or queried, the ***state** and ***merge** functions need to be called. The asterisk (*) indicates the aggregate functions used for defining the field type. For example, the **uniq** and **sum** functions are specified for the **name3** and **name4** fields defined in the **test_table**, respectively. Therefore, you need to call the **uniqState** and **sumState** functions and run the **INSERT** and **SELECT** statements when writing data into the table.

```
insert into test_table select '8','test1',uniqState('name1'),sumState(toInt32(100)),'2021-04-30
17:18:00';
insert into test_table select '8','test1',uniqState('name1'),sumState(toInt32(200)),'2021-04-30
17:18:00';
```

When querying data, you need to call the corresponding functions **uniqMerge** and **sumMerge**.

```
select name1,name2,uniqMerge(name3),sumMerge(name4) from test_table group by name1,name2;
┌─name1─┬─name2─┬─uniqMerge(name3)─┬─sumMerge(name4)─┐
│ 8     │ test1 │                1 │             300 │
└───────┴───────┴──────────────────┴─────────────────┘
```

AggregatingMergeTree is more commonly used with materialized views, which are query views of other data tables at the upper layer.

- CollapsingMergeTree

  CollapsingMergeTree defines a **Sign** field to record status of data rows. If **Sign** is **1**, the data in this row is valid. If **Sign** is **-1**, the data in this row needs to be deleted.

  Syntax for creating a table:

  ```
  CREATE TABLE [IF NOT EXISTS] [db.]table_name [ON CLUSTER cluster]
  (
     name1 [type1] [DEFAULT|MATERIALIZED|ALIAS expr1],
     name2 [type2] [DEFAULT|MATERIALIZED|ALIAS expr2],
     ...
  ) ENGINE = CollapsingMergeTree(sign)
  [PARTITION BY expr]
  [ORDER BY expr]
  [SAMPLE BY expr]
  [SETTINGS name=value, ...]
  ```

- VersionedCollapsingMergeTree

  The VersionedCollapsingMergeTree engine adds **Version** to the table creation statement to record the mapping between a **state** row and a **cancel** row in case that rows are out of order. The rows with the same primary key, same **Version**, and opposite **Sign** will be deleted during compaction.

  Syntax for creating a table:

  ```
  CREATE TABLE [IF NOT EXISTS] [db.]table_name [ON CLUSTER cluster]
  (
     name1 [type1] [DEFAULT|MATERIALIZED|ALIAS expr1],
     name2 [type2] [DEFAULT|MATERIALIZED|ALIAS expr2],
     ...
  ) ENGINE = VersionedCollapsingMergeTree(sign, version)
  [PARTITION BY expr]
  [ORDER BY expr]
  [SAMPLE BY expr]
  [SETTINGS name=value, ...]
  ```

- GraphiteMergeTree

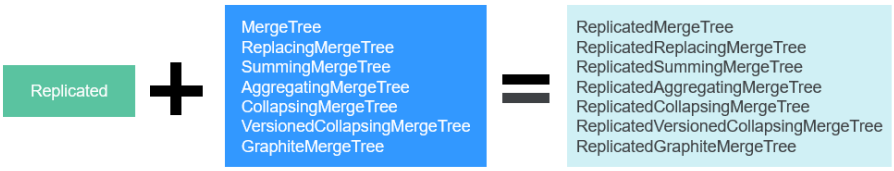
  The GraphiteMergeTree engine is used to store data in the time series database Graphite.

  Syntax for creating a table:

  ```
  CREATE TABLE [IF NOT EXISTS] [db.]table_name [ON CLUSTER cluster]
  (
     Path String,
     Time DateTime,
     Value <Numeric_type>,
     Version <Numeric_type>
     ...
  ) ENGINE = GraphiteMergeTree(config_section)
  [PARTITION BY expr]
  [ORDER BY expr]
  [SAMPLE BY expr]
  [SETTINGS name=value, ...]
  ```

Replicated*MergeTree Engines

All engines of the MergeTree family in ClickHouse prefixed with Replicated become MergeTree engines that support replicas.



Replicated series engines use ZooKeeper to synchronize data. When a replicated table is created, all replicas of the same shard are synchronized based on the information registered with ZooKeeper.

Template for creating a Replicated engine:

```
ENGINE = Replicated*MergeTree('Storage path in ZooKeeper','Replica name', ...)
```

Two parameters need to be specified for a Replicated engine:

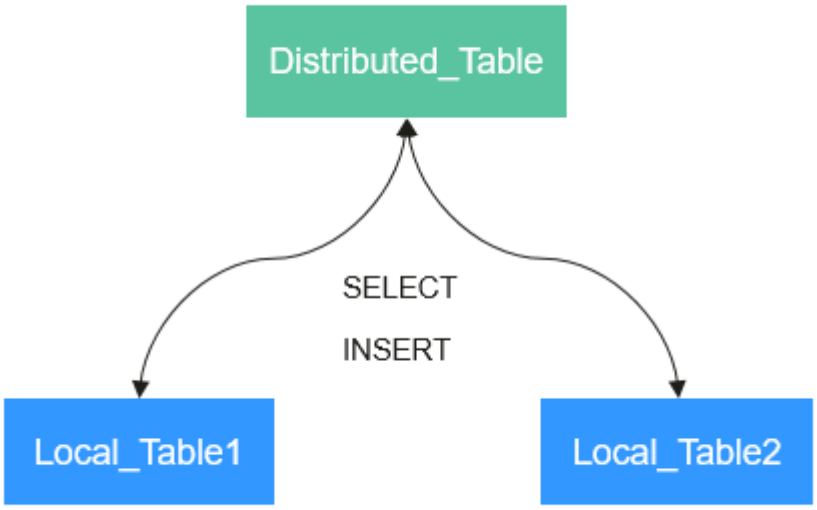
- *Storage path in ZooKeeper*: specifies the path for storing table data in ZooKeeper. The path format is ***/clickhouse/tables/{shard}/Database name/Table name***.
- *Replica name*: Generally, **{replica}** is used.

For details about the example, see **Creating a ClickHouse Table**.

Distributed Engine

The Distributed engine does not store any data. It serves as a transparent proxy for data shards and can automatically transmit data to each node in the cluster. Distributed tables need to work with other local data tables. Distributed tables distribute received read and write tasks to each local table where data is stored.

Figure 2-1 Working principle of the Distributed engine



Template for creating a Distributed engine:

```
ENGINE = Distributed(cluster_name, database_name, table_name, [sharding_key])
```

Parameters of a distributed table are described as follows:

- **cluster_name**: specifies the cluster name. When a distributed table is read or written, the cluster configuration information is used to search for the corresponding ClickHouse instance node.
- **database_name**: specifies the database name.
- **table_name**: specifies the name of a local table in the database. It is used to map a distributed table to a local table.
- **sharding_key** (optional): specifies the sharding key, based on which a distributed table distributes data to each local table.

Example:

```
-- Create a ReplicatedMergeTree local table named test.
CREATE TABLE default.test ON CLUSTER default_cluster_1
(
    `EventDate` DateTime,
    `id` UInt64
)
ENGINE = ReplicatedMergeTree('/clickhouse/tables/{shard}/default/test', '{replica}')
PARTITION BY toYYYYMM(EventDate)
ORDER BY id

-- Create a distributed table named test_all based on the local table test.
CREATE TABLE default.test_all ON CLUSTER default_cluster_1
(
    `EventDate` DateTime,
    `id` UInt64
)
ENGINE = Distributed(default_cluster_1, default, test, rand())
```

Rules for creating a distributed table:

- When creating a distributed table, add **ON CLUSTER** *cluster_name* to the table creation statement so that the statement can be executed once on a ClickHouse instance and then distributed to all instances in the cluster for execution.
- Generally, a distributed table is named in the following format: *Local table name*_all. It forms a one-to-many mapping with local tables. Then, multiple local tables can be operated using the distributed table proxy.
- Ensure that the structure of a distributed table is the same as that of local tables. If they are inconsistent, no error is reported during table creation, but an exception may be reported during data query or insertion.

2.4 Creating a ClickHouse Table

ClickHouse implements the replicated table mechanism based on the ReplicatedMergeTree engine and ZooKeeper. When creating a table, you can specify an engine to determine whether the table is highly available. Shards and replicas of each table are independent of each other.

ClickHouse also implements the distributed table mechanism based on the Distributed engine. Views are created on all shards (local tables) for distributed query, which is easy to use. ClickHouse has the concept of data sharding, which is one of the features of distributed storage. That is, parallel read and write are used to improve efficiency.

The ClickHouse cluster table engine that uses Kunpeng as the CPU architecture does not support HDFS and Kafka.

Viewing cluster and Other Environment Parameters of ClickHouse

Step 1 Use the ClickHouse client to connect to the ClickHouse server by referring to **Using ClickHouse from Scratch**.

Step 2 Query the cluster identifier and other information about the environment parameters.

select cluster,shard_num,replica_num,host_name from system.clusters;

```
SELECT
    cluster,
    shard_num,
    replica_num,
    host_name
FROM system.clusters
```

```
┌─cluster─────────────┬─shard_num─┬─replica_num─┬─host_name──────────┐
│ default_cluster_1   │         1 │           1 │ node-master1dOnG   │
│ default_cluster_1   │         1 │           2 │ node-group-1tXED0001 │
│ default_cluster_1   │         2 │           1 │ node-master2OXQS   │
│ default_cluster_1   │         2 │           2 │ node-group-1tXED0002 │
│ default_cluster_1   │         3 │           1 │ node-master3QsRI   │
│ default_cluster_1   │         3 │           2 │ node-group-1tXED0003 │
└─────────────────────┴───────────┴─────────────┴────────────────────┘

6 rows in set. Elapsed: 0.001 sec.
```

Step 3 Query the shard and replica identifiers.

select * from system.macros;

```
SELECT *
FROM system.macros
```

```
┌─macro───────┬─substitution─┐
│ id          │ 76           │
│ replica     │ 2            │
│ shard       │ 3            │
└─────────────┴──────────────┘
```

3 rows in set. Elapsed: 0.001 sec.

----End

Creating a Local Replicated Table and a distributed Table

Step 1 Log in to the ClickHouse node using the client, for example, **clickhouse client --host** *node-master3QsRI* **--multiline --port 9440 --secure;**

NOTE

node-master3QsRI is the value of **host_name** obtained in **Step 2** in **Viewing cluster and Other Environment Parameters of ClickHouse**.

Step 2 Create a replicated table using the ReplicatedMergeTree engine.

For example, run the following commands to create a ReplicatedMergeTree table named **test** on the **default_cluster_1** node and in the **default** database:

CREATE TABLE *default.test* **ON CLUSTER** *default_cluster_1*

(

`EventDate` DateTime,

`id` UInt64

)

ENGINE = ReplicatedMergeTree('*/clickhouse/tables/{shard}/default/test***', '***{replica}***')**

PARTITION BY toYYYYMM(EventDate)

ORDER BY id;

The parameters are described as follows:

- The **ON CLUSTER** syntax indicates the distributed DDL, that is, the same local table can be created on all instances in the cluster after the statement is executed once.
- **default_cluster_1** is the cluster identifier obtained in **Step 2** in **Viewing cluster and Other Environment Parameters of ClickHouse**.

CAUTION

ReplicatedMergeTree engine receives the following two parameters:

- Storage path of the table data in ZooKeeper

  The path must be in the **/clickhouse** directory. Otherwise, data insertion may fail due to insufficient ZooKeeper quota.

  To avoid data conflict between different tables in ZooKeeper, the directory must be in the following format:

  /clickhouse/tables/{shard}/default/test, in which **/clickhouse/tables/{shard}** is fixed, *default* indicates the database name, and *text* indicates the name of the created table.

  If multiple ClickHouse services are installed in the cluster, for example, the ZooKeeper path of **clickhouse-1** is **/clickhouse-1/tables/{shard}/**.

- **{replica}** is typically used to represent the replica name.

```
CREATE TABLE default.test ON CLUSTER default_cluster_1
(
   `EventDate` DateTime,
   `id` UInt64
)
ENGINE = ReplicatedMergeTree('/clickhouse/tables/{shard}/default/test', '{replica}')
PARTITION BY toYYYYMM(EventDate)
ORDER BY id

┌─host──────────────────────┬─port─┬─status─┬─error─┬─num_hosts_remaining─┬─num_hosts_activ
e─┐
│ node-group-1tXED0002      │ 9000 │      0 │       │                   5 │              3 │
│ node-group-1tXED0003      │ 9000 │      0 │       │                   4 │              3 │
│ node-master1dOnG          │ 9000 │      0 │       │                   3 │              3 │
└───────────────────────────┴──────┴────────┴───────┴─────────────────────┴─────────────────┘
┌─host──────────────────────┬─port─┬─status─┬─error─┬─num_hosts_remaining─┬─num_hosts_activ
e─┐
│ node-master3QsRI          │ 9000 │      0 │       │                   2 │              0 │
│ node-group-1tXED0001      │ 9000 │      0 │       │                   1 │              0 │
│ node-master2OXQS          │ 9000 │      0 │       │                   0 │              0 │
└───────────────────────────┴──────┴────────┴───────┴─────────────────────┴─────────────────┘

6 rows in set. Elapsed: 0.189 sec.
```

Step 3 Create a distributed table using the Distributed engine.

For example, run the following commands to create a distributed table named **test_all** on the **default_cluster_1** node and in the **default** database:

CREATE TABLE *default.test_all* **ON CLUSTER** *default_cluster_1*

(

`EventDate` DateTime,

`id` UInt64

)

ENGINE = Distributed(*default_cluster_1, default, test, rand()***);**

```
CREATE TABLE default.test_all ON CLUSTER default_cluster_1
(
   `EventDate` DateTime,
   `id` UInt64
)
```

```
ENGINE = Distributed(default_cluster_1, default, test, rand())

┌─host──────────────────────┬─port─┬─status─┬─error─┬─num_hosts_remaining─┬─num_hosts_active─┐
│ node-group-1tXED0002      │ 9000 │      0 │       │                   5 │                0 │
│ node-master3QsRI          │ 9000 │      0 │       │                   4 │                0 │
│ node-group-1tXED0003      │ 9000 │      0 │       │                   3 │                0 │
│ node-group-1tXED0001      │ 9000 │      0 │       │                   2 │                0 │
│ node-master1dOnG          │ 9000 │      0 │       │                   1 │                0 │
│ node-master2OXQS          │ 9000 │      0 │       │                   0 │                0 │
└───────────────────────────┴──────┴────────┴───────┴─────────────────────┴──────────────────┘

6 rows in set. Elapsed: 0.115 sec.
```

NOTE

Distributed requires the following parameters:

- **default_cluster_1** is the cluster identifier obtained in **Step 2** in **Viewing cluster and Other Environment Parameters of ClickHouse**.
- **default** indicates the name of the database where the local table is located.
- **test** indicates the name of the local table. In this example, it is the name of the table created in **Step 2**.
- (Optional) Sharding key

  This key and the weight configured in the **config.xml** file determine the route for writing data to the distributed table, that is, the physical table to which the data is written. It can be the original data (for example, **site_id**) of a column in the table or the result of the function call, for example, **rand()** is used in the preceding SQL statement. Note that data must be evenly distributed in this key. Another common operation is to use the hash value of a column with a large difference, for example, **intHash64(user_id)**.

----End

ClickHouse Table Data Operations

Step 1 Log in to the ClickHouse node on the client. Example:

clickhouse client --host *node-master3QsRI* **--multiline --port 9440 --secure;**

NOTE

node-master3QsRI is the value of **host_name** obtained in **Step 2** in **Viewing cluster and Other Environment Parameters of ClickHouse**.

Step 2 After creating a table by referring to **Creating a Local Replicated Table and a distributed Table**, you can insert data to the local table.

For example, run the following command to insert data to the local table **test**:

insert into test values(toDateTime(now()), rand());

Step 3 Query the local table information.

For example, run the following command to query data information of the table **test** in **Step 2**:

select * from test;

```
SELECT *
FROM test

┌─────────────EventDate─┬────────────id─┐
```

```
2020-11-05 21:10:42 │ 1596238076 │
└─────────────────────┴────────────┘

1 rows in set. Elapsed: 0.002 sec.
```

Step 4 Query the distributed table.

For example, the distributed table **test_all** is created based on table **test** in **Step 3**. Therefore, the same data in table **test** can also be queried in table **test_all**.

select * from test_all;

```
SELECT *
FROM test_all

┌─────────EventDate─┬────────id─┐
│ 2020-11-05 21:10:42 │ 1596238076 │
└─────────────────────┴────────────┘

1 rows in set. Elapsed: 0.004 sec.
```

Step 5 Switch to the shard node with the same **shard_num** and query the information about the current table. The same table data can be queried.

For example, run the **exit;** command to exit the original node.

Run the following command to switch to the **node-group-1tXED0003** node:

clickhouse client --host *node-group-1tXED0003* **--multiline --port 9440 --secure;**

NOTE

The **shard_num** values of **node-group-1tXED0003** and **node-master3QsRI** are the same by performing **Step 2**.

show tables;

```
SHOW TABLES

┌─name─────┐
│ test     │
│ test_all │
└──────────┘
```

Step 6 Query the local table data. For example, run the following command to query data in table **test** on the **node-group-1tXED0003** node:

select * from test;

```
SELECT *
FROM test

┌─────────EventDate─┬────────id─┐
│ 2020-11-05 21:10:42 │ 1596238076 │
└─────────────────────┴────────────┘

1 rows in set. Elapsed: 0.005 sec.
```

Step 7 Switch to the shard node with different **shard_num** value and query the data of the created table.

For example, run the following command to exit the **node-group-1tXED0003** node:

exit;

Switch to the **node-group-1tXED0001** node. The **shard_num** values of **node-group-1tXED0001** and **node-master3QsRI** are different by performing **Step 2**.

clickhouse client --host *node-group-1tXED0001* **--multiline --port 9440 --secure;**

Query the local table **test**. Data cannot be queried on the different shard node because table **test** is a local table.

select * from test;

```
SELECT *
FROM test

Ok.
```

Query data in the distributed table **test_all**. The data can be queried properly.

select * from test_all;

```
SELECT *
FROM test

┌─────────────EventDate─┬──────────id─┐
│ 2020-11-05 21:12:19   │ 3686805070  │
└───────────────────────┴─────────────┘

1 rows in set. Elapsed: 0.002 sec.
```

----End

2.5 Common ClickHouse SQL Syntax

2.5.1 CREATE DATABASE: Creating a Database

This section describes the basic syntax and usage of the SQL statement for creating a ClickHouse database.

Basic Syntax

CREATE DATABASE [IF NOT EXISTS] *database_name* **[ON CLUSTER** *ClickHouse cluster name***]**

NOTE

The syntax **ON CLUSTER** *ClickHouse cluster name* enables the Data Definition Language (DDL) statement to be executed on all instances in the cluster at a time. You can run the following statement to obtain the cluster name from the **cluster** field:

select cluster,shard_num,replica_num,host_name from system.clusters;

Example

- Create a database named **test**.
  ```
  CREATE DATABASE test ON CLUSTER default_cluster;
  ```
- After the creation is successful, run the query command for verification.

```
show databases;
┌─name────┐
│ default │
│ system  │
│ test    │
└─────────┘
```

2.5.2 CREATE TABLE: Creating a Table

This section describes the basic syntax and usage of the SQL statement for creating a ClickHouse table.

Basic Syntax

- Method 1: Creating a table named **table_name** in the specified **database_name** database.

  If the table creation statement does not contain **database_name**, the name of the database selected during client login is used by default.

  CREATE TABLE [IF NOT EXISTS] *[database_name.]table_name* **[ON CLUSTER** *ClickHouse cluster name***]**

  (

  name1 **[***type1***] [DEFAULT|MATERIALIZED|ALIAS** *expr1***],**

  name2 **[***type2***] [DEFAULT|MATERIALIZED|ALIAS** *expr2***],**

  ...

) *ENGINE = engine_name()*

  [**PARTITION BY** *expr_list*]

  [**ORDER BY** *expr_list*]

  CAUTION

  You are advised to use **PARTITION BY** to create table partitions when creating a ClickHouse table. The ClickHouse data migration tool migrates data based on table partitions. If you do not use **PARTITION BY** in the table creation statement, the table data cannot be migrated as described in **Using the ClickHouse Data Migration Tool**.

- Method 2: Creating a table with the same structure as **database_name2.table_name2** and specifying a different table engine for the table

  If no table engine is specified, the created table uses the same table engine as **database_name2.table_name2**.

  CREATE TABLE [IF NOT EXISTS] *[database_name.]table_name* **AS** [*database_name2.*]*table_name2* [ENGINE = *engine_name*]

- Method 3: Using the specified engine to create a table with the same structure as the result of the **SELECT** clause and filling it with the result of the **SELECT** clause

  CREATE TABLE [IF NOT EXISTS] *[database_name.]table_name ENGINE = engine_name* **AS SELECT** ...

Example

Create a table named **test** in the **default** database and **default_cluster** cluster.

```
CREATE TABLE default.test ON CLUSTER default_cluster
(
   `EventDate` DateTime,
   `id` UInt64
)
ENGINE = ReplicatedMergeTree('/clickhouse/tables/{shard}/default/test', '{replica}')
PARTITION BY toYYYYMM(EventDate)
ORDER BY id
```

2.5.3 INSERT INTO: Inserting Data into a Table

This section describes the basic syntax and usage of the SQL statement for inserting data to a table in ClickHouse.

Basic Syntax

- Method 1: Inserting data in standard format

  INSERT INTO *[database_name.]table* [(*c1, c2, c3*)] **VALUES** (*v11, v12, v13*), (*v21, v22, v23*), ...
- Method 2: Using the **SELECT** result to insert data

  INSERT INTO *[database_name.]table* [(c1, c2, c3)] **SELECT** ...

Example

- Insert data into the **test2** table.

  ```
  insert into test2 (id, name) values (1, 'abc'), (2, 'bbbb');
  ```
- Query data in the **test2** table.

  ```
  select * from test2;
  ┌─id─┬─name─┐
  │  1 │ abc  │
  │  2 │ bbbb │
  └────┴──────┘
  ```

2.5.4 DELETE: Lightweight Deleting Table Data

This section describes the basic syntax and usage of the SQL statement for deleting table data in a lightweight way.

Basic Syntax

DELETE FROM *[db.]table [ON CLUSTER cluster]* **WHERE** *expr*

Example

- Create a table.

  ```
  CREATE TABLE default.test_ligtwight_delete
  (
  `id`    Int32,
  `pdate` Date,
  `name`  String,
  `class` Int32
  )
  ENGINE = ReplicatedMergeTree('/clickhouse/tables/distributed_tests/{shard}/test_ligtwight_delete',
  '{replica}')
  PARTITION BY toYYYYMM(pdate)
  ```

```
PRIMARY KEY id
ORDER BY id
SETTINGS index_granularity = 8192, vertical_merge_algorithm_min_rows_to_activate = 1,
vertical_merge_algorithm_min_columns_to_activate = 1, min_rows_for_wide_part = 1,
min_bytes_for_wide_part = 1;
```

- Insert data.

```
insert into default.test_ligtwight_delete select rand(), rand() % 365, rand(), rand() from numbers(10);
```

- Delete data.

```
delete from default.test_ligtwight_delete where id > 0;
```

Precautions

- Deleted rows are immediately marked as deleted and automatically filtered out from all subsequent queries. Data cleanup occurs asynchronously in the background. This function is only available for the MergeTree table engine series.
- Currently, only lightweight deletion is supported for local tables and replication tables, but not for distributed tables.
- The lightweight deletion performance depends on the number of merge and mutation (alter table update/delete) tasks. Mutation tasks in a queue have the lowest priority (mutation tasks in the same table are executed serially). The number of concurrent delete tasks is directly affected by the execution of the merge tasks.
- The number of parts in the table also determines the lightweight deletion performance. The more parts, the slower the deletion.
- Data parts in Wide format can be deleted quickly, and those in compact files can be deleted slowly because all column data is stored in one file.

2.5.5 SELECT: Querying Table Data

This section describes the basic syntax and usage of the SQL statement for querying table data in ClickHouse.

Basic Syntax

SELECT [**DISTINCT**] expr_list

[**FROM** [*database_name*.]*table* | (subquery) | table_function] [**FINAL**]

[SAMPLE sample_coeff]

[ARRAY **JOIN** ...]

[**GLOBAL**] [**ANY**|**ALL**|**ASOF**] [**INNER**|**LEFT**|**RIGHT**|**FULL**|**CROSS**] [**OUTER**|SEMI|ANTI] **JOIN** (subquery)|**table** (**ON** <expr_list>)|(**USING** <column_list>)

[PREWHERE expr]

[**WHERE** expr]

[**GROUP BY** expr_list] [**WITH** TOTALS]

[**HAVING** expr]

[**ORDER BY** expr_list] [**WITH** FILL] [**FROM** expr] [**TO** expr] [STEP expr]

[**LIMIT** [offset_value,]n **BY** columns]

[**LIMIT** [n,]m] [**WITH** TIES]

[**UNION ALL** ...]

[**INTO** OUTFILE filename]

[FORMAT format]

Example

- View ClickHouse cluster information.
  ```
  select * from system.clusters;
  ```
- View the macros set for the node.
  ```
  select * from system.macros;
  ```
- Check the database capacity.
  ```
  select
  sum(rows) as "Total number of rows",
  formatReadableSize(sum(data_uncompressed_bytes)) as "Original size",
  formatReadableSize(sum(data_compressed_bytes)) as "Compression size",
  round(sum(data_compressed_bytes) / sum(data_uncompressed_bytes) * 100,
  0) "Compression rate"
  from system.parts;
  ```
- Query the capacity of the test table. Add or modify the where clause based on the site requirements.
  ```
  select
  sum(rows) as "Total number of rows",
  formatReadableSize(sum(data_uncompressed_bytes)) as "Original size",
  formatReadableSize(sum(data_compressed_bytes)) as "Compression size",
  round(sum(data_compressed_bytes) / sum(data_uncompressed_bytes) * 100,
  0) "Compression rate"
  from system.parts
  where table in ('test')
  and partition like '2020-11-%'
  group by table;
  ```

2.5.6 ALTER TABLE: Modifying a Table Schema

This section describes the basic syntax and usage of the SQL statement for modifying a table schema in ClickHouse.

Basic Syntax

ALTER TABLE [*database_name*].*name* [**ON CLUSTER** *cluster*] **ADD**|**DROP**|**CLEAR**|**COMMENT**|**MODIFY COLUMN** ...

NOTE

ALTER supports only *MergeTree, Merge, and Distributed engine tables.

The **ALTER** operation is executed asynchronously between replicas. To modify the result return policy, change the value of **profiles.default.replication_alter_partitions_sync** to:

- **0**: asynchronous execution
- **1**: waiting until the execution on the current server is complete
- **2**: waiting until all replicas (if any) are executed

When this parameter is set to **2**, the timeout interval can be specified by modifying **profiles.default.replication_wait_for_inactive_replica_timeout**.

To modify the parameter, do the following:

Log in to FusionInsight Manager and choose **Cluster** > **Services** > **ClickHouse**. Click **Configurations** then **All Configurations**, search for **replication_alter_partitions_sync** in the search box in the upper right corner, change the value of **profiles.default.replication_wait_for_inactive_replica_timeout**, and save the configuration.

Example

- Add the **test01** column to the **t1** table.

```
ALTER TABLE t1 ADD COLUMN test01 String DEFAULT 'defaultvalue';
```

- Query the modified table **t1**.

```
desc t1
┌─name────┬─type───┬─default_type─┬─default_expression─┬─comment─┬─codec_expression─┬─ttl_expression─┐
│ id      │ UInt8  │              │                    │         │                  │                │
│ name    │ String │              │                    │         │                  │                │
│ address │ String │              │                    │         │                  │                │
│ test01  │ String │ DEFAULT      │ 'defaultvalue'     │         │                  │                │
└─────────┴────────┴──────────────┴────────────────────┴─────────┴──────────────────┴────────────────┘
```

- Change the type of the **name** column in the **t1** table to UInt8.

```
ALTER TABLE t1 MODIFY COLUMN name UInt8;
```

- Query the modified table **t1**.

```
desc t1
┌─name────┬─type───┬─default_type─┬─default_expression─┬─comment─┬─codec_expression─┬─ttl_expression─┐
│ id      │ UInt8  │              │                    │         │                  │                │
│ name    │ UInt8  │              │                    │         │                  │                │
│ address │ String │              │                    │         │                  │                │
│ test01  │ String │ DEFAULT      │ 'defaultvalue'     │         │                  │                │
└─────────┴────────┴──────────────┴────────────────────┴─────────┴──────────────────┴────────────────┘
```

- Delete the **test01** column from the **t1** table.

```
ALTER TABLE t1 DROP COLUMN test01;
```

- Query the modified table **t1**.

```
desc t1
┌─name────┬─type───┬─default_type─┬─default_expression─┬─comment─┬─codec_expression─┬─ttl_expression─┐
│ id      │ UInt8  │              │                    │         │                  │                │
│ name    │ UInt8  │              │                    │         │                  │                │
│ address │ String │              │                    │         │                  │                │
└─────────┴────────┴──────────────┴────────────────────┴─────────┴──────────────────┴────────────────┘
```

2.5.7 ALTER TABLE: Modifying Table Data

- Exercise caution when doing delete, update, and mutation operations.

  The update and delete of standard SQL statements are synchronous operations. That is, the client needs to wait for the server to return the execution results (usually an **int** value). In contrast, the update and delete of

ClickHouse are asynchronous operations. When an update statement is processed, the server immediately returns the request status: success or fail, while the operation is not complete. At that time, the update request is accepted and queued in the background. As a result, the operation may be overwritten, and atomicity of operations cannot be ensured.

To solve this problem, you are advised to use the ReplacingMergeTree, CollapsingMergeTree, and VersionedCollapsingMergeTree engines to update and delete data. For details, see **https://clickhouse.com/docs/en/engines/table-engines/mergetree-family/collapsingmergetree**.

- Try to avoid adding or deleting data columns.

  Plan the number of columns for future use, reserve enough columns to avoid a large number of alter table modify operations during service running in the production system. Otherwise, unpredictable performance problem and data inconsistency may occur.

2.5.8 DESC: Querying a Table Structure

This section describes the basic syntax and usage of the SQL statement for querying a table structure in ClickHouse.

Basic Syntax

DESC|**DESCRIBE TABLE** [*database_name.*]*table* [**INTO** OUTFILE filename] [FORMAT format]

Example

Query the **t1** table structure.

```
desc t1;
┌─name────┬─type───┬─default_type─┬─default_expression
┬─comment─┬─codec_expression─┬─ttl_expression─┐
│ id      │ UInt8  │              │                    │         │                  │                │
│ name    │ UInt8  │              │                    │         │                  │                │
│ address │ String │              │                    │         │                  │                │
└─────────┴────────┴──────────────┴────────────────────┴─────────┴──────────────────┴────────────────┘
```

2.5.9 DROP: Deleting a Table

This section describes the basic syntax and usage of the SQL statement for deleting a ClickHouse table.

Basic Syntax

DROP [**TEMPORARY**] **TABLE** [**IF EXISTS**] [*database_name.*]*name* [**ON CLUSTER** *cluster*] [SYNC]

Example

Delete the **t1** table.

```
drop table t1 SYNC;
```

NOTE

- When you delete a replication table, create a path on ZooKeeper to store related data. The default library engine of ClickHouse is the atomic database engine. After a table in the atomic database is deleted, it is not deleted immediately but deleted 480 seconds later. To resolve this issue, when deleting a table, add the **SYNC** field or set **profiles.default.database_atomic_wait_for_drop_and_detach_synchronously** to **1**, for example, **drop table** *t1* **SYNC;**.

  To configure this parameter, do the following:

  Log in to FusionInsight Manager and choose **Cluster** > **Services** > **ClickHouse**. Click **Configurations** then **All Configurations**, search for **database_atomic_wait_for_drop_and_detach_synchronously** in the search box in the upper right corner, change the value of **profiles.default.database_atomic_wait_for_drop_and_detach_synchronously** to **1**, and save the configuration. Then, restart the ClickHouse service.
- This issue does not occur when a local or distributed table is deleted. The **SYNC** field is not required in your deletion command, for example, **drop table** *t1*;.

2.5.10 SHOW: Displaying Information About Databases and Tables

This section describes the basic syntax and usage of the SQL statement for displaying information about databases and tables in ClickHouse.

Basic Syntax

show databases

show tables

Example

- Query databases.

```
show databases;
┌─name────┐
│ default │
│ system  │
│ test    │
└─────────┘
```

- Query table information.

```
show tables;
┌─name──┐
│ t1    │
│ test  │
│ test2 │
│ test5 │
└───────┘
```

2.5.11 UPSERT: Writing Data

This section describes the basic SQL syntax and usage of the upsert function when ClickHouse data is written.

Basic Syntax

- INSERT VALUES

  UPSERT INTO *[database_name.]table* [(*c1, c2, c3*)] **VALUES** (*v11, v12, v13*), (*v21, v22, v23*), ...

- INSERT SELECT

  UPSERT INTO *[database_name.]table* [(c1, c2, c3)] **SELECT** ...

Example

- Create a table.

```
CREATE TABLE default.upsert_tab ON CLUSTER default_cluster
(
`id`     Int32,
`pdate`  Date,
`name`   String
)ENGINE = ReplicatedMergeTree('/clickhouse/tables/default/{shard}/upsert_tab', '{replica}')
PARTITION BY toYYYYMM(pdate)
PRIMARY KEY id
ORDER BY id
SETTINGS index_granularity = 8192;
```

- Upsert data.

```
Upsert into upsert_tab(id, pdate, name) values (1, rand() % 365, 'abc'), (2, rand() % 365, 'bcd'), (1, rand() % 365, 'def');
```

- Query data in the **test_upsert** table.

```
select * from upsert_tab;
┌─id─┬──────pdate─┬─name─┐
│  2 │ 1970-06-09 │ bcd  │
│  1 │ 1970-11-30 │ def  │
└────┴────────────┴──────┘
```

- Upsert for transactions

  Similar to other SQL syntax, Upsert also supports explicit and implicit transactions. Before using transactions, you need to enable the transaction function.

Precautions

- When creating MergeTree and ReplicatedMergeTree tables, specify the primary key or order by field as the unique key for deduplication. If no primary key is specified and only the order by attribute is specified during table creation, the order by field is used for deduplication.
- The key for deduplication must be sharded in advance to ensure that same key fields are in the same shard to ensure deduplication accuracy.

2.6 Migrating ClickHouse Data

2.6.1 Using ClickHouse to Import and Export Data

Using the ClickHouse Client to Import and Export Data

Use the ClickHouse client to import and export data.

- Importing data in CSV format

  clickhouse client --host *Host name or IP address of the ClickHouse instance* **--database** *Database name* **--port** *Port number* **--secure --format_csv_delimiter="***CSV file delimiter***" --query="INSERT INTO** *Table name* **FORMAT CSV" <** *Host path where the CSV file is stored*

  Example

```
clickhouse client --host 10.5.208.5 --database testdb --port 9440 --secure --format_csv_delimiter="," --query="INSERT INTO testdb.csv_table FORMAT CSV" < /opt/data
```

You need to create a table in advance.

- Exporting data in CSV format

  CAUTION

  Exporting data files in CSV format may cause CSV injection. Exercise caution when performing this operation.

  clickhouse client --host *Host name or IP address of the ClickHouse instance* **--database** *Database name* **--port** *Port number* **-m --secure --query=**"SELECT * **FROM** *Table name*" > *CSV file export path*

  Example

  ```
  clickhouse client --host 10.5.208.5 --database testdb --port 9440 -m --secure --query="SELECT * FROM test_table" > /opt/test
  ```

- Importing data in Parquet format

  cat *Parquet file* **| clickhouse client --host** *Host name or IP address of the ClickHouse instance* **--database** *Database name* **--port** *Port number* **-m --secure --query="INSERT INTO** *Table name* **FORMAT Parquet"**

  Example

  ```
  cat /opt/student.parquet | clickhouse client --host 10.5.208.5 --database testdb --port 9440 -m --secure --query="INSERT INTO parquet_tab001 FORMAT Parquet"
  ```

- Exporting data in Parquet format

  clickhouse client --host *Host name or IP address of the ClickHouse instance* **--database** *Database name* **--port** *Port number* **-m --secure --query="select** * **from** *Table name* **FORMAT Parquet**" > *Parquet file export path*

  Example

  ```
  clickhouse client --host 10.5.208.5 --database testdb --port 9440 -m --secure --query="select * from test_table FORMAT Parquet" > /opt/student.parquet
  ```

- Importing data in ORC format

  cat *ORC file path* **| clickhouse client --host** *Host name or IP address of the ClickHouse instance* **--database** *Database name* **--port** *Port number* **-m --secure --query="INSERT INTO** *Table name* **FORMAT ORC**"

  Example

  ```
  cat /opt/student.orc | clickhouse client --host 10.5.208.5 --database testdb --port 9440 -m --secure --query="INSERT INTO orc_tab001 FORMAT ORC"
  # Data in the ORC file can be exported from HDFS. For example:
  hdfs dfs -cat /user/hive/warehouse/hivedb.db/emp_orc/000000_0_copy_1 | clickhouse client --host 10.5.208.5 --database testdb --port 9440 -m --secure --query="INSERT INTO orc_tab001 FORMAT ORC"
  ```

- Exporting data in ORC format

  clickhouse client --host *Host name or IP address of the ClickHouse instance* **--database** *Database name* **--port** *Port number* **-m --secure --query="select** * **from** *Table name* **FORMAT ORC**" > *ORC file export path*

  Example

  ```
  clickhouse client --host 10.5.208.5 --database testdb --port 9440 -m --secure --query="select * from csv_tab001 FORMAT ORC" > /opt/student.orc
  ```

- Importing data in JSON format

  INSERT INTO *Table name* **FORMAT JSONEachRow** *JSON string 1 JSON string 2*

Example

```
INSERT INTO test_table001 FORMAT JSONEachRow {"PageViews":5,
"UserID":"4324182021466249494", "Duration":146,"Sign":-1}
{"UserID":"4324182021466249494","PageViews":6,"Duration":185,"Sign":1}
```

- Exporting data in JSON format

  clickhouse client --host *Host name or IP address of the ClickHouse instance* **--database** *Database name* **--port** *Port number* **-m --secure --query="SELECT** * **FROM** *Table name* **FORMAT JSON|JSONEachRow|JSONCompact|...**" > *JSON file export path*

  Example

```
# Export JSON file.
clickhouse client --host 10.5.208.5 --database testdb --port 9440 -m --secure --query="SELECT *
FROM test_table FORMAT JSON" > /opt/test.json

# Export json(JSONEachRow).
clickhouse client --host 10.5.208.5 --database testdb --port 9440 -m --secure --query="SELECT *
FROM test_table FORMAT JSONEachRow" > /opt/test_jsoneachrow.json

# Export json(JSONCompact).
clickhouse client --host 10.5.208.5 --database testdb --port 9440 -m --secure --query="SELECT *
FROM test_table FORMAT JSONCompact" > /opt/test_jsoncompact.json
```

2.6.2 Using the ClickHouse Data Migration Tool

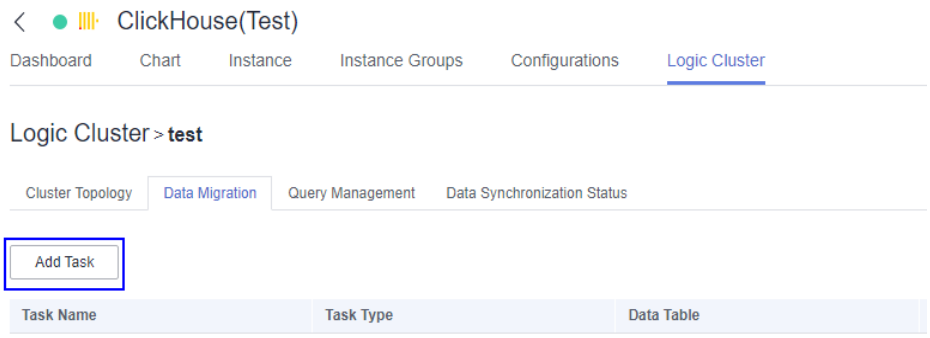
The ClickHouse data migration tool can migrate some partitions of one or more partitioned MergeTree tables on several ClickHouseServer nodes to the same tables on other ClickHouseServer nodes. In the capacity expansion scenario, you can use this tool to migrate data from an original node to a new node to balance data after capacity expansion.

Prerequisites

- The ClickHouse and Zookeeper services are running properly. The ClickHouseServer instances on the source and destination nodes are normal.
- The destination node has the data table to be migrated and the table is a partitioned MergeTree table.
- Before creating a migration task, ensure that all tasks for writing data to a table to be migrated have been stopped. After the task is started, you can only query the table to be migrated and cannot write data to or delete data from the table. Otherwise, data may be inconsistent before and after the migration.
- If automatic balancing is enabled, only a partitioned ReplicatedMergeTree table is migrated, and the partitioned table must have a corresponding distributed table.
- The ClickHouse data directory on the destination node has sufficient space.
- You have created a ClickHouse logical cluster by referring to **Using the ClickHouse Data Migration Tool**.
- You have checked that the SFTP service is enabled.

Procedure

Step 1 Log in to FusionInsight Manager and choose **Cluster** > **Services** > **ClickHouse**. Click the **Logic Cluster** tab, click the name of the target logical cluster, click **Data Migration**, and click **Add Task**.



NOTE

- The number of created migration tasks is limited. By default, a maximum of 20 migration tasks can be created. You can modify the number of migration tasks allowed by modifying the **max_migration_task_number** configuration item on the ClickHouse configuration page of Manager. A migration task occupies a certain number of Znodes on ZooKeeper. Therefore, you are not advised to set the maximum number of migration tasks allowed to a large value.
- If the number of existing migration tasks exceeds the upper limit, no more migration tasks can be created. The system automatically deletes the earliest migration tasks that have been successfully executed. If no historical migration task is successfully executed, perform **Step 11** based on the site requirements and manually delete historical migration tasks.

Step 2 On the page for creating a migration task, set the migration task parameters. For details, see **Table 2-4**. After configuring the parameters, click **Next**. If **Automatic balancing** is not enabled, go to **Step 3**. If **Automatic balancing** is enabled, go to **Step 5**.

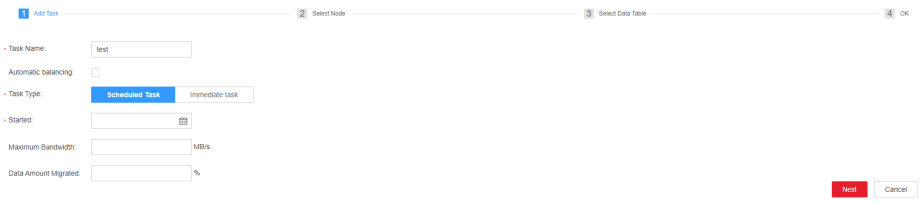
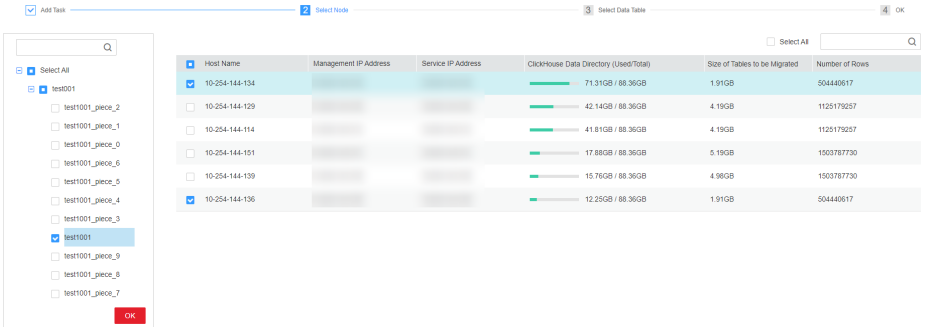


Table 2-4 Migration task parameters

Parameter	Description
Task Name	Enter a specific task name. The value can contain 1 to 50 characters, including letters, digits, and underscores (_), and cannot be the same as that of an existing migration task.

Parameter	Description
Automatic balancing	Choose whether to enable **Automatic balancing**. • If this function is enabled, the system supports automatic balancing for tables. You need to select the tables to be balanced from the table list. The system automatically selects the migrate-in and migrate-out nodes. In this way, data is evenly distributed on each node in the partitioned tables of the ReplicatedMergeTree series engine corresponding to the tables selected by the user in the cluster. • If it is not enabled, you need to manually select the source and destination nodes.
Task Type	• **Scheduled Task**: When the scheduled task is selected, you can set **Started** to specify a time point later than the current time to execute the task. • **Immediate task**: The task is executed immediately after it is started.
Started	Set this parameter when **Task Type** is set to **Scheduled Task**. The valid value is a time point within 90 days from now.
Maximum Bandwidth	Bandwidth upper limit of each ClickHouseServer node. The value ranges from 1 MB/s to 1,000 MB/s. In automatic balancing scenarios, increase the bandwidth as much as possible. Flow control is disabled by default.
Data Amount Migrated	Percentage of the amount of data migrated in each table to the total amount of data in the table. The value ranges from 0 to 100%. If this parameter is left blank, the value is set to 50% by default. This parameter is valid only when **Automatic balancing** is disabled.

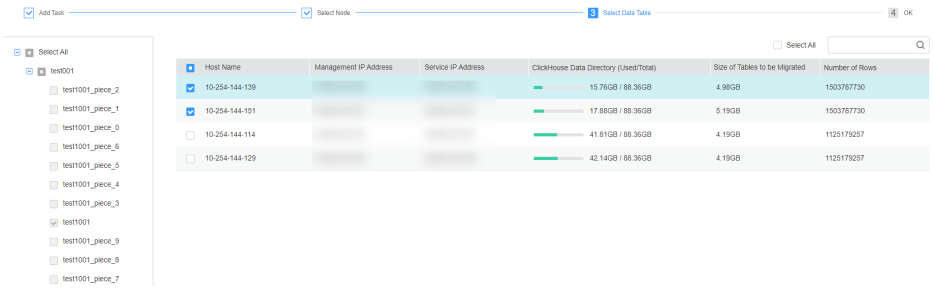
Step 3 On the **Select Node** page, select the data table to be migrated from the list on the left and click **OK**. In the list on the right, select a source node of the selected data table and click **Next**.



NOTE

After a node is selected, its replicas are automatically selected as the source nodes too.

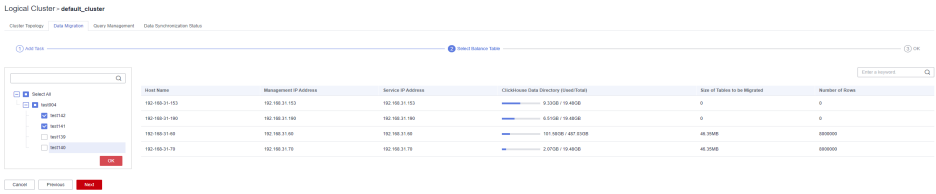
Step 4 On the **Select Data Table** page, select the host name of the destination node and click **Next**. Go to **Step 6**.



NOTE

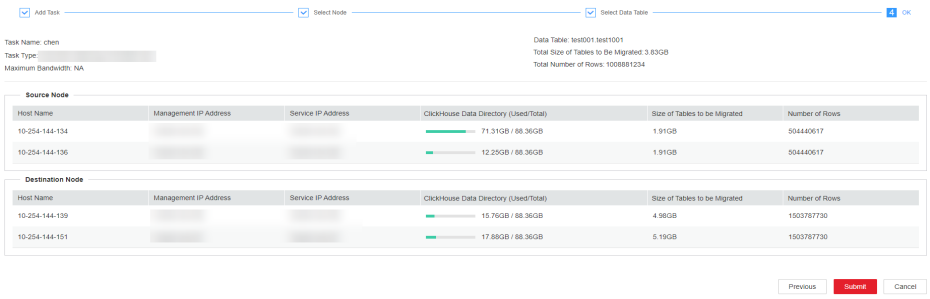
The destination node must be different from the source nodes. The selected source nodes are not displayed on the page.

Step 5 Select target tables and click **Next**.

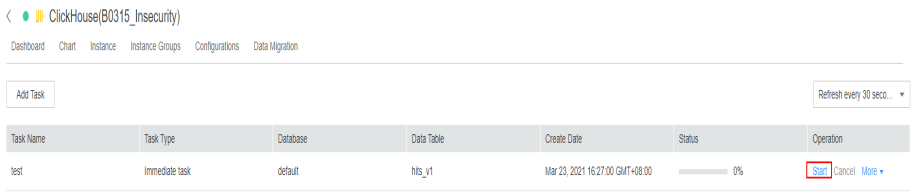


Step 6 Confirm the task information and click **Submit**.

The data migration tool automatically calculates the partitions to be migrated based on the size of the data table to be migrated and the value of **Data Amount Migrated** set on the **Add Task** page.



Step 7 After the migration task is submitted, click **Start** in the **Operation** column. If the task is an immediate task, the task starts to be executed. If the task is a scheduled task, the countdown starts.



Step 8 During the migration task execution, you can click **Cancel** to cancel the migration task. If the migration task is canceled, the migrated data on the destination node will not be rolled back.

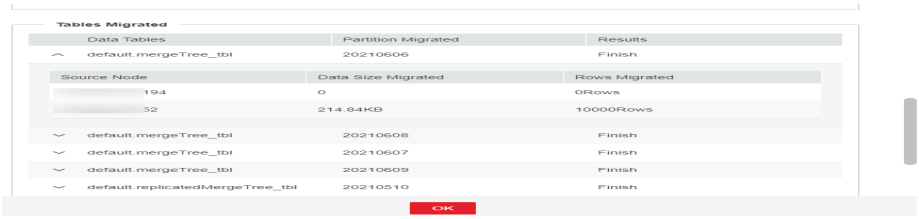
CAUTION

After a task with automatic balancing enabled is canceled, it will not stop immediately. It will stop after the table migration is complete. After a task with automatic balancing disabled is canceled, the task stops immediately. After the task stops, a partition may have been migrated to the destination node, but it is not deleted from the source node. In this case, duplicate data exists. Manually check whether the migrated partition still exists on the source node. If it still exists, check that the total data volume of the partition on the destination node is the same as that on the source node, and then delete the partition from the source node.

Step 9 Choose **More** > **Details** to view details about the migration task.

Step 10 After the migration is complete, choose **More** > **Results** to view the migration result.

In a non-automatic balancing task, you can view the migrated partitions of each table and the partition migration result. If the partition migration is not finished, the partition has been copied to the destination node but not deleted from the source node because the data volume of the partition on the source node is inconsistent with that of the partition on the destination node. In this case, check whether the data volume of the partition on the source node is consistent with that of the partition on the destination node, and then delete the partition from the source node.



Step 11 After the migration is complete, choose **More** > **Delete** to delete the directories related to the migration task on ZooKeeper and the destination node.

----End

2.6.3 ClickHouse Batch Data Import

Scenario

If a large number of data files need to be imported, you can use the multi-thread import tool to import ClickHouse data files in batches.

Prerequisites

- The ClickHouse client has been installed in a directory, for example, **/opt/client**.
- For a cluster in security mode, a user with ClickHouse permissions has been created, for example, **clickhouseuser**. For details, see **ClickHouse User and Permission Management**.

- The data file to be imported has been uploaded to a client node directory, for example, **/opt/data**. For details about all data types supported by ClickHouse, visit **https://clickhouse.com/docs/en/interfaces/formats**.

Procedure

Step 1 Log in to the node where the client is installed as the client installation user.

Step 2 Go to the directory where the multi-thread write tool **clickhouse_insert_tool** is deployed.

cd /opt/client/ClickHouse/clickhouse_insert_tool

Step 3 Use the text editor to open **clickhouse_insert_tool.sh** and enter required information based on the comments.

Parameter	Description	Example
datapath	Directory containing the data to be imported	/opt/data
balancer_ip_list	IP addresses of Balancer instances of the ClickHouse service. The IP addresses must be enclosed in parentheses. A single IP address must be enclosed in double quotation marks, and IP addresses must be separated by spaces.	("192.168.1.1" "192.168.1.2")
balancer_tcp_port	TCP port for the Balancer instance of the ClickHouse service	21428
local_table_name	Names of the local library and table to be imported	testdb1.testtb1
thread_num	Number of concurrent threads for importing data	10
data_format	Format of the data to be imported	CSV
is_security_cluster	Whether the security mode is used • **true** indicates that the security mode. • **false** indicates the normal mode.	true

Step 4 Save the modified **clickhouse_insert_tool.sh** file and run the following commands:

cd /opt/client

source bigdata_env

In security mode (Kerberos authentication is enabled), run the **kinit** command. In normal mode (Kerberos authentication is disabled), you do not need to run the following command:

kinit *clickhouseuser*

Step 5 Run the script to import data.

./ClickHouse/clickhouse_insert_tool/clickhouse_insert_tool.sh

Step 6 Log in to the ClickHouse client node and connect the server. For details, see **Using ClickHouse from Scratch**.

Step 7 Run the following command to query the distributed table corresponding to the local table where data is inserted and check the result:

select count(1) from testdb1.testtb1_all;

----End

2.7 Adaptive MV Usage in ClickHouse

Scenario

Materialized views (MVs) are used in ClickHouse to save the precomputed result of time-consuming operations. When querying data, you can query the materialized views rather than the original tables, thereby quickly obtaining the query result.

Currently, MVs are not easy to use in ClickHouse. Users can create one or more MVs based on the original table data as required. Once multiple MVs are created, you need to identify which MV is used and convert the query statement of an original table to that of an MV. In this way, the querying process is inefficient and prone to errors.

The problem mentioned above is readily solved since the adoption of adaptive MVs. When querying an original table, the corresponding MV of this table will be queried, which greatly improves the usability and efficiency of ClickHouse.

Matching Rules of Adaptive MVs

To ensure that the SQL statement for querying an original table can be automatically converted to that for querying the corresponding MV, the following matching rules must be met:

- The table to be queried using an SQL statement must be associated with an MV.
- The AggregatingMergeTree engine must be used with MVs.
- Both the SELECT clause of SQL and MVs must contain aggregate functions.
- If the SQL query contains a GROUP BY clause, MVs must also contain this clause.
- If an MV contains a WHERE clause of SQL, the WHERE clause must be the same as that of the MV. This also applies to the PREWHERE and HAVING clauses.

- Fields to be queried using the SQL statements must exist in the MVs.
- If multiple MVs meet the preceding requirements, the SQL statement for querying the original table will be used.

For details about common matching failures of adaptive MVs, see **Common Matching Failures of MVs**.

Using Adaptive MVs

In the following operations, **local_table** is the original table and **view_table** is the MV created based on **local_table**. Change the table creation and query statements based on the site requirements.

Step 1 Use the ClickHouse client to connect to the default database. For details, see **Using ClickHouse from Scratch**.

Step 2 Run the following table creation statements to create the original table **local_table**.

```
CREATE TABLE local_table
(
id String,
city String,
code String,
value UInt32,
create_time DateTime,
age UInt32
)
ENGINE = MergeTree
PARTITION BY toDate(create_time)
ORDER BY (id, city, create_time);
```

Step 3 Create the MV **view_table** based on **local_table**.

```
CREATE MATERIALIZED VIEW view_table
ENGINE = AggregatingMergeTree
PARTITION BY toDate(create_time)
ORDER BY (id, city, create_time)
AS SELECT
create_time,
id,
city,
uniqState(code),
sumState(value) AS value_new,
minState(create_time) AS first_time,
maxState(create_time) AS last_time
FROM local_table
WHERE create_time >= toDateTime('2021-01-01 00:00:00')
GROUP BY id, city, create_time;
```

Step 4 Insert data to the **local_table** table.

```
INSERT INTO local_table values('1','zzz','code1',1,toDateTime('2021-01-02 00:00:00'), 10);
INSERT INTO local_table values('2','kkk','code2',2,toDateTime('2020-01-01 00:00:00'), 20);
INSERT INTO local_table values('3','ccc','code3',3,toDateTime('2022-01-01 00:00:00'), 30);
```

Step 5 Run the following command to enable the adaptive MVs.

```
set adaptive_materialized_view = 1;
```

NOTE

If **adaptive_materialized_view** is set to **1**, the adaptive MV is enabled. If it is set to **0**, the adaptive MV is disabled. The default value is **0**. **set adaptive_materilized_view = 1;** is a session-level command and needs to be reset each time the client connects to the server.

Step 6 Query data in the **local_table** table.

```
SELECT sum(value)
FROM local_table
WHERE create_time >= toDateTime('2021-01-01 00:00:00');
┌─sumMerge(value_new)─┐
│                   4 │
└─────────────────────┘
```

Step 7 Run the **explain syntax** command to view the execution plan of the SQL statement in step **Step 6**. According to the query result, **view_table** is queried.

```
EXPLAIN SYNTAX
SELECT sum(value)
FROM local_table
WHERE create_time >= toDateTime('2021-01-01 00:00:00');
┌─explain──────────────────┐
│ SELECT sumMerge(value_new) │
│ FROM default.view_table    │
└──────────────────────────┘
```

----End

Common Matching Failures of MVs

- When creating an MV, the aggregate functions must contain the State suffix. Otherwise, the corresponding MV cannot be matched. Example:

```
# # The MV agg_view is created based on the original table test_table. However, the count aggregate function does not contain the State suffix.
CREATE MATERIALIZED VIEW agg_view
ENGINE = AggregatingMergeTree
PARTITION BY toDate(create_time)
ORDER BY (id)
AS SELECT
create_time,
id,
count(id)
FROM test_table
GROUP BY id,create_time;

# To ensure that the MV can be matched, the count aggregate function for creating the MV must contain the State suffix. The correct example is as follows:
CREATE MATERIALIZED VIEW agg_view
ENGINE = AggregatingMergeTree
PARTITION BY toDate(create_time)
ORDER BY (id)
AS SELECT
create_time,
id,
countState(id)
FROM test_table
GROUP BY id,create_time;
```

- Only if the WHERE clause of the statement for querying an original table is completely the same as that in an MV can the MV be matched.

  For example, if the WHERE clause of the original table statement is **where a=b** while the WHERE clause of the MV is **where b=a**, the corresponding MV cannot be matched.

  However, if the statement for querying the original table does not contain the database name, the corresponding MV can be matched. Example:

```
# The MV view_test is created based on db_test.table_test. The WHERE clause for querying the original table contains the database name db_test.
CREATE MATERIALIZED VIEW db_test.view_test ENGINE = AggregatingMergeTree ORDER BY phone AS SELECT
name,
phone,
uniqExactState(class) as uniq_class,
```

```
sumState(CRC32(phone))
FROM db_test.table_test
WHERE (class, name) GLOBAL IN
(
SELECT class, name FROM db_test.table_test
WHERE
name = 'zzzz'
AND class = 'class one'
)
GROUP BY
name, phone;
# If the WHERE clause does not contain the database name db_test, the corresponding MV will be
matched.
USE db_test;
EXPLAIN SYNTAX
SELECT
name,
phone,
uniqExact(class) as uniq_class,
sum(CRC32(phone))
FROM table_test
WHERE (class, name) GLOBAL IN
(
SELECT class, name FROM table_test
WHERE
name = 'zzzz'
AND class = 'class one'
)
GROUP BY
name, phone;
```

- If the GROUP BY clause contains functions, the corresponding MV can be matched only when the column field names in the functions are the same as those in an original table. Example:

```
# Create the MV agg_view based on test_table.
CREATE MATERIALIZED VIEW agg_view
ENGINE = AggregatingMergeTree
PARTITION BY toDate(create_time)
ORDER BY (id, city, create_time)
AS SELECT
create_time,
id,
city,
value as value1,
uniqState(code),
sumState(value) AS value_new,
minState(create_time) AS first_time,
maxState(create_time) AS last_time
FROM test_table
GROUP BY id, city, create_time, value1 % 2, value1;
# The corresponding MV can be matched if the statement is as follows:
SELECT uniq(code) FROM test_table GROUP BY id, city, value1 % 2;
# The corresponding MV cannot be matched if the statement is as follows:
SELECT uniq(code) FROM test_table GROUP BY id, city, value % 2;
```

- In a created MV, the FROM clause cannot be a SELECT statement. Otherwise, the corresponding MV will fail to be matched. In the following example, the FROM clause is a SELECT statement. In this case, the corresponding MV cannot be matched.

```
CREATE MATERIALIZED VIEW agg_view
ENGINE = AggregatingMergeTree
PARTITION BY toDate(create_time)
ORDER BY (id)
AS SELECT
create_time,
id,
countState(id)
FROM
```

```
(SELECT id, create_time FROM test_table)
GROUP BY id,create_time;
```

- When querying original tables or creating MVs, an aggregate function cannot be used together with another aggregate function or a common function. Example:

```
# Case 1: Multiple aggregate functions are used when querying an original table.
# Create an MV.
CREATE MATERIALIZED VIEW agg_view
ENGINE = AggregatingMergeTree
PARTITION BY toDate(create_time)
ORDER BY (id)
AS SELECT
create_time,
id,
countState(id)
FROM test_table
GROUP BY id,create_time;
# Two aggregate functions are used when querying the original table, leading to the MV matching failure.
SELECT count(id) + count(id) FROM test_table;
# Case 2: Multiple aggregate functions are used when creating an MV.
# Two countState(id) functions are used when creating the MV, leading to the MV matching failure.
CREATE MATERIALIZED VIEW agg_view
ENGINE = AggregatingMergeTree
PARTITION BY toDate(create_time)
ORDER BY (id)
AS SELECT
 create_time,
 id,
(countState(id) + countState(id)) AS new_count
FROM test_table
GROUP BY id,create_time;
# The corresponding MV cannot be matched when querying the original table.
SELECT new_count FROM test_table;
```

  However, if the parameter of an aggregate function is the combination operation of fields, the corresponding MV can be matched.

```
CREATE MATERIALIZED VIEW agg_view
ENGINE = AggregatingMergeTree
PARTITION BY toDate(create_time)
ORDER BY (id)
AS SELECT
create_time,
id,
countState(id + id)
FROM test_table
GROUP BY id,create_time;
# The corresponding MV can be matched when querying the original table.
SELECT count(id + id) FROM test_table;
```

2.8 Configuring Interconnection Between ClickHouse and HDFS

Scenario

This section describes how to read and write files after connecting ClickHouse in security mode to HDFS in security mode. Functions same as those provided in the open source community are available after ClickHouse is connected to HDFS in normal mode. ClickHouse and HDFS deployed in clusters of different modes cannot be connected.

Prerequisites

- The ClickHouse client has been installed in a directory, for example, **/opt/client**.
- A user, for example, **clickhouseuser**, who has permissions on ClickHouse tables and has the permission to access HDFS has been created on FusionInsight Manager.
- A corresponding directory exists in HDFS. The HDFS engine of ClickHouse only works with files but does not create or delete directories.
- When ClickHouse accesses HDFS across clusters, a user, for example, **hdfsuser**, who has the permission to access HDFS has been created on FusionInsight Manager in the cluster where HDFS is.
- You have obtained the HDFS cluster domain name by logging in to FusionInsight Manager and choosing **System** > **Permission** > **Domain and Mutual Trust**.
- ClickHouse cannot connect to encrypted HDFS directories.
- Only the ClickHouse cluster deployed on x86 nodes can connect to HDFS. The ClickHouse cluster deployed on Arm nodes cannot connect to HDFS.

Interconnecting ClickHouse with HDFS in a Cluster

Step 1 Log in to FusionInsight Manager, choose **Cluster** > **Services** > **HDFS**, select **Configuration** > **All Configurations**, search for and change the value of **hadoop.rpc.protection** to **Authentication** or **Integrity**, save the settings, and restart the HDFS service.

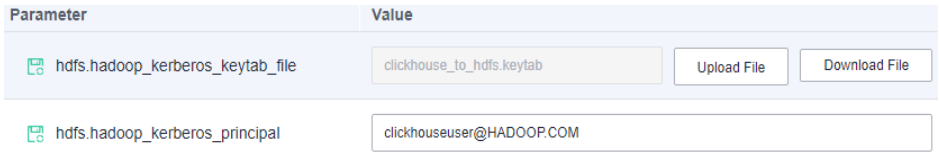
Step 2 Choose **System** > **User**, select **clickhouseuser**, and choose **More** > **Download Authentication Credential**.

NOTE

For the first authentication, change the initial password before downloading the authentication credential file. Otherwise, the security authentication will fail.

Step 3 Decompress the downloaded authentication credential package and change the name of **user.keytab** to **clickhouse_to_hdfs.keytab**.

Step 4 Log in to FusionInsight Manager, choose **Cluster** > **Services** > **ClickHouse**, and click **Configurations** then **All Configurations**. Click **ClickHouseServer(Role)** and select **Engine**. Click **Upload File** next to **hdfs.hadoop_kerberos_keytab_file**. Then upload the authentication credential file in **Step 3**. Set **hdfs.hadoop_kerberos_principal** to a value in the format of *Username*@*Domain name*, for example, **clickhouseuser@HADOOP.COM**.



Step 5 Save the configuration and restart ClickHouse.

Step 6 Log in to the node where the client is installed as the client installation user.

Step 7 Run the following command to go to the client installation directory:

cd /opt/client

Step 8 Run the following command to configure environment variables:

source bigdata_env

Step 9 Run the following command to authenticate the current user. (Skip this step for a cluster with Kerberos authentication disabled.)

kinit clickhouseuser

Step 10 Run the client command of ClickHouse to log in to the ClickHouse client.

clickhouse client --host *Service IP address of the ClickHouseServer instance* **--secure --port 9440**

Step 11 Run the following command to connect ClickHouse to HDFS:

CREATE TABLE default.hdfs_engine_table (`name` String, `value` UInt32) ENGINE = HDFS('hdfs://*{namenode_ip}***:***{dfs.namenode.rpc.port}***/tmp/secure_ck.txt', 'TSV')**

NOTE

- To obtain the service IP address of the ClickHouseServer instance, perform the following steps:

  Log in to FusionInsight Manager and choose **Cluster** > **Services** > **ClickHouse**. On the page that is displayed, click the **Instance** tab. On this tab page, obtain the service IP addresses of the ClickHouseServer instance.
- To obtain the value of *namenode_ip*, perform the following steps:

  Log in to FusionInsight Manager and choose **Cluster** > **Services** > **HDFS**. On the page that is displayed, click the **Instance** tab. On this tab page, obtain the service IP addresses of the active NameNode.
- To obtain the value of *dfs.namenode.rpc.port*, perform the following steps:

  Log in to FusionInsight Manager and choose **Cluster** > **Services** > **HDFS**. On the page that is displayed, click the **Configurations** tab then the **All Configurations** sub-tab. On this sub-tab page, search for **dfs.namenode.rpc.port** to obtain its value.
- HDFS file path to be accessed:

  If multiple files need to be accessed, add an asterisk (*) to the end of the folder, for example, **hdfs://***{namenode_ip}***:***{dfs.namenode.rpc.port}***/tmp/***.

  ClickHouse cannot connect to encrypted HDFS directories.
- Write data. For details, see **Process of Writing ClickHouse Data to HDFS**.

----End

Interconnecting ClickHouse with HDFS Across Clusters

Step 1 Log in to the FusionInsight Manager of the HDFS cluster, choose **Cluster** > **Services** > **HDFS**, select **Configuration** > **All Configurations**, search for and change the value of **hadoop.rpc.protection** to **Authentication** or **Integrity**, save the settings, and restart the HDFS service.

Step 2 Log in to FusionInsight Manager of the ClickHouse cluster and choose **System** > **Permission** > **Domain and Mutual Trust**. Configure mutual trust or unilateral mutual trust with the HDFS cluster. To configure unilateral mutual trust, configure mutual trust with the HDFS cluster only on the ClickHouse cluster.

Step 3 Log in to FusionInsight Manager of the HDFS cluster and choose **System** > **Permission** > **User**. On the page that is displayed, select **hdfsuser**, click **More**, and select **Download Authentication Credential**.

NOTE

For the first authentication, change the initial password before downloading the authentication credential file. Otherwise, the security authentication will fail.

Step 4 Decompress the downloaded authentication credential package and change the name of **user.keytab** to **clickhouse_to_hdfs.keytab**.

Step 5 Log in to FusionInsight Manager of the ClickHouse cluster, choose **Cluster** > **Services** > **ClickHouse**, and click **Configurations** then **All Configurations**. Click **ClickHouseServer(Role)** and select **Engine**. Click **Upload File** next to **hdfs.hadoop_kerberos_keytab_file** to upload the authentication credential file in **Step 3**. Set **hdfs.hadoop_kerberos_principal** to a value in the format of *Username*@*Domain name*, for example, **hdfsuser@HDFS_HADOOP.COM**.

Step 6 Save the configuration and restart ClickHouse.

Step 7 Log in to the node where the client is installed as the client installation user.

Step 8 Run the following command to go to the client installation directory:

cd /opt/client

Step 9 Run the following command to configure environment variables:

source bigdata_env

Step 10 Run the following command to authenticate the current user. (Skip this step for a cluster with Kerberos authentication disabled.)

kinit clickhouseuser

Step 11 Run the client command of ClickHouse to log in to the ClickHouse client.

clickhouse client --host *Service IP address of the ClickHouseServer instance* **--secure --port 9440**

Step 12 Run the following command to connect ClickHouse to HDFS:

CREATE TABLE default.hdfs_engine_table (`name` String, `value` UInt32) ENGINE = HDFS('hdfs://*{namenode_ip}***:***{dfs.namenode.rpc.port}***/tmp/secure_ck.txt', 'TSV')**

NOTE

- To obtain the service IP address of the ClickHouseServer instance, perform the following steps:

  Log in to FusionInsight Manager and choose **Cluster** > **Services** > **ClickHouse**. On the page that is displayed, click the **Instance** tab. On this tab page, obtain the service IP addresses of the ClickHouseServer instance.
- To obtain the value of *namenode_ip*, perform the following steps:

  Log in to FusionInsight Manager and choose **Cluster** > **Services** > **HDFS**. On the page that is displayed, click the **Instance** tab. On this tab page, obtain the service IP addresses of the active NameNode.
- To obtain the value of *dfs.namenode.rpc.port*, perform the following steps:

  Log in to FusionInsight Manager and choose **Cluster** > **Services** > **HDFS**. On the page that is displayed, click the **Configurations** tab then the **All Configurations** sub-tab. On this sub-tab page, search for **dfs.namenode.rpc.port** to obtain its value.
- HDFS file path to be accessed:

  If multiple files need to be accessed, add an asterisk (*) to the end of the folder, for example, **hdfs://***{namenode_ip}*:*{dfs.namenode.rpc.port}*/**tmp/***.
- Write data. For details, see **Process of Writing ClickHouse Data to HDFS**.

----End

Process of Writing ClickHouse Data to HDFS

When ClickHouse data is written, for example, to a Hive table in HDFS, data write succeeds if the Hive table is empty or data write fails if the Hive table contains data. If the data fails to write, perform the following steps:

Step 1 Back up the Hive table mapped to the ClickHouse table. For example, if the ClickHouse table is **ck_tab_a** and the corresponding Hive table is **hive_tab_a**, back up **hive_tab_a** to **hive_tab_a_bak**.

Step 2 Delete the Hive table **hive_tab_a**.

Step 3 Insert data to the ClickHouse table **ck_tab_a** on the ClickHouse client.

Step 4 On the Hive client, insert data in the **hive_tab_a_bak** table to the Hive table **hive_tab_a**.

Step 5 Delete the backup Hive table **hive_tab_a_bak**.

----End

2.9 Configuring Interconnection Between ClickHouse and Kafka

2.9.1 Interconnecting with Kafka Using a Username and Password

Scenario

The following content describes how to connect ClickHouse to Kafka using a username and password to consume Kafka data.

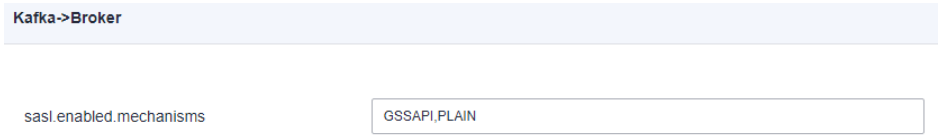
Prerequisites

- A Kafka cluster has been created and is in security mode.
- The cluster client has been installed.
- If ClickHouse and Kafka are not in the same cluster, ensure you have established cross-cluster mutual trust.

Procedure

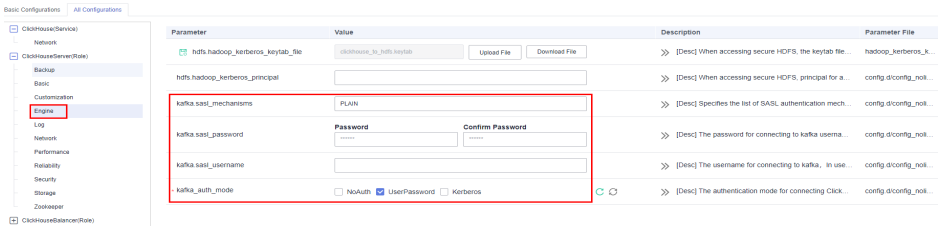
Step 1 Log in to FusionInsight Manager, select **Kafka**, choose **System** > **Permission** > **User** > **Create User**, and create a human-machine user with the Kafka permission. For example, create a human-machine user **ck_user1**. Change the initial password upon first login. For details about Kafka user permissions, see **Managing Kafka User Permissions**.

Step 2 Choose **Cluster** > **Services** > **Kafka** and choose **Configurations** > **All Configurations**. Search for **sasl.enabled.mechanisms**, and change the value to **GSSAPI,PLAIN**. Click **Save**.



Step 3 Log in to FusionInsight Manager, select **ClickHouse**, choose **Cluster** > **Services** > **ClickHouse**, and click **Configurations** > **All Configurations**. Select **ClickHouseServer (Role)** > **Engine**, and modify the parameters listed in the following table. Configure the username and password for connecting to Kafka.

Parameter	Description
kafka.sasl_mechanisms	SASL authentication for connecting to Kafka. The parameter value is **PLAIN**.
kafka.sasl_password	Password for connecting to Kafka. The initial password of the new user **ck_user1** must be changed. Otherwise, the authentication fails.
kafka.sasl_username	Username for connecting to Kafka. Enter the username created in **Step 1**.
kafka_auth_mode	Authentication mode for the ClickHouse to connect to the Kafka. Set this parameter to **UserPassword**.



Step 4 Click **Save**. In the displayed dialog box, click **OK** to save the configuration. Choose **Instances**, select **ClickHouseServer**, and click **More** > **Instance Rolling Restart**.

Step 5 Go to the Kafka client installation directory. For details, see **Using the Kafka Client**.

1. Log in to the node where the Kafka client is installed as the Kafka client installation user.
2. Run the following command to go to the client installation directory:

   cd /opt/client
3. Configure environment variables.

   source bigdata_env
4. If Kerberos authentication is enabled for the current cluster, run the following command to authenticate the user. If Kerberos authentication is disabled for the current cluster, skip this step.

   kinit *Component service user*

Step 6 Run the following command to create a Kafka topic. For details, see **Managing Kafka Topics**.

kafka-topics.sh --topic *topic1* **--create --zookeeper** *IP address of the Zookeeper role instance:Port used by ZooKeeper to listen to the client*/**kafka --partitions** *2* **--replication-factor** *1*

NOTE

- **--topic** is the name of the topic to be created, for example, **topic1**.
- **--zookeeper** is the IP address of the node where the ZooKeeper role instances are deployed, which can be the IP address of any of the three role instances. You can obtain the IP address of the node by performing the following steps:

  Log in to FusionInsight Manager, choose **Cluster** > **Services** > **ZooKeeper**. On the page that is displayed, click the **Instance** tab to query the IP addresses of ZooKeeper instances.
- **--partitions** and **--replication-factor** are the topic partitions and topic backup replicas, respectively. The number of the two parameters cannot exceed the number of Kafka role instances.
- To obtain the *Port used by ZooKeeper to listen to the client*, log in to FusionInsight Manager, click **Cluster**, choose **Services** > **ZooKeeper**, and view the value of **clientPort** on the **Configuration** tab page. The default port is 24002.

Step 7 Log in to the ClickHouse client node and connect it to the ClickHouse server. For details, see **Using ClickHouse from Scratch**.

Step 8 Create a Kafka table engine. The following is an example:

```
CREATE TABLE queue1 (
key String,
value String,
event_date DateTime
```

```
) ENGINE = Kafka()
SETTINGS kafka_broker_list = 'kafka_ip1:21007,kafka_ip2:21007,kafka_ip3:21007',
kafka_topic_list = 'topic1',
kafka_group_name = 'group1',
kafka_format = 'CSV',
kafka_row_delimiter = '\n',
kafka_handle_error_mode='stream';
```

The required parameters are as follows.

Parameter	Description
kafka_broker_list	A list of IP addresses and port numbers of Kafka broker instances. For example, *:IP address 1 of Kafka broker instance*:9092,*IP address 2 of Kafka broker instance*:9092,*IP address 3 of Kafka broker instance*:9092 To obtain the IP address of a Kafka broker instance, perform the following operations: Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Kafka**. Click the **Instances** tab to query the IP addresses of the Kafka instances.
kafka_topic_list	Topic where Kafka data is consumed
kafka_group_name	Kafka consumer group
kafka_format	Formatting type of consumed data. **JSONEachRow** indicates the JSON format (a piece of data in each line). **CSV** indicates the data is in a line but separated by commas (,).
kafka_row_delimiter	Delimiter character, which ends a message.

Parameter	Description

kafka_handle_error_mode	If this parameter is set to **stream**, each message processing exception is printed. You need to create a view and query the specific exception of abnormal data through the view.
	The following example shows you how to create a view:
	`CREATE MATERIALIZED VIEW default.kafka_errors2 ( `topic` String, `key` String, `partition` Int64, `offset` Int64, `timestamp` Date, `timestamp_ms` Int64, `raw` String, `error` String ) ENGINE = MergeTree ORDER BY (topic, partition, offset) SETTINGS index_granularity = 8192 AS SELECT _topic AS topic, _key AS key, _partition AS partition, _offset AS offset, _timestamp AS timestamp, _timestamp_ms AS timestamp_ms, _raw_message AS raw, _error AS error FROM default.queue1;`
	Query the view. The following is an example:
	`host1 :) select * from kafka_errors2; SELECT * FROM kafka_errors2 Query id: bf4d788f-bcb9-44f5-95d0-a6c83c591ddb ┌─topic──┬─key─┬─partition─┬─offset─┬─timestamp──┬─timestamp_ms─┬─raw─┬─error──┐ │ topic1 │ │ 1 │ 8 │ 2023-06-20 │ 1687252213 │ 456 │ Cannot parse date: value is too short: (at row 1) Buffer has gone, cannot extract information about what has been parsed. │ └────────┴─────┴───────────┴────────┴────────────┴──────────────┴─────┴──┘ 1 rows in set. Elapsed: 0.003 sec. host1 :)`

kafka_skip_broken_messages	(Optional) Number of Kafka data records where parsing exceptions are ignored. If *N* exceptions occur and the background thread ends, the materialized view is re-arranged to monitor the data.
kafka_num_consumers	(Optional) Number of consumers of a single Kafka engine. You can set this parameter to a larger value to improve the consumption data throughput. But the maximum value of this parameter cannot exceed the total number of partitions of the corresponding topic.

For details about other configurations, see **https://clickhouse.com/docs/en/engines/table-engines/integrations/kafka**.

Step 9 Connect the client to ClickHouse to create a local table. The following is an example:

```
CREATE TABLE daily1(
key String,
value String,
event_date DateTime
)ENGINE = MergeTree()
ORDER BY key;
```

Step 10 Connect the client to ClickHouse to create a materialized view. The following is an example:

```
CREATE MATERIALIZED VIEW default.consumer TO default.daily1 (
`event_date` DateTime,
`key` String,
`value` String
) AS
SELECT
event_date,
key,
value
FROM default.queue1;
```

Step 11 Perform **Step 5** again to go to the Kafka client installation directory.

Step 12 Run the following command to send a message to the topic created in **Step 6**:

kafka-console-producer.sh --broker-list *IP address 1 of the Kafka broker instance*:**9092,***IP address 2 of the Kafka broker instance*:**9092,***IP address 3 of the Kafka broker instance*:**9092 --topic** *topic1*

```
>a1,b1,'2020-08-01 10:00:00'
>a2,b2,'2020-08-02 10:00:00'
>a3,b3,'2020-08-02 10:00:00'
>a4,b4,'2023-09-02 10:00:00'
```

Step 13 Query the consumed Kafka data and the preceding materialized view. The following is an example:

```
select * from daily1;
```

```
┌─key─┬─value─┬──────────event_date─┐
│ >a1 │ b1    │ 2020-08-01 10:00:00 │
│ >a2 │ b2    │ 2020-08-02 10:00:00 │
│ >a3 │ b3    │ 2020-08-02 10:00:00 │
│ >a4 │ b4    │ 2023-09-02 10:00:00 │
└─────┴───────┴─────────────────────┘
```

----End

2.9.2 Interconnecting with Kafka Through Kerberos Authentication

Scenario

The following content describes how to connect ClickHouse to Kafka using Kerberos authentication to consume Kafka data.

Prerequisites

- A Kafka cluster has been created and is in security mode.
- The cluster client has been installed.

- If ClickHouse and Kafka are not in the same cluster, ensure you have established cross-cluster mutual trust.

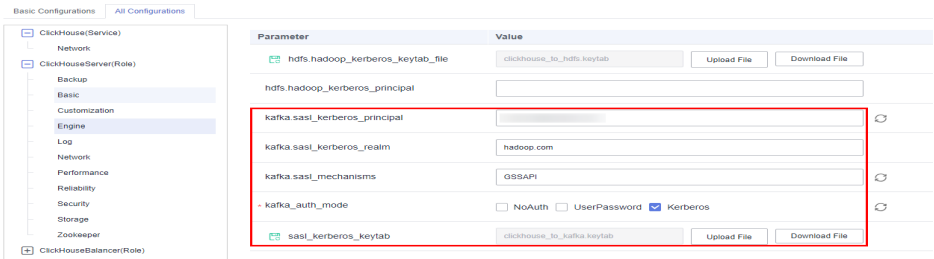
Procedure

Step 1 Log in to the FusionInsight Manager of the cluster where Kafka is deployed, choose **System** > **Permission** > **User** > **Create User**, and create a human-machine user with the Kafka permission. For example, create a human-machine user **ck_user1**. For details about Kafka user permissions, see **Managing Kafka User Permissions**.

Step 2 Choose **System** > **Permission** > **User**. On the displayed page, locate the **ck_user1** user, and click **More** > **Download Authentication Credential** in the **Operation** column of the user. Save the file and decompress it to obtain the **user.keytab** and **krb5.conf** files. Rename the **user.keytab** file **clickhouse_to_kafka.keytab**.

Step 3 Log in to the FusionInsight Manager of the cluster where ClickHouse is deployed, and choose **Cluster** > **Services** > **ClickHouse**. Click **Configurations** then **All Configurations**, and click **ClickHouseServer(Role)** > **Engine**. The following table shows the parameters need to be configured.

Parameter	Description
kafka.sasl_kerberos_principal	Principal for connecting to Kafka. Enter the username created in **Step 1**.
kafka.sasl_kerberos_realm	Domain name of the Kafka cluster
kafka.sasl_mechanisms	SASL authentication for connecting to Kafka. The parameter value is **GSSAPI**.
kafka_auth_mode	Authentication mode for the ClickHouse to connect to the Kafka. Set this parameter to **Kerberos**.
sasl_kerberos_keytab	Authentication file for connecting to Kafka, which is the **clickhouse_to_kafka.keytab** file uploaded in **Step 2**.



Step 4 Click **Save**. In the displayed dialog box, click **OK** to save the configuration. Choose **Instances**, select **ClickHouseServer**, and click **More** > **Instance Rolling Restart**.

Step 5 Go to the Kafka client installation directory. For details, see **Using the Kafka Client**.

1. Log in to the node where the Kafka client is installed as the Kafka client installation user.
2. Run the following command to go to the client installation directory:

   cd /opt/client
3. Configure environment variables.

   source bigdata_env
4. Run the following command to authenticate the current user:

   kinit *Component service user*

Step 6 Run the following command to create a Kafka topic. For details, see **Managing Kafka Topics**.

kafka-topics.sh --topic *topic1* **--create --zookeeper** *IP address of the Zookeeper role instance:Port used by ZooKeeper to listen to the client*/**kafka --partitions** *2* **--replication-factor** *1*

NOTE

- **--topic** is the name of the topic to be created, for example, **topic1**.
- **--zookeeper** is the IP address of the node where the ZooKeeper role instances are deployed, which can be the IP address of any of the three role instances. You can obtain the IP address of the node by performing the following steps:

  Log in to FusionInsight Manager, choose **Cluster** > **Services** > **ZooKeeper**. On the page that is displayed, click the **Instance** tab to query the IP addresses of ZooKeeper instances.
- **--partitions** and **--replication-factor** are the topic partitions and topic backup replicas, respectively. The number of the two parameters cannot exceed the number of Kafka role instances.
- To obtain the *Port used by ZooKeeper to listen to the client*, log in to FusionInsight Manager, click **Cluster**, choose **Services** > **ZooKeeper**, and view the value of **clientPort** on the **Configuration** tab page. The default port is 24002.

Step 7 Log in to the ClickHouse client node and connect it to the ClickHouse server. For details, see **Using ClickHouse from Scratch**.

Step 8 Create a Kafka table engine. The following is an example:

```
CREATE TABLE queue1 (
key String,
value String,
event_date DateTime
) ENGINE = Kafka()
SETTINGS kafka_broker_list = 'kafka_ip1:21007,kafka_ip2:21007,kafka_ip3:21007',
kafka_topic_list = 'topic1',
kafka_group_name = 'group2',
kafka_format = 'CSV',
kafka_row_delimiter = '\n',
kafka_handle_error_mode='stream';
```

The required parameters are as follows.

Parameter	Description
kafka_broker_list	A list of IP addresses and port numbers of Kafka broker instances. For example, *:IP address 1 of Kafka broker instance*:9092,*IP address 2 of Kafka broker instance*:9092,*IP address 3 of Kafka broker instance*:9092 To obtain the IP address of a Kafka broker instance, perform the following operations: Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Kafka**. Click the **Instances** tab to query the IP addresses of the Kafka instances.
kafka_topic_list	Topic where Kafka data is consumed
kafka_group_name	Kafka consumer group
kafka_format	Formatting type of consumed data. **JSONEachRow** indicates the JSON format (a piece of data in each line). **CSV** indicates the data is in a line but separated by commas (,).
kafka_row_delimiter	Delimiter character, which ends a message.

Parameter	Description

kafka_handle_error_mode	If this parameter is set to **stream**, each message processing exception is printed. You need to create a view and query the specific exception of abnormal data through the view.
	The following example shows you how to create a view:
	`CREATE MATERIALIZED VIEW default.kafka_errors2 ( `topic` String, `key` String, `partition` Int64, `offset` Int64, `timestamp` Date, `timestamp_ms` Int64, `raw` String, `error` String ) ENGINE = MergeTree ORDER BY (topic, partition, offset) SETTINGS index_granularity = 8192 AS SELECT _topic AS topic, _key AS key, _partition AS partition, _offset AS offset, _timestamp AS timestamp, _timestamp_ms AS timestamp_ms, _raw_message AS raw, _error AS error FROM default.queue1;`
	Query the view. The following is an example:
	`host1 :) select * from kafka_errors2; SELECT * FROM kafka_errors2 Query id: bf4d788f-bcb9-44f5-95d0-a6c83c591ddb ┌─topic──┬─key─┬─partition─┬─offset─┬─timestamp──┬─timestamp_ms─┬─raw─┬─error──┐ │ topic1 │ │ 1 │ 8 │ 2023-06-20 │ 1687252213 │ 456 │ Cannot parse date: value is too short: (at row 1) Buffer has gone, cannot extract information about what has been parsed. │ └────────┴─────┴───────────┴────────┴────────────┴──────────────┴─────┴──┘ 1 rows in set. Elapsed: 0.003 sec. host1 :)`

kafka_skip_broken_messages	(Optional) Number of Kafka data records where parsing exceptions are ignored. If *N* exceptions occur and the background thread ends, the materialized view is re-arranged to monitor the data.
kafka_num_consumers	(Optional) Number of consumers of a single Kafka engine. You can set this parameter to a larger value to improve the consumption data throughput. But the maximum value of this parameter cannot exceed the total number of partitions of the corresponding topic.

For details about other configurations, see **https://clickhouse.com/docs/en/engines/table-engines/integrations/kafka**.

Step 9 Connect the client to ClickHouse to create a local table. The following is an example:

```
CREATE TABLE daily1(
key String,
value String,
event_date DateTime
)ENGINE = MergeTree()
ORDER BY key;
```

Step 10 Connect the client to ClickHouse to create a materialized view. The following is an example:

```
CREATE MATERIALIZED VIEW default.consumer1 TO default.daily1 (
`event_date` DateTime,
`key` String,
`value` String
) AS
SELECT
event_date,
key,
value
FROM default.queue1;
```

Step 11 Perform **Step 5** again to go to the Kafka client installation directory.

Step 12 Run the following command to send a message to the topic created in **Step 6**:

kafka-console-producer.sh --broker-list *IP address 1 of the Kafka broker instance*:**9092,***IP address 2 of the Kafka broker instance*:**9092,***IP address 3 of the Kafka broker instance*:**9092 --topic** *topic1*

```
>a1,b1,'2020-08-01 10:00:00'
>a2,b2,'2020-08-02 10:00:00'
>a3,b3,'2020-08-02 10:00:00'
>a4,b4,'2023-09-02 10:00:00'
```

Step 13 Query the consumed Kafka data and the preceding materialized view. The following is an example:

```
select * from daily1;
```

```
┌─key─┬─value─┬──────────event_date─┐
│ >a1 │ b1    │ 2020-08-01 10:00:00 │
│ >a2 │ b2    │ 2020-08-02 10:00:00 │
│ >a3 │ b3    │ 2020-08-02 10:00:00 │
│ >a4 │ b4    │ 2023-09-02 10:00:00 │
└─────┴───────┴─────────────────────┘
```

----End

2.9.3 Interconnecting with Kafka in Normal Mode

Scenario

The following content describes how to connect to Kafka in normal mode and consume Kafka data.

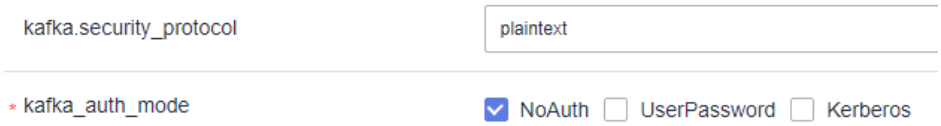
Prerequisites

- A Kafka cluster has been created and is in normal mode.
- You have created a ClickHouse cluster and installed the ClickHouse client. The ClickHouse and Kafka clusters can communicate with each other.

Procedure

Step 1 Log in to the FusionInsight Manager of the cluster where ClickHouse is deployed, and choose **Cluster** > **Services** > **ClickHouse**. Click **Configurations** then **All Configurations**, and click **ClickHouseServer(Role)** > **Engine**. The following table shows the parameter needs to be configured.

Parameter	Description
kafka.security_protocol	Value: **plaintext**
kafka_auth_mode	Authentication method for the connection between ClickHouse and Kafka. Set this parameter to **NoAuth**.



Step 2 Click **Save**. In the displayed dialog box, click **OK** to save the configuration. Choose **Instance**, select **ClickHouseServer**, and click **More** > **Instance Rolling Restart**.

Step 3 Go to the Kafka client installation directory. For details, see **Using the Kafka Client**.

1. Log in to the node where the Kafka client is installed as the Kafka client installation user.
2. Run the following command to go to the client installation directory:

   cd /opt/client
3. Configure environment variables.

   source bigdata_env

Step 4 Run the following command to create a Kafka topic. For details, see **Managing Kafka Topics**.

kafka-topics.sh --topic *topic1* **--create --zookeeper** *IP address of the Zookeeper role instance:Port used by ZooKeeper to listen to the client*/**kafka --partitions** *2* **--replication-factor** *1*

NOTE

- **--topic** is the name of the topic to be created, for example, **topic1**.
- **--zookeeper** is the IP address of the node where the ZooKeeper role instances are deployed, which can be the IP address of any of the three role instances. You can obtain the IP address of the node by performing the following steps:

  Log in to FusionInsight Manager, choose **Cluster** > **Services** > **ZooKeeper**. On the page that is displayed, click the **Instance** tab to query the IP addresses of ZooKeeper instances.
- **--partitions** and **--replication-factor** are the topic partitions and topic backup replicas, respectively. The number of the two parameters cannot exceed the number of Kafka role instances.
- To obtain the *Port used by ZooKeeper to listen to the client*, log in to FusionInsight Manager, click **Cluster**, choose **Services** > **ZooKeeper**, and view the value of **clientPort** on the **Configuration** tab page. The default port is 24002.

Step 5 Log in to the ClickHouse client node and connect it to the ClickHouse server. For details, see **Using ClickHouse from Scratch**.

Step 6 Create a Kafka table engine. The following is an example:

```
CREATE TABLE queue1 (
key String,
value String,
event_date DateTime
) ENGINE = Kafka()
SETTINGS kafka_broker_list = 'kafka_ip1:21005,kafka_ip2:21005,kafka_ip3:21005',
kafka_topic_list = 'topic1',
kafka_group_name = 'group2',
kafka_format = 'CSV',
kafka_row_delimiter = '\n',
kafka_handle_error_mode='stream';
```

The following table lists the related parameters.

Parameter	Description
kafka_broker_list	A list of IP addresses and port numbers of Kafka broker instances. For example, *:IP address 1 of Kafka broker instance*:9092,*IP address 2 of Kafka broker instance*:9092,*IP address 3 of Kafka broker instance*:9092 To obtain the IP address of the Kafka broker instance, perform the following steps: Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Kafka**. Click the **Instances** tab to query the IP addresses of the Kafka instances.
kafka_topic_list	Topic where Kafka data is consumed
kafka_group_name	Kafka consumer group
kafka_format	Formatting type of consumed data. **JSONEachRow** indicates the JSON format (a piece of data in each line). **CSV** indicates the data is in a line but separated by commas (,).
kafka_row_delimiter	Delimiter character, which ends a message.

Parameter	Description

kafka_handle_error_mode	If this parameter is set to **stream**, each message processing exception is printed. You need to create a view and query the specific exception of abnormal data through the view.
	The following example shows you how to create a view:
	`CREATE MATERIALIZED VIEW default.kafka_errors2 ( `topic` String, `key` String, `partition` Int64, `offset` Int64, `timestamp` Date, `timestamp_ms` Int64, `raw` String, `error` String ) ENGINE = MergeTree ORDER BY (topic, partition, offset) SETTINGS index_granularity = 8192 AS SELECT _topic AS topic, _key AS key, _partition AS partition, _offset AS offset, _timestamp AS timestamp, _timestamp_ms AS timestamp_ms, _raw_message AS raw, _error AS error FROM default.queue1;`
	Query the view. The following is an example:
	`host1 :) select * from kafka_errors2; SELECT * FROM kafka_errors2 Query id: bf4d788f-bcb9-44f5-95d0-a6c83c591ddb ┌─topic──┬─key─┬─partition─┬─offset─┬─timestamp──┬─timestamp_ms─┬─raw──┬─error──┐ │ topic1 │ │ 1 │ 8 │ 2023-06-20 │ 1687252213 │ 456 │ Cannot parse date: value is too short: (at row 1) Buffer has gone, cannot extract information about what has been parsed. │ └────────┴─────┴───────────┴────────┴────────────┴──────────────┴──────┴──┘ 1 rows in set. Elapsed: 0.003 sec. host1 :)`

kafka_skip_broken_messages	(Optional) Number of Kafka data records where parsing exceptions are ignored. If *N* exceptions occur and the background thread ends, the materialized view is re-arranged to monitor the data.
kafka_num_consumers	(Optional) Number of consumers of a single Kafka engine. You can set this parameter to a larger value to improve the consumption data throughput. But the maximum value of this parameter cannot exceed the total number of partitions of the corresponding topic.

For details about other configurations, see **https://clickhouse.com/docs/en/engines/table-engines/integrations/kafka**.

Step 7 Connect the client to ClickHouse to create a local table. The following is an example:

```
CREATE TABLE daily1(
key String,
value String,
event_date DateTime
)ENGINE = MergeTree()
ORDER BY key;
```

Step 8 Connect the client to ClickHouse to create a materialized view. The following is an example:

```
CREATE MATERIALIZED VIEW default.consumer1 TO default.daily1 (
`event_date` DateTime,
`key` String,
`value` String
) AS
SELECT
event_date,
key,
value
FROM default.queue1;
```

Step 9 Perform **Step 3** again to go to the Kafka client installation directory.

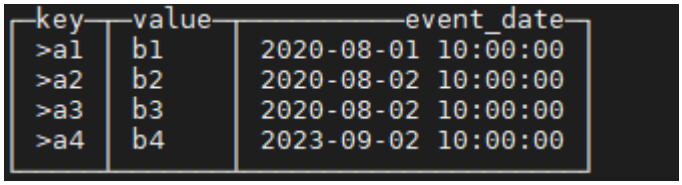
Step 10 Run the following command to send a message to the topic created in **Step 4**:

kafka-console-producer.sh --broker-list *IP address 1 of the Kafka broker instance*:**9092,***IP address 2 of the Kafka broker instance*:**9092,***IP address 3 of the Kafka broker instance*:**9092 --topic** *topic1*

```
>a1,b1,'2020-08-01 10:00:00'
>a2,b2,'2020-08-02 10:00:00'
>a3,b3,'2020-08-02 10:00:00'
>a4,b4,'2023-09-02 10:00:00'
```

Step 11 Query the consumed Kafka data and the preceding materialized view. The following is an example:

```
select * from daily1;
```



key	value	event_date
>a1	b1	2020-08-01 10:00:00
>a2	b2	2020-08-02 10:00:00
>a3	b3	2020-08-02 10:00:00
>a4	b4	2023-09-02 10:00:00

----End

2.10 Configuring the Connection Between ClickHouse and Open-Source ClickHouse

Scenario

For clusters in normal mode (Kerberos authentication disabled), you need to configure CLICKHOUSE_OPENSOURCE_COMMUNITY to connect to open-source or other vendors' ClickHouse. For clusters in security mode (Kerberos authentication enabled), the connection is not supported.

Parameter Configuration

Step 1 Log in to FusionInsight Manager and choose **Cluster** > **Services** > **ClickHouse**. Click **Configurations** then **All Configurations**, click **ClickHouseServer(Role)** > **Security**, and search for and modify the following parameters.

Parameter	Description
CLICKHOUSE_OPENSOURCE_COMMUNITY	Whether to support the connection to the open-source ClickHouse. The default value is **false**, indicating that ClickHouse cannot be connected to an open-source ClickHouse. Value **true** indicates that ClickHouse can be connected to an open-source ClickHouse.

Step 2 Click **Save**. In the displayed dialog box, click **OK** to save the configuration. Choose **Instances**, select **ClickHouseServer**, and click **More** > **Instance Rolling Restart**.

----End

2.11 Configuring Strong Data Consistency Between ClickHouse Replicas

Scenario

ClickHouse supports multiple replicas. When data is written to a local table, the data on the current node is updated immediately, but the data between other replicas is asynchronously updated.

Configure ClickHouse to ensure strong data consistency between replicas.

Parameter Configuration

NOTE

The priority of configuring strong data consistency between ClickHouse replicas is as follows: single statements > sessions > global defaults.

Strong data consistency between replicas must be used together with atomicity. Otherwise, an exception occurs during data insertion and the rollback fails.

Log in to FusionInsight Manager and choose **Cluster** > **Services** > **ClickHouse**. Click **Configurations** then **All Configurations**, click **ClickHouseServer(Role)** > **Reliability**, and search for and modify the following parameters:

Parameter	Description
profiles.default.insert_quorum	Whether to enable strong data consistency between ClickHouse replicas. The default value is **0**, indicating that strong consistency between replicas is disabled. Value options are as follows: 0 to 9, **auto**, and **all**. • If this parameter is set to a number, the INSERT operation can succeed only when ClickHouse attempts to correctly write data to the insert_quorum of replicas during the insert_quorum_timeout period. • **auto** indicates that the INSERT operation is successful only when data is correctly written to more than half of the replicas. • **all** indicates that the INSERT operation is successful only when data is correctly written to all replicas.
profiles.default.insert_quorum_timeout	Timeout interval for writing strongly consistent data between replicas. The default value is **600000** ms. The value must be greater than 0.

2.12 Configuring the Support for Transactions on ClickHouse

Scenario

Atomicity means that a transaction is an inseparable unit of work. A transaction can contain multiple operations, which are either all executed or none executed. However, some exceptions may occur during transaction execution, for example, a user rolls back a transaction, a connection is disconnected, or a power failure occurs. As a result, the transaction execution is interrupted.

ClickHouse supports atomic write and transaction capabilities. The atomicity of a transaction means that after an operation of a transaction fails, the transaction can be rolled back to the state before the transaction is executed.

Start a ClickHouse transaction.

NOTE

- Writing data to local tables achieves better performance. So, multi-replica distributed transactions are recommended for adding, deleting, modifying, and querying data on local tables.
- When data is written to a distributed table, the distributed table transaction **insert_distributed_sync** and local table transaction **Mergetree/ReplicateMergeTree** must be combined to support data writing.

Parameter Configuration

Log in to FusionInsight Manager and choose **Cluster** > **Services** > **ClickHouse**. Click **Configurations** then **All Configurations**, click **ClickHouseServer(Role)** > **Reliability**, and search for and modify the following parameters:

Parameter	Description
allow_transactions	Whether to support transactions. The value can be **0** or **1**. ● The default value is **0**, indicating that transactions are not supported. ● Set this parameter to **1**, save the configuration, and restart the service for the support for transactions to take effect.
_clickhouse.metrika.cluster.internal_replication	Whether to write data to only one replica. The value can be **true** or **false**. ● The default value is **true**, indicating that data is inserted only to one replica. ● If this parameter is set to **false**, data is inserted to both replicas.

NOTE

- You can run the **set implicit_transaction='true';** statement to use session-level implicit transactions. Currently, ClickHouse does not support interruption of alter queries. If the execution of alter queries (for example, lightweight delete) is interrupted, it cannot be rolled back even if implicit transactions are enabled. This is the same as open-source ClickHouse.
- To insert data into a distributed table, perform the following steps:

  Log in to FusionInsight Manager, choose **Cluster** > **Services** > **ClickHouse**, click **Configurations** then **All Configurations**, and change the value of **_clickhouse.metrika.cluster.internal_replication** to **false**, indicating that data is written to all replicas of a shard when being inserted to a distributed table.

  At the session level, **set insert_distributed_sync='true';** indicates that data is inserted to each actual table in synchronous mode when being inserted to a distributed table.

2.13 Pre-Caching ClickHouse Metadata to the Memory

Scenario

If there are a large number of service tables holding a large amount of data, loading metadata during rolling restart is time-consuming. You can use RocksDB to pre-cache the metadata to the memory to accelerate metadata loading.

Enabling Metadata Pre-Caching

You can set **use_metadata_cache** to **1** or **true** to cache metadata to the memory through RocksDB.

1. Use the ClickHouse client to connect to the ClickHouse server by referring to **Using ClickHouse from Scratch**.
2. Configure metadata pre-caching.
   - Enable metadata pre-caching for historical tables.

     ALTER TABLE *<table name>* **MODIFY SETTING use_metadata_cache=1;**

     Or

     ALTER TABLE *<table name>* **MODIFY SETTING use_metadata_cache=true;**
   - Enable metadata pre-caching when you create a table.

     CREATE TABLE *<table name>*

     (

     `x` UInt32,

     `y` UInt32,

     `z` UInt32,

     `t` UInt32

)

     ENGINE = MergeTree

     PARTITION BY x % 10

     ORDER BY (x, y)

     SETTINGS index_granularity = 8192, use_metadata_cache = 1

     or

     CREATE TABLE *<table name>*

     (

     `x` UInt32,

     `y` UInt32,

     `z` UInt32,

     `t` UInt32

)

     ENGINE = MergeTree

     PARTITION BY x % 10

     ORDER BY (x, y)

     SETTINGS index_granularity = 8192, use_metadata_cache = true

Parameter Tuning

Metadata pre-caching can be optimized as follows:

Log in to FusionInsight Manager, choose **Cluster** > **Services** > **ClickHouse**, click **Configurations** and then **All Configurations**, and modify the following parameters:

Parameter	Value	Description
merge_tree_metadata_cache.continue_if_corrupted	true	If the local RocksDB directory fails to be read, **false** indicates that you can exit the process, and **true** indicates that dirty data is cleared.
merge_tree_metadata_cache.lru_cache_size	1 GB	Size of the LRU in the RocksDB instance used to cache part metadata

2.14 Collecting Dumping Logs of the ClickHouse System Tables

Scenario

If an exception occurs, you need to restart ClickHouse to restore services. Before restart, you need to dump the status information of each ClickHouse system table for efficient ClickHouse fault locating.

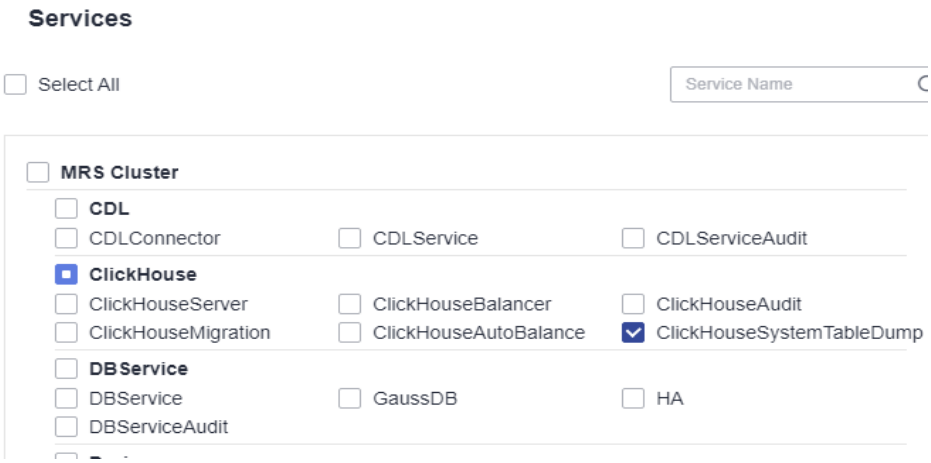
System table logs can be dumped in real time or in one-click mode, as shown in the following table.

Log Dumping Type	System Tables
Real-time dumping	• system.asynchronous_metrics • system.clusters • system.distribution_queue • system.events • system.grants • system.mutations • system.processes • system.metrics • system.part_moves_between_shards • system.replicas • system.replicated_fetches • system.replication_queue

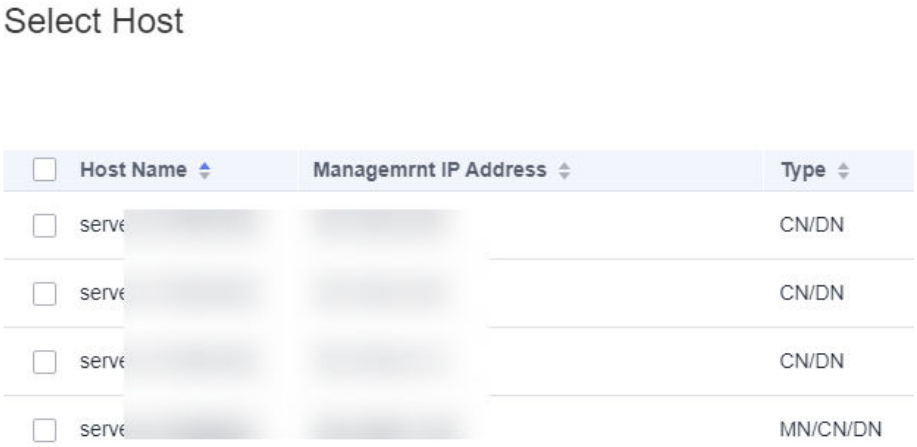
Log Dumping Type	System Tables
One-click dumping	• system.distributed_ddl_queue • system.errors • system.parts • system.parts_columns • system.query_log • system.query_thread_log • system.trace_log

Collecting Real-Time Dumping Logs

Step 1 Log in to FusionInsight Manager, choose **O&M** > **Log** > **Download**, and select **ClickHouseSystemTableDump** for **Service**.



Step 2 Select the hosts where you want to collect dumping logs and click **OK**.



Step 3 Click the time editing button in the upper right corner and set **Start Time** and **End Time** for log collection.

NOTE

For details about how long it takes to collect logs, contact technical support engineers.

Step 4 Click **Download**. The real-time system table dumping logs are saved to the local PC.

----End

Collecting One-Click Dumping Logs

Step 1 Log in to any ClickHouseServer node as the **root** user and go to the **sbin** directory.

cd ${BIGDATA_HOME}/FusionInsight_ClickHouse_*/*_*_ClickHouseServer/install/clickhouse/sbin

Step 2 Run the following command to obtain dumping logs:

./clickhouse_systemtable_dump.sh 1 "*Start time***" "***End time***"**

Example: **./clickhouse_systemtable_dump.sh 1 "2023-08-04 12:00:00" "2023-08-04 16:37:20"**

Step 3 Go to the **/var/log/Bigdata/clickhouse/systemTableDump/oneclickTable** directory and view the compressed one-click dumping logs.

```
[root@server-2110082001-0018 ~]#cd /opt       ./Bigdata/FusionInsight_ClickHouse_*/*_*_ClickHouseServer/install/clickhouse/sbin
[root@server-2110082001-0018 sbin]#./clickhouse_systemtable_dump.sh 1 "2023-08-04 12:00:00" "2023-08-04 16:37:20"
tar: Removing leading `/var/log/Bigdata/clickhouse/clickhouseServer/../' from member names
tar: Removing leading `/var/log/Bigdata/clickhouse/clickhouseServer/../' from hard link targets
[root@server-2110082001-0018 sbin]#cd /var/log/Bigdata/clickhouse/systemTableDump/oneclickTable
[root@server-2110082001-0018 oneclickTable]#ll
total 98884
-rw------- 1 root root 101252782 Aug 11 15:11 oneClickTableDump_20230811151114.tar.gz
-rw------- 1 root root      2043 Aug 11 16:03 oneClickTableDump_20230811160306.tar.gz
[root@server-2110082001-0018 oneclickTable]#
```

----End

2.15 ClickHouse Log Overview

Log Description

Log path: ClickHouse logs are stored in **${BIGDATA_LOG_HOME}/clickhouse** by default.

- ClickHouse run logs: **/var/log/Bigdata/clickhouse/clickhouseServer/ *.log**
- Balancer run logs: **/var/log/Bigdata/clickhouse/balance/*.log**
- Data migration logs: **/var/log/Bigdata/clickhouse/migration/${task_name}/clickhouse-copier_{timestamp}_{processId}/copier.log**
- ClickHouse audit logs: **/var/log/Bigdata/audit/clickhouse/clickhouse-server-audit.log**

Log archiving rules:

- The automatic compression and archiving function has been enabled for ClickHouse logs. By default, when the size of log files exceeds 100 MB, the log files will be automatically compressed.
- The file generated after log files are compressed is named in the format of **<***Original log name***>.[***ID***].gz**.

- A maximum of 10 latest compressed files are reserved by default. The number of compressed files can be configured on Manager.

Table 2-5 ClickHouse log list

Log Type	Log File Name	Description
ClickHouse log	/var/log/Bigdata/clickhouse/clickhouseServer/clickhouse-server.err.log	Path of ClickHouseServer error log files
	/var/log/Bigdata/clickhouse/clickhouseServer/checkService.log	Path of key ClickHouseServer run log files
	/var/log/Bigdata/clickhouse/clickhouseServer/clickhouse-server.log	
	/var/log/Bigdata/clickhouse/clickhouseServer/ugsync.log	User role synchronization tool log
	/var/log/Bigdata/clickhouse/clickhouseServer/prestart.log	ClickHouse prestart log
	/var/log/Bigdata/clickhouse/clickhouseServer/start.log	ClickHouse startup log
	/var/log/Bigdata/clickhouse/clickhouseServer/checkServiceHealthCheck.log	ClickHouse health check log
	/var/log/Bigdata/clickhouse/clickhouseServer/checkugsync.log	User role synchronization check log
	/var/log/Bigdata/clickhouse/clickhouseServer/checkDisk.log	Path of ClickHouse disk check log files
	/var/log/Bigdata/clickhouse/clickhouseServer/backup.log	Path of log files generated when ClickHouse performs the backup and restoration operations on Manager
	/var/log/Bigdata/clickhouse/clickhouseServer/stop.log	ClickHouse stop log
	/var/log/Bigdata/clickhouse/clickhouseServer/postinstall.log	postinstall.sh script invoking log of ClickHouse
	/var/log/Bigdata/clickhouse/balance/start.log	Path of ClickHouseBalancer startup log files
	/var/log/Bigdata/clickhouse/balance/error.log	Path of ClickHouseBalancer error log files
	/var/log/Bigdata/clickhouse/balance/access_http.log	Path of the HTTP log files generated during ClickHouseBalancer running

Log Type	Log File Name	Description
	/var/log/Bigdata/clickhouse/balance/access_tcp.log	Path of the TCP log files generated during ClickHouseBalancer running
	/var/log/Bigdata/clickhouse/balance/checkService.log	ClickHouseBalancer service check log
	/var/log/Bigdata/clickhouse/balance/postinstall.log	Invoking log of the **postinstall.sh** script of ClickHouseBalancer
	/var/log/Bigdata/clickhouse/balance/prestart.log	Path of prestart log files of ClickHouseBalancer
	/var/log/Bigdata/clickhouse/balance/stop.log	Path of stop log files of ClickHouseBalancer
	/var/log/Bigdata/clickhouse/clickhouseServer/auth.log	ClickHouse service authentication log
	/var/log/Bigdata/clickhouse/clickhouseServer/cleanService.log	Log generated when an instance fails to reinstall
	/var/log/Bigdata/clickhouse/clickhouseServer/offline_shard_table_manager.log	ClickHouse recommissioning/ decommissioning log
	/var/log/Bigdata/clickhouse/clickhouseServer/traffic_control.log	ClickHouse active/standby DR traffic control log
	/var/log/Bigdata/clickhouse/clickhouseServer/clickhouse_migrate_metadata.log	ClickHouse metadata migration log
	/var/log/Bigdata/clickhouse/clickhouseServer/clickhouse_migrate_data.log	ClickHouse service data migration log
	/var/log/Bigdata/clickhouse/clickhouseServer/changePassword.log	ClickHouse user password change log
	/var/log/coredump/clickhouse-*.core.gz	Compressed package of memory dump files generated after the ClickHouse process breaks down
Data migration log	/var/log/Bigdata/clickhouse/migration/*Data migration task name*/clickhouse-copier_*{timestamp}_{processId}*/copier.log	Run log generated when you use the migration tool by referring to **Using the ClickHouse Data Migration Tool**
	/var/log/Bigdata/clickhouse/migration/*Data migration task name*/clickhouse-copier_*{timestamp}_{processId}*/copier.err.log	Error log generated when you use the migration tool by referring to **Using the ClickHouse Data Migration Tool**

Log Type	Log File Name	Description
	/var/log/Bigdata/tomcat/clickhouse/auto_balance/*Data migration task name*/balance_manager.log	Run log generated when one-click balancing is selected by referring to **Using the ClickHouse Data Migration Tool**
clickhouse-tomcat log	/var/log/Bigdata/tomcat/clickhouse/web_clickhouse.log	ClickHouse custom UI run log
	/var/log/Bigdata/tomcat/audit/clickhouse/clickhouse_web_audit.log	Clickhouse data migration audit log
ClickHouse audit log	/var/log/Bigdata/audit/clickhouse/clickhouse-server-audit.log	Path of ClickHouse audit log files

Log Level

Table 2-6 describes the log levels supported by ClickHouse.

Levels of run logs are error, warning, trace, information, and debug from the highest to the lowest priority. Run logs of equal or higher levels are recorded. The higher the specified log level, the fewer the logs recorded.

Table 2-6 Log levels

Level	Description
error	Logs of this level record error information about system running
warning	Logs of this level record exception information about the current event processing
trace	Logs of this level record trace information about the current event processing
information	Logs of this level record normal running status information about the system and events
debug	Logs of this level record system running and debugging information

To modify log levels, perform the following operations:

Step 1 Log in to FusionInsight Manager.

Step 2 Choose **Cluster** > **Services** > **ClickHouse** > **Configurations**.

Step 3 Select **All Configurations**.

Step 4 On the menu bar on the left, select the log menu of the target role.

Step 5 Select a desired log level.

Step 6 Click **Save**. Then, click **OK**.

----End

NOTE

The configurations take effect immediately without the need to restart the service.

Log Format

The following table lists the ClickHouse log format:

Table 2-7 Log formats

Log Type	Format	Example
ClickHouse run log	<*yyyy-MM-dd HH:mm:ss,SSS*>|<*Log level*>|<*Name of the thread that generates the log*>|<*Message in the log*>|<*Location where the log event occurs*>	2021.02.23 15:26:30.691301 [6085] {} <Error> DynamicQueryHandler: Code: 516, e.displayText() = DB::Exception: default: Authentication failed: password is incorrect or there is no user with such name, Stack trace (when copying this message, always include the lines below): 0. Poco::Exception::Exception(std::__1::basic_string<char, std::__1::char_traits<char>, std::__1::allocator<char> > const&, int) @ 0x1250e59c

2.16 ClickHouse FAQ

2.16.1 How Do I Do If the Disk Status Displayed in the System.disks Table Is fault or abnormal?

Symptom

How do I do if the disk status displayed in the System.disks table is fault or abnormal?

Procedure

This problem is caused by I/O errors on the disk. To rectify the fault, perform the following steps:

- Method 1: Log in to FusionInsight Manager and check whether an alarm is generated indicating that the disk I/O is abnormal. If yes, replace the faulty disk by referring to the alarm help.
- Method 2: Log in to FusionInsight Manager and restart the ClickHouse instance to restore the disk status.

  NOTE

  If an I/O error occurs but the disk is not replaced, the disk status will still turn to fault or abnormal.

2.16.2 How Do I Quickly Restore the Status of a Logical Cluster in a Scale-in Fault Scenario?

Symptom

After the scale-in of the ClickHouse logical cluster is complete, **Status** is displayed as **Scaling in** for a long time.

Procedure

Step 1 Log in to FusionInsight Manager, choose **Cluster** > **Services** > **ClickHouse**, and click **Logical Cluster**. After the cluster scale-in is complete, check whether **Status** is **Scaling in** for a long time.

- If yes, go to **Step 2**.
- If no, the scale-in of the logical cluster is complete. No further action is required.

Step 2 Log in to the node where the ZooKeeper client is installed in the MRS cluster and run the following commands:

su - omm

source *{Client installation directory}***/bigdata_env**

kinit *Component user* (You do not need to run the **kinit** command for normal clusters.)

zkCli.sh -server *{Service IP address of the ZooKeeper service instance node}*:*{Client port number}*

get /clickhouse/logic_cluster

Check whether the value of **<status>** is **REDUCING**.

- If yes, go to **Step 3**.
- If no, contact technical support to further analyze the customized UI log information to locate the fault.

NOTE

The ClickHouse metadata root directory in ZooKeeper varies depending on ClickHouse multi-service scenarios.

Log in to FusionInsight Manager and choose **Cluster** > **Services** > **ClickHouse**. Click **Configurations** then **All Configurations**, and query the value of **clickhouse.zookeeper.root.path**.

Step 3 Run the following command to update the **<status>** value of the logical cluster to **CHECKING**:

set /clickhouse/logic_cluster *<clusters><default_cluster><createTime>……</createTime><sslBalancerPort>……</sslBalancerPort><balancerPort>……</balancerPort><httpsBalancerPort>……</httpsBalancerPort><httpBalancerPort>……</httpBalancerPort><replicaNum>……</replicaNum>***<status>CHECKING</status>***<node>……</node><node>……</node></default_cluster></clusters>*

NOTE

To modify the ZNode information in ZooKeeper, convert all content into one line and change the value of **<status>** to **CHECKING**.

----End

2.16.3 What Should I Do If a File System Error Is Reported and Core Dump Occurs During Process Startup and part Loading After a ClickHouserServer Instance Node Is Power Cycled?

Symptom

The ClickHouseServer instance fails to be restarted. The following shows the displayed error message.

A core dump occurred during restart. The key error message is as follows:
2023.09.11 15:34:49.085595 [30174] {} <Fatal> BaseDaemon [BaseDaemon.cpp:338] : (version 23.3.2.1, build id: 86C97F3EED917A2F2D9A691B4FB845F860FE7FF2) (from thread 29814) (no query) Received signal Aborted (6)
2023.09.11 15:34:49.085636 [30174] {} <Fatal> BaseDaemon [BaseDaemon.cpp:354] :
2023.09.11 15:34:49.085662 [30174] {} <Fatal> BaseDaemon [BaseDaemon.cpp:367] : Stack trace: 0x7f2ed263a207 0x7f2ed263b8f8 0xb97032b 0x7f2ed30c7b83 0x7f2ed30c7b18 0x16de788c 0x151ccd63 0x151cf0ea 0x151cf77d 0xb7b8958 0xb7bc720 0x7f2ed29d8dd5 0x7f2ed2701ead
2023.09.11 15:34:49.085739 [30174] {} <Fatal> BaseDaemon [BaseDaemon.cpp:371] : 3. gsignal @ 0x36207 in /usr/lib64/libc-2.17.so
2023.09.11 15:34:49.085775 [30174] {} <Fatal> BaseDaemon [BaseDaemon.cpp:371] : 4. __GI_abort @ 0x378f8 in /usr/lib64/libc-2.17.so
2023.09.11 15:34:49.085820 [30174] {} <Fatal> BaseDaemon [BaseDaemon.cpp:371] : 5. terminate_handler() @ 0xb97032b in /opt/AA/BB/Bigdata/FusionInsight_ClickHouse_8.3.0/install/FusionInsight-ClickHouse-v23.3.2.37-lts/clickhouse/bin/clickhouse
2023.09.11 15:34:49.085854 [30174] {} <Fatal> BaseDaemon [BaseDaemon.cpp:371] : 6. std::__terminate(void (*)()) @ 0x99b83 in /opt/AA/BB/Bigdata_func/comp/ck/lib_lemmagen.so
2023.09.11 15:34:49.085875 [30174] {} <Fatal> BaseDaemon [BaseDaemon.cpp:371] : 7. std::terminate() @ 0x99b18 in /opt/AA/BB/Bigdata_func/comp/ck/lib_lemmagen.so
2023.09.11 15:34:49.085898 [30174] {} <Fatal> BaseDaemon [BaseDaemon.cpp:371] : 8. DB::MergeTreeData::loadOutdatedDataParts(bool) @ 0x16de788c in /opt/AA/BB/Bigdata/FusionInsight_ClickHouse_8.3.0/install/FusionInsight-ClickHouse-v23.3.2.37-lts/clickhouse/bin/clickhouse
2023.09.11 15:34:49.085920 [30174] {} <Fatal> BaseDaemon [BaseDaemon.cpp:371] : 9. DB::BackgroundSchedulePoolTaskInfo::execute() @ 0x151ccd63 in /opt/AA/BB/Bigdata/FusionInsight_ClickHouse_8.3.0/install/FusionInsight-ClickHouse-v23.3.2.37-lts/clickhouse/bin/clickhouse

The core dump is caused by the following file system errors:
2023.09.11 15:34:49.084809 [28762] {} <Fatal> BaseDaemon [BaseDaemon.cpp:280] : (version 23.3.2.1, build id: 86C97F3EED917A2F2D9A691B4FB845F860FE7FF2) (from thread 29814) Terminate called for uncaught exception:
2023.09.11 15:34:49.084883 [28762] {} <Fatal> BaseDaemon [BaseDaemon.cpp:291] : std::exception. Code: 1001, type: std::__1::__fs::filesystem::filesystem_error, e.what() = filesystem error: in directory_iterator::directory_iterator(...): Structure needs cleaning ["**/srv/AA/BB/clickhouse/data1/clickhouse/store/b0b/b0b1f040-4bdb-4584-9be6-782e81fafeae/202309_46191_47131_657**"]

Procedure

Step 1 Log in to the ClickHouseServer instance node that fails to be restarted, search for **Structure needs cleaning** in **/var/log/Bigdata/clickhouse/clickhouseServer/clickhouse-server.log** to locate the damaged **part** directory.

Step 2 Go the the damaged **part** directory, as shown in the following log (**/srv/AA/BB/clickhouse/data1/clickhouse/store/b0b/b0b1f040-4bdb-4584-9be6-782e81fafeae/202309_46191_47131_657**), clear the **202309_46191_47131_657** directory. If it cannot be cleared, clear the upper level directory (**b0b1f040-4bdb-4584-9be6-782e81fafeae**).

Step 3 Log in to FusionInsight Manager and restart the ClickHouseServer instance.

----End

2.16.4 What Should I Do If an Exception Occurred in the replication_queue and Data Is Inconsistent Between Replicas After a ClickHouse Cluster Is Powered On from a Sudden Poweroff?

Symptom

ClickHouseServer replicas failed to be synchronized. The following error message was displayed:

When the system table **system.replication_queue** is queried, the following error message was displayed:
Code: 234. DB::Exception: No active replica has part 1694228400_0_3742_2242 or covering part (cannot execute queue-0000010315: GET_PART with virtual parts [1694228400_0_3742_2242]). (NO_REPLICA_HAS_PART)

Procedure

Step 1 Log in to the ClickHouse client node and connect to ClickHouseServer by referring to **Using ClickHouse from Scratch**.

Step 2 Run **SELECT * from system.replication_queue** to query the information in the **system.replication_queue** system table. The following error message is displayed in the **last_exception** column:

Code: 234. DB::Exception: No active replica has part 1694228400_0_3742_2242 or covering part (cannot execute queue-0000010315: GET_PART with virtual parts [1694228400_0_3742_2242]). (NO_REPLICA_HAS_PART)

Step 3 Run the following statement to obtain the ZooKeeper storage path and locate all abnormal nodes:

SELECT replica_path || '/queue/' || node_name, last_exception FROM system.replication_queue JOIN system.replicas USING (database, table) WHERE create_time < now();

Step 4 Log in to the ZooKeeper client by referring to **Using ZooKeeper from Scratch**.

Step 5 Run the **delete** command to delete all abnormal nodes obtained in **Step 3**. The following is an example.

delete */clickhouse/tables/68/test0722/test156/replicas/1/queue/queue-0000010315*

The command parameters are as follows:

- **/clickhouse/tables/68/test0722/test156/replicas/1/queue** indicates the path of the abnormal nodes obtained in **Step 3**.
- **queue-0000010315** indicates the abnormal nodes obtained in **Step 3**.

Step 6 Log in to the ClickHouse client node, connect to ClickHouseServer, and run the following statement to restart the replicas:

SYSTEM RESTART REPLICAS

----End

3 Using DBService

3.1 DBService Log Overview

Log Description

Log path: The default storage path of DBService log files is **/var/log/Bigdata/dbservice**.

- GaussDB: **/var/log/Bigdata/dbservice/DB** (GaussDB run log directory), **/var/log/Bigdata/dbservice/scriptlog/gaussdbinstall.log** (GaussDB installation log), and **/var/log/gaussdbuninstall.log** (GaussDB uninstallation log).
- HA: **/var/log/Bigdata/dbservice/ha/runlog** (HA run log directory) and **/var/log/Bigdata/dbservice/ha/scriptlog** (HA script log directory)
- DBServer: **/var/log/Bigdata/dbservice/healthCheck** (Directory of service and process health check logs)

  /var/log/Bigdata/dbservice/scriptlog (run log directory), **/var/log/Bigdata/audit/dbservice/** (audit log directory)

Log archive rule: The automatic DBService log compression function is enabled. By default, when the size of logs exceeds 1 MB, logs are automatically compressed into a log file named in the following format: *<Original log file name>-[No.]*.**gz**. A maximum of 20 latest compressed files are reserved.

NOTE

Log archive rules cannot be modified.

Table 3-1 DBService log list

Type	Log File Name	Description
DBServer run log	dbservice_serviceCheck.log	Run log file of the service check script

Type	Log File Name	Description
	dbservice_processCheck.log	Run log file of the process check script
	backup.log	Run logs of backup and restoration operations (The DBService backup and restoration operations need to be performed.)
	checkHaStatus.log	Log file of HA check records
	cleanupDBService.log	Uninstallation log file (You need to uninstall DBService logs.)
	componentUserManager.log	Log file that records the adding and deleting operations on the database by users (Services that depend on DBService need to be added.)
	install.log	Installation log file
	preStartDBService.log	Pre-startup log file
	start_dbserver.log	DBServer startup operation log file (DBService needs to be started.)
	stop_dbserver.log	DBServer stop operation log file (DBService needs to be stopped.)
	status_dbserver.log	Log file of the DBServer status check (You need to execute the **$DBSERVICE_HOME/sbin/status-dbserver.sh** script.)
	modifyPassword.log	Run log file of changing the DBService password script. (You need to execute the **$DBSERVICE_HOME/sbin/modifyDBPwd.sh** script.)

Type	Log File Name	Description
	modifyDBPwd_yyyy-mm-dd.log	Run log file that records the DBService password change tool (You need to execute the **$DBSERVICE_HOME/sbin/modifyDBPwd.sh** script.)
	dbserver_switchover.log	Log for DBServer to execute the active/standby switchover script (the active/standby switchover needs to be performed)
GaussDB run log	gaussdb.log	Log file that records database running information
	gs_ctl-current.log	Log file that records operations performed by using the **gs_ctl** tool
	gs_guc-current.log	Log file that records operations, mainly parameter modification performed by using the **gs_guc** tool
	gaussdbinstall.log	GaussDB installation log file
	gaussdbuninstall.log	GaussDB uninstallation log file
HA script run log	floatip_ha.log	Log file that records the script of floating IP addresses
	gaussDB_ha.log	Log file that records the script of GaussDB resources
	ha_monitor.log	Log file that records the HA process monitoring information
	send_alarm.log	Alarm sending log file
	ha.log	HA run log file

Type	Log File Name	Description
DBService audit log	dbservice_audit.log	Audit log file that records DBService operations, such as backup and restoration operations

Log Format

The following table lists the DBService log formats.

Table 3-2 Log format

Type	Format	Example
Run log	[<*yyyy-MM-dd HH:mm:ss*>] <*Log level*>: [< *Name of the script that generates the log*: *Line number* >]: < *Message in the log*>	[2020-12-19 15:56:42] INFO [postinstall.sh:653] Is cloud flag is false. (main)
Audit log	[<*yyyy-MM-dd HH:mm:ss,SSS*>] UserName:<*Username*> UserIP:<*User IP address*> Operation:<*Operation content*> Result:<*Operation results*> Detail:<*Detailed information*>	[2020-05-26 22:00:23] UserName:omm UserIP:192.168.10.21 Operation:DBService data backup Result: SUCCESS Detail: DBService data backup is successful.

4 Using Doris

4.1 Installing a MySQL Client

Doris supports the MySQL protocol. Therefore, most clients (including the CLI or IDE) that support the MySQL protocol can access Doris, for example, MariaDB, DBeaver, and Navicat for MySQL.

This section uses the MySQL 8.0.22 client of Red Hat as an example.

Prerequisite

The node where you want to install the MySQL client can communicate with the MRS cluster.

Procedure

Step 1 Log in to the node where you want to install the MySQL client as the **root** user.

Step 2 Run the following command to check the version of the **ncurses-libs** library on which the MySQL client depends:

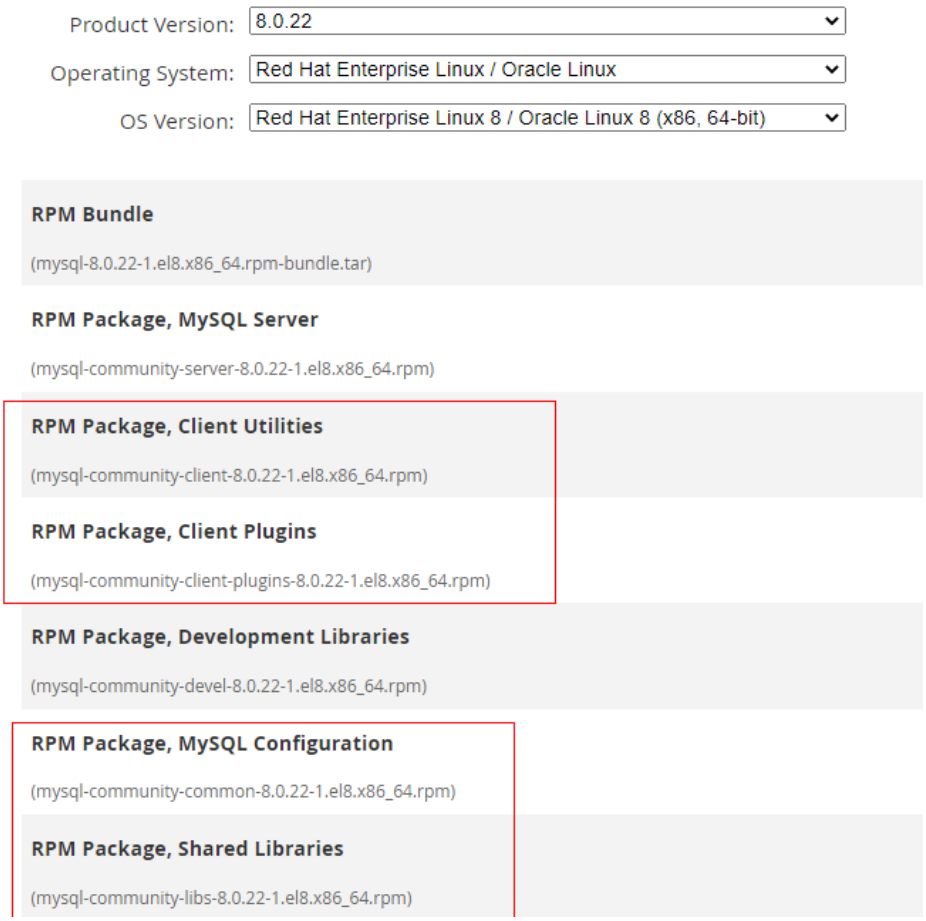
rpm -qa | grep ncurses

```
[root@node-master1hlrt ~]# rpm -qa | grep ncurses
ncurses-base-6.3-2.r2.hce2.noarch
ncurses-libs-6.3-2.r2.hce2.x86_64
ncurses-6.3-2.r2.hce2.x86_64
```

Step 3 Download the software package of the MySQL client from **https://downloads.mysql.com/archives/community/**. You are advised to install MySQL 8.x. The following uses Red Hat as an example:

- If the dependent library in **Step 2** is 6.x, you are advised to download the MySQL software package whose OS version is Red Hat 8.
- If the dependent library in **Step 2** is 5.x, you are advised to download the MySQL software package whose OS version is Red Hat 7.

For example, to install the MySQL 8.0.22 client of Red Hat, download the following software packages:



Step 4 Upload the downloaded software packages to the node where you want to install the MySQL client.

Step 5 Run the following commands in the directory where the uploaded files are stored to install the MySQL client and the corresponding dependency packages:

rpm -ivh mysql-community-client-8.0.22-1.el7.x86_64.rpm --nodeps --force

rpm -ivh mysql-community-client-plugins-8.0.22-1.el7.x86_64.rpm --nodeps --force

rpm -ivh mysql-community-common-8.0.22-1.el7.x86_64.rpm --nodeps --force

rpm -ivh mysql-community-libs-8.0.22-1.el7.x86_64.rpm --nodeps --force

Step 6 Run the following command to check the MySQL client version:

mysql --version

```
[root@node-master1hlrt ~]# mysql --version
mysql  Ver 8.0.22 for Linux on x86_64 (MySQL Community Server - GPL)
```

Step 7 After the MySQL client is successfully installed, you can access Doris. For details, see **Using Doris from Scratch**.

----End

4.2 Using Doris from Scratch

Doris us an easy-to-use, high-performance, and real-time analytical database based on the MPP architecture. It supports high-concurrency point queries and complex analysis that requires high throughput.

The following content describes how to perform basic table creation and query operations on an MRS Doris cluster.

NOTE

Doris database names and table names are case sensitive.

Prerequisite

- A cluster containing the Doris service has been created, and all services in the cluster are running properly.
- The nodes to be connected to the Doris database can communicate with the MRS cluster.
- The MySQL client has been installed. For details, see **Installing a MySQL Client**.

Procedure

Step 1 Create a user with the Doris management permission.

- Kerberos authentication is enabled for the cluster (the cluster is in security mode)
  a. Log in to FusionInsight Manager and choose **System**. In the navigation pane on the left, click **Permission** > **Role**, and click **Create Role**. On the displayed page, enter the role name, for example, **dorisrole**. In the **Configure Resource Permission** area, select *target cluster* > **Doris**, select **Doris Admin Privilege**, and click **OK**.
  b. Choose **User** > **Create**, enter a username, for example, **dorisuser**, set **User Type** to **Human-Machine**, retain the **default** value for **Password Policy**, enter the user password, confirm the password, associate the user with the **dorisrole** role, and click **OK**.
  c. Log in to FusionInsight Manager as the created **dorisuser** user and change the initial password of the user.
- Kerberos authentication is disabled for the cluster (the cluster is in normal mode)
  a. Log in to the node where the MySQL client is installed and connect to the Doris service as user **admin**.

     mysql -uadmin -P*Connection port for FE queries* **-h***IP address of the Doris FE instance*

NOTE

- The default password of user **admin** is empty.
- To obtain the query connection port of the Doris FE instance, you can log in to FusionInsight Manager, choose **Cluster** > **Services** > **Doris** > **Configurations**, and query the value of **query_port** of the Doris service.
- To obtain the IP address of the Doris FE instance, log in to FusionInsight Manager of the MRS cluster and choose **Cluster** > **Services** > **Doris** > **Instances** to view the IP address of any FE instance.
- You can also use the MySQL connection software or Doris web UI to connect to the database.

b. Run the following command to create a role:

CREATE ROLE *dorisrole*;

c. Grant permissions to the role. For details about the permissions, see **User Permissions**. For example, to grant the ADMIN_PRIV permission to the role, run the following command:

GRANT *ADMIN_PRIV* **ON *.*.* TO ROLE** '*dorisrole*';

d. Run the following commands to create a user and bind the user to a role:

CREATE USER '*dorisuser*'**@'%' IDENTIFIED BY** '*password*' **DEFAULT ROLE** '*dorisrole*';

Commands carrying authentication passwords pose security risks. Disable historical command recording before running such commands to prevent information leakage.

Step 2 Log in to the node where MySQL is installed and run the following command to connect to the Doris database:

If Kerberos authentication is enabled for the cluster (the cluster is in security mode), run the following command to connect to the Doris database:

export LIBMYSQL_ENABLE_CLEARTEXT_PLUGIN=1

mysql -u*Database login username* **-p***Database login password* **-P***Connection port for FE queries* **-h***IP address of the Doris FE instance*

NOTE

- To obtain the query connection port of the Doris FE instance, you can log in to FusionInsight Manager, choose **Cluster** > **Services** > **Doris** > **Configurations**, and query the value of **query_port** of the Doris service.
- To obtain the IP address of the Doris FE instance, log in to FusionInsight Manager of the MRS cluster and choose **Cluster** > **Services** > **Doris** > **Instances** to view the IP address of any FE instance.
- You can also use the MySQL connection software or Doris web UI to connect to the database.

Step 3 Run the following commands to check the status of the FE and BE instances:

SHOW FRONTENDS\G;

SHOW BACKENDS\G;

Step 4 Run the following commands to create a database:

create database if not exists *mrs_demo*;

use *mrs_demo*;

Step 5 Run the following statement to create a data table.

CREATE TABLE IF NOT EXISTS *mrs_table*

(

`user_id` LARGEINT NOT NULL COMMENT "User ID",

`date` DATE NOT NULL COMMENT "Data ingestion date",

`city` VARCHAR(20) COMMENT "City",

`age` SMALLINT COMMENT "Age",

`sex` TINYINT COMMENT "Gender",

`last_visit_date` DATETIME REPLACE DEFAULT "1970-01-01 00:00:00" COMMENT "Last access time",

`cost` BIGINT SUM DEFAULT "0" COMMENT "Total consumption",

`max_dwell_time` INT MAX DEFAULT "0" COMMENT "Dwell time",

`min_dwell_time` INT MIN DEFAULT "99999" COMMENT "Minimum dwell time"

)

AGGREGATE KEY(`user_id`, `date`, `city`, `age`, `sex`)

DISTRIBUTED BY HASH(`user_id`) BUCKETS 1

PROPERTIES (

"replication_allocation" = "tag.location.default: 1"

);

Step 6 Create the **test.csv** file in any directory on the current node. The file content is as follows:

```
10000,2017-10-01,city1,20,0,2017-10-01 06:00:00,20,10,10
10000,2017-10-01,city2,20,0,2017-10-01 07:00:00,15,2,2
10001,2017-10-01,city3,30,1,2017-10-01 17:05:45,2,22,22
10002,2017-10-02,city4,20,1,2017-10-02 12:59:12,200,5,5
10003,2017-10-02,city5,32,0,2017-10-02 11:20:00,30,11,11
10004,2017-10-01,city6,35,0,2017-10-01 10:00:15,100,3,3
10004,2017-10-03,city7,35,0,2017-10-03 10:20:22,11,6,6
```

Step 7 Import data to the **test.csv** file to the table created in **Step 5** using Stream load.

cd *Directory where* ***test.csv*** *is stored*

curl -k --location-trusted -u *Doris user name*:*Password*-**H "***label:table1_20230217***" -H "c***olumn_separator:,***" -T test.csv http://***IP address of Doris FE instance*:*HTTP port*/**api/mrs_demo/***mrs_table*/**_stream_load**

NOTE

- To view the IP address of the active Doris FE instance, log in to FusionInsight Manager and choose **Cluster** > **Services** > **Doris** > **Instances**.
- You can log in to FusionInsight Manager, choose **Cluster** > **Services** > **Doris** > **Configurations**, and search for **http_port** to view the HTTP port.

Step 8 Query data.

select * from *mrs_table* **where city='city1';**

----End

4.3 Permissions Management

4.3.1 Doris Permissions Management

The Doris permission management system implements row-level fine-grained permission control and role-based permission access control.

User Permissions

Table 4-1 lists the permissions supported by the Doris.

Table 4-1 Doris permission list

Permission	Description
Node_priv	Node change permission to add and delete FE, BE, and DBroker nodes, and take them offline. This permission can be granted only at the global level.
Admin_priv	All permissions except NODE_PRIV.
Grant_priv	Permission to grant, revoke, add, delete, and change users and roles. Users with this permission cannot grant the NODE_PRIV permission to other users unless they already have the NODE_PRIV permission.
Select_priv	Read-only permission on databases and tables.
Load_priv	Write permission on databases and tables, including permission to load, insert, and delete data.
Alter_priv	Permission to modify databases and tables, including renaming databases and tables, adding, deleting, and changing columns, and adding and deleting partitions.
Create_priv	Permission to create databases, tables, and views.
Drop_priv	Permission to delete databases, tables, and views.
Usage_priv	Permission to use resources and workload groups.

Database and table permissions are classified into the following four levels based on the scope:

- **CATALOG LEVEL**: catalog-level permission on any databases and tables in the specified catalog
- **DATABASE LEVEL**: database-level permission on any tables in specified databases
- **TABLE LEVEL**: table-level permission on specified tables in a specified database
- **RESOURCE LEVEL**: resource-level permission on specified resources

Prerequisite

- The Doris service is running properly.
- The role name must not be **operator** or **admin**.
- If Kerberos authentication is enabled for the cluster (the cluster is in security mode), it takes about 2 minutes for the permission to take effect after assignment.

Adding a Doris Role (Security Mode)

Step 1 Log in to Manager and choose **System** > **Permission** > **Role**. On the displayed page, click **Create Role**.

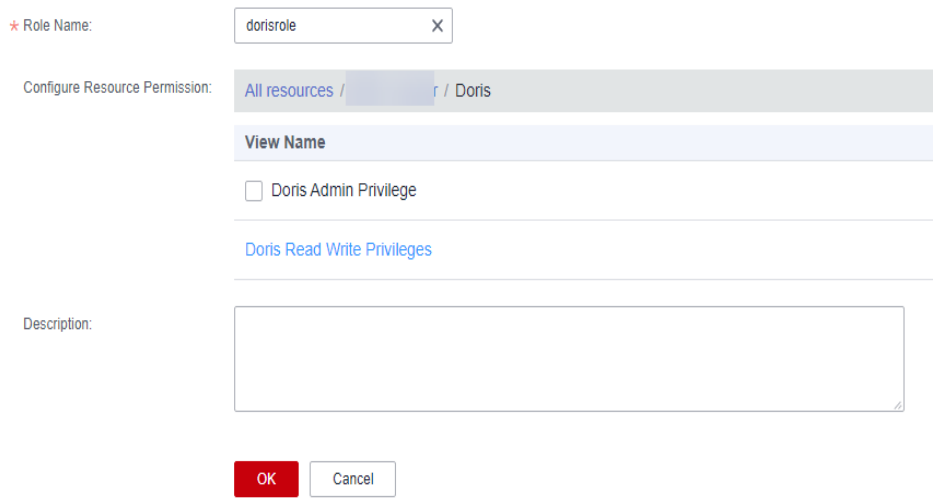
Step 2 Specify **Role Name**. In the **Configure Resource Permission** area, click the cluster name. On the displayed service list page, click the Doris service.

Determine whether to create a role with the Doris administrator rights based on service requirements.

NOTE

- The Doris administrator has all the rights except the node operation rights.
- The role name cannot contain hyphens (-). Otherwise, the authentication will fail.

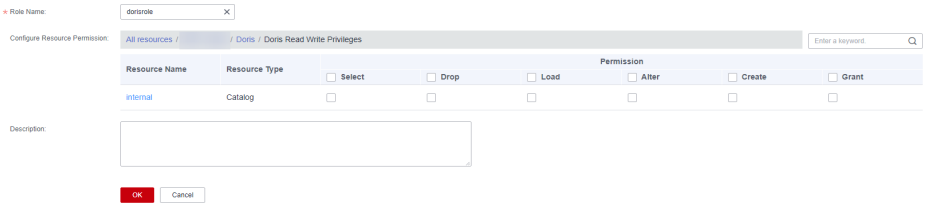
- If you want to create such a role, go to **Step 3**.
- If you don't, go to **Step 4**.



Step 3 Select **Doris Admin Privilege** and click **OK**.

Step 4 Click **Doris Read Write Privileges** and select **Select**, **Drop**, **Load**, **Alter**, **Create**, or **Grant** for the corresponding resource.

Determine whether to grant the permission based on the service requirements.



Step 5 Wait until the authorization is complete, and click **OK**.

----End

Adding a User and Binding the User to the Doris Role (Security Mode)

Step 1 Log in to Manager and choose **System** > **Permission** > **User** and click **Create**.

Step 2 Select **Human-Machine** for **User Type** and set **Password** and **Confirm Password** to the password of the user.

NOTE

- **Username**: The username cannot contain hyphens (-). Otherwise, the authentication will fail.
- **Password**: The password cannot contain special characters the dollar sign ($), period (.), or number sign (#). Otherwise, the authentication will fail.

Step 3 In the **Role** area, click **Add**. In the displayed dialog box, select a role with the Doris permission and click **OK** to add the role. Then, click **OK**.

Step 4 Log in to FusionInsight Manager as the new user and change the initial password.

Step 5 Log in to the node where the MySQL client is installed and use the new username and new password to connect to the Doris service.

export LIBMYSQL_ENABLE_CLEARTEXT_PLUGIN=1

mysql -u*Doris user***-p***Database login password* **-P***Connection port for FE queries***-h***IP address of the Doris FE instance*

NOTE

- To obtain the query connection port of the Doris FE instance, you can log in to FusionInsight Manager, choose **Cluster** > **Services** > **Doris** > **Configurations**, and query the value of **query_port** of the Doris service.
- To obtain the IP address of the Doris FE instance, log in to FusionInsight Manager of the MRS cluster and choose **Cluster** > **Services** > **Doris** > **Instances** to view the IP address of any FE instance.
- You can also use the MySQL connection software or Doris web UI to connect to the database.

----End

Adding a Role and Binding It to a User (Normal Mode)

Step 1 Log in to the node where the MySQL client is installed and connect to the Doris service as user **admin**.

mysql -uadmin -P*Connection port for FE queries* **-h***IP address of the Doris FE instance*

NOTE

- The default password of user **admin** is empty.
- To obtain the query connection port of the Doris FE instance, you can log in to FusionInsight Manager, choose **Cluster** > **Services** > **Doris** > **Configurations**, and query the value of **query_port** of the Doris service.
- To obtain the IP address of the Doris FE instance, log in to FusionInsight Manager of the MRS cluster and choose **Cluster** > **Services** > **Doris** > **Instances** to view the IP address of any FE instance.
- You can also use the MySQL connection software or Doris web UI to connect to the database.

Step 2 Run the following command to create a role:

CREATE ROLE *dorisrole***;**

Step 3 Run the following command to grant a permission to the role. For details about permissions, see **User Permissions**. For example, to grant the ADMIN_PRIV permission to the role, run the following command:

GRANT *ADMIN_PRIV* **ON *.*.* TO ROLE '***dorisrole***';**

Step 4 Run the following command to create a user and bind the user to a role:

CREATE USER '*dorisuser***'@'%' IDENTIFIED BY '***password***' DEFAULT ROLE '***dorisrole***';**

----End

4.3.2 Column Permission Management

Scenarios

You can manage column-level permission in Doris. by adding the **enable_col_auth** parameter to the custom configuration item of the FE service.

NOTE

- Only the **Select_priv** permission is supported by this function.
- You must use a user with the **Grant_priv** permission to manage column permission.
- If a user with the column-level **Select_priv** permission runs **select *** to query table data, it can access only the columns allowed by the permission.
- If a user with the column-level **Select_priv** permission runs **desc** *tbl* to query table details, it can access only the information of columns allowed by the permission.
- Column-level permission is also available for views and materialized views.

Prerequisite

- A cluster containing the Doris service has been created, and all services in the cluster are running properly.
- The nodes to be connected to the Doris database can communicate with the MRS cluster.
- The MySQL client has been installed. For details, see **Installing a MySQL Client**.

Procedure

Step 1 Log in to FusionInsight Manager, choose **Cluster** > **Services** > **Doris**, and click **Configurations** and then **All Configurations**.

Step 2 Choose **FE(Role)** > **Customization**. Enter the custom parameter **enable_col_auth**, set its value to **true**, and add it to the **fe.conf** file.

Step 3 Click **Save** and then **OK**.

Step 4 Click **Instances**, select all FE instances, and choose **More** > **Restart Instance**.

Step 5 Log in to the node where MySQL is installed and run the following command to connect to the Doris database:

If Kerberos authentication is enabled for the cluster (the cluster is in security mode), run the following command to connect to the Doris database:

export LIBMYSQL_ENABLE_CLEARTEXT_PLUGIN=1

mysql -u*Database login username* **-p***Database login password* **-P***Connection port for FE queries* **-h***IP address of the Doris FE instance*

NOTE

- To obtain the query connection port of the Doris FE instance, you can log in to FusionInsight Manager, choose **Cluster** > **Services** > **Doris** > **Configurations**, and query the value of **query_port** of the Doris service.
- To obtain the IP address of the Doris FE instance, log in to FusionInsight Manager of the MRS cluster and choose **Cluster** > **Services** > **Doris** > **Instances** to view the service IP address of any FE instance.
- You can also use the MySQL connection software or Doris web UI to connect to the database.

Step 6 Run the following commands to grant the **Select_priv** permission:

- Grant permission to a user.

  GRANT select_priv [(col1, col2...)] ON *ctl.db.tbl* **TO '***user***';**
- Grant permission to a role.

  GRANT select_priv [(col1, col2...)] ON *ctl.db.tbl* **TO ROLE '***role***';**

Step 7 Check the user permission.

show grants for *user***;**

Step 8 Revoke the **Select_priv** permission.

- Revoke permission from a user.

  revoke select_priv [(col1, col2...)] ON *ctl.db.tbl* **from '***user***';**

- Revoke permission from a role.
  revoke select_priv [(col1, col2...)] ON *ctl.db.tbl* **from ROLE '***role***';**

Step 9 Check user permission.

show grants for *user*;

----End

4.4 Multi-Tenancy

4.4.1 Overview

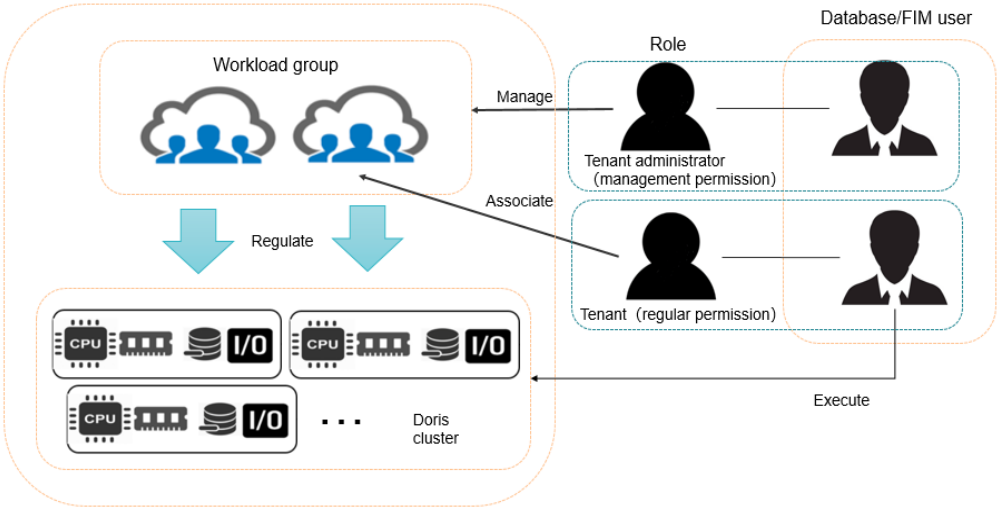
Doris Multi-Tenancy

Doris multi-tenancy is built on top of the Workload Group Resource soft limit of the kernel. Workloads are managed by group to ensure flexible allocation and control of memory and CPU resources. Each tenant role of a user can have many workload groups. You can manage CPU, memory, concurrency, and queues with this model shown in **Figure 4-1**.

NOTE

Multiple tenants can be created and managed only on FusionInsight Manager when Kerberos authentication is enabled for the cluster (the cluster is in security mode).

Figure 4-1 Doris tenant model



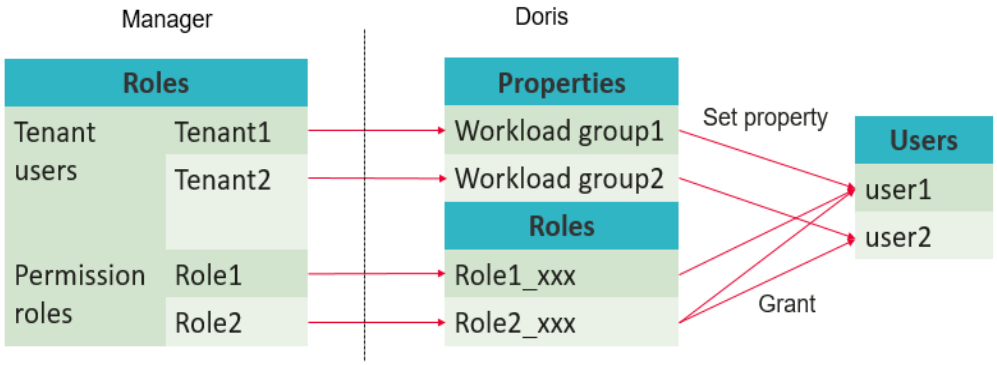
After a user is associated with a tenant, all query tasks submitted by the user are added to the workload group. You can limit the percentage of CPU and memory resources on BE nodes for a single query and configure a soft memory limit for the workload group.

When cluster resources are insufficient, the system automatically stops several query tasks that occupy memory the most in the group. If the resources used by a workload group exceed the preset limit, multiple workloads share idle resources in

the cluster and use resources more than the limit. This ensures stable execution of query tasks. In addition, the query queuing function is introduced to relieve system pressure in heavy-load scenarios. When creating a workload group, you can set the maximum number of concurrent queries to queue the exceeding queries.

Associations Between Doris Tenant Roles and Users

On the FusionInsight Manager service configuration and tenant management pages, you can create tenants, associate tenants with services, configure tenant resources, and associate tenants with users. The following figure shows the association between roles and users on the Manager and Doris sides.



A user, a tenant role, and a workload group are in one-on-one relationship. A user can have multiple permission roles.

Table 4-2 lists the Doris tenant resource configurations supported by the current version.

Table 4-2 tenant resource configuration

Configuration	Value Range	Description	Remarks
CPU Quota Usage	1 to 100	Weight of CPU resources that can be used by a tenant	The value specifies a relative ratio that is valid during resource competition. For example, if this value for tenant A is 10 and that for tenant B is 20, the CPU resources can be used by the query tasks of tenant A is one third of total resources, that is, 10/(10 + 20). If tenant C starts query tasks and its CPU quota usage is 30, a CPU quota of tenant A is one sixth of total resources, that is, 10/(10 + 20 + 30).
Memory Quota	1% to 70%	Maximum proportion of memory that can be used by a tenant	The available memory of a tenant is calculated as follows: Physical memory x **mem_limit** x Memory quota. The upper limit is 70%. By default, a tenant in **normal** state occupies 30% of memory.

Configuration	Value Range	Description	Remarks
Concurrencies	1 to 2147483647	Maximum number of concurrent query tasks that a tenant can run	This parameter specifies the maximum number of tasks on each FE node. For example, if the number of concurrent SQL statements is set to 1 and the Doris has three FE nodes, the maximum number of SQL statements that can be executed in a cluster is 3.
Queue Length	0 to 2147483647	Maximum number of waiting query tasks	Excessive SQL statements are queued. When the queue is full, newly submitted queries are rejected.
Waiting Duration	0 to 2147483647	Maximum waiting duration of a tenant query task	If the query waiting duration exceeds the value of this parameter, the query is rejected. The unit is millisecond.
Soft Memory Limit	• On • Off	Whether a tenant can use more memory resources than the limit	• If this function is disabled, the system immediately cancels the tasks that occupy the most memory in the tenant groups when detecting that the memory usage of the tenant exceeds the upper limit. • If this function is enabled and the cluster has idle memory resources, the tenant can use the system memory more than the limit. The tasks that occupy the most memory in the tenant groups are canceled only when cluster resources are insufficient.

4.4.2 Managing Doris Tenants

The cluster administrator can create a Doris tenant on FusionInsight Manager.

Creating a Doris Tenant

Step 1 Log in to FusionInsight Manager and choose **Tenant Resources**.

Step 2 On the **Tenant Resources Management** page, click . On the displayed page, configure tenant properties by referring to **Table 4-3**.

Table 4-3 Tenant parameters

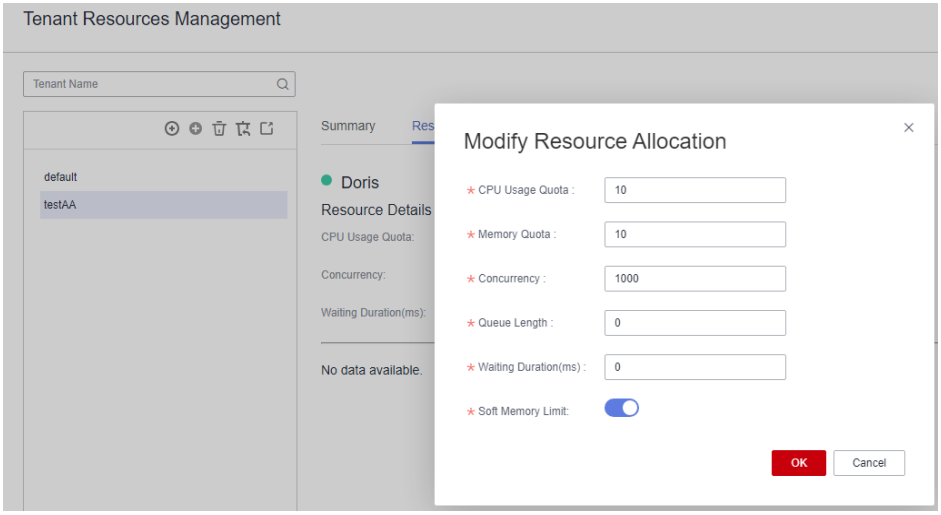
Parameter	Description
Name	Specify the name of the current tenant. The value can contain 3 to 50 characters but cannot contain only digits. Only digits, letters, and underscores (_) are allowed. Plan a tenant name based on service requirements. The name cannot be the same as that of a role, HDFS directory, or YARN queue that exists in the current cluster.
Tenant Type	Select **Leaf Tenant**. **NOTE** A Doris tenant can only be a leaf tenant.
Compute Resource	Do not select **Yarn** if only Doris-related tenants are created.
Storage Resource	Do not select **HDFS** if only Doris-related tenants are created.

Parameter	Description
Service	Click **Associate Service**. In the displayed dialog box, set the following parameters and click **OK**: • **Service**: Select **Doris**. • **Association Type**: Maintain the default option **Shared**. For details about the following parameters, see **Table 4-2**. • **CPU Usage Quota**: specifies the weight of CPU resources occupied by a tenant. This parameter is valid during resource competition. • **Memory Quota**: specifies the maximum percentage of memory resources occupied by a tenant. For example, if this parameter is set to 10, the available memory of the tenant on each BE node is 10% of the available memory on the BE node. The default **normal** Doris tenant occupies 30% of the resources. Therefore, for other tenants this parameter can be set up to 70%. If the sum exceeds 100%, the Doris tenant fails to be created. • **Concurrency**: specifies the maximum number of concurrent query tasks a tenant can run. Excessive query tasks are queued. • **Queue Length**: specifies the maximum number of query tasks waiting in the queue. • **Waiting Duration**: specifies the maximum waiting duration of a query task. The unit is milliseconds. • **Soft Memory Limit**: By default, soft memory limit is disabled. If this option is enabled and when resources are sufficient, query tasks can use resources more than the limit. When resources are insufficient, the occupied memory is released. If this function is disabled and when the memory limit of a workload group is reached, som SQL statements will be canceled or rejected.
Description	Description of the tenant.

Step 3 Click **OK**. Wait until the tenant is created.

Step 4 View and modify the tenant in the **Tenant Resources Management** page.

1. On FusionInsight Manager, click **Tenant Resources**. In the tenant list, select the desired Doris tenant and view the tenant information and the resource quota.
2. Click **Resource** and click  next to **Resource Details** to modify tenant resources.



3. Click **OK**. The details are displayed in the **Resource** tab.

NOTE

- In the **Summary** tab, resource quota is not updated in real time. It is updated only when it is loaded.
- A Doris tenant represents a workload group, which limits the compute resources of tasks in the group on a single instance node. The **Resource Quota** and **Chart** information show monitoring data of the average metric values. The chart is refreshed every 30 seconds.

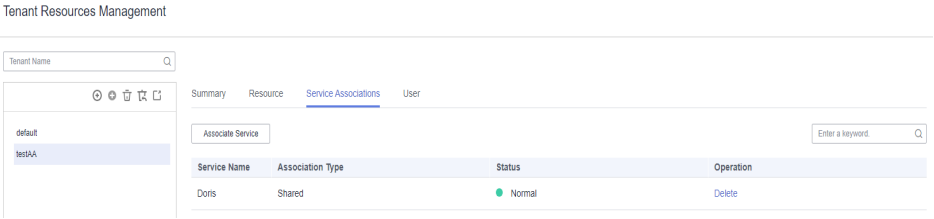
----End

Associating an Existing Tenant with the Doris Service

Step 1 On FusionInsight Manager, choose **Tenant Resources**. In the tenant list, select the desired tenant, click the **Service Associations** tab, and click **Associate Service**.

Step 2 On the displayed dialog box, set **Service** to **Doris**, set other parameters as you need, and click **OK** to associate the tenant with the Doris service.

Step 3 To disassociate the Doris service, click **Delete** in the **Operation** column of the Doris service. In the displayed dialog box, click **OK**.



NOTE

After a tenant is disassociated from the Doris service, the workload group of the Doris kernel is deleted, and the workload group of the users bound to the tenant is also set to **normal**.

----End

Adding a User and Binding It to a Tenant

- Create a user and bind it to a tenant: Log in to FusionInsight Manager, choose **System** > **Permission** > **User**, click **Create**, add a human-machine user, and add the created Doris tenant to the role.
- Bind a tenant to an existing user: Log in to FusionInsight Manager, choose **System** > **Permission** > **User**, click **Modify** in the **Operation** column of the user, and add the created Doris tenant to the role.

NOTE

- To delete a Doris tenant, choose **System** > **User**, locate the row that contains the user in the user list, click **Modify**, and delete the Doris tenant bound added to the role.
- A user cannot be bound to multiple Doris tenants. If **user1** has been associated with **tenant1** of Doris, no error message is displayed when **user1** is associated with **tenant2**. However, a description is recorded in background logs, indicating that the user has already been associated with a tenant and this association operation is invalid.

4.4.3 Multi-Tenancy Alarms

Doris multi-tenancy is built on top of the Workload Group Resource soft limit of the kernel. Workload groups only restrict the compute and memory resources used by tasks in a group on a single BE node. There is no resource pool for tenants. When query tasks are executed, resources are dynamically allocated to each BE node.

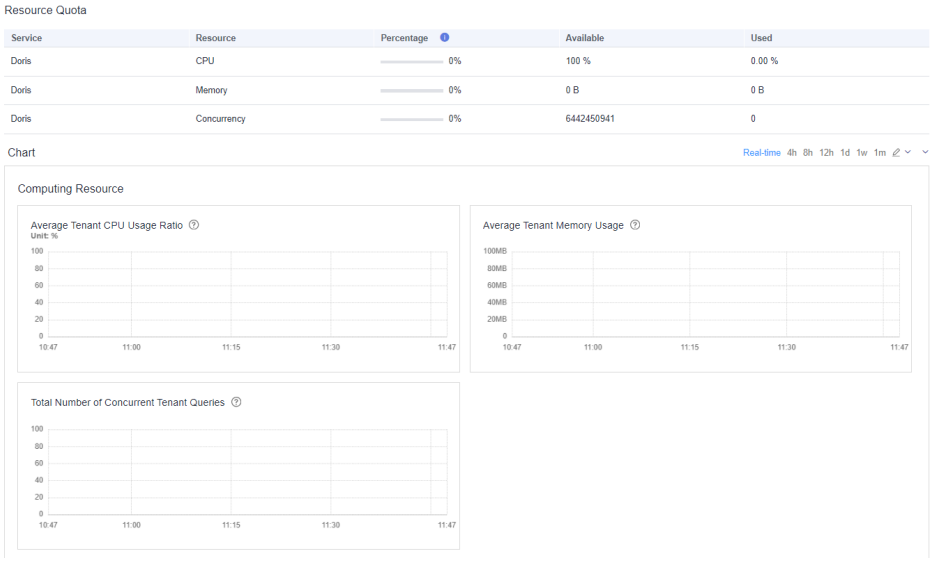
Doris multi-tenancy alarms are reported for nodes. The monitoring metric data can be aggregated by service or tenant.

Multi-Tenancy Monitoring

- Tenant monitoring

  On the FusionInsight Manager homepage, click **Tenant Resources**. In the tenant list, click the name of a Doris tenant. In the **Summary** tab, you can view monitoring information of the tenant in the **Resource Quota** and **Chart** areas.

  - CPU: average CPU usage of all BE nodes used by the tenant
  - Memory: average memory usage of all BE nodes used by the tenant
  - Concurrency: total number of concurrent queries on all FE nodes used by the tenant



NOTE

- Resource quota is not refreshed in real time. The resource usage is queried only when you go to the **Summary** tab. The monitoring is in real time but monitoring data is refreshed every 30 seconds.
- The **Average Tenant CPU Usage Ratio** chart shows the average percentage of the time when the query tasks of the tenant occupy the CPU resources of all BE nodes.
- The number of FEs is not counted when jobs are queued. Therefore, the number of concurrent queries set by a tenant takes effect only on FE nodes. The**Total Number of Concurrent Tenant Queries** chart indicates the overall number of concurrent queries of a tenant.

- Service monitoring

  On the FusionInsight Manager homepage, choose **Cluster** > **Services** > **Doris** and click **Chart**. In **Chart Category**, select **Tenant Resource** to view the resource usage of all Doris tenants.

- Instance monitoring

  On the FusionInsight Manager homepage, choose **Cluster** > **Services** > **Doris** and click **Instances**, click the FE or BE instance of the desired tenant. In the **Chart** tab, select **Tenant Resource** from **Chart Category**. You can view the node resources used by all tenants.

Figure 4-2 FE instance resource monitoring

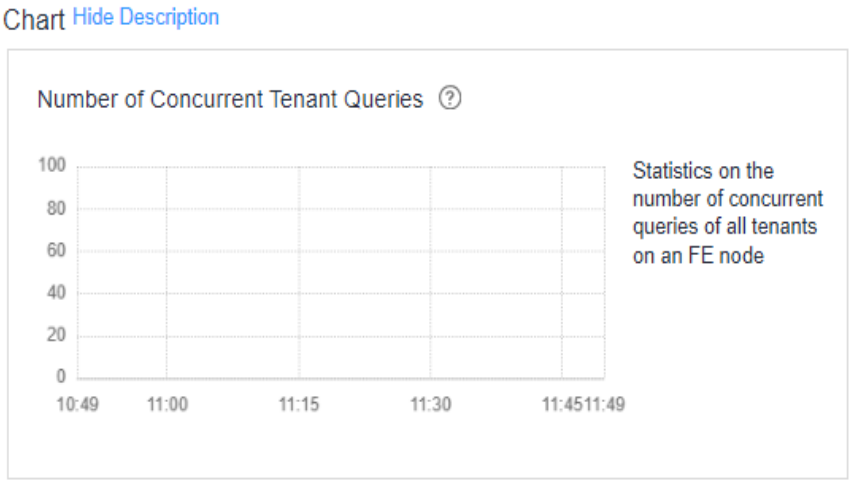
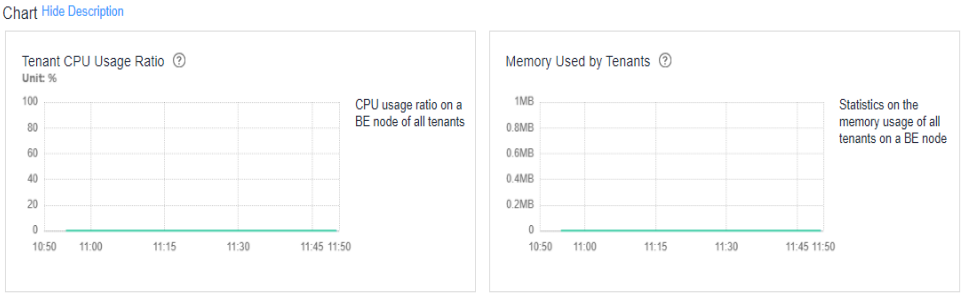


Figure 4-3 BE instance resource monitoring



Multi-Tenancy Alarms

Doris multi-tenancy alarms include:

- Number of concurrent requests (alarm ID: 50227): The alarm is generated when the number of concurrent tenant requests on an FE node exceeds the threshold (90% by default).
- Memory usage (alarm ID: 50228): The alarm is generated when the memory usage of a BE node exceeds the threshold (90% for critical alarms and 85% for major alarms).

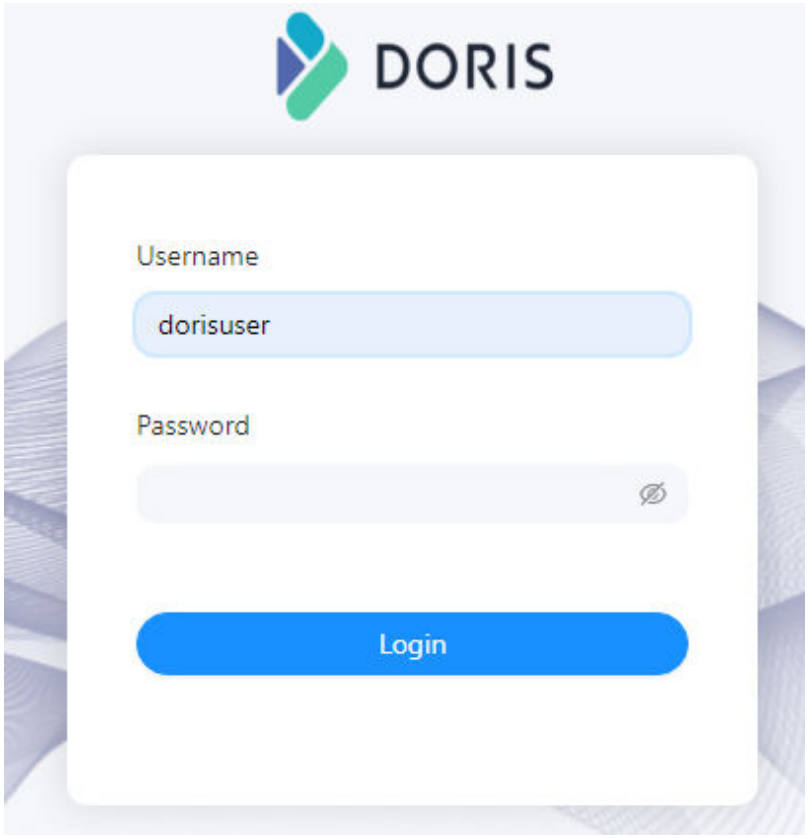
NOTE

- The memory usage alarm is generated only for tenants who disabled soft memory soft limit.
- On FusionInsight Manager, choose **O&M** > **Alarm** > **Alarms**, click on the left of an alarm name, and determine the role and node for which the alarm is generated in the **Location** field. To identify the tenant for which the alarm is generated, view the monitoring chart on the FE or BE node for which the alarm is generated.

4.5 Native Web UI

Step 1 Log in to FusionInsight Manager as a user with administrator rights. Choose **Cluster** > **Services** > **Doris**.

Step 2 On the **Dashboard** page, click the hyperlink on the right of **FE WebUI**. On the displayed Doris web UI login page, enter the username and password of the account with the Doris management permission. The initial password must have been changed if Kerberos authentication is enabled for the cluster (the cluster is in security mode). For details about how to create a user, see **Doris Permissions Management**. Then, click **Login**.



Step 3 On the home page of the Doris web UI, view the Doris cluster information. You can also view Doris table information in **Playground** and run a SQL query statement.

----End

4.6 Doris Data Model

Basic Concepts

In Doris, data is logically described in the form of tables. A table consists of rows and columns. A row is a line of user data, and a column describes different fields in a row of data. Columns are classified into two categories: Key and Value. From a business perspective, Key and Value correspond to dimension columns and indicator columns, respectively.

Data models in Doris fall into three types:

- Aggregate
- Unique

- Duplicate

Aggregate Model

The following examples show you what aggregation model is and how to use it correctly:

CREATE TABLE IF NOT EXISTS *example_db.example_tbl*

(

`user_id` LARGEINT NOT NULL COMMENT "User ID",

`date` DATE NOT NULL COMMENT "Data import date and time",

`city` VARCHAR(20) COMMENT "City",

`age` SMALLINT COMMENT "Age",

`sex` TINYINT COMMENT "Gender",

`last_visit_date` DATETIME REPLACE DEFAULT "1970-01-01 00:00:00" COMMENT "Last access time",

`cost` BIGINT SUM DEFAULT "0" COMMENT "Total consumption",

`max_dwell_time` INT MAX DEFAULT "0" COMMENT "Dwell time",

`min_dwell_time` INT MIN DEFAULT "99999" COMMENT "Minimum dwell time"

)

AGGREGATE KEY(`user_id`, `date`, `city`, `age`, `sex`)

DISTRIBUTED BY HASH(`user_id`) BUCKETS 1

PROPERTIES (

"replication_allocation" = "tag.location.default: 1"

);

NOTE

When data is imported, rows with the same contents in the Key columns will be aggregated into one row, and their values in the Value columns will be aggregated as their **AggregationType** specify. Currently, there are several aggregate methods:

- SUM: Accumulate the values in multiple rows.
- REPLACE: Replace the previous value with the newly imported value.
- MAX: Keep the maximum value.
- MIN: Keep the minimum value.

The columns in the table are divided into Key (dimension) columns and Value (indicator columns) based on whether they are set with an **AggregationType.** Key columns are not set with an **AggregationType**, such as **user_id**, **date**, and **age**, while Value columns are.

Unique Model

- Merge on Read

If your data does not need to be aggregated, you use this implementation. You only need to ensure the uniqueness of the primary keys (**user_id** and **username**). The Merge On Read implementation of the unique model is equivalent to the REPLACE aggregation type in the aggregate model. The following is an example:

```
CREATE TABLE IF NOT EXISTS example_db.example_tbl
(
`user_id` LARGEINT NOT NULL COMMENT "User ID",
`username` VARCHAR(50) NOT NULL COMMENT "Username",
`city` VARCHAR(20) COMMENT "City",
`age` SMALLINT COMMENT "Age",
`sex` TINYINT COMMENT "Gender",
`phone` LARGEINT COMMENT "User phone number",
`address` VARCHAR(500) COMMENT "User address",
`register_time` DATETIME COMMENT "User registration time"
)
UNIQUE KEY(`user_id`, `username`)
DISTRIBUTED BY HASH(`user_id`) BUCKETS 1
PROPERTIES (
"replication_allocation" = "tag.location.default: 1"
);
```

- Merge on Write

  The Merge On Write implementation of the unique model is completely different from that of the aggregate model. It can deliver better performance (almost like that of the duplicate model) in aggregation queries with primary key limitations. This implementation is suitable for aggregation queries and those using indexes to filter out large-scale data.

  When creating a table, you can enable the unique model by adding the following property:

  ```
  "enable_unique_key_merge_on_write" = "true"
  ```

  For example:

  ```
  CREATE TABLE IF NOT EXISTS example_db.example_tbl
  (
  `user_id` LARGEINT,
  `username` VARCHAR(50) NOT NULL,
  `city` VARCHAR(20),
  `age` SMALLINT,
  `sex` TINYINT,
  `phone` LARGEINT,
  `address` VARCHAR(500),
  `register_time` DATETIME
  )
  UNIQUE KEY(`user_id`, `username`)
  ```

```
DISTRIBUTED BY HASH(`user_id`) BUCKETS 1
PROPERTIES (
"replication_allocation" = "tag.location.default: 1",
"enable_unique_key_merge_on_write" = "true"
);
```

NOTE

On a unique table with the Merge on Write option enabled, during the import stage, the data that is to be overwritten and updated will be marked for deletion, and new data will be written in. During a query, all data marked for deletion will be filtered out at the file level, and only the latest data would be read. This eliminates the data aggregation cost while reading, and supports many types of predicate pushdown now. Performance is improved in many scenarios, especially in aggregation queries.

Duplicate Model

In some multidimensional analysis scenarios, there is no need for primary keys or data aggregation. This is when we use the Duplicate model. The Duplicate Model stores the data as they are and executes no aggregation. Even if there are two identical rows of data, they will both be retained. The **DUPLICATE KEY** specified in the table creation statement is only used to specify based on which columns the data are sorted.

The statement for creating a table in duplicate model is as follows:

```
CREATE TABLE IF NOT EXISTS example_db.example_tbl
(
`timestamp` DATETIME NOT NULL COMMENT " Log time",
`type` INT NOT NULL COMMENT " Log type",
`error_code` INT COMMENT "Error code",
`error_msg` VARCHAR(1024) COMMENT "Error details",
`op_id` BIGINT COMMENT "Owner ID",
`op_time` DATETIME COMMENT "Processing time"
)
DUPLICATE KEY(`timestamp`, `type`, `error_code`)
DISTRIBUTED BY HASH(`type`) BUCKETS 1
PROPERTIES (
"replication_allocation" = "tag.location.default: 1"
);
```

Key Columns

For the duplicate, aggregate, and unique models, the Key column is specified during table creation. The differences are as follows:

- Duplicate model: The Key columns can be regarded as just "sorting columns", but not unique identifiers.
- Aggregate and unique models: For tables of the two aggregation types, the Key columns are both "sorting columns" and "unique identifier columns".

Suggestions on Data Model Selection

The data model is established when the table is created and cannot be modified. Therefore, it is important to select a proper data model.

- The Aggregate Model can greatly reduce the amount of data scanned and query computation by pre-aggregation. Thus, it is very suitable for report query scenarios with fixed patterns, but is unfriendly to **count (*)** queries. Since the aggregation method on the Value column is fixed, semantic correctness should be considered in other types of aggregation queries.
- The unique model guarantees the uniqueness of primary key for scenarios requiring a unique primary key. The downside is that it cannot exploit the advantage brought by pre-aggregation such as ROLLUP in queries.
  - Users who have high-performance requirements for aggregate queries are recommended to use the Merge on Write implementation.
  - The unique model only supports entire-row updates. If you require primary key uniqueness as well as partial updates of certain columns (such as loading multiple source tables into one Doris table), you can consider using the aggregate model, while setting the aggregate type of the non-primary key columns to **REPLACE_IF_NOT_NULL**.
- Duplicate is suitable for ad-hoc queries in any dimensions. Although it may not be able to take advantage of the pre-aggregation feature, it is not limited by what constraints the aggregate model and can give full play to the advantage of columnar storage (reading only the relevant columns, but not all Key columns).

4.7 Doris Cold and Hot Data Separation

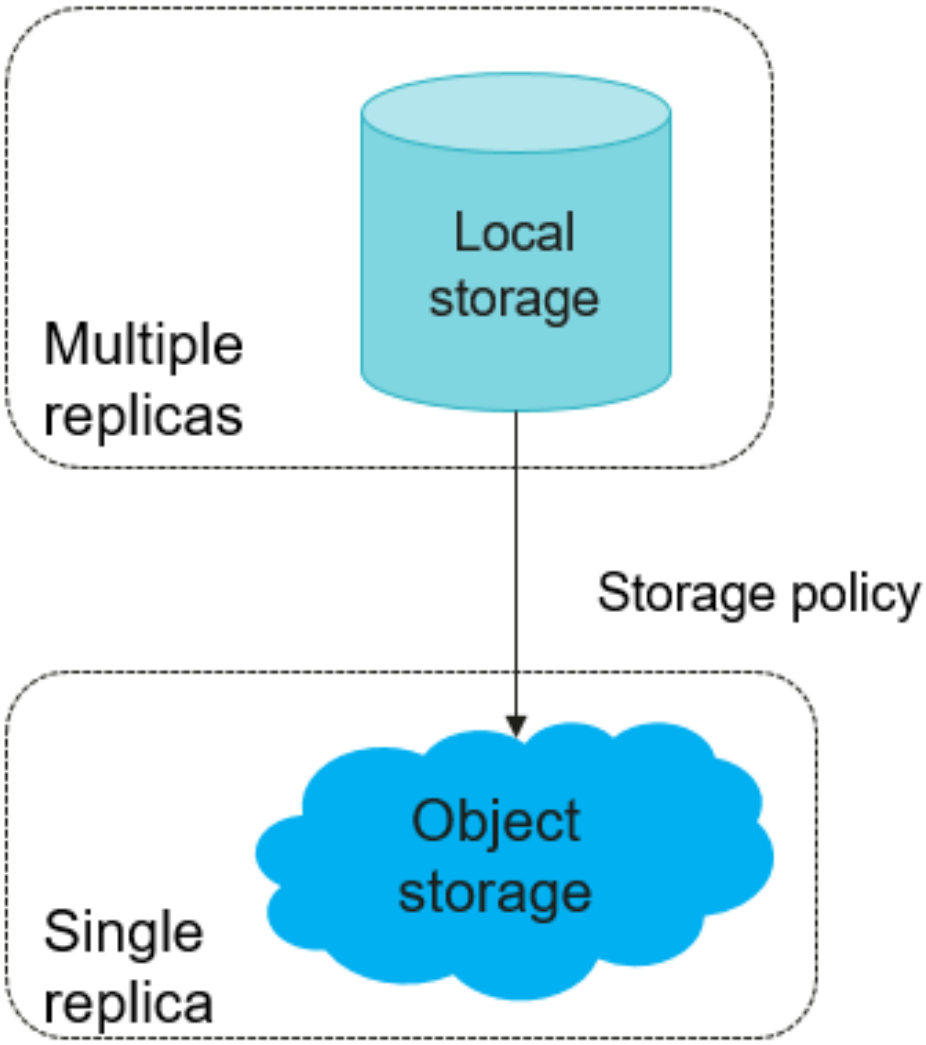
4.7.1 Introduction

When analyzing data, it's common to query hot and cold data at varying frequencies and with different response speed needs. For example, to analyze user behavior, traffic data must be frequently queried and and the requests need to be quickly responded. Historical data that is seldomly accessed needs to be backed up over a long period for audit and backtracking. Query demands on such data decrease sharply as time goes by. If all data is stored locally, a large number of resources will be wasted.

Principles

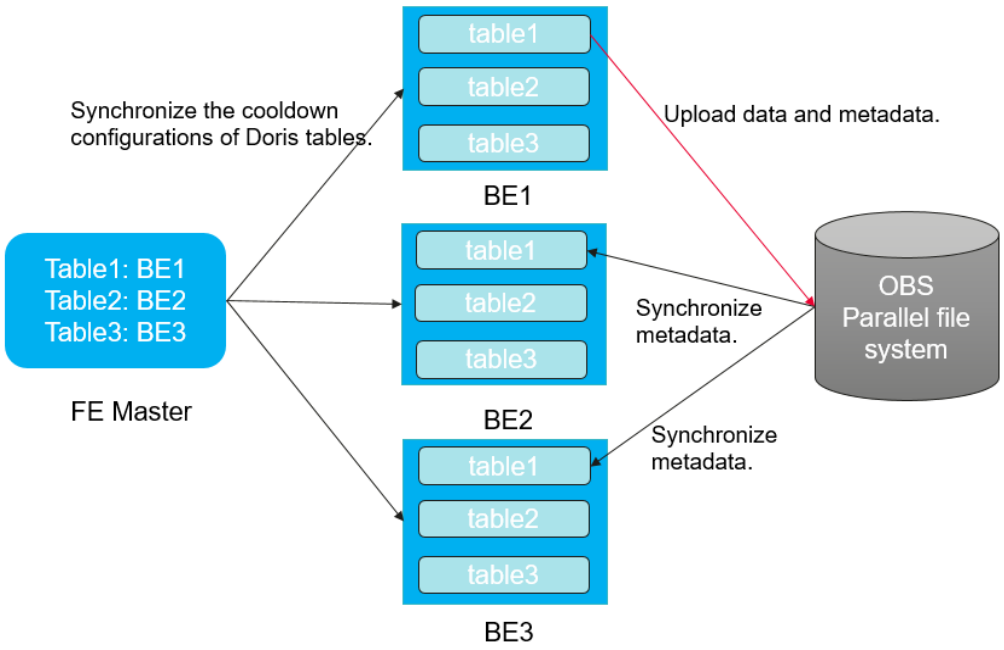
Apache Doris 2.0 supports the separation storage of cold and hot data. You can use this function to sink data from the local host to the object storage.

Figure 4-4 Hot and cold data separation



OBS provides secure, reliable, and cost-effective distributed storage service that supports large-scale data. Doris uses OBS to store data separately. **Figure 4-5** shows the princiole.

Figure 4-5 Cold and hot data separation principle



4.7.2 Configuring Cold and Hot Data Separation

This topic describes how to configure Doris cold and hot separation.

Prerequisite

The Doris cluster can communicate with OBS.

Creating an OBS Parallel File System and Obtaining the AK/SK and Domain ID

Create an OBS parallel file system.

Step 1 Log in to the OBS console.

Step 2 Choose **Parallel File Systems** > **Create Parallel File System**.

Step 3 Enter a file system name, for example, **doris-obs**.

The name of an enterprise project must be the same as that of the MRS cluster. Set other parameters.

Step 4 Click **Create Now**.

Step 5 In the parallel file system list, click the name of the one you just created and click **Overview** to obtain the endpoint information.

NOTE

After a service is deleted or a cluster is uninstalled, dirty data may remain in the parallel file system created in **Step 2** to **Step 4**. You need to delete the dirty data.

Obtain AK/SK information.

Step 6 Click the username in the upper right corner and select **My Credentials** from the drop-down list.

Step 7 On the **API Credentials** page, obtain the **Account ID** whish is used as the domain ID.

Step 8 Click **Access Keys**, click **Create Access Key**, and enter the verification code or password. Click **OK** and download the access keys. Obtain the AK/SK information from the **.csv** file.

----End

Creating a Cloud Service Agency and Binding It to a Cluster

Step 1 Log in to the management console.

Step 2 In the service list, choose **Management & Governance** > **Identity and Access Management**.

Step 3 In the navigation pane on the left, choose **Agencies** and click **Create Agency**. On the displayed page, set the following parameters and click **Next**:

- **Agency Name**: Enter an agency name, for example, **mrs_ecs_obs**.
- **Agency Type**: Select **Cloud service**.
- **Cloud Service**: Select **Elastic Cloud Server (ECS) and Bare Metal Server (BMS)**.
- **Validity Period**: Select **Unlimited**.

Step 4 On the displayed page, search for the **OBS OperateAccess** policy and select it.

Step 5 Click **Next**, click **Show More**, select **Global services**, and click **OK**.

Step 6 In the displayed dialog box, click **OK** to start authorization. Click **Finish** after the message "Authorization successful." is displayed.

Step 7 On the MRS console, choose **Active Clusters** in the navigation pane on the left and click the name of the target cluster to access its details page.

Step 8 On the **Dashboard** page, click **Synchronize** on the right of **IAM User Sync** to synchronize the IAM user.

Step 9 Click **Manage Agency** on the right of **Agency**, select the created agency, for example, **mrs_ecs_obs**, and click **OK** to bind the agency to the cluster.

----End

Creating a Common Account Agency and Binding It to a Cluster

Step 1 Log in to the management console.

Step 2 In the service list, choose **Management & Governance** > **Identity and Access Management**.

Step 3 Choose **Permissions** > **Policies/Roles**, and click **Create Custom Policy**. Set the following parameters, and click **OK**:

- **Policy Name**: Enter a policy name, for example, **doris-policy**.
- **Policy View**: Select **JSON**.

- **Policy Content**: Enter the following content.

```
{
   "Version": "1.1",
   "Statement": [
      {
         "Effect":"Allow",
         "Action":[
            "OBS:*:*"
            ]
      }
      ]
}
```

Step 4 In the navigation pane on the left, click **Agencies**. Click **Create Agency**. On the displayed page, set the following parameters and click **Next**:

- **Agency Name**: Enter an agency name, for example, **agency-MRS-to-OBS**.
- **Agency Type**: Select **Account**.
- Enter your cloud account in the **Delegated Account** field, that is, the account you register using your mobile phone number. It cannot be a federated user or an IAM user created using your cloud account.
- **Validity Period**: Select **Unlimited**.

Step 5 In the search box on the displayed **Authorize Agency** page, search for the custom policy created in **Step 3** and select it, for example, **doris-policy**.

Step 6 Click **Next**, click **Show More**, select **Global services**, and click **OK**.

Step 7 Check and record the agency ID.

Step 8 On the **Identity and Access Management** page, click **Agencies**.

Step 9 Click the name of the cloud service agency created in **Step 3**, for example, **mrs_ecs_obs**.

Step 10 Click the **Permissions** tab and click **Authorize**. On the displayed page, click **Create Policy** in the upper right corner, and set the parameters as follows:

- **Policy Name**: Enter a policy name, for example, **doris-assume-policy**.

- **Policy View**: Select **JSON**.
- **Policy Content**: Enter the following content. *{Agency ID}* indicates the ID recorded in **Step 7**.

```
{
   "Version": "1.1",
   "Statement": [
      {
         "Action": [
            "iam:agencies:assume"
         ],
         "Resource": {
            "uri": [
               "/iam/agencies/{Agency ID}"
            ]
         },
         "Effect": "Allow"
      }
   ]
}
```

Step 11 Click **Next**. On the **Select Policy/Role** page, select the policy created in **Step 10**.

Step 12 Click **Next**, click **Show More**, select **Global services**, and click **OK**.

----End

Enabling Cold and Hot Data Separation

By default, cold and hot data separation is disabled. To use this function, perform the following operations:

Step 1 Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Doris**. Click the **Configurations** tab.

Step 2 Search for the **obs_cooldown_enable** parameter and set it to **true**.

Step 3 (Optional) If the data on the local disk is cooled down and stored on OBS, and related data needs to be stored on the local disk in a certain period of time, select **All Configurations** > **BE(Role)** > **Customization**, add the **moveback_enable** parameter to the customized parameter **be.conf.customized.configs** and set the parameter value to **true**.

Step 4 Click **Save** and then **OK**.

Step 5 Click **Instances**, select the affected FE and BE instances, choose **More** > **Restart Instance**, and enter the password of the current user to restart the FE and BE instances.

----End

Use Case

Step 1 Log in to the node where MySQL is installed and run the following command to connect to the Doris database:

If Kerberos authentication is enabled for the cluster (the cluster is in security mode), run the following command to connect to the Doris database:

export LIBMYSQL_ENABLE_CLEARTEXT_PLUGIN=1

mysql -u*Database login username* **-p***Database login password* **-P***Connection port for FE queries* **-h***IP address of the Doris FE instance*

NOTE

- To obtain the query connection port of the Doris FE instance, you can log in to FusionInsight Manager, choose **Cluster** > **Services** > **Doris** > **Configurations**, and query the value of **query_port** of the Doris service.
- To obtain the IP address of the Doris FE instance, log in to FusionInsight Manager of the MRS cluster and choose **Cluster** > **Services** > **Doris** > **Instances** to view the service IP address of any FE instance.
- You can also use the MySQL connection software or Doris web UI to connect to the database.

Step 2 Create a resource.

- Create a resource by configuring an agency.
  a. Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Doris**. Click **Configurations** then **All Configurations**, click **OBS**, and search for and modify the following parameters:
     - **obs_authentication_method**: Change the value to **agency**.
     - **obs_endpoint**: endpoint information queried in **Step 5**, for example, **obs.***XXX*.
     - **obs_iam_endpoint**: The value is the endpoint value queried in **https://iam.***Endpoint queried in **Step 5***.
     - **obs_iam_domain_id**: domain ID queried in **Step 7**.
     - **obs_agency_name**: common account agency created in **Creating a Common Account Agency and Binding It to a Cluster**, for example, **agency-MRS-to-OBS**.
  b. Connect the node where the MySQL client is installed to Doris. For details, see **Using Doris from Scratch**.
  c. Run the following statement to create a resource:

     CREATE RESOURCE IF NOT EXISTS *resource_obs_hot_cold* **PROPERTIES (**

     "type" = "obs",

     "obs.bucket" = "*Name of the created OBS parallel file system***",**

     "obs.root.path" = "*Root directory for storing data***"**

     );
- Create a resource using AK/SK.

  CREATE RESOURCE IF NOT EXISTS *resource_obs_hot_cold* **PROPERTIES (**

  "type" = "obs",

  "obs.endpoint" = "*xxx***",**

  "obs.region" = "*xxx***",**

  "obs.bucket" = "*xxx***",**

  "obs.root.path" = "*xxx***",**

  "obs.access_key" = "*xxx***",**

"obs.secret_key" = "*xxx*",

'obs_validity_check' = 'false'

);

NOTE

- **type**: data storage type. The value is **obs**.
- **obs.endpoint**: endpoint information viewed in **Step 5**
- **obs.region**: region of the cluster where the Doris service is deployed
- **obs.bucket**: name of the OBS parallel file system created in **Step 3**
- **obs.root.path**: root directory for storing data
- **obs.access_key**: AK information obtained in **Step 8**
- **obs.secret_key**: SK information obtained in **Step 8**

Step 3 Set the data cooling policy using the storage policy.

- Set the time to live (TTL) to cool down data.

  CREATE STORAGE POLICY IF NOT EXISTS *policy_doris_hot_cold* **PROPERTIES("storage_resource" = "***resource_obs_hot_cold***", "cooldown_ttl" = "***1d***");**

  If the value of **cooldown_ttl** is **1d**, newly imported data will be cooled one day later and the cooled data will be stored in the OBS path configured during resource creation in **Step 2**.

- Set a time point to cool down data.

  In addition to setting the TTL, you can also set a time point in the cooling policy.

  CREATE STORAGE POLICY IF NOT EXISTS *policy_doris_hot_cold2* **PROPERTIES("storage_resource" = "resource_obs_hot_cold", "cooldown_datetime" = "***2024-01-01 10:00:00***");**

Step 4 Set the storage policy of a table or partition.

- Set the storage policy when creating a table.

  CREATE TABLE *ORDERS* **(**
  ORDER_ID VARCHAR(50),
  USER_ID BIGINT,
  PRODUCT_ID VARCHAR(10),
  PRICE DECIMAL(15,2),
  CHANNEL VARCHAR(20),
  CREATE_DT DATE
)
  DUPLICATE KEY(`ORDER_ID`)
  PARTITION BY RANGE(`CREATE_DT`)
  (
  PARTITION `p202401` VALUES LESS THAN ("2024-02-01"),
  PARTITION `p202402` VALUES LESS THAN ("2024-03-01")
)
  DISTRIBUTED BY HASH(`ORDER_ID`) BUCKETS 3

PROPERTIES (
"replication_num" = "3",
"storage_policy" = "policy_doris_hot_cold "
);

- Modify the properties of an existing table.
  ALTER TABLE *ORDERS* **SET("storage_policy" = "policy_doris_hot_cold");**
- Set the cold and hot separation policy for a partition when creating a table.
  CREATE TABLE *ORDERS* **(**
  ORDER_ID VARCHAR(50),
  USER_ID BIGINT,
  PRODUCT_ID VARCHAR(10),
  PRICE DECIMAL(15,2),
  CHANNEL VARCHAR(20),
  CREATE_DT DATE
)
  DUPLICATE KEY(`ORDER_ID`)
  PARTITION BY RANGE(`CREATE_DT`)
  (
  PARTITION `p202401` VALUES LESS THAN ("2024-02-01")
  ("storage_policy" = "policy_doris_hot_cold"),
  PARTITION `p202402` VALUES LESS THAN ("2024-03-01")
)
  DISTRIBUTED BY HASH(`ORDER_ID`) BUCKETS 3
  PROPERTIES (
  "replication_num" = "3"
  );
- Modify the partition properties of an existing table.
  ALTER TABLE *ORDERS* **MODIFY PARTITION (`p202401`)**
  SET("storage_policy"="policy_doris_hot_cold");

NOTE

- A single table or partition can be associated with only one storage policy. Associated storage policies cannot be deleted before disassociation.
- Information about the object associated with a storage policy cannot be modified, such as bucket, endpoint, and root_path.
- A storage policy can be created, modified, and deleted. Before deleting a storage policy, ensure that no table references the storage policy.
- When the Merge-on-Write feature is enabled for the Unique model, storage policies cannot be set.

Step 5 Run the following statement to query data:

show tablets from *ORDERS*;

This command views the tablet information of the table. In the tablet information, LocalDataSize and RemoteDataSize are distinguished. LocalDataSize indicates the

data stored locally, and RemoteDataSize indicates the data that has been cooled and stored on OBS.

Before the data is cooled, the tablet information of the table is as follows.

```
*************************** 1. row ***************************
             TabletId: 10210
            ReplicaId: 10211
            BackendId: 10002
           SchemaHash: 1629210097
              Version: 26
     LstSuccessVersion: 26
      LstFailedVersion: -1
         LstFailedTime: NULL
         LocalDataSize: 2718
        RemoteDataSize: 0
              RowCount: 25
                 State: NORMAL
LstConsistencyCheckTime: NULL
          CheckVersion: -1
          VersionCount: 2
             QueryHits: 0
              PathHash: -2692135266043659989
               MetaUrl: http://192.165.0.218:29986/api/meta/header/10210
      CompactionStatus: http://192.165.0.218:29986/api/compaction/show?tablet_id=10210
     CooldownReplicaId: 10211
        CooldownMetaId: TUniqueId(hi:-629967361863696654, lo:-8577590943874589763)
1 row in set (0.00 sec)
```

After the data is cooled, the tablet information of the table is as follows.

```
*************************** 1. row ***************************
             TabletId: 10210
            ReplicaId: 10211
            BackendId: 10002
           SchemaHash: 1629210097
              Version: 26
     LstSuccessVersion: 26
      LstFailedVersion: -1
         LstFailedTime: NULL
         LocalDataSize: 0
        RemoteDataSize: 2718
              RowCount: 25
                 State: NORMAL
LstConsistencyCheckTime: NULL
          CheckVersion: -1
          VersionCount: 2
             QueryHits: 0
              PathHash: -2692135266043659989
               MetaUrl: http://192.165.0.218:29986/api/meta/header/10210
      CompactionStatus: http://192.165.0.218:29986/api/compaction/show?tablet_id=10210
     CooldownReplicaId: 10211
        CooldownMetaId: TUniqueId(hi:-629967361863696654, lo:-8577590943874589763)
1 row in set (0.01 sec)
```

----End

4.8 Data Operations

4.8.1 Data Import

4.8.1.1 Broker Load

Broker load is an asynchronous import method, and the supported data sources depend on the data sources supported by the Broker process.

Data in the Doris table is ordered. Broker load uses the Doris cluster resources to sort the data when importing data. Comparing with massive historical data

migration with Spark load, this method user a large amount of Doris cluster resources. Broker load is used when users do not have Spark computing resources. If there are Spark computing resources, Spark load is recommended.

You need to import data with Broker Load through MySQL protocol and check the import result by viewing the import command. Broker Load is suitable for the following scenes:

- The source data is in a storage system that the broker can access, such as HDFS.
- The data volume ranges from tens to hundreds of GB.
- Data in CSV, Parquet, and ORC formats can be imported. Only data in CSV format is supported by default.

Prerequisites

- A cluster containing the Doris service has been created, and all services in the cluster are running properly.
- The nodes to be connected to the Doris database can communicate with the MRS cluster.
- A user with Doris management permission has been created.
  - Kerberos authentication is enabled for the cluster (the cluster is in security mode)

    Log in to FusionInsight Manager, create a human-machine user, for example, **dorisuser**, create a role with Doris administrator permissions, and bind the role to the user.

    Log in to FusionInsight Manager as the new user **dorisuser** and change the initial password.
  - Kerberos authentication is disabled for the cluster (the cluster is in normal mode)

    After connecting to Doris as user **admin**, create a role with administrator permissions, and bind the role to the user.
- The MySQL client has been installed. For details, see **Installing a MySQL Client**.
- The DBroker instance has been installed and started in Doris.
- The Hive client has been installed.

Importing Hive Table Data to Doris

- Import Hive table data in text format to Doris.
  a. Run the following commands to log in to the Hive beeline CLI:

     cd /opt/hadoopclient

     source bigdata_env

     kinit *Component service user* (If Kerberos authentication is disabled for the cluster (the cluster is in normal mode), skip this step.)

     beeline

  b. Run the following statements to create a Hive table in the **default** database (the partition field is **c4**):

     CREATE TABLE *test_table***(**

`c1` int,

`c2` int,

`c3` string)

PARTITIONED BY (c4 string)

row format delimited fields terminated by ','lines terminated by '\n' stored as textfile ;

c. Run the following command to insert data to the Hive table:

insert into table *test_table* **values(1,1,'1','2022-04-10'), (2,2,'2','2022-04-22');**

d. Log in to the node where MySQL is installed and connect the Doris database.

If Kerberos authentication is enabled for the cluster (the cluster is in security mode), run the following command to connect the Doris database:

export LIBMYSQL_ENABLE_CLEARTEXT_PLUGIN=1

mysql -u*Database login username* **-p***Database login password* **-P***Connection port for FE queries* **-h***IP address of the Doris FE instance*

NOTE

- To obtain the query connection port of the Doris FE instance, you can log in to FusionInsight Manager, choose **Cluster** > **Services** > **Doris** > **Configurations**, and query the value of **query_port** of the Doris service.
- To obtain the IP address of the Doris FE nstance, log in to FusionInsight Manager of the MRS cluster and choose **Cluster** > **Services** > **Doris** > **Instances** to view the IP address of any FE instance.
- You can also use the MySQL connection software or Doris web UI to connect the database.

e. Run the following command to create a Doris table:

CREATE TABLE *example_db.test_t1* **(**

`c1` int NOT NULL,

`c4` date NULL,

`c2` int NOT NULL,

`c3` String NOT NULL

) ENGINE=OLAP

UNIQUE KEY(`c1`, `c4`)

PARTITION BY RANGE(`c4`)

(

PARTITION P_202204 VALUES [('2022-04-01'), ('2022-05-01')))

DISTRIBUTED BY HASH(`c1`) BUCKETS 1

PROPERTIES (

"replication_allocation" = "tag.location.default: 3",

"dynamic_partition.enable" = "true",

"dynamic_partition.time_unit" = "MONTH",

"dynamic_partition.start" = "-2147483648",

"dynamic_partition.end" = "2",

"dynamic_partition.prefix" = "P_",

"dynamic_partition.buckets" = "1",

"in_memory" = "false",

"storage_format" = "V2"

);

f. Run the following command to import data:

- Kerberos authentication is enabled for the cluster (the cluster is in security mode)

  LOAD LABEL *broker_load_2022_03_23*

  (

  DATA INFILE("hdfs://*IP address of the active NameNode instance*:*RPC port number*/**user/hive/warehouse/test_table/*/*")**

  INTO TABLE *test_t1*

  COLUMNS TERMINATED BY ","

  (c1,c2,c3)

  COLUMNS FROM PATH AS (`c4`)

  SET

  (

  c4 = str_to_date(`c4`,'%Y-%m-%d'),c1=c1,c2=c2,c3=c3

)

)

  WITH BROKER "*broker_192_168_67_78*"

  (

  "hadoop.security.authentication"="kerberos",

  "kerberos_principal"="doris/hadoop.hadoop.com@HADOOP.COM",

  "kerberos_keytab"="${BIGDATA_HOME}/FusionInsight_Doris_8.3.1/install/FusionInsight-Doris-2.0.3/doris-fe/bin/doris.keytab"

)

  PROPERTIES

  (

  "timeout"="1200",

  "max_filter_ratio"="0.1"

  );

- Kerberos authentication is disabled for the cluster (the cluster is in normal mode)

  LOAD LABEL *broker_load_2022_03_23*

  (

  DATA INFILE("hdfs://*IP address of the active NameNode instance*:*RPC port number*/**user/hive/warehouse/***test_table***/*/*")**

  INTO TABLE *test_t1*

```
COLUMNS TERMINATED BY ","
(c1,c2,c3)
COLUMNS FROM PATH AS (`c4`)
SET
(
c4 = str_to_date(`c4`,'%Y-%m-%d'),c1=c1,c2=c2,c3=c3
)
)
WITH BROKER "broker_192_168_67_78"
(
"username"="hdfs",
"password"=""
)
PROPERTIES
(
"timeout"="1200",
"max_filter_ratio"="0.1"
);
```

NOTE

- To view the IP address of the active NameNode instance, log in to FusionInsight Manager and choose **Cluster** > **Services** > **HDFS** > **Instances**.
- You can log in to FusionInsight Manager, choose **Cluster** > **Services** > **HDFS** > **Configurations**, and search for **dfs.namenode.rpc.port** to view the RPC port number.
- *broker_192_168_67_78* indicates the broker name. You can run the **show broker;** command on the MySQL client to view the broker name.
- Commands carrying authentication passwords pose security risks. Disable historical command recording before running such commands to prevent information leakage.

g. Run the following statement to check the status of the import job:

show load order by createtime desc limit 1\G;

```
JobId: 41326624
Label: broker_load_2022_03_23
State: FINISHED
Progress: ETL:100%; LOAD:100%
Type: BROKER
EtlInfo: unselected.rows=0; dpp.abnorm.ALL=0; dpp.norm.ALL=27
TaskInfo: cluster:N/A; timeout(s):1200; max_filter_ratio:0.1
ErrorMsg: NULL
CreateTime: 2022-04-01 18:59:06
EtlStartTime: 2022-04-01 18:59:11
EtlFinishTime: 2022-04-01 18:59:11
LoadStartTime: 2022-04-01 18:59:11
LoadFinishTime: 2022-04-01 18:59:11
URL: NULL
JobDetails: {"Unfinished backends":{"5072bde59b74b65-8d2c0ee5b029adc0":
[]},"ScannedRows":27,"TaskNumber":1,"All backends":{"5072bde59b74b65-8d2c0ee5b029adc0":
[36728051]},"FileNumber":1,"FileSize":5540}
1 row in set (0.01 sec)
```

h. You can manually cancel an import task whose Broker Load job status is not **CANCELLED** or **FINISHED**. To cancel an import task, you need to specify the label of the import task. The statement is as follows:

CANCEL LOAD FROM *Database name* WHERE LABEL = "*Label name*";

For example, to cancel the import job whose label is **broker_load_2022_03_23** in database **demo**, run the following command:

CANCEL LOAD FROM demo WHERE LABEL = "broker_load_2022_03_23";

- Import Hive table data in ORC format to Doris

a. Run the following commands to log in to the Hive beeline CLI:

cd /opt/hadoopclient

source bigdata_env

kinit *Component service user* (If Kerberos authentication is disabled for the cluster (the cluster is in normal mode), skip this step.)

beeline

b. Run the following statement to create a Hive table in ORC format in the **default** database:

CREATE TABLE *test_orc_tbl***(**

`c1` int,

`c2` int,

`c3` string)

PARTITIONED BY (c4 string)

row format delimited fields terminated by ','lines terminated by '\n' stored as orc;

c. Log in to the node where MySQL is installed and connect the Doris database.

If Kerberos authentication is enabled for the cluster (the cluster is in security mode), run the following command to connect the Doris database:

export LIBMYSQL_ENABLE_CLEARTEXT_PLUGIN=1

mysql -u*Database login username* **-p***Database login password* **-P***Connection port for FE queries* **-h***IP address of the Doris FE instance*

NOTE

- To obtain the query connection port of the Doris FE instance, you can log in to FusionInsight Manager, choose **Cluster** > **Services** > **Doris** > **Configurations**, and query the value of **query_port** of the Doris service.
- To obtain the IP address of the Doris FE instance, log in to FusionInsight Manager of the MRS cluster and choose **Cluster** > **Services** > **Doris** > **Instances** to view the IP address of any FE instance.
- You can also use the MySQL connection software or Doris web UI to connect the database.

d. Run the following statement to create a Doris table:

CREATE TABLE *example_db.test_orc_t1* **(**

`c1` int NOT NULL,

```
`c4` date NULL,
`c2` int NOT NULL,
`c3` String NOT NULL
) ENGINE=OLAP
UNIQUE KEY(`c1`, `c4`)
PARTITION BY RANGE(`c4`)
(
PARTITION P_202204 VALUES [('2022-04-01'), ('2022-05-01')))
DISTRIBUTED BY HASH(`c1`) BUCKETS 1
PROPERTIES (
"replication_allocation" = "tag.location.default: 3",
"dynamic_partition.enable" = "true",
"dynamic_partition.time_unit" = "MONTH",
"dynamic_partition.start" = "-2147483648",
"dynamic_partition.end" = "2",
"dynamic_partition.prefix" = "P_",
"dynamic_partition.buckets" = "1",
"in_memory" = "false",
"storage_format" = "V2"
);
```

e. Run the following statement to import data using Broker Load:

- Kerberos authentication is enabled for the cluster (the cluster is in security mode):

  ```
  LOAD LABEL broker_load_2022_03_24
  (
  DATA INFILE("hdfs://IP address of the active NameNode instance:RPC port number/user/hive/warehouse/test_orc_tbl/*/*")
  INTO TABLE test_orc_t1
  COLUMNS TERMINATED BY ","
  FORMAT AS "orc"
  (c1,c2,c3)
  COLUMNS FROM PATH AS (`c4`)
  SET
  (
  c4 = str_to_date(`c4`,'%Y-%m-%d'),c1=c1,c2=c2,c3=c3
  )
  )
  WITH BROKER "broker_192_168_67_78"
  (
  "hadoop.security.authentication"="kerberos",
  "kerberos_principal"="doris/
  hadoop.hadoop.com@HADOOP.COM",
  ```

"kerberos_keytab"="${BIGDATA_HOME}/FusionInsight_Doris_8.3.1/install/FusionInsight-Doris-2.0.3/doris-fe/bin/doris.keytab"

)

PROPERTIES

(

"timeout"="1200",

"max_filter_ratio"="0.1"

);

- Kerberos authentication is disabled for the cluster (the cluster is in normal mode)

  LOAD LABEL *broker_load_2022_03_24*

  (

  DATA INFILE("hdfs://*IP address of the active NameNode instance*:*RPC port number*/**user/hive/warehouse/***test_orc_tbl*/***/*")**

  INTO TABLE *test_orc_t1*

  COLUMNS TERMINATED BY ","

  FORMAT AS "orc"

  (c1,c2,c3)

  COLUMNS FROM PATH AS (`c4`)

  SET

  (

  c4 = str_to_date(`c4`,'%Y-%m-%d'),c1=c1,c2=c2,c3=c3

)

)

  WITH BROKER "broker_192_168_67_78"

  (

  'username"="hdfs",

  'password"=""

)

  PROPERTIES

  (

  "timeout"="1200",

  "max_filter_ratio"="0.1"

  );

NOTE

- **FORMAT AS "orc"** : The data to be imported is in ORC format.
- **SET**: The field mapping between Hive tables and Doris tables and field conversion rules.
- To view the IP address of the active NameNode instance, log in to FusionInsight Manager and choose **Cluster** > **Services** > **HDFS** > **Instances**.
- You can log in to FusionInsight Manager, choose **Cluster** > **Services** > **HDFS** > **Configurations**, and search for **dfs.namenode.rpc.port** to view the RPC port number.
- *broker_192_168_67_78* indicates the broker name. You can run the **show broker;** command on the MySQL client to view the broker name.

f. Run the following statement to check the status of the imported task:

show load order by createtime desc limit 1\G;

g. You can manually cancel an import task whose Broker Load job status is not **CANCELLED** or **FINISHED**. To cancel an import task, you need to specify the label of the import task. The statement is as follows:

CANCEL LOAD FROM *Database name* WHERE LABEL = "*Label name*";

For example, to cancel the import job whose label is **broker_load_2022_03_23** in database **demo**, run the following command:

CANCEL LOAD FROM demo WHERE LABEL = "broker_load_2022_03_23";

Related Parameter Configurations

The following configurations take effect in the whole system for Broker load and apply to all Broker load import jobs.

Log in to FusionInsight Manager, choose **Cluster** > **Services** > **Doris** and click the **Configurations** tab. On the displayed page, choose **FE (Role)** > **Customization**, and add the following parameters to **fe.conf.customized.configs**:

- **min_bytes_per_broker_scanner**: specifies the minimum amount of data that can be processed by a single BE. The default value is 64 MB. The value must be in bytes.
- **max_bytes_per_broker_scanner**: specifies the maximum amount of data that can be processed by a single BE. The default value is 3 GB. The value must be in bytes.
- **max_broker_concurrency**: specifies the maximum number of concurrent import tasks in a job. The default value is **10**.

The minimum data volume allowed, maximum number of concurrent jobs, source file size, and number of BE nodes in the current cluster determine the number of concurrent import jobs can be processed.

- Number of concurrent import jobs = **Math.min** (Source file size/Minimum data volume allowed, Maximum number of concurrent import jobs, Number of current BE nodes)
- Minimum data volume processed by a single BE = Size of the source file/ Number of concurrent import jobs

Usually the maximum amount of data supported by an import job is the product of the value of **max_bytes_per_broker_scanner** and the number of BE nodes. To import a larger amount of data, you need to adjust the value of **max_bytes_per_broker_scanner**.

4.8.1.2 Stream Load

Stream load is a synchronous way of importing. Users import local files or data streams into Doris by sending HTTP protocol requests. Stream load synchronously executes the import and returns the import result. Users can directly determine whether the import is successful by the return body of the request.

Stream load is mainly suitable for importing local files or data from data streams through procedures. Data in CSV, Parquet, and ORC formats can be imported. Only data in CSV format is supported by default.

Syntax

- Create a stream load import job.

  Stream load submits and transfers data through HTTP protocol. The following curl commands are used to show you how to submit an import. You can also operation through other HTTP clients.

  – Kerberos authentication is enabled for the cluster (the cluster is in security mode)

    curl -k --location-trusted -u *user:passwd* **[-H ""...] -T data.file -XPUT https://** *IP address of the Doris FE instance*:*HTTPS port number*/**api/***{Database name}*/*{Table name}*/_**stream_load**

  – Kerberos authentication is disabled for the cluster (the cluster is in normal mode)

    curl --location-trusted -u *user:passwd* **[-H ""...] -T data.file -XPUT http://***IP address of the Doris FE instance*:*HTTP port number*/**api/***{Database name}*/*{Table name}*/_**stream_load**

  To view the IP address of the active Doris FE instance, log in to FusionInsight Manager and choose **Cluster** > **Services** > **Doris** > **Instances**.

  You can log in to FusionInsight Manager, choose **Cluster** > **Services** > **Doris** > **Configurations**, and search for **https_port** to view the HTTPS port.

  . To view the port, log in to FusionInsight Manager, choose **Cluster** > **Services** > **Doris** > **Configurations**, and search for **http_port**.

  Table 4-4 describes other parameters for creating a stream load task.

Table 4-4 Parameters of a stream load task

Parameter		Description
Signature parameter	user:passwd	Stream load uses the HTTP protocol to create the imported protocol and signs it through the Basic Access authentication. The Doris system verifies user identity and import permissions based on signatures.

Parameter		Description
Load parameters (format: **-H "key1:value1"**)	label	Identity of import task. Each import task has a unique label inside a single database. Label is a user-defined name in the import command. With this label, you can view the execution status of the corresponding import task.
	column_separator	Column separator in the file to be imported. The default value is **\t**. You can use a combination of multiple characters as the column separator. If it is an invisible character, you need to add **\x** as a prefix and hexadecimal to indicate the separator. For example, the separator **\x01** of the hive file needs to be specified as **-H "column_separator:\x01"**.
	line_delimiter	Line delimiter in the file to be imported. The default value is **\n**. You can use a combination of multiple characters as the line delimiter.
	max_filter_ratio	Maximum tolerance rate of the import task. The default value is 0, and the range of values is 0-1. When the import error rate exceeds this value, the import fails.
	where	Filter criteria specified for an import task. Stream Load allows you to specify **where** statements to filter raw data. The filtered data will not be imported or involved in the calculation of **filter ratio**, but will be counted as **num_rows_unselected**.
	Partitions	Partition information of the table to be imported. If the data to be imported does not belong to the specified partition, the information will not be imported and will be included in **dpp.abnorm.ALL**.
	columns	The function transformation configuration of data to be imported. The sequence change of columns and the expression transformation are included. The expression transformation method is consistent with the query statement.
	format	Format of the data to be imported. The value can be CSV (default), JSON, Parquet, or ORC.
	exec_mem_limit	Memory limit in byes. The default value is 2 GB.

Parameter		Description
	strict_mode	The strict mode affects the import behavior of certain values and the final imported data. You can declare **strict_mode=true** in the header to enable the strict mode. By default, the strict mode is disabled. The strict mode is used to restrict the filtering of column type conversions during import. ● For column type conversions, if **strict mode** is **true**, incorrect data will be filtered. Incorrect data here refers to the originally non-null data that is converted into nulls. ● If a column to be imported is converted by a function, the strict mode does not affect the column. ● For an imported column type that contains range restrictions, if the original data can pass the type conversion normally, but cannot pass the range restrictions, the strict mode will not affect it. For example, if the type is decimal(1,0) and the original data is 10, it belongs to the range that can be converted by type but is not within the scope of the column declaration. The strict mode has no effect on this kind of data.
	merge_type	Data merging type. The options are **APPEND**, **DELETE**, and **MERGE**. The default value is **APPEND**. APPEND is the default value, which appends all this batch of data to the existing data. DELETE deletes all rows with the same key as this batch of data. MERGE semantics need to be used in conjunction with the delete condition, which means that the data that meets the delete condition is processed according to DELETE semantics and the rest is processed according to APPEND semantics.
	two_phase_commit	Stream load import can enable two-stage transaction commit mode. In the stream load process, data is written and the information is returned to you. At this time, the data is invisible and the transaction status is PRECOMMITTED. After you commit the transaction, the data is visible.
	enable_profile	If **enable_profile** is set to **true**, the stream load profile will be recorded in logs. Otherwise, it will not be recorded in logs.

- Returned results

  Since stream load imports data synchronously, the result of the import is directly returned to the user by creating the return value of the import. The following is an example:

  ```
  {
  "TxnId": 1003,
  "Label": "b6f3bc78-0d2c-45d9-9e4c-faa0a0149bee",
  ```

```
"Status": "Success",
"ExistingJobStatus": "FINISHED", // optional
"Message": "OK",
"NumberTotalRows": 1000000,
"NumberLoadedRows": 1000000,
"NumberFilteredRows": 1,
"NumberUnselectedRows": 0,
"LoadBytes": 40888898,
"LoadTimeMs": 2144,
"BeginTxnTimeMs": 1,
"StreamLoadPutTimeMs": 2,
"ReadDataTimeMs": 325,
"WriteDataTimeMs": 1933,
"CommitAndPublishTimeMs": 106,
"ErrorURL": "http://192.168.1.1:8042/api/_load_error_log?file=__shard_0/
error_log_insert_stmt_db18266d4d9b4ee5-
abb00ddd64bdf005_db18266d4d9b4ee5_abb00ddd64bdf005"
}
```


Table 4-5 describes the parameters in the import result.

Table 4-5 Parameters in a stream load result

Parameter	Description
TxnId	The imported transaction ID.
Label	Import labels, which are specified by users or automatically generated by the system.
Status	Import completion status. • **Success**: indicates that the import is successful. • **Publish Timeout**: also indicates that the import is complete. The only difference is that the data may be delayed and visible without retrying. • **Label Already Exists**: indicates that a label is duplicate and needs to be replaced. • **Fail**: Import failed.
ExistingJobStatus	The state of the load job corresponding to the existing Label. This field is displayed only when Status is **"Label Already Exists"**. You can know the status of the load job corresponding to **Label** through this state. **"RUNNING"** indicates that the job is still being executed, and **"FINISHED"** indicates that the job is successfully executed.
Message	Import error information.
NumberTotalRows	Number of rows imported for total processing.
NumberLoadedRows	Number of rows successfully imported.
NumberFilteredRows	Number of rows that do not qualify for data quality.

Parameter	Description
NumberUnselectedRows	Number of rows filtered by the where condition.
LoadBytes	Number of imported bytes.
LoadTimeMs	Import completion time, in milliseconds.
BeginTxnTimeMs	Time cost for requesting FE to begin a transaction. The unit is millisecond.
StreamLoadPutTimeMs	Time cost for requesting FE to obtain the data import plan. The unit is millisecond.
ReadDataTimeMs	Time cost for reading data, in milliseconds.
WriteDataTimeMs	Time cost for writing data, in milliseconds.
CommitAndPublishTimeMs	Time cost for submitting a request to FE and releasing a transaction, in milliseconds.
ErrorURL	URL to view a specific error line if there are data quality problems.

NOTE

Since Stream load is a synchronous import mode, import information will not be recorded in Doris system. You cannot see Stream load asynchronously by looking at import commands. You need to view the return value of the import request to obtain the import result.

- Canceling Load

  You cannot manually cancel stream load tasks. Stream load will be automatically canceled by the system after a timeout or import error.

- Viewing Stream Load

  You can view completed stream load tasks through **show stream load**.

  By default, the BE does not record stream load information. To view the information, you need to set the **enable_stream_load_record=true** parameter.

Prerequisite

- A cluster containing the Doris service has been created, and all services in the cluster are running properly.
- The nodes to be connected to the Doris database can communicate with the MRS cluster.
- A user with Doris management permission has been created.
  - Kerberos authentication is enabled for the cluster (the cluster is in security mode)

Log in to FusionInsight Manager, create a human-machine user, for example, **dorisuser**, create a role with Doris administrator permissions, and bind the role to the user.

Log in to FusionInsight Manager as the new user **dorisuser** and change the initial password.

- Kerberos authentication is disabled for the cluster (the cluster is in normal mode)

  After connecting to Doris as user **admin**, create a role with administrator permissions, and bind the role to the user.

- The MySQL client has been installed. For details, see **Installing a MySQL Client**.

Stream Load Example

Step 1 Log in to the node where MySQL is installed and run the following command to connect to the Doris database:

If Kerberos authentication is enabled for the cluster (the cluster is in security mode), run the following command to connect to the Doris database:

export LIBMYSQL_ENABLE_CLEARTEXT_PLUGIN=1

mysql -u*Database login username* **-p***Database login password* **-P***Connection port for FE queries* **-h***IP address of the Doris FE instance*

NOTE

- To obtain the query connection port of the Doris FE instance, you can log in to FusionInsight Manager, choose **Cluster** > **Services** > **Doris** > **Configurations**, and query the value of **query_port** of the Doris service.
- To obtain the IP address of the Doris FE instance, log in to FusionInsight Manager of the MRS cluster and choose **Cluster** > **Services** > **Doris** > **Instances** to view the IP address of any FE instance.
- You can also use the MySQL connection software or Doris web UI to connect to the database.

Step 2 Run the following statement to create a database:

create database if not exists *example_db*;

Step 3 Run the following statement to create a table:

CREATE TABLE *example_db.test_stream_tbl* **(**

`c1` int NOT NULL,

`c2` int NOT NULL,

`c3` string NOT NULL,

`c4` date NOT NULL

) ENGINE=OLAP

UNIQUE KEY(`c1`, `c2`)

DISTRIBUTED BY HASH(`c1`) BUCKETS 1;

Step 4 Create the **data.csv** file and add the following content to the file:

```
1,1,1,2020-02-21
2,2,2,2020-03-21
3,3,3,2020-04-21
```

Step 5 Use stream load to import **data.csv** file data to the table created in **Step 3**.

- Kerberos authentication is enabled for the cluster (the cluster is in security mode)

  curl -k --location-trusted -u *user:passwd* -H "*label:table1_20230217***" -H "c*olumn_separator:,*" -T data.csv https://** IP address of the Doris FE instance**:**HTTPS port **/api/***example_db***/***test_stream_tbl***/_stream_load**

- Kerberos authentication is disabled for the cluster (the cluster is in normal mode)

  curl --location-trusted -u *user:passwd* -H "*label:table1_20230217***" -H "c*olumn_separator:,*" -T data.csv http://** IP address of the Doris FE instance**:**HTTP port **/api/***example_db***/***test_stream_tbl***/_stream_load**

Step 6 Run the following command to view the table data:

select * from *example_db.test_stream_tbl***;**

----End

Parameter Configurations

Log in to FusionInsight Manager, choose **Cluster** > **Services** > **Doris**, and click **Configurations** then **All Configurations**.

- Choose **FE(Role)** > **Customization**, and add the following parameters to **fe.conf.customized.configs**:

  stream_load_default_timeout_second: timeout interval of a stream load task, in seconds. If a load task is not complete within the specified time, the system cancels the task and the task status changes to **CANCELLED**. The default value is 600 seconds. If source files cannot be imported within this period, you can set another timeout period in the stream load request or change the value of **stream_load_default_timeout_second** to make the global timeout a longer period.

- Choose **BE(Role)** > **Customization** and add the following parameters to **be.conf.customized.configs**:

  streaming_load_max_mb: maximum file size (in MB) allowed for the stream load task. The default size is 10 GB. If a source file exceeds the maximum size, you need to adjust the value of this parameter.

4.8.2 Exporting Data

4.8.2.1 Exporting Data from HDFS to OBS

You can export data in specified tables or partitions in text format through the Broker process or S3 protocol, to remote storage, such as HDFS and object storage.

NOTE

- You are not advised to export a large amount of data at a time. It is recommended that a maximum of dozens of GB data be exported with an export job. Large exports result in many junk files and high retry costs.
- If a table contains a large amount of data, you are advised to export the data by partition.
- If the FE is restarted or an active/standby switchover occurs when the export job is running, the job will fail and you will need to submit it again.
- If an export job fails, the temporary directory **__doris_export_tmp**_*xxx* generated in the remote storage and generated files will not be deleted. You need to manually delete them.
- If an export job is successfully executed, the **__doris_export_tmp**_*xxx* directory generated in the remote storage may be retained or cleared based on the file system semantics of the remote storage.

  For example, in object storage (using S3 protocol), after the last file in a directory is moved by the **rename** operation, the directory will also be deleted. If the directory is not cleared by the system, you can clear it.
- After the export ends (successful or failed), if the FE is restarted or an active/standby switchover occurs, some job information displayed in **SHOW EXPORT** will be lost and cannot be viewed.
- This function exports only Base table data and does not export Rollup Index data.
- Export jobs scan data and occupy I/O resources, which may cause query latency.

Syntax

- Exporting Doris data to HDFS
  - Kerberos authentication is enabled for the cluster (the cluster is in security mode)

    EXPORT TABLE *db1.tbl1*

    PARTITION (p1,p2)

    [WHERE [expr]]

    TO "hdfs://*IP address of the active NameNode instance***:***RPC port number***/tmp/export/"**

    PROPERTIES

    (

    "label" = "*mylabel***",**

    "column_separator"=",",

    "columns" = "col1,col2",

    "exec_mem_limit"="2147483648",

    "timeout" = "3600"

)

    WITH BROKER "broker_name"

    (

    "hadoop.security.authentication"="kerberos",

    "kerberos_principal"="doris/hadoop.hadoop.com@HADOOP.COM",

    "kerberos_keytab"="${BIGDATA_HOME}/FusionInsight_Doris_*/install/FusionInsight-Doris-*/doris-fe/bin/doris.keytab"

);

- Kerberos authentication is disabled for the cluster (the cluster is in normal mode)

  EXPORT TABLE *db1.tbl1*

  PARTITION (p1,p2)

  [WHERE [expr]]

  TO "hdfs://*IP address of the active NameNode instance*:*RPC port number*/**tmp/export/"**

  PROPERTIES

  (

  "label" = "*mylabel***",**

  "column_separator"=",",

  "columns" = "col1,col2",

  "exec_mem_limit"="2147483648",

  "timeout" = "3600"

)

  WITH BROKER "broker_name"

  (

  "username" = "*user***",**

  "password" = "*passwd***"**

  );

To view the IP address of the active NameNode instance, log in to FusionInsight Manager and choose **Cluster** > **Services** > **HDFS** > **Instances**. Commands carrying authentication passwords pose security risks. Disable historical command recording before running such commands to prevent information leakage.

You can log in to FusionInsight Manager, choose **Cluster** > **Services** > **HDFS** > **Configurations**, and search for **dfs.namenode.rpc.port** to view the RPC port.

Table 4-6 describes other parameters.

Table 4-6 Parameters in the command for exporting Doris data to HDFS

Parameter	Description
label	Label of the export job. You can use this identifier to view the job status.
column_separator	Column separator. The default value is **\t**. Invisible characters are supported, for example, **'\x07'**.
columns	Columns to be exported. Use commas (,) to separate them. If this parameter is not set, all columns in the table will be exported by default.
line_delimiter	Line delimiter. The default value is **\n**. Invisible characters are supported, for example, **'\x07'**.

Parameter	Description
exec_mem_limit	Maximum memory can be used by a query plan in an export job on a BE. The default value is 2 GB, in bytes.
timeout	Job timeout period. The default value is 2 hours. The unit is second.
tablet_num_per_task	Maximum number of shards allocated to each query plan. The default value is 5.

- Viewing the status of an export job.

  After submitting a job, you can run the **SHOW EXPORT;** command to query the status of the export job. The following is an example:

```
JobId: 14008
State: FINISHED
Progress: 100%
TaskInfo: {"partitions":["*"],"exec mem limit":2147483648,"column separator":",","line
delimiter":"\n","tablet num":1,"broker":"hdfs","coord num":1,"db":"default_cluster:db1","tbl":"tbl3"}
Path: hdfs://host/path/to/export/
CreateTime: 2019-06-25 17:08:24
StartTime: 2019-06-25 17:08:28
FinishTime: 2019-06-25 17:08:34
Timeout: 3600
ErrorMsg: NULL
1 row in set (0.01 sec)
```

Table 4-7 Export job information

Parameter	Description
JobId	Job ID, which is unique.
State	Job status. ● PENDING: The job is to be scheduled. ● EXPORTING: Data is being exported. ● FINISHED: The export job is successfully executed. ● ANCELLED: The export job fails to be executed.
Progress	Work progress based on the query plan. Assuming there are 10 threads in total and 3 have been completed, the progress will be 30%.

Parameter	Description
TaskInfo	Job information displayed in JSON format • **db**: database name • **tbl**: table name • **partitions**: partitions to be exported. * indicates all partitions. • **exec mem limit**: memory usage limit for the query plan, in bytes. • **column separator**: column separator for the exported file • **line delimiter**: line delimiter for the exported file • **tablet num**: total number of tablets • **broker**: name of the Broker • **coord num**: number of query plans
Path	Export path on the remote storage
CreateTime/ StartTime/ FinishTime	Creation time, scheduling start time, and end time of a job
Timeout	Job timeout period, in seconds. The time starts from CreateTime.
ErrorMsg	If an error occurs, ErrorMsg displays the cause of the error.

- Canceling an export task

  After submitting a job, you can run the **CANCEL_EXPORT** command to cancel the export job. The cancellation command is as follows:

  CANCEL EXPORT

  FROM *example_db*

  WHERE LABEL like "*%example%***";**

Prerequisite

- A cluster containing the Doris service has been created, and all services in the cluster are running properly.
- The nodes to be connected to the Doris database can communicate with the MRS cluster.
- A user with Doris management permission has been created.
  - Kerberos authentication is enabled for the cluster (the cluster is in security mode)

    Log in to FusionInsight Manager, create a human-machine user, for example, **dorisuser**, create a role with Doris administrator permissions, and bind the role to the user.

    Log in to FusionInsight Manager as the new user **dorisuser** and change the initial password.

  - Kerberos authentication is disabled for the cluster (the cluster is in normal mode)

    After connecting to Doris as user **admin**, create a role with administrator permissions, and bind the role to the user.

- The MySQL client has been installed. For details, see **Installing a MySQL Client**.

Export Job Example

Step 1 Log in to the node where MySQL is installed and run the following command to connect to the Doris database:

If Kerberos authentication is enabled for the cluster (the cluster is in security mode), run the following command to connect to the Doris database:

export LIBMYSQL_ENABLE_CLEARTEXT_PLUGIN=1

mysql -u*Database login username* **-p***Database login password* **-P***Connection port for FE queries* **-h***IP address of the Doris FE instance*

NOTE

- To obtain the query connection port of the Doris FE instance, you can log in to FusionInsight Manager, choose **Cluster** > **Services** > **Doris** > **Configurations**, and query the value of **query_port** of the Doris service.
- To obtain the IP address of the Doris FE instance, log in to FusionInsight Manager of the MRS cluster and choose **Cluster** > **Services** > **Doris** > **Instances** to view the IP address of any FE instance.
- You can also use the MySQL connection software or Doris web UI to connect to the database.

Step 2 Run the following statement to create a database:

create database if not exists *example_db*;

Step 3 Run the following statement to create a table:

CREATE TABLE *example_db.test_export_tbl* **(**

`c1` int NOT NULL,

`c2` int NOT NULL,

`c3` string NOT NULL,

`c4` date NOT NULL

) ENGINE=OLAP

DUPLICATE KEY(`c1`, `c2`)

DISTRIBUTED BY HASH(`c1`) BUCKETS 1;

Step 4 Run the following statement to insert data:

insert into example_db.test_export_tbl values(1,1,1,"2020-02-21"), (2,2,2,"2020-03-21"),(3,3,3,"2020-04-21");

Step 5 Run the following statement to export data from the **test_export_tbl** table to HDFS:

EXPORT TABLE *example_db.test_export_tbl*

TO "hdfs://*IP address of the active NameNode instance***:***RPC port number***/tmp/export/"**

PROPERTIES

(

"label" = "*label_exporthdfs_20230218031***",**

"column_separator"=",",

"columns" = "c1,c2,c3,c4",

"exec_mem_limit"="2147483648",

"timeout" = "3600"

)

with broker "broker_192_168_67_78"

(

"hadoop.security.authentication"="kerberos",

"kerberos_principal"="doris/hadoop.hadoop.com@HADOOP.COM",

"kerberos_keytab"="${BIGDATA_HOME}/FusionInsight_Doris_8.3.1/install/FusionInsight-Doris-2.0.3/doris-fe/bin/doris.keytab"

);

Step 6 Run the following statement to query the status of the export job:

SHOW EXPORT;

----End

Related Configuration Parameters

Log in to FusionInsight Manager, choose **Cluster** > **Services** > **Doris** > **Configurations** > **FE(Role)** > **Customization**, and add the following parameters to **fe.conf.customized.configs**:

- **export_checker_interval_second**: scheduling interval of the export job scheduler. The default value is 5 seconds. After setting this parameter, restart the FE.
- **export_running_job_num_limit**: maximum number of running export jobs Exceeding jobs wait and are in the **PENDING** state. The default value is 5, which can be adjusted at runtime.
- **export_task_default_timeout_second**: default timeout period of an export job. The default value is 2 hours, which can be adjusted at runtime.
- **export_tablet_num_per_task**: maximum number of shards that a query plan is responsible for. The default value is 5.
- **label**: user-customized label of an export task. If this parameter is not specified, a label will be automatically generated.

4.8.2.2 Exporting the Query Result Set

This topic describes how to use the **SELECT INTO OUTFILE** command to export query results.

NOTE

- The export command does not check whether the file and file path exist. Whether the path will be automatically created or whether the existing file will be overwritten is entirely determined by the semantics of the remote storage system.
- If an error occurs during the export process, the exported file may remain on the remote storage system. Doris will not clean these files. You need to clean them up.
- The timeout of the export command is the same as the timeout of the query. It can be set by **SET query_timeout =** *xxx*.
- For empty result query, there will be an empty file.
- File splitting will ensure that a row of data is stored in a single file. Therefore, the size of the file is not strictly equal to **max_file_size**.
- For functions whose output is invisible characters, such as BITMAP and HLL types, the output is \N, which is NULL.
- At present, the output type of some geographic functions, such as **ST_Point** is **VARCHAR**, but the actual output value is an encoded binary character. Currently these functions will output garbled characters. For geographic functions, use **ST_AsText** for output.

Syntax

query_stmt

INTO OUTFILE "file_path"

[format_as]

[properties]

file_path

format_as

properties

NOTE

format_as indicates the export format. The value can be **CSV**, **PARQUET**, **CSV_WITH_NAMES**, **CSV_WITH_NAMES_AND_TYPES** or **ORC**. The default value is CSV.

Example

- Export to HDFS

  Export simple query results to the **hdfs://path/to/result.txt** file in CSV format.

  - Kerberos authentication is enabled for the cluster (the cluster is in security mode)

    SELECT * FROM example_db.test_export_tbl

    INTO OUTFILE "hdfs://*192.168.67.78:25000***/tmp/result_"**

    FORMAT AS CSV

PROPERTIES

(

"broker.name" = "broker_192_168_67_78",

"column_separator" = ",",

"line_delimiter" = "\n",

"max_file_size" = "100MB",

"broker.hadoop.security.authentication" = "kerberos",

"broker.kerberos_principal" = "doris/hadoop.hadoop.com@HADOOP.COM",

"broker.kerberos_keytab" = "${BIGDATA_HOME}/FusionInsight_Doris_8.3.1/install/FusionInsight-Doris-2.0.3/doris-fe/bin/doris.keytab"

);

– Kerberos authentication is disabled for the cluster (the cluster is in normal mode)

SELECT * FROM example_db.test_export_tbl

INTO OUTFILE "hdfs://*192.168.67.78:25000***/tmp/result_"**

FORMAT AS CSV

PROPERTIES

(

"broker.name" = "broker_192_168_67_78",

"column_separator" = ",",

"line_delimiter" = "\n",

"max_file_size" = "100MB",

"broker.username"="hdfs",

"broker.password"=""

);

- Export to local file

  Before exporting data to a local file, you need to configure **enable_outfile_to_local=true in the fe.conf file**.

  select * from *tbl1* **limit 10**

  INTO OUTFILE "file:///*home/work/path/result_***";**

4.9 Typical SQL Syntax

4.9.1 Creating a Database

This topic describes the basic SQL syntax and example statements for creating Doris databases.

Basic Syntax

CREATE DATABASE [IF NOT EXISTS] *db_name*

[PROPERTIES ("key"="value", ...)];

Example

Step 1 Connect to Doris through MySQL client as a user with Doris administrator permissions.

Step 2 Run the following statement to create the database **example_db**:

create database if not exists example_db;

Step 3 Run the following statement to view the database information:

SHOW DATABASES;

```
mysql> SHOW DATABASES;
+--------------------+
| Database           |
+--------------------+
| example_db         |
| information_schema |
+--------------------+
2 rows in set (0.00 sec)
```

Step 4 Run the following statement to switch to **example_db**:

use example_db;

----End

4.9.2 Creating a Table

This topic describes the basic SQL syntax and example statements for creating tables.

Basic Syntax

CREATE TABLE [IF NOT EXISTS] [database.]*table*

(

column_definition_list,

[index_definition_list]

)

[engine_type]

[keys_type]

[table_comment]

[partition_info]

distribution_desc

[rollup_list]

[properties]

[extra_properties]

Example

- Create a regular table named **table1**.

  CREATE TABLE example_db.table1
  (
  k1 TINYINT,
  k2 DECIMAL(10, 2) DEFAULT "10.5",
  k3 CHAR(10) COMMENT "string column",
  k4 INT NOT NULL DEFAULT "1" COMMENT "int column"
)
  COMMENT "table comment"
  DISTRIBUTED BY HASH(k1) BUCKETS 32;

- Create a partitioned table named **table2**.

  Partition the table into three partitions by the **event_day** column: p201706, p201707, and p201708. The values are as follows:

  - p201706: The value range is [Minimum value, 2017-07-01).
  - p201707: The value range is [2017-07-01, 2017-08-01).
  - p201708: The value range is [2017-08-01, 2017-09-01).

  Each partition uses **siteid** for hash bucketing. The number of buckets is 10.

  The command for creating a table is as follows:

  CREATE TABLE table2
  (
  event_day DATE,
  siteid INT DEFAULT '10',
  citycode SMALLINT,
  username VARCHAR(32) DEFAULT '',
  pv BIGINT SUM DEFAULT '0'
)
  AGGREGATE KEY(event_day, siteid, citycode, username)
  PARTITION BY RANGE(event_day)
  (
  PARTITION p201706 VALUES LESS THAN ('2017-07-01'),
  PARTITION p201707 VALUES LESS THAN ('2017-08-01'),
  PARTITION p201708 VALUES LESS THAN ('2017-09-01')
)
  DISTRIBUTED BY HASH(siteid) BUCKETS 10
  PROPERTIES("replication_num" = "1");

NOTE

- In the preceding table creation options, **replication_num** creates single-copy tables. Doris recommends the default three-copy setting to ensure high availability.
- You can add a rollup to a table to improve query performance.
- By default, the **Null** property of a column in a table is **true**, which affects the query performance.
- The bucket column must be specified for a Doris table.

- View the table content.
  - **SHOW TABLES;**

```
+----------------------+
| Tables_in_example_db |
+----------------------+
| table1               |
| table2               |
+----------------------+
2 rows in set (0.01 sec)
```

  - **DESC table1;**

```
+----------+-------------+------+-------+---------+-------+
| Field    | Type        | Null | Key   | Default | Extra |
+----------+-------------+------+-------+---------+-------+
| siteid   | int(11)     | Yes  | true  | 10      |       |
| citycode | smallint(6) | Yes  | true  | N/A     |       |
| username | varchar(32) | Yes  | true  |         |       |
| pv       | bigint(20)  | Yes  | false | 0       | SUM   |
+----------+-------------+------+-------+---------+-------+
4 rows in set (0.00 sec)
```

  - **DESC table2;**

```
+-----------+-------------+------+-------+---------+-------+
| Field     | Type        | Null | Key   | Default | Extra |
+-----------+-------------+------+-------+---------+-------+
| event_day | date        | Yes  | true  | N/A     |       |
| siteid    | int(11)     | Yes  | true  | 10      |       |
| citycode  | smallint(6) | Yes  | true  | N/A     |       |
| username  | varchar(32) | Yes  | true  |         |       |
| pv        | bigint(20)  | Yes  | false | 0       | SUM   |
+-----------+-------------+------+-------+---------+-------+
5 rows in set (0.00 sec)
```

4.9.3 Inserting Data

This topic describes the basic SQL syntax and example statements for inserting table data.

Basic Syntax

INSERT INTO *table_name*

[PARTITION (p1, ...)]

[WITH LABEL label]

[(column [, ...])]

[[hint [, ...]]]

{ VALUES ({ expression | DEFAULT } [, ...]) [, ...] | query }

Example

- Insert multiple rows of data into the **test** table at a time.

  INSERT INTO test VALUES (1, 2), (3, 4);
- Import the result of a query statement to the **test** table.

  INSERT INTO test (c1, c2) SELECT * from test2;

4.9.4 Modifying a Table Structure

There are different methods for modifying table structures in an aggregate model and a non-aggregate model. The methods for modifying the Key and Value columns are also different.

- If **AGGREGATE KEY** is specified during table creation, the table is in aggregation model. In other scenarios, a non-aggregation model is used.
- In the table creation statement, the columns following the keyword **'unique key'**, **'aggregate key'**, or **'duplicate key'** are the Key column, and the remaining columns are Value columns.

Example for an Aggregate Model

The aggregate type of the aggregate columns cannot be changed.

- Add the **new_col** column (Key column) following the **col1** column.

  ALTER TABLE example_db.my_table ADD COLUMN new_col INT DEFAULT "0" AFTER col1;
- Add the **new_col** column (sum aggregate on the Value column) following **col1**.

  ALTER TABLE example_db.my_table ADD COLUMN new_col INT SUM DEFAULT "0" AFTER col1;
- Change the type of the **col1** column (Key column) to BIGINT.

  ALTER TABLE example_db.my_table MODIFY COLUMN col1 BIGINT DEFAULT "1";
- Change the type of the **col1** column (Value column) to BIGINT.

  ALTER TABLE example_db.my_table MODIFY COLUMN col1 BIGINT MAX DEFAULT "1";
- Delete the **col1** column.

  ALTER TABLE example_db.my_table DROP COLUMN col1;

Example for a Non-Aggregate Model

- Add the **new_col** column (Key column) following the **col1** column:

  ALTER TABLE example_db.my_table ADD COLUMN new_col INT KEY DEFAULT "0" AFTER col1;
- Add the **new_col** column (Value column) following the **col1** column.

  ALTER TABLE example_db.my_table ADD COLUMN new_col INT DEFAULT "0" AFTER col1;
- Change the type of the **col1** column (Key column) to BIGINT.

  ALTER TABLE example_db.my_table MODIFY COLUMN col1 BIGINT KEY DEFAULT "1";

- Change the type of the **col1** column (Value column) to BIGINT.

  ALTER TABLE example_db.my_table MODIFY COLUMN col1 BIGINT DEFAULT "1";
- Delete the **col1** column.

  ALTER TABLE example_db.my_table DROP COLUMN col1;

4.9.5 Deleting Tables

This topic describes the basic SQL syntax and example statements for deleting tables.

Basic Syntax

DROP TABLE [IF EXISTS] [db_name.]*table_name* [FORCE]**;**

Example

- Delete the **my_table** table.

  DROP TABLE IF EXISTS example_db.my_table;

4.10 Backing Up and Restoring Data

4.10.1 Backing Up Doris Data

Doris data can be backed up in form of files to a remote storage system through Broker. You can periodically back up and migrated data using snapshots.

NOTE

- Currently, only users with the **ADMIN** permission can perform backup and restoration operations.
- There can be only one backup job that is being executed in a database.
- Doris data can be backed up with smallest partition granularity. If a table contains a large amount of data, you can back up data by partition to reduce the retry cost upon failure.
- The backup and restoration operations are performed on the actual data files. When a table has too many shards, or a shard has too many small versions, it may take a long time to back up or restore even if the total amount of data is small.
- You can run the **SHOW BACKUP** or **SHOW RESTORE** command to view the job status. An error information may be displayed in the **TaskErrMsg** column. If the value in the **State** column is not **CANCELLED**, the job continues. Some tasks may be retried successfully. However, some tasks are in error, causing job failures.

Data Backup Principles

Backup operations upload the data of a specified table or partition as Doris files to a remote store. After a user submits a backup request, the system performs the following operations:

1. Take snapshots and upload

   The system takes a snapshot of the specified table or partition data file. A snapshot only generates a hard link to the current data file, which is less

time-consuming. After the snapshot, changes and imports to the table no longer affect the results of the backup. After the snapshot is completed, the snapshot files will be uploaded one by one. Snapshot uploads are done concurrently by each BE.

2. Prepare and upload metadata

   After the data file snapshot upload is complete, FE will first write the corresponding metadata to a local file, and then upload the local metadata file to the remote warehouse through the Broker, completing the final backup job.

NOTE

- If a table to be backed up is a dynamic partitioned table, the dynamic partitioning function is automatically disabled after backup. Before restoring data, run the following command to manually enable dynamic partitioning for the table:

  ALTER TABLE *tbl1* **SET ("dynamic_partition.enable"="true")**

- The data backup operation does not keep the **colocate_with** property of a table.

Prerequisite

- A cluster containing the Doris service has been created, and all services in the cluster are running properly.
- The node to be connected to the Doris database can communicate with the MRS cluster.
- The MySQL client has been installed. For details, see **Installing a MySQL Client**.
- Create a user with the Doris management permission.
  - Kerberos authentication is enabled for the cluster (the cluster is in security mode)

    On FusionInsight Manager, create a human-machine user, for example, **dorisuser**, create a role with Doris administrator permission, and bind the role to the user.

    Log in to FusionInsight Manager as the new user **dorisuser** and change the initial password.
  - Kerberos authentication is disabled for the cluster (the cluster is in normal mode)

    After connecting to Doris as user **admin**, create a role with administrator permissions, and bind the role to the user.

Backing Up Doris Data

Step 1 Log in to the node where MySQL is installed and connect the Doris database.

If Kerberos authentication is enabled for the cluster (the cluster is in security mode), run the following command to connect to the Doris database:

export LIBMYSQL_ENABLE_CLEARTEXT_PLUGIN=1

mysql -u*Database login username* **-p***Database login password* **-P***Connection port for FE queries* **-h***IP address of the Doris FE instance*

NOTE

- To obtain the query connection port of the Doris FE instance, you can log in to FusionInsight Manager, choose **Cluster** > **Services** > **Doris** > **Configurations**, and query the value of **query_port** of the Doris service.
- To obtain the IP address of the Doris FE instance, log in to FusionInsight Manager of the MRS cluster and choose **Cluster** > **Services** > **Doris** > **Instances** to view the IP address of any FE instance.
- You can also use the MySQL connection software or Doris web UI to connect the database.

Step 2 Run the following command to create a remote repository **example_repo** in HDFS:

Kerberos authentication is enabled for the cluster (the cluster is in security mode)

```
CREATE REPOSITORY `example_repo`
WITH BROKER `hdfs_broker`
ON LOCATION "hdfs://hadoop-name-node:25000/path/to/repo/"
PROPERTIES
(
"hadoop.security.authentication"="kerberos",
"kerberos_principal"="doris/hadoop.hadoop.com@HADOOP.COM",
"kerberos_keytab"="${BIGDATA_HOME}/FusionInsight_Doris_8.3.1/install/FusionInsight-Doris-2.0.3/doris-fe/bin/doris.keytab"
);
```

Kerberos authentication is disabled for the cluster (the cluster is in normal mode)

```
CREATE REPOSITORY `example_repo`
WITH BROKER `hdfs_broker`
ON LOCATION "hdfs://hadoop-name-node:25000/path/to/repo/"
PROPERTIES
(
"username" = "hdfs",
"password" = ""
);
```

Step 3 View the created repository.

```
SHOW REPOSITORIES;
```

Step 4 Back up data to **example_repo**. You can back up table data or partition data. The following are examples:

- Fully back up data in the **example_tbl** table from **example_db** to **example_repo**.

  ```
  BACKUP SNAPSHOT example_db.snapshot_label1
  ```

TO example_repo

ON (example_tbl)

PROPERTIES ("type" = "full");

- Fully back up the **example_tbl2** table and the **p1** and **p2** partitions of the **example_tbl** table in the **example_db** to **example_repo**.

  BACKUP SNAPSHOT example_db.snapshot_label2

  TO example_repo

  ON

  (

  example_tbl PARTITION (p1,p2),

  example_tbl2

  );

Step 5 Run the following command to check the execution status of the backup job:

show BACKUP;

Step 6 Check whether the backup is successful in the remote repository.

SHOW SNAPSHOT ON example_repo WHERE SNAPSHOT = "snapshot_label1";

```
+-----------------+---------------------+--------+
| Snapshot        | Timestamp           | Status |
+-----------------+---------------------+--------+
| snapshot_label1 | 2022-04-08-15-52-29 | OK     |
+-----------------+---------------------+--------+
1 row in set (0.15 sec)
```

----End

4.10.2 Restoring Doris Data

Doris data can be backed up in form of files to a remote storage system through Broker. Then, you can run the restoration command to restore data from the remote storage system to any Doris cluster. You can periodically back up and migrated data using snapshots.

NOTE

- Currently, only users with the **ADMIN** permission can perform backup and restoration operations.
- There can be only one restoration job that is being executed in a database.
- Doris data can be restored with smallest partition granularity. If a table contains a large amount of data, you can restore data by partition to reduce the retry cost upon failure.
- The backup and restoration operations are performed on the actual data files. When a table has too many shards, or a shard has too many small versions, it may take a long time to restore data even if the total amount of data is small.
- You can run the **SHOW BACKUP** or **SHOW RESTORE** command to view the job status. An error information may be displayed in the **TaskErrMsg** column. If the value in the **State** column is not **CANCELLED**, the job continues. Some tasks may be retried successfully. However, some tasks are in error, causing job failures.
- If a restoration job overwrites data (restoring data to an existing table or partition), the overwritten data in the cluster may not be restored since the COMMIT phase of the restoration job. If a restoration job fails or is canceled, the overwritten data may be damaged and cannot be accessed. In this case, you need to perform the restoration operation again and wait until the job is complete. You are not advised to restore data by overwriting data unless you confirm that the data is no longer used.

Data Restoration Principles

To restore Doris data, you need to specify an existing backup in a remote repository and then restore the backup data to the local cluster. After a restore request is submitted, the system performs the following operations:

1. Create the corresponding metadata locally.

   This step will first create and restore the corresponding table partition and other structures in the local cluster. After creation, the table is visible, but not accessible.

2. Create a local snapshot

   This step is to take a snapshot of the table created in the previous step. This is actually an empty snapshot (the table just created has no data), and its purpose is to generate the corresponding snapshot directory on the Backend for receiving the snapshot file downloaded from the remote warehouse.

3. Download a snapshot

   The snapshot files in the remote warehouse will be downloaded to the corresponding snapshot directory generated in the previous step. This step is done concurrently by each Backend.

4. Make a snapshot take effect

   After the snapshot download is complete, you need to map each snapshot to the metadata of the current local table. These snapshots are then reloaded to take effect, completing the final recovery job.

Prerequisite

- A cluster containing the Doris service has been created, and all services in the cluster are running properly.
- The node to be connected to the Doris database can communicate with the MRS cluster.

- The MySQL client has been installed. For details, see **Installing a MySQL Client**.
- Create a user with the Doris management permission.
  - Kerberos authentication is enabled for the cluster (the cluster is in security mode)

    On FusionInsight Manager, create a human-machine user, for example, **dorisuser**, create a role with Doris administrator permission, and bind the role to the user.

    Log in to FusionInsight Manager as the new user **dorisuser** and change the initial password.
  - Kerberos authentication is disabled for the cluster (the cluster is in normal mode)

    After connecting to Doris as user **admin**, create a role with administrator permissions, and bind the role to the user.
- You have backed up Doris table or partition data to be restored by referring to **Backing Up Doris Data**.

Restoring Doris Data

Step 1 Log in to the node where MySQL is installed and connect the Doris database.

If Kerberos authentication is enabled for the cluster (the cluster is in security mode), run the following command to connect to the Doris database:

export LIBMYSQL_ENABLE_CLEARTEXT_PLUGIN=1

mysql -u*Database login username* **-p***Database login password* **-P***Connection port for FE queries* **-h***IP address of the Doris FE instance*

NOTE

- To obtain the query connection port of the Doris FE instance, you can log in to FusionInsight Manager, choose **Cluster** > **Services** > **Doris** > **Configurations**, and query the value of **query_port** of the Doris service.
- To obtain the IP address of the Doris FE instance, log in to FusionInsight Manager of the MRS cluster and choose **Cluster** > **Services** > **Doris** > **Instances** to view the IP address of any FE instance.
- You can also use the MySQL connection software or Doris web UI to connect the database.

Step 2 Restore table or partition data from the remote warehouse where data has been backed up.

- Run the following command to restore the **example_tbl** table in **snapshot_label1** from **example_repo** to the **example_db2** database. Set the time version to 2018-05-04-16-45-08. One copy will be restored.

  RESTORE SNAPSHOT *example_db2*.**`snapshot_label1`**

  FROM `*example_repo*`

  ON (`*example_tbl*` **)**

  PROPERTIES

  (

  "backup_timestamp"="2023-08-16-20-13-55",

"replication_num" = "1"

);

You can run the **SHOW SNAPSHOT ON example_repo WHERE SNAPSHOT = "snapshot_label1";** command to obtain the value of **backup_timestamp**.

- Restore partitions **p1** and **p2** of the **example_tbl** table in the backup **snapshot_label2** from **example_repo**, restore the **example_tbl2** table to the **example_db1** database, rename the table **new_tbl**, and set the time version to 2018-05-04-17-11-01. By default, three copies will be restored.

  RESTORE SNAPSHOT *example_db1*.`*snapshot_2*`

  FROM `*example_repo*`

  ON

  (

  `*backup_tbl*` **PARTITION (**`*p1*`**,** `*p2*`**),**

  `*backup_tbl2*` **AS** `*new_tbl*`

)

  PROPERTIES

  (

  "backup_timestamp"="2023-08-16-20-13-55**"**

  );

  Note: You can run the **SHOW SNAPSHOT ON example_repo WHERE SNAPSHOT = "snapshot_label1";** command to obtain the value of **backup_timestamp**.

Step 3 Run the following command to check the execution status of the restoration job:

SHOW RESTORE\G;

----End

4.11 Hive Data Analysis

4.11.1 Multi-Catalog

Multi-Catalog is designed to make it easier to connect to external data catalogs to enhance Doris's data lake analysis and federated data query capabilities.

With the advent of Multi-Catalog, Doris now has a new three-tiered metadata hierarchy (catalog -> database -> table), which means users can connect to external data at the catalog level.

Basic Concepts

- Internal Catalog

  Existing databases and tables in Doris are all under the Internal catalog, which is the default catalog in Doris and cannot be modified or deleted.

- External Catalog

  Users can create an external catalog using the **CREATE CATALOG** command, and view the existing catalogs via the **SHOW CATALOGS** command.

- Switch Catalog

  After login, you will enter the Internal catalog by default. Then, you can view or switch to your target database via **SHOW DATABASES** and **USE DB** .

  You can run the **SWITCH** command to switch between catalog. For example:

  ```
  SWITCH internal;
  SWITCH hive_catalog;
  ```

  After switching catalog, you can view or switch to your target database in that catalog via **SHOW DATABASES** and **USE DB**. Doris automatically synchronizes databases and tables in catalog. You can view and access data in external catalogs the same way as doing that in internal catalogs.

  Doris only supports read-only access to data in external catalogs currently.

- Delete Catalog

  Databases and tables in external catalogs are for read only. External Catalogs are deletable via the **DROP CATALOG** command. (The Internal catalog cannot be deleted.) You can run the **DROP CATALOG** command to delete an external catalog.

  This operation only deletes the mapping information of the catalog in Doris, but does not modify or change the content of any external data catalog.

- Resource

  Resource is a set of configurations. You can run the **CREATE RESOURCE** command to create a resource. Then, you can use the resource when creating a catalog.

  A resource can be used by multiple catalogs to reuse the configuration of the resource.

4.11.2 Hive

By connecting to Hive Metastore, or a metadata service compatible with Hive Metatore, Doris can automatically obtain Hive database table information and perform data queries.

In addition to Hive, many other systems also use the Hive Metastore to store metadata. Through Hive Catalog, we can access Hive, and access systems, such as Iceberg and Hudi, that use Hive Metastore as metadata storage.

NOTE

- Managed Table is supported.
- Hive and Hudi metadata stored in Hive Metastore can be identified.
- If you want to access a catalog that is not created by the current user, you need to grant the user the permission to operate the OBS path where the catalog is.
- The Hive table format can only be Parquet, ORC, or TextFile.

Prerequisite

- A cluster containing the Doris service has been created, and all services in the cluster are running properly.
- The nodes to be connected to the Doris database can communicate with the MRS cluster.
- A user with Doris management permission has been created.

  - Kerberos authentication is enabled for the cluster (the cluster is in security mode)

    Log in to FusionInsight Manager, create a human-machine user, for example, **dorisuser**, create a role with Doris administrator permissions, and bind the role to the user.

    Log in to FusionInsight Manager as the new user **dorisuser** and change the initial password.
  - Kerberos authentication is disabled for the cluster (the cluster is in normal mode)

    After connecting to Doris as user **admin**, create a role with administrator permissions, and bind the role to the user.
- The MySQL client has been installed. For details, see **Installing a MySQL Client**.

Hive Table Operations

Step 1 Perform the following operations to read Hive data stored in OBS with Doris:

1. Log in to the MRS management console. Move the cursor to the username in the upper right corner and select **My Credentials** from the drop-down list.
2. Click **Access Keys**, click **Create Access Key**, and enter the verification code or password. Click **OK** to generate an access key, and download it.

   Obtain the values of obs.access_key and obs.secret_key required for creating a catalog from the .csv file. The mapping is as follows:

   - The value of obs.access_key is the value in the **Access Key Id** column of the .csv file.
   - The value of obs.secret_key is the value in the **Secret Access Key** column of the .csv file.

   NOTE

   - Keep the CSV file properly. You can only download the file right after the access key is created. If you cannot find the file, you can create an access key again.
   - Keep your access keys secure and change them periodically for security purposes.
3. You can obtain the value of **obs.region** from .
4. Log in to the OBS management console, click **Parallel File System**, click the name of the OBS parallel file system where the Hive table is stored, and view the value of **Endpoint** on the overview page. The value is the same as that of **obs.endpointT** set during catalog creation.

Step 2 Log in to the node where MySQL is installed and connect the Doris database.

If Kerberos authentication is enabled for the cluster (the cluster is in security mode), run the following command to connect to the Doris database:

export LIBMYSQL_ENABLE_CLEARTEXT_PLUGIN=1

mysql -u*Database login username* **-p***Database login password* **-P***Connection port for FE queries* **-h***IP address of the Doris FE instance*

NOTE

- To obtain the query connection port of the Doris FE instance, you can log in to FusionInsight Manager, choose **Cluster** > **Services** > **Doris** > **Configurations**, and query the value of **query_port** of the Doris service.
- To obtain the IP address of the Doris FE instance, log in to FusionInsight Manager of the MRS cluster and choose **Cluster** > **Services** > **Doris** > **Instances** to view the IP address of any FE instance.
- You can also use the MySQL connection software or Doris web UI to connect the database.

Step 3 Create a catalog.

- Hive table data is stored in HDFS. Run the following command to create a catalog:
  - Kerberos authentication is enabled for the cluster (the cluster is in security mode):

    CREATE CATALOG hive_catalog PROPERTIES (

    'type'='hms',

    'hive.metastore.uris' = 'thrift://*192.168.67.161:21088***',**

    'hive.metastore.sasl.enabled' = 'true',

    'hive.server2.thrift.sasl.qop' = 'auth-conf',

    'hive.server2.authentication' = 'KERBEROS',

    'dfs.nameservices'='hacluster',

    'dfs.ha.namenodes.hacluster'='*24,25***',**

    'dfs.namenode.rpc-address.hacluster.*24***='** *IP address of the active NameNode:RPC communication port***',**

    'dfs.namenode.rpc-address.hacluster.*25***='** *IP address of the active NameNode:RPC communication port***',**

    'dfs.client.failover.proxy.provider.hacluster'='org.apache.hadoop.hdfs.server.namenode.ha.ConfiguredFailoverProxyProvider',

    'hive.version' = '3.1.0',

    'yarn.resourcemanager.address' = '*192.168.67.78:26004***',**

    'yarn.resourcemanager.principal' = 'mapred/hadoop.hadoop.com@HADOOP.COM',

    'hive.metastore.kerberos.principal' = 'hive/hadoop.hadoop.com@HADOOP.COM',

    'hadoop.security.authentication' = 'kerberos',

    'hadoop.kerberos.keytab' = '${BIGDATA_HOME}/FusionInsight_Doris_8.3.1/install/FusionInsight-Doris-2.0.3/doris-be/bin/doris.keytab',

    'hadoop.kerberos.principal' = 'doris/hadoop.hadoop.com@HADOOP.COM',

    'java.security.krb5.conf' = '${BIGDATA_HOME}/FusionInsight_BASE_*/1_16_KerberosClient/etc/krb5.conf',

    'hadoop.rpc.protection' = 'privacy'

    );

- Kerberos authentication is disabled for the cluster (the cluster is in normal mode):

  CREATE CATALOG hive_catalog PROPERTIES (

  'type'='hms',

  'hive.metastore.uris' = 'thrift://*192.168.67.161:21088***',**

  'hive.version' = '3.1.0',

  'hadoop.username' = 'hive',

  'yarn.resourcemanager.address' = '*192.168.67.78:26004***',**

  'dfs.nameservices'='hacluster',

  'dfs.ha.namenodes.hacluster'='24,25',

  'dfs.namenode.rpc-address.hacluster.24'='192-168-67-172:25000',

  'dfs.namenode.rpc-address.hacluster.25'='192-168-67-78:25000',

  'dfs.client.failover.proxy.provider.hacluster'='org.apache.hadoop.hdfs.server.namenode.ha.ConfiguredFailoverProxyProvider'

  );

NOTE

- **hive.metastore.uris**: URL of Hive MetaStore. The format is **thrift://***<IP address of Hive MetaStore>*:*<Port number >*. Multiple values are supported and need to be separated by commas (,).
- **dfs.nameservices**: NameService name of the cluster. The value can be found in **hdfs-site.xml**, which is in the **${BIGDATA_HOME}/FusionInsight_HD_*/1_*_NameNode/etc** directory on the node where NameNode is deployed.
- **dfs.ha.namenodes.hacluster**: prefix of NameService node in a cluster, which contains two values. The value can be found in **hdfs-site.xml**, which is in the **${BIGDATA_HOME}/FusionInsight_HD_*/1_*_NameNode/etc** directory on the node where NameNode is deployed.
- **dfs.namenode.rpc-address.hacluster.***xx1*: RPC communication address of the active NameNode. You can search for the value of this configuration item in **hdfs-site.xml** in the **${BIGDATA_HOME}/FusionInsight_HD_*/1_*_NameNode/etc** directory on the node where NameNode is deployed. *xx* is the value of **dfs.ha.namenodes.hacluster**.
- **dfs.namenode.rpc-address.hacluster.***xx2*: RPC communication address of the standby NameNode. You can search for the value of this configuration item in **hdfs-site.xml** in the **${BIGDATA_HOME}/FusionInsight_HD_*/1_*_NameNode/etc** directory on the node where NameNode is deployed. *xx* is the value of **dfs.ha.namenodes.hacluster**.
- **dfs.client.failover.proxy.provider.hacluster**: Java class for the HDFS client to connect the active node in the cluster. The value is **org.apache.hadoop.hdfs.server.namenode.ha.ConfiguredFailoverProxyProvider**.
- **hive.version**: Hive version. To obtain the version, log in to FusionInsight Manager, choose **Cluster** > **Services** > **Hive**, and view the version on the **Dashboard** page.
- **yarn.resourcemanager.address**: IP address of the active ResourceManager instance. On FusionInsight Manager, choose **Cluster** > **Services** > **Yarn** > **Instances** to view the service IP address of the active ResourceManager instance.
- **hadoop.rpc.protection**: whether to encrypt the RPC stream of each Hadoop module. The default value is **privacy**. To obtain the value, log in to FusionInsight Manager, choose **Cluster** > **Services** > **HDFS** > **Configurations**, and search for **hadoop.rpc.protection**.
- Kerberos authentication is enabled for the cluster (the cluster is in security mode):
  - **hive.metastore.sasl.enabled**: whether to enable MetaStore management permission. The value is **true**.
  - **hive.server2.thrift.sasl.qop**: whether to encrypt the interaction between HiveServer2 and the client. The value is **auth-conf**.
  - **hive.server2.authentication**: security authentication for accessing HiveServer. The value is **KERBEROS**.
  - **yarn.resourcemanager.principal**: Principal for accessing the Yarn cluster. The value is **mapred/hadoop.hadoop.com@HADOOP.COM**.
  - **hive.metastore.kerberos.principal**: Principal for accessing the Hive cluster. The value is **hive/hadoop.hadoop.com@HADOOP.COM**.
  - **hadoop.security.authentication**: security authentication for accessing Hadoop. The value is **KERBEROS**.
  - **hadoop.kerberos.keytab**: keytab for accessing the Hadoop cluster. The value is the path of the **${BIGDATA_HOME}/FusionInsight_Doris_*/install/FusionInsight-Doris-*/doris-be/bin/doris.keytab** file.

    - **hadoop.kerberos.principal**: Principal for accessing the Hadoop cluster. The value is **doris/hadoop.hadoop.com@HADOOP.COM**.
    - **java.security.krb5.conf**: krb5 file. The value is the path of the **${BIGDATA_HOME}/FusionInsight_BASE_*/1_*_KerberosClient/etc/krb5.conf** file.
  - Kerberos authentication is disabled for the cluster (the cluster is in normal mode):

    hadoop.username: username for accessing the Hadoop cluster. The value is **hdfs**.

- Hive table data is stored in OBS. Run the following command to create a catalog. For details about related parameter values, see **Step 1**.

  CREATE CATALOG *hive_obs_catalog* **PROPERTIES (**

  'type'='hms',

  'hive.version' = '3.1.0',

  'hive.metastore.uris' = 'thrift://*192.168.67.161:21088***',**

  'obs.access_key' = '*AK***',**

  'obs.secret_key' = '*SK***',**

  'obs.endpoint' = '*Endpoint address of the OBS parallel file system* **',**

  'obs.region' = '*sa-fb-1***'**

  );

Step 4 Query the Hive table:

- Query catalogs:

  show catalogs;

- Query the databases in the catalog:

  show databases from *hive_catalog*;

- Switch the catalog and access the database:

  switch *hive_catalog*;

  use *default*;

- Query all tables in a database in the catalog:

  show tables from **`***hive_catalog***`.`***default***`;**

  Query a specified table:

  select * from **`***hive_catalog***`.`***default***`.`***test_table***`;**

  View the schema of the table:

  DESC *test_table*;

Step 5 After creating or operating a Hive table, you need to refresh the table in Doris.

refresh catalog *hive_catalog*;

Step 6 Perform an associated query with tables in other data catalog:

SELECT h.h_shipdate FROM *hive_catalog.default.htable* **h WHERE h.h_partkey IN (SELECT p_partkey FROM internal.db1.part) LIMIT 10;**

NOTE

- Identify a table with **catalog.database.table** full restriction, for example, **internal.db1.part**.
- **catalog** and **database** can be omitted. If omitted, the catalog and database switched to by **SWITCH** and **USE** are used.
- You can run the **INSERT INTO** command to insert table data in the Hive catalog to an internal table in the internal catalog.

----End

4.12 Ecosystem

4.12.1 Spark Doris Connector

Spark Doris Connector allows Spark to read data stored in Doris and write data to Doris.

- Data can be read from Doris.
- Spark DataFrame can write data to Doris with batch and stream processing.
- You can map a Doris table to a DataFrame or RDD. DataFrame is recommended.
- Data can be filtered at the Doris side to reduce the amount of data to be transferred.

Prerequisite

- A cluster containing the Doris service has been created, and all services in the cluster are running properly.
- The nodes to be connected to the Doris database can communicate with the MRS cluster.
- A user with Doris management permission has been created.
  - Kerberos authentication is enabled for the cluster (the cluster is in security mode)

    Log in to FusionInsight Manager, create a human-machine user, for example, **dorisuser**, create a role with Doris administrator permissions, and bind the role to the user.

    Log in to FusionInsight Manager as the new user **dorisuser** and change the initial password.
  - Kerberos authentication is disabled for the cluster (the cluster is in normal mode)

    After connecting to Doris as user **admin**, create a role with administrator permissions, and bind the role to the user.
- The MySQL client has been installed. For details, see **Installing a MySQL Client**.
- The Spark client has been installed.

Procedure

Create a table in Doris and insert data into the table.

Step 1 Log in to the node where MySQL is installed and connect the Doris database.

If Kerberos authentication is enabled for the cluster (the cluster is in security mode), run the following command to connect to the Doris database:

export LIBMYSQL_ENABLE_CLEARTEXT_PLUGIN=1

mysql -u*Database login username* **-p***Database login password* **-P***Connection port for FE queries* **-h***IP address of the Doris FE instance*

NOTE

- To obtain the query connection port of the Doris FE instance, you can log in to FusionInsight Manager, choose **Cluster** > **Services** > **Doris** > **Configurations**, and query the value of **query_port** of the Doris service.
- To obtain the IP address of the Doris FE instance, log in to FusionInsight Manager of the MRS cluster and choose **Cluster** > **Services** > **Doris** > **Instances** to view the IP address of any FE instance.
- You can also use the MySQL connection software or Doris web UI to connect the database.

Step 2 Run the following statements to create a database and switch the database:

create database if not exists *sparkconnector***;**

use *sparkconnector***;**

Step 3 Run the following statement to create a table:

CREATE TABLE *spark_connector_test_decimal* **(**

c1 int NOT NULL,

c2 VARCHAR(25) NOT NULL,

c3 VARCHAR(152),

c4 boolean,

c5 tinyint,

c6 smallint,

c7 bigint,

c8 float,

c9 double,

c10 date,

c11 datetime,

c12 char,

c13 largeint,

c14 varchar,

c15 decimal(15, 5)

)

DUPLICATE KEY(`c1`)

COMMENT "OLAP"

DISTRIBUTED BY HASH(`c1`) BUCKETS 1;

Step 4 Run the following statements to insert data to the table:

insert into *spark_connector_test_decimal* **values(10000,'aaa','abc',true, 100, 3000, 100000, 1234.567, 12345.678, '2022-12-01','2022-12-01 12:00:00', 'a', 200000, 'g', 1000.12345);**

insert into *spark_connector_test_decimal* **values(10001,'aaa','abc',false, 100, 3000, 100000, 1234.567, 12345.678, '2022-12-01','2022-12-01 12:00:00', 'a', 200000, 'g', 1000.12345);**

insert into *spark_connector_test_decimal* **values(10002,'aaa','abc',True, 100, 3000, 100000, 1234.567, 12345.678, '2022-12-01','2022-12-01 12:00:00', 'a', 200000, 'g', 1000.12345);**

insert into *spark_connector_test_decimal* **values(10003,'aaa','abc',False, 100, 3000, 100000, 1234.567, 12345.678, '2022-12-01','2022-12-01 12:00:00', 'a', 200000, 'g', 1000.12345);**

Perform the following operations on the **Spark side**:

Step 5 Run the following commands to log in to the spark-sql client:

cd *Spark client installation directory*

source bigdata_env

kinit*Component service user* (skip this step if Kerberos authentication is disabled for the cluster (the cluster is in normal mode))

spark-sql --master yarn

Step 6 Run the following statement to create a temporary view:

CREATE TEMPORARY VIEW *spark_doris_decimal*

USING doris

OPTIONS(

"table.identifier"="sparkconnector.spark_connector_test_decimal",

"fenodes"="*IP address of FE instance***:***29991***",**

"user"="*dorisuser***",**

"password"="*User password***",**

'doris.enable.https' = 'true',

'doris.ignore.https.ca' = 'true'

);

Run the following statement to query the data in the Doris table:

select * from *spark_doris_decimal*;

Run the following statement to insert data into the Doris table:

insert into *spark_doris_decimal* **values(10005,'aaa','abc',False, 100, 3000, 100000, 1234.567, 12345.678, '2022-12-01','2022-12-01 12:00:00', 'a', 200000, 'g', 1000.12345);**

NOTE

- After switching to HTTP, delete the following configuration parameters from the **WITH** clause for creating a table:
  - **'doris.enable.https' = 'true'**
  - **'doris.ignore.https.ca' = 'true'**
- *29991* is the HTTPS port of the FE service. After the port is switched to HTTP, change the port number to **29980**. You can log in to FusionInsight Manager, choose **Cluster** > **Services** > **Doris** > **Configurations**, and search for **http**.

----End

4.12.2 Flink Doris Connector

Flink Doris Connector allows you to perform operations (read, insert, modify, and delete) on data stored in Doris through Flink.

NOTE

Only tables in the Unique Key model can be modified or deleted.

Prerequisite

- A cluster containing the Doris service has been created, and all services in the cluster are running properly.
- The nodes to be connected to the Doris database can communicate with the MRS cluster.
- A user with Doris management permission has been created.
  - Kerberos authentication is enabled for the cluster (the cluster is in security mode)

    Log in to FusionInsight Manager, create a human-machine user, for example, **dorisuser**, create a role with Doris administrator permissions, and bind the role to the user.

    Log in to FusionInsight Manager as the new user **dorisuser** and change the initial password.
  - Kerberos authentication is disabled for the cluster (the cluster is in normal mode)

    After connecting to Doris as user **admin**, create a role with administrator permissions, and bind the role to the user.
- The MySQL client has been installed. For details, see **Installing a MySQL Client**.
- The Flink client has been installed.

Procedure

Perform the following operations on the Doris side:

Step 1 Log in to the node where MySQL is installed and connect the Doris database.

If Kerberos authentication is enabled for the cluster (the cluster is in security mode), run the following command to connect to the Doris database:

export LIBMYSQL_ENABLE_CLEARTEXT_PLUGIN=1

mysql -u*Database login username* **-p***Database login password* **-P***Connection port for FE queries* **-h***IP address of the Doris FE instance*

NOTE

- To obtain the query connection port of the Doris FE instance, you can log in to FusionInsight Manager, choose **Cluster** > **Services** > **Doris** > **Configurations**, and query the value of **query_port** of the Doris service.
- To obtain the IP address of the Doris FE instance, log in to FusionInsight Manager of the MRS cluster and choose **Cluster** > **Services** > **Doris** > **Instances** to view the IP address of any FE instance.
- You can also use the MySQL connection software or Doris web UI to connect the database.

Step 2 Run the following statements to create a database and switch the database:

create database if not exists *testdb***;**

use *testdb***;**

Step 3 Run the following statements to create the **z_test** table and insert data into the table:

create table *z_test***(id int, name string) distributed by hash(id) buckets 10;**

insert into *z_test* **values(123, 'aaa'), (234, 'bbb'), (345, 'ccc');**

Step 4 Run the following statement to create the **z_test_sink_3** table:

create *table z_test_sink_3***(id int, name string) distributed by hash(id) buckets 10;**

Perform the following operations on the Flink side:

Step 5 Log in to the node where the Flink client is installed as the client installation user and run the following commands:

cd *Client installation directory*

source bigdata_env

kinit *Component service user* (If Kerberos authentication is disabled for the cluster (the cluster is in normal mode), skip this step.)

Step 6 Run the following commands to log in to the Flink SQL client:

cd Flink/flink/bin/

sql-client.sh

Step 7 Create a Flink stream or batch SQL job on the Flink client. The following statement is an example:

CREATE TABLE *flink_doris_source* **(id INT, name STRING) WITH (**

'connector' = 'doris',

'fenodes' ='*IP address of the FE instance***:***29991***',**

'table.identifier' = 'testdb.z_test',

'username' = '*user***',**

'password' = '*password***',**

'doris.enable.https' = 'true',

'doris.ignore.https.ca' = 'true'

);

CREATE TABLE *flink_doris_sink* **(id INT, name STRING) WITH (**

'connector' = 'doris',

'fenodes' ='*IP address of the FE instance***:***29991***',**

'table.identifier' = 'testdb.z_test_sink_3',

'username' = '*user***',**

'password' = '*password***',**

'sink.label-prefix' = 'doris_label_6',

'doris.enable.https' = 'true',

'doris.ignore.https.ca' = 'true'

);

Run the following statement to insert data:

INSERT INTO

flink_doris_sink

select

id,

name

from

*flink_doris_source***;**

NOTE

- After HTTPS is enabled, add the following configuration parameters to the **with** clause for creating a table:
  - **'doris.enable.https' = 'true'**
  - **'doris.ignore.https.ca' = 'true'**
- The fields in the source and sink tables must be the same as those in the Doris table.
- *29991* is the HTTPS port of the FE service. After the port is switched to HTTP, change the port number to **29980**. You can log in to FusionInsight Manager, choose **Cluster** > **Services** > **Doris** > **Configurations**, and search for **http**.
- When you create a Flink job, set **username** to the Doris user and **password** to the password of the Doris user.

----End

4.13 Doris FAQs

4.13.1 What Should I Do If "Failed to find enough host with storage medium and tag" Occasionally Occurs During Table Creation Due to the Configuration of the SSD and HDD Data Directories?

Symptom

Error message "Failed to find enough host with storage medium and tag" was occasionally displayed during table creation.

Cause Analysis

Doris allows you to configure multiple storage paths for a BE node and specify the storage medium of the paths, such as SSDs or HDDs. Generally, only one storage path needs to be configured for each disk.

The **default_storage_medium** parameter of FE nodes is HDD by default. If only the SSD is specified in the **be.conf** file, an error is reported because no HDD medium is available during table creation. Doris does not automatically detect the actual storage medium of disks where the storage path is located. You need to explicitly indicate the storage medium in the path configuration. **.HDD** and **.SSD** are used only to identify the speed of the storage paths. They are not the actual storage medium types. If the storage medium of the BE node has no difference, you do not need to enter the suffix.

Procedure

- Change the value of **default_storage_medium** of the FE node to the correct storage medium and restart the FE node for the modification to take effect.
- Delete the explicit SSD configuration from the **be.conf** file.
- Add the properties parameter **properties {"storage_medium" = "ssd"}** when creating a table.

4.13.2 What Should I Do If a Query Is Performed on the BE Node Where Some Copies Are Lost or Damaged and an Error Is Reported?

Symptom

If multiple copies were lost from the disk, for example, **mv** was renamed, the kernel could not detect the loss of the copies. If the query request runs on the BE node where the copies are lost, the following error is reported:

Procedure

Step 1 Log in to the node where MySQL is installed and connect to the Doris database.

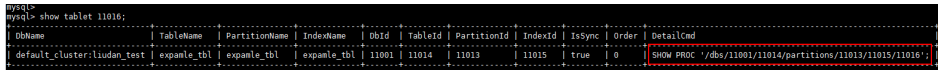
Step 2 Call **check_tablet_segment_lost** of the BE node to request automatic recovery of lost copies.

curl -X POST http://*192.168.67.78:29986***/api/check_tablet_segment_lost?repair=true** (

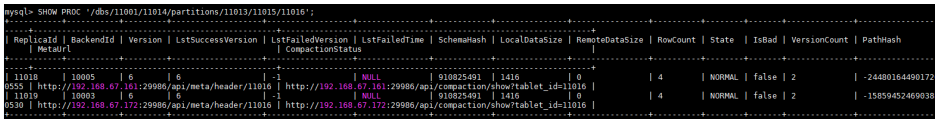
In the preceding command, *192.168.67.78* indicates the IP address of the abnormal BE node, and *29986* indicates the service port of the HTTP server of the BE node. You can search for **webserver_port** on the Doris configuration page of Manger to view the port.

Step 3 Run the following command to obtain DetailCmd:

show tablet *tabletId*



Step 4 Run DetailCmd. If the copies of the abnormal node have been removed, run the query again.



----End

4.13.3 What Should I Do If RPC Timeout Error Is Reported When Stream Load Is Used?

Symptom

During data import, RPC startup timed out when the tablet writer was opened by a BE node. The following error was reported:

```
failed to open tablet writer, error=RPC call is timeout, error_text=[E1008] Reached timeout=xxx ms
```

Cause Analysis

When data is imported, a BE node opens the tablet writer, which may involve the write operation of multiple memory blocks. As a result, the RPC times out. You can adjust the RPC timeout interval to avoid the timeout error.

Procedure

Step 1 Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Doris** > **Configurations** > **All Configurations**.

Step 2 In the navigation pane on the left, choose **BE(Role)** > **Customization**. Add the custom parameter **tablet_writer_open_rpc_timeout_sec** to **be.conf.customized.configs**. The parameter value is the RPC timeout interval. The default value is 60. You can increase the value, for example, set this parameter to **300**.

Step 3 Click **Instance**, select all BE instances, and choose **More** > **Restart Instance** to restart the BE instances.

----End

4.13.4 How Do I Restore the FE Service from a Fault?

Symptom

The FE service failed to start bdbje, data could not be synchronized between FE nodes, metadata could not be written, or no master node was available. To restore the FE service, start a new master node based on the metadata in **meta_dir**, and then add FE nodes one by one.

Procedure

Step 1 Stop all FE processes and stop all service access to prevent unexpected problems caused by external access during metadata restoration.

Step 2 Search for the metadata on all FE instance nodes and locate the latest FE node as the master node to be restored.

1. Log in to the FE background node and check the value of **meta_dir** in the **${BIGDATA_HOME}/FusionInsight_Doris_x.x.x/x_x_FE/etc/fe.conf** file. The value is the metadata storage directory.
2. Search for the metadata storage directories of all FE nodes and check the **image/image.***xxxx* files in the directories. A larger value of **image.***xxxx* indicates a newer metadata. Locate the latest FE node and use it as the first FE to be restored, that is, the master FE.
3. Back up the metadata storage directories of all FEs.

   For example, if the metadata storage directory is **/srv/BigData/doris_fe/doris-meta**, run the following command:

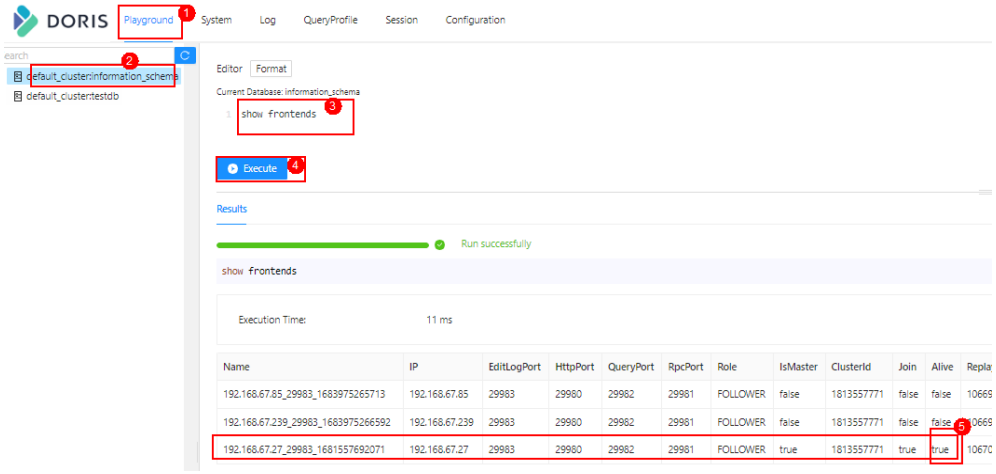
   cp -r /srv/BigData/doris_fe/doris-meta /srv/BigData/doris_fe/doris-meta.bak

Step 3 Go to **Step 2** and locate the node where the FE node with the latest metadata is deployed (that is, the master node) and add **metadata_failure_recovery=true** to **${BIGDATA_HOME}/FusionInsight_Doris_x.x.x/x_x_FE/etc/fe.conf**. If the **${BIGDATA_HOME}/FusionInsight_Doris_x.x.x/x_x_FE_UPDATE** directory exists, add the configuration to **fe.conf** in **x_x_FE_UPDATE**.

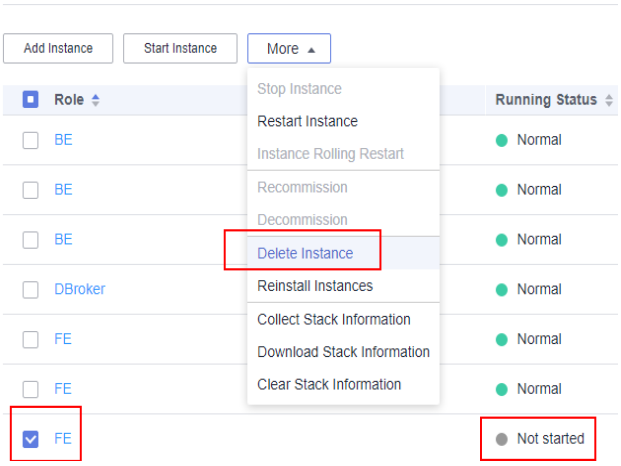
Step 4 Log in to FusionInsight Manager, choose **Cluster** > **Services** > **Instances**, select the FE node whose configuration is modified in **Step 3**, and choose **More** > **Restart Instance** to restart the FE instance. Other instances are still stopped.

Step 5 Check the status of the FE instance after it is started. After the FE instance is started, enter **http://***192.168.67.27:29980* in the address box of the browser to connect to the FE instance.

Log in to the FE web UI, click **Playground**, select **default_cluster:information_schema**, enter the **show frontends** command in the command box on the right, and click **Execute**. If the value in the **Alive** column of the current FE instance in the **Results** list is **true**, the FE is restored.

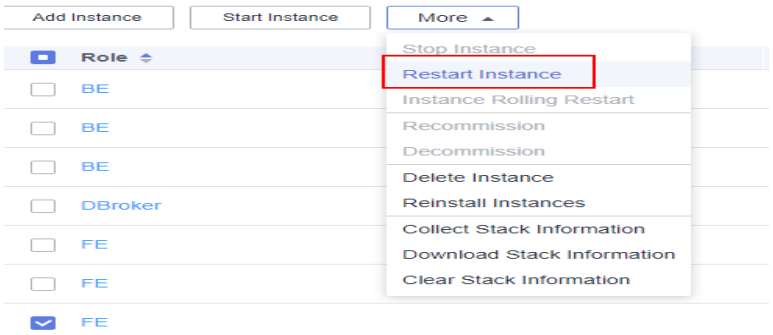


Step 6 On FusionInsight Manager, choose **Cluster** > **Services** > **Instances**, select the FE instance that is not a Master node and is not started, and choose **More** > **Delete Instance**.



Step 7 After the FE instance is deleted, click **Add Instance** to add the FE instance deleted in **Step 6**.

Step 8 Select the instance whose configuration has expired, choose **More** > **Restart Instance** to restart the FE instance whose configuration has expired, and delete the **metadata_failure_recovery** parameter added to the **fe.conf** file on the node where the FE instance is deployed.

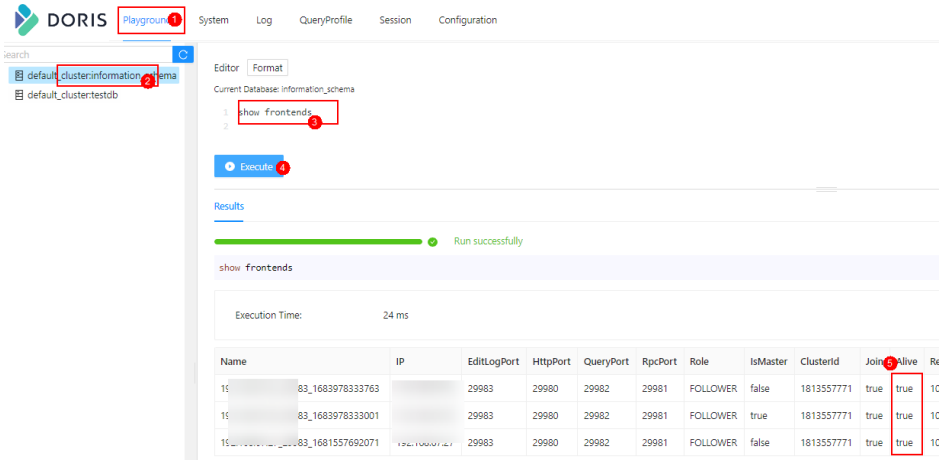


Step 9 Check whether the cluster is running properly. On the FE web UI, run the following command to check whether the FE, BE, and DBroker processes are healthy and in the same cluster. If the value of **Alive** for all instances in the **Results** list is **true**, the processes are healthy.

For example, the following commands are executed in **default_cluster:information_schema** of **Playground** on the Doris web UI:

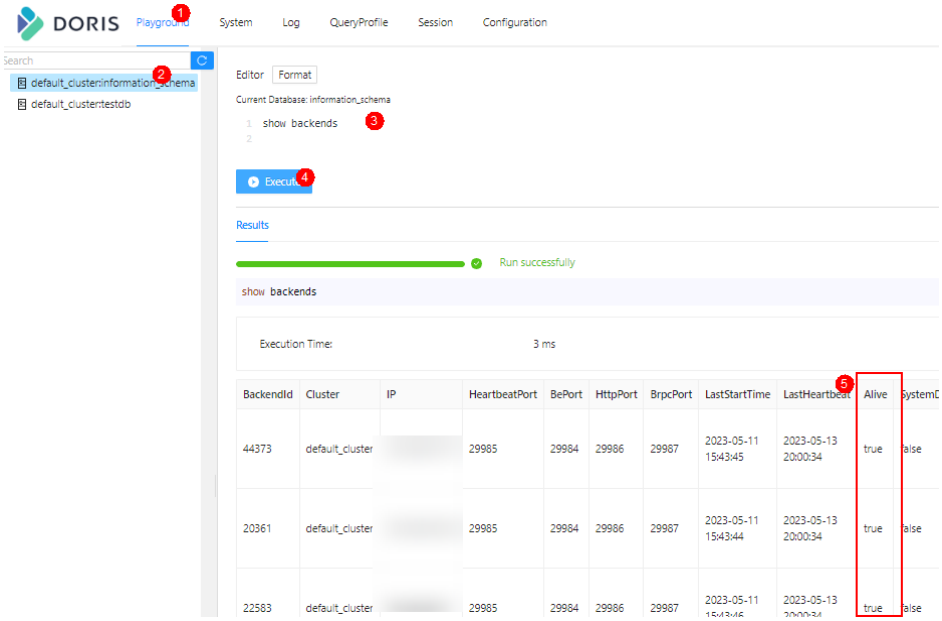
- Run the following command to check whether all FE processes are healthy:

  show frontends;



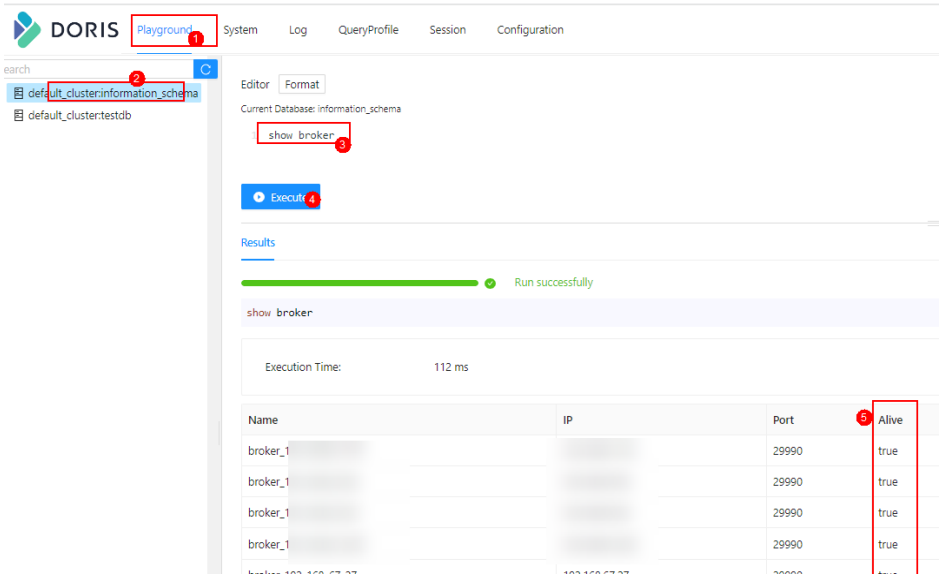
- Run the following command to check whether all BE processes are healthy:

  show backends;



- Run the following command to check whether all DBroker processes are healthy:

  show broker;



----End

4.13.5 What Do I Do If the Error Message "plugin not enabled" Is Displayed When the MySQL Client Is Used to Connect to the Doris Database?

Symptom

The following error message is displayed when the MySQL client is used to connect to the Doris database:

```
ERROR 2059 (HY000): Authentication plugin 'mysql_clear_password' cannot be loaded: plugin not enabled
```

Cause Analysis

The mysql_clear_password plug-in is disabled.

Procedure

- When you use the MySQL client to connect to the Doris database, run the following command with **--enable-cleartext-plugin** added:

  mysql --enable-cleartext-plugin -u*Database login user* **-p***Database login user password* **-P***Database connection port* **-h***Doris FE instance IP address*

- Run the following command on the node where the MySQL client is installed to enable the mysql_clear_password plug-in, and then reconnect to Doris:

  export LIBMYSQL_ENABLE_CLEARTEXT_PLUGIN=1

4.13.6 How Do I Handle the FE Startup Failure?

Symptom

The FE instance failed to be started, and the **/var/log/Bigdata/doris/fe/fe.log** file kept showing the following error message:

```
wait catalog to be ready. FE type UNKNOWN
```

Cause Analysis

- The FE installation node has multiple network adapter IP addresses. The **priority_network** parameter is incorrectly set. As a result, an incorrect IP address is matched during FE startup.
- Most follower FE nodes in the cluster are not started. For example, there are three follower FE nodes and only one follower FE node is started.

Procedure

Step 1 Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Doris**, and click **Configurations**.

Step 2 Search for the **priority_network** parameter and set it correctly for the FE service. You can view the IP address of the network adapter bound to the FE node by checking the **CURRENT_INSTANCE_IP** variable in *FE installation directory*/**FusionInsight_Doris_*/1_*_FE/etc/ENV_VARS**.

The **priority_network** parameter is used to help the system select the correct IP address of the network adapter as the IP address of the FE or BE. You are advised to set this parameter explicitly in any case to prevent incorrect IP address selection after network adapters are added. The value of **priority_network** is in CIDR format and is used to ensure that all nodes can use the same configuration value. The parameter value consists of two parts. The first part is the IP address in dotted decimal notation, and the second part is the prefix length.

For example, 10.168.1.0/8 matches all 10.xx.xx.xx IP addresses, and 10.168.1.0/16 matches all 10.168.xx.xx IP addresses. If there are two nodes: 10.168.10.1 and 10.168.10.2, **10.168.10.0/24** can be the value of **priority_network**.

Step 3 Click **Instance**, select the follower FE to be started, and click **Start Instance**. For example, if there are three followers and only one follower is started, you need to

start at least one FE so that a master node can be elected from the FE election group to provide services.

Step 4 If the FE still fails to be started, contact O&M engineers to rectify the fault.

----End

4.13.7 How Do I Handle the Startup Failure Due to Incorrect IP Address Matching for the BE Instance?

Symptom

The BE instance failed to be started and the following error message was displayed:

```
backend ip saved in master does not equal to backend local ipx.x.x.x vs. x.x.x.x
```

Cause Analysis

Search for **local host ip** in the **be.INFO** file and check whether the IP address is the IP address of the BE in the **show backends** command output. If it is not, there are multiple network adapters. In this case, set **priority_networks** to specify the network IP address range.

```
CGroup Info: Process CGroup Info: memory.limit_in_bytes=9223372036854771712, cpu cfs limits: unlimited
I1207 11:13:22.699915 40263 backend_options.cpp:76] local host ip=192.168.20.232
I1207 11:13:22.702514 40263 exec_env_init.cpp:105] scan thread pool use PriorityWorkStealingThreadPool
I1207 11:13:22.722644 40648 fragment_mgr.cpp:847] FragmentMgr cancel worker start working.
```

Procedure

Step 1 Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Doris**, and click **Configurations**.

Step 2 Search for the **priority_network** parameter and set it correctly. To view the IP address of the NIC bound to the BE node, connect the MySQL client to Doris and run **show backends;**.

The **priority_network** parameter is used to help the system select the correct IP address of the network adapter as the IP address of the FE or BE. You are advised to set this parameter explicitly in any case to prevent incorrect IP address selection after network adapters are added. The value of **priority_network** is in CIDR format and is used to ensure that all nodes can use the same configuration value. The parameter value consists of two parts. The first part is the IP address in dotted decimal notation, and the second part is the prefix length.

For example, 10.168.1.0/8 matches all 10.xx.xx.xx IP addresses, and 10.168.1.0/16 matches all 10.168.xx.xx IP addresses. If there are two nodes: 10.168.10.1 and 10.168.10.2, **10.168.10.0/24** can be the value of **priority_network**.

----End

4.13.8 What Should I Do If Error Message "Read timed out" Is Displayed When the MySQL Client Connects to the Doris?

Symptom

An error was reported when the MySQL client is connected to Doris.

```
java.net.SocketTimeoutException: Read timed out
```

Cause Analysis

The Doris server responds slowly.

Procedure

When you use the MySQL client to connect to the Doris database, run the following command with **connect_timeout** added (default value: 10 seconds):

mysql -u*Database login user* **-p***Database login user password* **-P***Database connection port* **-h***IP address of Doris FE instance* **--connect_timeout=***120*

4.13.9 What Should I Do If an Error Is Reported When the BE Runs a Data Import or Query Task?

Symptom

When data is imported or queried, the following error message is displayed:

```
Not connected to 192.168.100.1:8060 yet, server_id=384
```

Cause Analysis

- The BE node where the task is running breaks down.
- RPC congestion or other errors occur.

Procedure

- If the BE node where the task is running breaks down, check the breakdown cause and rectify the fault.
- If a large amount of unsent data on the RPC source exceeds the threshold, set the following parameters:
  - **brpc_socket_max_unwritten_bytes**: specifies the threshold of the amount of data that is not sent. The default value is 1 GB. If the amount of data that is not sent exceeds the threshold value, the OVERCROWDED error is reported. You need to increase the value.
  - **tablet_writer_ignore_eovercrowded**: specifies whether to ignore OVERCROWDED error that occurs during data import. The default value is **false**. This parameter is used to prevent import failures and improve stability.
  - **max_body_size**: specifies the maximum packet size allowed. The default value is 3 GB. If the query contains data of the string or bitmap type, you can modify this parameter to avoid this problem.

4.13.10 What Should I Do If a Timeout Error Is Reported When Broker Load Imports Data?

Symptom

The following error message was displayed when Broker Load was used to import data:

```
org.apache.thrift.transport.TTransportException: java.net.SocketException: Broken pipe
```

Cause Analysis

When data is imported from an external storage device (for example, HDFS), file directory query times out because there are too many files in the directory.

Procedure

Log in to FusionInsight Manager, choose **Cluster** > **Services** > **Doris** and click **Configurations** > **All Configurations**. Select **FE (Role)** > **Customization**, and add the custom parameter **broker_timeout_ms**. The default value is 10 seconds. You need to increase the value of this parameter, for example, to **1000**, and restart the FE instance whose configuration has expired.

4.13.11 What Should I Do If the Data Volume of a Broker Load Import Task Exceeds the Threshold?

Symptom

The following error message was displayed when Broker Load was used to import data:

```
Scan bytes per broker scanner exceed limit:xxx
```

Cause Analysis

The maximum data volume of a single import task processed by the BE process is 3 GB. You can adjust the import parameters of Broker Load for large files.

Procedure

Modify the maximum scan amount and maximum concurrent number of tasks of a single BE node according to the current number of BE instances and the size of the files to be imported. Perform the following steps to modify the parameters:

1. Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Doris**. On the dashboard page, view the IP address of leader host to determine the node where the active FE node is deployed.
2. Click **Instance**, and click the BE instance whose IP address was viewed in **1**. Click **Configurations** > **All Configurations**, select **BE (Role)** > **Customization**, and add the following parameters:
   - **max_broker_concurrency**: number of BE nodes

- **max_bytes_per_broker_scanner**: size of the file to be imported/number of BE nodes

NOTE

The configuration items take effect only when they are modified in the **fe.conf** file of the leader FE.

3. Click **Save** to save the configuration and restart the instance whose configuration has expired.

4.13.12 What Should I Do If an Error Message Is Displayed When Broker Load Is Used to Import Data?

Symptom

When Broker Load is used to import data, the error message "failed to send batch" or "TabletWriter add batch with unknown id" is displayed.

Cause Analysis

The task execution times out due to a large number of concurrent requests or a large amount of data.

Procedure

Step 1 Log in to the MySQL client and run the following command to increase the value of **query_timeout**. The default value is 300 seconds.

SET GLOBAL query_timeout = *xxx*;

Step 2 Log in to FusionInsight Manager, choose **Cluster** > **Services** > **Doris** and click **Configurations** > **All Configurations**. Select **BE (Role)** > **Customization**, and add the custom parameter **streaming_load_rpc_max_alive_time_sec**. The default value is 1200 seconds. You need to increase the value of this parameter and restart the BE instance whose configuration has expired.

----End

4.13.13 How Do I Rectify the Serialization Exception Reported When Data Is Imported to Spark Load?

Symptom

When Spark Load is used to import data, error message "java.io.NotSerializableException: org.apache.spark.defense.DefenseRules" is displayed.

Cause Analysis

The **org.apache.spark.defense.DefenseRules** class of the Spark component does not support serialization.

Procedure

Step 1 Delete the **spark-sql-defense_2.12-3.3.1-h0.cbu.mrs.330.r9.jar** package from the *Client installation directory*/**Spark/spark/jars** directory.

Step 2 Run the following command to compress the packages in the **Spark jars** directory again:

cd *Client installation directory*/**Spark/spark/jars**

zip -qr spark-archive.zip

Step 3 Execute the Spark Load task on the Doris client again.

----End

4.13.14 What Should I Do If An App ID Cannot Be Obtained When Spark Load Imports Data?

Symptom

When Spark Load is used to import data, error message "Waiting too much time to get appId from handle" is displayed.

Cause Analysis

The Doris reads logs and parses each line of log information to obtain **appId** and **state**. If the INFO log information is not printed, the obtained **appId** and **state** values are null. If the task times out, the task is canceled. As a result, data fails to be imported.

Procedure

Step 1 Change the values of the following parameters in the **log4j2.properties** and **log4j.properties** files in the *Client installation directory*/**Spark/spark/conf** directory to **INFO** and save the changes:

- **log4j2.properties** file:
  - rootLogger.level
  - logger.repl.level
  - logger.thriftserver.level
  - logger.jetty1.level
  - logger.jetty2.level
  - logger.parquet1.level
  - logger.parquet2.level
  - logger.RetryingHMSHandler.level
  - logger.FunctionRegistry.level
  - logger.hiveconf.level
- **log4j.properties** file:
  - log4j.rootCategory

- log4j.logger.org.apache.spark.repl.Main
- log4j.logger.org.spark_project.jetty
- log4j.logger.org.spark_project.jetty.util.component.AbstractLifeCycle
- log4j.logger.org.apache.parquet
- log4j.logger.parquet
- log4j.logger.org.apache.hadoop.hive.metastore.RetryingHMSHandler
- log4j.logger.org.apache.hadoop.hive.ql.exec.FunctionRegistry
- log4j.logger.org.apache.hadoop.hive.ql.metadata.multiversion.MultiVersionFactory
- log4j.logger.org.apache.hadoop.hive.conf.HiveConf
- log4j.logger.org.apache.ranger.authorization.hadoop.config
- log4j.logger.org.apache.ranger.audit.provider.AuditProviderFactory
- log4j.logger.com.xxx.bigdata.om.agent.alarmcommon.SuppressionAlarmUtils

Step 2 Execute the Spark Load task on the Doris client again.

----End

4.14 Doris Logs

Description

Log path: Doris logs are stored in **/var/log/Bigdata/doris/***role name* by default.

- FE: **/var/log/Bigdata/doris/fe** (run logs) and **/var/log/Bigdata/audit/doris/fe** (audit logs)
- BE: **/var/log/Bigdata/doris/be** (run logs)
- DBroker: **/var/log/Bigdata/doris/dbroker** (run logs)

Log archive rule: The automatic compression and archive function is enabled for Doris logs. By default, when a log file exceeds a specified size (which is configurable), the log file is automatically compressed. The naming rule of the compressed log file is as follows: *<Original log file name>-<yyyy-mm-dd_hh-mm-ss>.[ID]***.log.zip**. A maximum of 20 latest compressed files are retained by default. The number of compressed files and compression threshold can be changed.

Table 4-8 Doris logs

Log Type	Log File	Description
Run log	/fe/fe.out	Standard/Error logs (stdout and stderr)
	/fe/fe.log	Main log, including all contents except **fe.out**
	/fe/fe.warn.log	Subset of **fe.log**. Only WARN and ERROR logs are recorded.

Log Type	Log File	Description
	/fe/fe-omm-*<Date>*-*<PID>*-gc.log.*<No.>*	GC logs of the FE process
	/fe/preStart.log	Work logs before the FE starts
	/fe/check_fe_status.log.log	Log file that records whether the FE service is started successfully
	/fe/cleanup.log	Cleanup log for FE uninstallation
	/fe/start_fe.log	FE process startup log
	/fe/stop_fe.log	FE process stop log
	/fe/postinstallDetail.log	Work logs generated after the FE is installed and before it starts
	/be/be.INFO	Run log of the BE process
	be.WARNING	Subset of **be.log**. Only WARN and FATAL logs are recorded.
	/be/be-omm-*<Date>*-*<PID>*-gc.log.*<No.>*	GC logs of the BE process
	/be/postinstallDetail.log	Work logs generated after BE is installed and before it starts
	/be/preStart.log	Work logs before BE starts
	/be/cleanup.log	Cleanup log for BE uninstallation
	/be/start_be.log	BE process startup log
	/be/stop_be.log	BE process stop log
	/be/check_be_status.log	Log file that records whether the BE service is started successfully
	/be/be.out	Standard/Error output logs of the BE process (stdout and stderr)
	/dbroker/start_broker.log	Log file that records the normal start and stop of the DBroker process
	/dbroker/stop_broker.log	log file that records start and stop exceptions of the DBroker process
	/dbroker/preStart.log	Work log before DBroker starts
	/dbroker/cleanup.log	Cleanup log generated during or before DBroker uninstallation

Log Type	Log File	Description
	/dbroker/check_db_status.log	Log file that records whether the DBroker service is started successfully
	/dbroker/dbroker-omm-*<Date>*-*<PID>*-gc.log.*<No.>*	GC log of the DBroker process
	/dbroker/apache_hdfs_broker.log	Run log of the DBroker process
Audit log	fe.audit.log	Audit log, which records all SQL requests received by the FE

Log Levels

Table 4-9 describes the log levels supported by Doris.

The priorities of run log levels are FATAL, ERROR, WARN, and INFO in descending order. Logs whose levels are higher than or equal to a specified level are displayed. The number of displayed logs decreases as the specified log level increases.

Table 4-9 Log levels

Level	Description
FATAL	Logs of this level record program assertion errors
ERROR	Logs of this level record error information about system running
WARN	Logs of this level record exception information about the current event processing
INFO	Logs of this level record normal running status information about the system and events

To change log levels, perform the following operations:

Step 1 Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Doris** > **Configurations** > **All Configurations**. The **All Configurations** page of the Doris service is displayed.

Step 2 On the menu bar on the left, select the log menu of the target role.

Step 3 Select a desired log level and save the configuration.

NOTE

The Doris log level takes effect immediately after being configured. You do not need to restart the service.

----End

Log Formats

The following table describes Doris log formats and gives you some examples:

Table 4-10 Log format

Log Type	Format	Example
FE run log	<yyyy-MM-dd HH:mm:ss,SSS><*LogLevel*>(*Thread name*|*Thread ID*)<*Location where the log event occurs*>|<*Messages in the log*>	2023-04-13 11:17:14,371 INFO (tablet stat mgr|34) [TabletStatMgr.runAfterCatalogReady():125] finished to update index row num of all databases. cost: 0 ms
BE run log	<Log level. I for INFO, W for WARN, F for FATAL|MMdd HH:mm:ss.SSS> <*Thread ID*> <*Location where a log event occurs*> <Messages in the log>	I0413 11:26:03.439189 25248 tablet_manager.cpp:895] begin to build all report tablets info
DBroker run log	<MMdd HH:mm:ss.SSS> <*Thread ID*> <*Log Level*><*Messages in the log*>	2023-04-11 11:43:13 [main:0] - [INFO] starting apache hdfs broker....

Log Type	Format	Example
Audit log	<yyyy-MM-dd HH:mm:ss,SSS[*Operation type*] >|<Client>|<User Name>|<Db Name>|<State>|<ErrorCode>|<ErrorMessage>|<Time>|<ScanBytes>|<ScanRows>|<ReturnRows>|<StmtId>|<QueryId>|<IsQuery>|<feIp>| |<Stmt>|<CpuTimeMS>|<SqlHash>|<peakMemoryBytes>|<SqlDigest>|<TraceId>|<FuzzyVariables>	2023-04-13 10:49:26,410 [query] | Client=192.168.64.223:44382| User=root|Db=hivedoris| State=ERR|ErrorCode=1105| ErrorMessage=errCode = 2, detailMessage = (192.168.64.78) [INTERNAL_ERROR]failed to init reader for file /user/hive/warehouse/hivedoris.db/test/000000_0, err: [INTERNAL_ERROR]connect to hdfs failed. error: (255), Unknown error 255), reason: NullPointerException: | Time=67|ScanBytes=0| ScanRows=0|ReturnRows=0| StmtId=91| QueryId=e1125283f12c4994-a69e3a323044d681| IsQuery=true| feIp=192.168.64.78| Stmt=select * from test| CpuTimeMS=0| SqlHash=3bbc220823c3e757002fb9490196cf84| peakMemoryBytes=0| SqlDigest=|TraceId=| FuzzyVariables=

5 Using Flink

5.1 Using Flink from Scratch

Scenario

Use Flink to run wordcount jobs.

Prerequisites

- Flink has been installed in the MRS cluster and all components in the cluster are running properly.
- The cluster client has been installed in a directory, for example, **/opt/hadoopclient**.

Procedure

Step 1 Log in to the node where the client is installed as the client installation user.

Step 2 Run the following commands to go to the client installation directory.

cd /opt/hadoopclient

Step 3 Run the following command to initialize environment variables:

source /opt/hadoopclient/bigdata_env

Step 4 If Kerberos authentication is enabled for the cluster, perform the following substeps. If Kerberos authentication is not enabled for the cluster, skip the following substeps.

1. Create a user, for example, **test**, for submitting Flink jobs.

   Log in to FusionInsight Manager and choose **System** > **Permission** > **Role**. Click **Create Role** and configure **Role Name** and **Description**. In **Configure Resource Permission**, choose *Name of the desired cluster* > **Flink** and select **FlinkServer Admin Privilege**. Then click **OK**.

   Choose **System** > **Permission** > **User** and click **Create User**. Configure **Username**, set **User Type** to **Human-Machine**, configure **Password** and **Confirm Passowrd**, click **Add** next to **User Group** to add the **hadoop**,

yarnviewgroup, and **hadooppmanager** user groups as needed, click **Add** next to **Role** to add the **System_administrator**, **default**, and the created role, and click **OK**. (If you create a Flink job user for the first time, log in to FusionInsight Manager as the user and change the password.)

NOTE

When a user submits or runs a job in Flink, the user must have the following permissions based on whether Ranger authentication is enabled for related services (such as HDFS and Kafka):

- If Ranger authentication is enabled, the current user must belong to the **hadoop** group or the user has been granted the **/flink** read and write permissions in Ranger.
- If Ranger authentication is disabled, the current user must belong to the **hadoop** group.

2. Log in to FusionInsight Manager and choose **System > Permission > User**. On the displayed page, locate the row that contains the added user, click **More** in the **Operation** column, and select **Download Authentication Credential** to download the authentication credential file of the user to the local PC and decompress the file.
3. Copy the decompressed **user.keytab** and **krb5.conf** files to the **/opt/hadoopclient/Flink/flink/conf** directory on the client node.
4. Log in to the client node and add the service IP address of the client node and the floating IP address of FusionInsight Manager to the **jobmanager.web.allow-access-address** configuration item in the **/opt/hadoopclient/Flink/flink/conf/flink-conf.yaml** file. Use commas (,) to separate the IP addresses.

   vi /opt/hadoopclient/Flink/flink/conf/flink-conf.yaml
5. Configure security authentication.

   Add the **keytab** path and username to the **/opt/hadoopclient/Flink/flink/conf/flink-conf.yaml** configuration file.

   security.kerberos.login.keytab: *<user.keytab file path>*
   security.kerberos.login.principal: *<Username>*

   Example:

   ```
   security.kerberos.login.keytab: /opt/hadoopclient/Flink/flink/conf/user.keytab
   security.kerberos.login.principal: test
   ```
6. Configure security hardening by referring to **Authentication and Encryption**. Run the following commands to set a password for submitting jobs.

   cd /opt/hadoopclient/Flink/flink/bin

   sh generate_keystore.sh

   The script automatically changes the SSL-related parameter values in the **/opt/hadoopclient/Flink/flink/conf/flink-conf.yaml** file.
7. Configure paths for the client to access the **flink.keystore** and **flink.truststore** files.
   - Absolute path

     After the **generate_keystore.sh** script is executed, the **flink.keystore** and **flink.truststore** file paths are automatically set to absolute paths in the **flink-conf.yaml** file by default. In this case, you need to place the **flink.keystore** and **flink.truststore** files in the **conf** directory to the absolute paths of the Flink client and each Yarn node, respectively.

- Relative path (recommended)

  Perform the following steps to set the file paths of **flink.keystore** and **flink.truststore** to relative paths and ensure that the directory where the Flink client command is executed can directly access the relative paths.

  i. Create a directory, for example, **ssl**, in **/opt/hadoopclient/Flink/flink/conf/**.

  cd /opt/hadoopclient/Flink/flink/conf/

  mkdir ssl

  ii. Move the **flink.keystore** and **flink.truststore** files to the new paths.

  mv flink.keystore ssl/

  mv flink.truststore ssl/

  iii. Change the values of the following parameters to relative paths in the **flink-conf.yaml** file:

  vi /opt/hadoopclient/Flink/flink/conf/flink-conf.yaml

  ```
  security.ssl.keystore: ssl/flink.keystore
  security.ssl.truststore: ssl/flink.truststore
  ```

Step 5 Run a wordcount job.

NOTE

Job submission modes are as follows:

- Session

  In this mode, a YARN property file is created in *Client installation directory*/**Flink/tmp/.yarn-properties-**<*Username*>. Jobs are submitted to the application corresponding to the application ID recorded in the file. After jobs are complete, the Flink cluster is not closed. In session mode, jobs can be submitted in either of the following modes:

  – attached (default)

    The yarn-session.sh client submits the Flink cluster to YARN, but the client keeps running to trace the cluster status. If the cluster fails, the client displays an error. If the client is terminated, a shutdown signal is sent to the cluster.

  – detached (-d or --detached)

    The yarn-session.sh client submits the Flink cluster to YARN, and then the client returns a response. You need to invoke the client or YARN again to stop the Flink cluster.

- Application

  In this mode, a Flink cluster is started on YARN. The main() method of the application JAR file is executed on JobManager in YARN. You can use the dependency package on HDFS. After the application is complete, the cluster is shut down immediately. You can also use **yarn application -kill** *<ApplicationId>* or cancel the Flink job to manually stop the cluster. After the job is complete, the Flink cluster is also stopped.

- Per-Job Cluster

  In this mode, a Flink cluster is started on YARN, the provided application JAR file is run locally, and JobGraph is submitted to JobManager in YARN. If the **--detached** parameter is used, the client stops after the job is submitted. After the job is complete, the Flink cluster is also closed.

- Yarn-cluster mode

  This mode is similar to the Per-Job Cluster mode.

- If the job registration function is enabled, that is, the **job.alarm.enable**, **job.register.enable**, and **flinkServer.tenant.name** parameters in the **/opt/client/Flink/flink/conf/flink-conf.yaml** file are set to **true**, **true**, and **CLIENT_APP**, respectively, you need to specify the job name in the job running command by adding the **-Dyarn.application.name=***Job name* parameter.

- Normal cluster (Kerberos authentication disabled)
  – Submitting a Job in session's attached mode

    yarn-session.sh -nm "*session-name***"**

    Start a new client connection and submit the job:

    source /opt/hadoopclient/bigdata_env

    flink run /opt/hadoopclient/Flink/flink/examples/streaming/WordCount.jar

  – Submitting a job in application mode

    flink run-application -t yarn-application /opt/hadoopclient/Flink/flink/examples/streaming/WordCount.jar

  – Submitting a Job in Per-job mode

    flink run -t yarn-per-job /opt/hadoopclient/Flink/flink/examples/streaming/WordCount.jar

  – Submitting a Job in yarn-cluster mode

    flink run -m yarn-cluster /opt/hadoopclient/Flink/flink/examples/streaming/WordCount.jar

- Security cluster (Kerberos authentication enabled)
  - If the **flink.keystore** and **flink.truststore** file paths are relative paths:
    - Submit a job in session's attached mode. **ssl/** is a relative path.

      cd /opt/hadoopclient/Flink/flink/conf/

      yarn-session.sh -t ssl/ -nm "*session-name***"**

      ```
      ...
      Cluster started: Yarn cluster with application id application_1624937999496_0017
      JobManager Web Interface: http://192.168.1.150:32261
      ```

      Start a new client connection and submit the job:

      source /opt/hadoopclient/bigdata_env

      flink run /opt/hadoopclient/Flink/flink/examples/streaming/WordCount.jar

      ```
      ...
      Job has been submitted with JobID 587d5498fff18d8b2501fdf7ebb9c4fb
      Program execution finished
      Job with JobID 587d5498fff18d8b2501fdf7ebb9c4fb has finished.
      Job Runtime: 19917 ms
      ```

    - Submitting a job in application mode

      cd /opt/hadoopclient/Flink/flink/conf/

      flink run-application -t yarn-application -Dyarn.ship-files="ssl/" /opt/hadoopclient/Flink/flink/examples/streaming/WordCount.jar

      ```
      ...
      Submitted application application_1669179911005_0070
      Waiting for the cluster to be allocated
      Deploying cluster, current state ACCEPTED
      YARN application has been deployed successfully.
      Found Web Interface xxx.xxx of application 'application_1669179911005_0070'.
      ```

    - Submitting a Job in Per-job mode

      cd /opt/hadoopclient/Flink/flink/conf/

      flink run -t yarn-per-job -Dyarn.ship-files="ssl/" /opt/hadoopclient/Flink/flink/examples/streaming/WordCount.jar

      ```
      ...
      Cluster started: Yarn cluster with application id application_1669179911005_0071
      Job has been submitted with JobID 75011429a29f230121809f54f4570ed0
      Program execution finished
      Job with JobID 75011429a29f230121809f54f4570ed0 has finished.
      Job Runtime: 21245 ms
      ```

    - Submitting a Job in yarn-cluster mode

      flink run -m yarn-cluster -yt ssl/ /opt/hadoopclient/Flink/flink/examples/streaming/WordCount.jar
  - If the **flink.keystore** and **flink.truststore** file paths are absolute paths:
    - Submitting a Job in session's attached mode

      cd /opt/hadoopclient/Flink/flink/conf/

      yarn-session.sh -nm "*session-name***"**

      Start a new client connection and submit the job:

      source /opt/hadoopclient/bigdata_env

      flink run /opt/hadoopclient/Flink/flink/examples/streaming/WordCount.jar

Or **flink run -t yarn-session -Dyarn.application.id=application_*xxx* /opt/hadoopclient/Flink/flink/examples/streaming/WordCount.jar**

- Submitting a job in application mode

  cd /opt/hadoopclient/Flink/flink/conf/

  flink run-application -t yarn-application /opt/hadoopclient/Flink/flink/examples/streaming/WordCount.jar

- Submitting a Job in Per-job mode

  cd /opt/hadoopclient/Flink/flink/conf/

  flink run -t yarn-per-job /opt/hadoopclient/Flink/flink/examples/streaming/WordCount.jar

- Submitting a Job in yarn-cluster mode

  flink run -m yarn-cluster /opt/hadoopclient/Flink/flink/examples/streaming/WordCount.jar

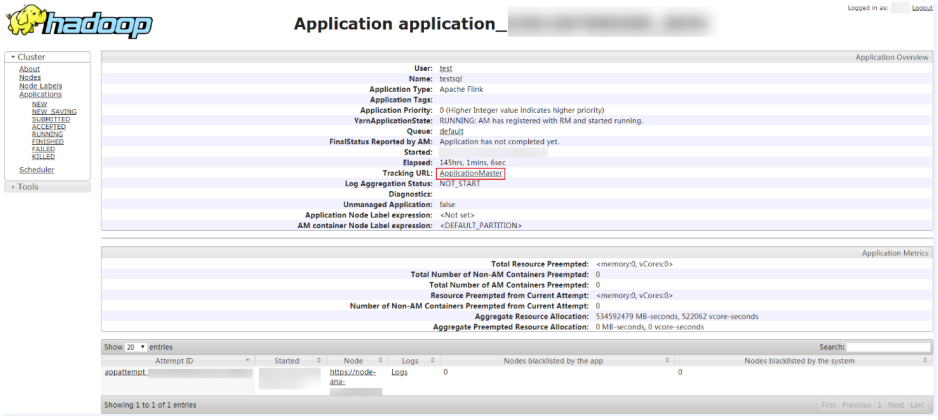
NOTE

If the function of registering jobs with FlinkServer is not enabled, you cannot start, develop, or stop jobs registered with FlinkServer through the client on the FlinkServer web UI. For details about how to enable the function, see **Verifying Flink's Job Inspection**.

Step 6 Log in to FusionInsight Manager as a running user, go to the native page of the Yarn service, find the application of the corresponding job, and click the application name to go to the job details page.

- If the job is not completed, click **Tracking URL** to go to the native Flink page and view the job running information.
- If the job submitted in a session has been completed, you can click **Tracking URL** to log in to the native Flink service page to view job information.

Figure 5-1 Application



----End

5.2 Viewing Flink Job Information

You can view Flink job information on the Yarn web UI.

Prerequisites

The Flink service has been installed in a cluster.

Accessing the Yarn Web UI

Step 1 Go to the Yarn service page.

Log in to FusionInsight Manager, choose **Cluster**, click the name of the target cluster, choose **Services** > **Yarn**, and click **Dashboard**.

Step 2 Click the link next to **ResourceManager WebUI** to go to the Yarn web UI page.

----End

5.3 Configuring Flink Service Parameters

Description

All Flink parameters can be configured on the client. You are advised to modify the flink-conf.yaml configuration file on the client. If Flink service parameters are modified on FusionInsight Manager, you need to download and install the client again after the configuration is complete.

- Configuration file path: *Client installation path*/**Flink/flink/conf/flink-conf.yaml**
- File configuration format: *Key*:*Value*

  Example: **taskmanager.heap.size: 1024mb**

  A space is required between *Key*: and *Value*.

Configurations

This section describes the following parameters:

- **JobManager & TaskManager**:

  JobManager and TaskManager are main components of Flink. For various security and performance scenarios, configuration items include communication ports, memory management, and connection retry.

- **Blob server**:

  The Blob server on the JobManager node is used to receive JAR packages uploaded by users on the client, send JAR packages to TaskManager, and transfer log files. The configuration items include the port, SSL, retry times, and concurrency.

- **Distributed Coordination (via Akka)**:

  The Akka actor model is the basis of communications between a Flink client and JobManager, JobManager and TaskManager, as well as TaskManagers. Related parameters can be configured based on the network environment or optimization policy. The configuration items include the timeout settings for message sending and waiting and the Akka listening mechanism DeathWatch.

- **SSL**:

To configure a secure Flink cluster, you need to configure SSL-related configuration items, including the SSL switch, certificate, password, and encryption algorithm.

- **Network communication (via Netty)**:

  When Flink runs a job, data transmission and reverse pressure detection between tasks depend on Netty. In certain environments, **Netty** parameters should be configured. For advanced optimization, you can adjust some Netty configuration items. The default configuration can meet the requirements of concurrent and high-throughput tasks in a large-scale cluster.

- **JobManager Web Frontend**:

  When JobManager is started, the web server is started in the same process. You can access the web server to obtain information about the current Flink cluster, including JobManager, TaskManager, and jobs running in the cluster. Configuration items of the web server include the port, temporary directory, display items, error redirection, and security-related items.

- **File Systems**:

  When a task is running, a result file is created. You can configure the file creation behavior, including the file overwriting policy and directory creation.

- **State Backend**:

  Flink enables HA and job exception, as well as job pause and recovery during version upgrade. Flink depends on state backend to store job states and on the restart strategy to restart a job. You can configure state backend and the restart strategy. Configuration items include the state backend type, storage path, and restart strategy.

- **Kerberos-based Security**:

  Kerberos-related configuration items must be configured in Flink security mode. The configuration items include keytab and principal of Kerberos.

- **HA**:

  The HA mode of Flink depends on ZooKeeper. Therefore, ZooKeeper configurations must be configured, including the ZooKeeper address, path, and security authentication.

- **Environment**:

  In scenarios raising special requirements on JVM configuration, users can use configuration items to transfer JVM parameters to the client, JobManager, and TaskManager.

- **Yarn**:

  Flink runs on a Yarn cluster and JobManager runs on ApplicationMaster. Some configuration parameters of JobManager depend on Yarn. You can configure YARN-related configurations to enable Flink to better run on Yarn. The configuration items include the memory, virtual kernel, and port of Yarn containers.

- **Pipeline**:

  The Netty connection is used among multiple jobs to reduce latency. In this case, NettySink is used on the server and NettySource is used on the client for data transmission. Configuration items include NettySink information storing path, range of NettySink listening port, whether to enable SSL encryption, domain of the network used for NettySink monitoring.

- **Enabling the Alarm Function for Job Submission on the Client**:

  By default, the alarm function is disabled for jobs submitted through the Flink client. To enable it, install two FlinkServer instances on the node where the jobs are submitted and configure related parameters in the **flink-conf.yaml** file on the client.

  NOTE

  If the HA mode of Flink servers is changed on the FusionInsight Manager of an ECS/BMS cluster, you must update the Flink configuration on the default client of the cluster to ensure that the alarm function of Flink jobs can work properly.

  Perform the following steps to update Flink configuration:

  1. Log in to the active and standby OMS nodes in the cluster as user **root**.
  2. Run the following command to update client configurations:

     sh /opt/executor/bin/refresh-client-config.sh

- **FlinkServer HA**

  You can start the FlinkServer in HA mode. To do so, you need to configure the floating IP address and arbitration IP address of the FlinkServer.

JobManager & TaskManager

Table 5-1 JobManager & TaskManager parameters

Parameter	Description	Default Value	Mandatory
taskmanager.rpc.port	IPC port range of TaskManager	32326-32390	No
taskmanager.memory.segment-size	Size of the memory buffer used by the memory manager and network stack The unit is bytes.	32768	No
taskmanager.data.port	Data exchange port range of TaskManager	32391-32455	No
taskmanager.data.ssl.enabled	Whether to enable secure sockets layer (SSL) encryption for data transfer between TaskManagers. This parameter is valid only when the global switch **security.ssl** is enabled.	false	No
taskmanager.numberOfTaskSlots	Number of slots occupied by TaskManager. Generally, the value is configured as the number of cores of the physical machine. In **yarn-session** mode, the value can be transmitted by only the **-s** parameter. In **yarn-cluster** mode, the value can be transmitted by only the **-ys** parameter.	2	No

Parameter	Description	Default Value	Mandatory
parallelism.default	Default degree of parallelism, which is used for jobs for which the degree of parallelism is not specified	1	No
task.cancellation.interval	Interval between two successive task cancellation attempts. The unit is millisecond.	30000	No
client.rpc.port	Akka system listening port on the Flink client.	32651-32720	No
jobmanager.memory.process.size	Size of the heap memory of JobManager. In **yarn-session** mode, the value can be transmitted by only the **-jm** parameter. In **yarn-cluster** mode, the value can be transmitted by only the **-yjm** parameter. If the value is smaller than **yarn.scheduler.minimum-allocation-mb** in the Yarn configuration file, the Yarn configuration value is used. The unit is B/KB/MB/GB/TB.	2GB	No
taskmanager.memory.process.size	Size of the heap memory of TaskManager. In **yarn-session** mode, the value can be transmitted by only the **-tm** parameter. In **yarn-cluster** mode, the value can be transmitted by only the **-ytm** parameter. If the value is smaller than **yarn.scheduler.minimum-allocation-mb** in the Yarn configuration file, the Yarn configuration value is used. The unit is B/KB/MB/GB/TB.	4GB	No
taskmanager.network.numberOfBuffers	Number of TaskManager network transmission buffer stacks. If an error indicates insufficient system buffer, increase the parameter value.	2048	No
taskmanager.debug.memory.log	Enable this item for debugging Flink memory and garbage collection (GC)-related problems. TaskManager periodically collects memory and GC statistics, including the current utilization of heap and off-heap memory pools and GC time.	false	No
taskmanager.debug.memory.log-interval	Interval for TaskManager to periodically record memory and GC statistics, in milliseconds	5000	No

Parameter	Description	Default Value	Mandatory
taskmanager.maxRegistrationDuration	Maximum duration of TaskManager registration on JobManager. If the actual duration exceeds the value, TaskManager is disabled.	5 min	No
taskmanager.initial-registration-pause	Initial interval between two consecutive registration attempts. The value must contain a time unit (ms/s/min/h/d), for example, 5 seconds. The time value and unit are separated by half-width spaces. ms/s/m/h/d indicates millisecond, second, minute, hour, and day, respectively.	500 ms	No
taskmanager.max-registration-pause	Maximum registration retry interval in case of TaskManager registration failures. The unit is ms/s/m/h/d.	30s	No
taskmanager.refused-registration-pause	Retry interval when a TaskManager registration connection is rejected by JobManager. The unit is ms/s/m/h/d.	10s	No
classloader.resolve-order	Class resolution policies defined when classes are loaded from user codes, which means whether to first check the user code JAR file (**child-first**) or the application class path (**parent-first**). The default setting indicates that the class is first loaded from the user code JAR file, which means that the user code JAR file can contain and load dependencies that are different from those used by Flink.	child-first	No
slot.idle.timeout	Timeout for an idle slot in Slot Pool, in milliseconds.	50000	No
slot.request.timeout	Timeout for requesting a slot from Slot Pool, in milliseconds.	300000	No
task.cancellation.timeout	Timeout of task cancellation, in milliseconds. If a task cancellation times out, a fatal TaskManager error may occur. If this parameter is set to **0**, no error is reported when a task cancellation times out.	180000	No

Parameter	Description	Default Value	Mandatory
taskmanager.network.detailed-metrics	Indicates whether to enable the detailed metrics monitoring of network queue lengths.	false	No
taskmanager.network.memory.buffers-per-channel	Maximum number of network buffers used by each outgoing/incoming stream (sub-partition/input streams). In credit-based flow control, this indicates how many credits are in each input stream. It should be configured with at least 2 buffers to deliver good performance. One buffer is used to receive in-flight data in the sub-partition, and the other for parallel serialization.	2	No
taskmanager.network.memory.floating-buffers-per-gate	Number of extra network buffers used by each output gate (result partition) or input gate, indicating the amount of floating credit shared among all input channels in credit-based flow control mode. Floating buffers are distributed based on the backlog feedback (real-time output buffers in sub-partitions) and can help mitigate back pressure caused by unbalanced data distribution among sub-partitions. Increase this value if the round-trip time between nodes is long and/or the number of machines in the cluster is large.	8	No
taskmanager.network.memory.fraction	Ratio of JVM memory used for network buffers, which determines how many streaming data exchange channels a TaskManager can have at the same time and the extent of channel buffering. Increase this value or the values of **taskmanager.network.memory.min** and **taskmanager.network.memory.max** if the job is rejected or a warning indicating that the system does not have enough buffers is received. Note that the values of **taskmanager.network.memory.min** and **taskmanager.network.memory.max** may overwrite this value.	0.1	No

Parameter	Description	Default Value	Mandatory
taskmanager.network.memory.max	Maximum memory size of the network buffer. The value must contain a unit (B/KB/MB/GB/TB).	5GB	No
taskmanager.network.memory.min	Minimum memory size of the network buffer. The value must contain a unit (B/KB/MB/GB/TB).	64MB	No
taskmanager.network.request-backoff.initial	Minimum backoff for partition requests of input channels.	100	No
taskmanager.network.request-backoff.max	Maximum backoff for partition requests of input channels.	10000	No
taskmanager.registration.timeout	Timeout for TaskManager registration. TaskManager will be terminated if it is not successfully registered within the specified time. The value must contain a time unit (ms/s/min/h/d).	5 min	No
resourcemanager.taskmanager-timeout	Timeout interval for releasing an idle TaskManager, in milliseconds.	30000	No

Blob server

Table 5-2 Blog server parameters

Parameter	Description	Default Value	Mandatory
blob.server.port	Blob server port	32456-32520	No
blob.service.ssl.enabled	Indicates whether to enable the encryption for the blob transmission channel. This parameter is valid only when the global switch **security.ssl** is enabled.	true	Yes
blob.fetch.retries	Number of times that TaskManager tries to download blob files from JobManager.	50	No

Parameter	Description	Default Value	Mandatory
blob.fetch.num-concurrent	Number of concurrent tasks for downloading blob files supported by JobManager.	50	No
blob.fetch.backlog	Number of blob files, such as **.jar** files, to be downloaded in the queue supported by JobManager. The unit is count.	1000	No
library-cache-manager.cleanup.interval	Interval at which JobManager deletes the JAR files stored on the HDFS when the user cancels the Flink job. The unit is second.	3600	No

Distributed Coordination (via Akka)

Table 5-3 Distributed Coordination parameters

Parameter	Description	Default Value	Mandatory
akka.ask.timeout	Timeout duration of Akka asynchronous and block requests. If a Flink timeout failure occurs, this value can be increased. Timeout occurs when the machine processing speed is slow or the network is blocked. The unit is ms/s/m/h/d.	300s	No
akka.lookup.timeout	Timeout duration for JobManager actor object searching. The unit is ms/s/m/h/d.	10s	No
akka.framesize	Maximum size of the message transmitted between JobManager and TaskManager. If a Flink error occurs because the message exceeds this limit, the value can be increased. The unit is b/B/KB/MB.	10485760b	No
akka.watch.heartbeat.interval	Heartbeat interval at which the Akka DeathWatch mechanism detects disconnected TaskManager. If TaskManager is frequently and incorrectly marked as disconnected due to heartbeat loss or delay, the value can be increased. The unit is ms/s/m/h/d.	10s	No

Parameter	Description	Default Value	Mandatory
akka.watch.heartbeat.pause	Acceptable heartbeat pause for Akka DeathWatch mechanism. A small value indicates that irregular heartbeat is not accepted. The unit is ms/s/m/h/d.	60s	No
akka.watch.threshold	DeathWatch failure detection threshold. A small value may mark normal TaskManager as failed and a large value increases failure detection time.	12	No
akka.tcp.timeout	Timeout duration of Transmission Control Protocol (TCP) connection request. If TaskManager connection timeout occurs frequently due to the network congestion, the value can be increased. The unit is ms/s/m/h/d.	20s	No
akka.throughput	Number of messages processed by Akka in batches. After an operation, the processing thread is returned to the thread pool. A small value indicates the fair scheduling for actor message processing. A large value indicates improved overall performance but lowered scheduling fairness.	15	No
akka.log.lifecycle.events	Switch of Akka remote time logging, which can be enabled for debugging.	false	No
akka.startup-timeout	Timeout interval before a remote component fails to be started. The value must contain a time unit (ms/s/min/h/d).	The value is the same as the value of **akka.ask.timeout**.	No
akka.ssl.enabled	Switch of Akka communication SSL. This parameter is valid only when the global switch **security.ssl** is enabled.	true	Yes
akka.client-socket-worker-pool.pool-size-factor	Factor that is used to determine the thread pool size. The pool size is calculated based on the following formula: ceil (available processors * factor). The size is bounded by the **pool-size-min** and **pool-size-max** values.	1.0	No

Parameter	Description	Default Value	Mandatory
akka.client-socket-worker-pool.pool-size-max	Maximum number of threads calculated based on the factor.	2	No
akka.client-socket-worker-pool.pool-size-min	Minimum number of threads calculated based on the factor.	1	No
akka.client.timeout	Timeout duration of the client. The value must contain a time unit (ms/s/min/h/d).	60s	No
akka.server-socket-worker-pool.pool-size-factor	Factor that is used to determine the thread pool size. The pool size is calculated based on the following formula: ceil (available processors * factor). The size is bounded by the **pool-size-min** and **pool-size-max** values.	1.0	No
akka.server-socket-worker-pool.pool-size-max	Maximum number of threads calculated based on the factor.	2	No
akka.server-socket-worker-pool.pool-size-min	Minimum number of threads calculated based on the factor.	1	No

SSL

Table 5-4 SSL parameters

Parameter	Description	Default Value	Mandatory
security.ssl.protocol	SSL transmission protocol version.	TLSv1.2	Yes

Parameter	Description	Default Value	Mandatory
security.ssl.algorithms	Supported SSL standard algorithm..	TLS_DHE_RSA_WITH_AES_128_GCM_SHA256,TLS_ECDHE_RSA_WITH_AES_128_GCM_SHA256,TLS_DHE_RSA_WITH_AES_256_GCM_SHA384,TLS_ECDHE_RSA_WITH_AES_256_GCM_SHA384	Yes
security.ssl.enabled	Specifies whether to enable SSL for internal communication. This parameter is automatically configured based on the cluster installation mode.	• Security mode: **true** • Normal mode: **false**	Yes
security.ssl.keystore	Java keystore file.	-	Yes
security.ssl.keystore-password	Password used to decrypt the keystore file.	-	Yes
security.ssl.key-password	Password used to decrypt the server key in the keystore file.	-	Yes
security.ssl.truststore	**truststore** file containing the public CA certificates.	-	Yes
security.ssl.truststore-password	Password used to decrypt the truststore file.	-	Yes

Network communication (via Netty)

Table 5-5 Network communication parameters

Parameter	Description	Default Value	Mandatory
taskmanager.network.netty.num-arenas	Number of Netty memory blocks.	1	No

Parameter	Description	Default Value	Mandatory
taskmanager.network.netty.server.numThreads	Number of Netty server threads The value **-1** indicates that the number of threads is equal to the number of TM slots.	-1	No
taskmanager.network.netty.client.numThreads	Number of Netty client threads The value **-1** indicates that the number of threads is equal to the number of TM slots.	-1	No
taskmanager.network.netty.client.connectTimeoutSec	Netty client connection timeout duration. The unit is second.	120	No
taskmanager.network.netty.sendReceiveBufferSize	Size of Netty sending and receiving buffers. This defaults to the system buffer size (**cat /proc/sys/net/ipv4/tcp_[rw]mem**) and is 4 MB in modern Linux. The unit is bytes.	4096	No
taskmanager.network.netty.transport	Netty transport type, either **nio** or **epoll**	nio	No

JobManager Web Frontend

Table 5-6 JobManager Web Frontend parameters

Parameter	Description	Default Value	Mandatory
jobmanager.web.allow-access-address	Web access whitelist. IP addresses are separated by commas (,). Only whitelisted IP addresses can access the web.	*	Yes

Parameter	Description	Default Value	Mandatory
flink.security.enable	When installing a Flink cluster, you are required to select **security mode** or **normal mode**. • If **security mode** is selected, this parameter is automatically set to **true**. • If **normal mode** is selected, this parameter is automatically set to **false**. For an installed Flink cluster, you can view the configured value to determine whether the cluster is in security or normal mode.	Automatic configuration	No
rest.bind-port	The web port. Value range: 32261–32325.	32261-32325	No
jobmanager.web.history	Number of recent jobs to be displayed.	5	No
jobmanager.web.checkpoints.disable	Whether to disable checkpoint statistics.	false	No
jobmanager.web.checkpoints.history	Number of checkpoint statistical records.	10	No
jobmanager.web.backpressure.cleanup-interval	Interval for clearing unaccessed backpressure records. The unit is millisecond.	600000	No
jobmanager.web.backpressure.refresh-interval	Interval for updating backpressure records. The unit is millisecond.	60000	No
jobmanager.web.backpressure.num-samples	Number of stack tracing records for reverse pressure calculation.	100	No
jobmanager.web.backpressure.delay-between-samples	Sampling interval for reverse pressure calculation. The unit is millisecond.	50	No

Parameter	Description	Default Value	Mandatory
jobmanager.web.ssl.enabled	Whether SSL encryption is enabled for web transmission. This parameter is valid only when the global switch **security.ssl** is enabled.	false	Yes
jobmanager.web.accesslog.enable	Switch to enable or disable web operation logs. The log is stored in **webaccess.log**.	true	Yes
jobmanager.web.x-frame-options	Value of the HTTP security header **X-Frame-Options**. The value can be **SAMEORIGIN**, **DENY**, or **ALLOW-FROM uri**.	DENY	Yes
jobmanager.web.cache-directive	Whether the web page can be cached.	no-store	Yes
jobmanager.web.expires-time	Expiration duration of web page cache. The unit is millisecond.	0	Yes
jobmanager.web.access-control-allow-origin	Web page same-origin policy that prevents cross-domain attacks.	*	Yes
jobmanager.web.refresh-interval	Web page refresh interval. The unit is millisecond.	3000	Yes
jobmanager.web.logout-timer	Automatic logout interval when no operation is performed. The unit is millisecond.	600000	Yes
jobmanager.web.403-redirect-url	Web page access error 403. If 403 error occurs, the page switch to a specified page.	Automatic configuration	Yes
jobmanager.web.404-redirect-url	Web page access error 404. If 404 error occurs, the page switch to a specified page.	Automatic configuration	Yes
jobmanager.web.415-redirect-url	Web page access error 415. If 415 error occurs, the page switch to a specified page.	Automatic configuration	Yes
jobmanager.web.500-redirect-url	Web page access error 500. If 500 error occurs, the page switch to a specified page.	Automatic configuration	Yes

Parameter	Description	Default Value	Mandatory
rest.await-leader-timeout	Time of the client waiting for the leader address. The unit is millisecond.	30000	No
rest.client.max-content-length	Maximum content length that the client handles (unit: bytes).	104857600	No
rest.connection-timeout	Maximum time for the client to establish a TCP connection (unit: ms).	15000	No
rest.idleness-timeout	Maximum time for a connection to stay idle before failing (unit: ms).	300000	No
rest.retry.delay	The time that the client waits between retries (unit: ms).	3000	No
rest.retry.max-attempts	The number of retry times if a retrievable operator fails.	20	No
rest.server.max-content-length	Maximum content length that the server handles (unit: bytes).	104857600	No
rest.server.numThreads	Maximum number of threads for the asynchronous processing of requests.	4	No
web.timeout	Timeout for web monitor (unit: ms).	10000	No

File Systems

Table 5-7 File Systems parameters

Parameter	Description	Default Value	Mandatory
fs.overwrite-files	Whether to overwrite the existing file by default when the file is written.	false	No

Parameter	Description	Default Value	Mandatory
fs.output.always-create-directory	When the degree of parallelism (DOP) of file writing programs is greater than 1, a directory is created under the output file path and different result files (each parallel write program) are stored in the directory. ● If this parameter is set to **true**, a directory is created for the writing program whose DOP is 1 and a result file is stored in the directory. ● If this parameter is set to **false**, the file of the writing program whose DOP is 1 is created directly in the output path and no directory is created.	false	No

State Backend

Table 5-8 State Backend parameters

Parameter	Description	Default Value	Mandatory
state.backend.fs.checkpointdir	Path when the backend is set to **filesystem**. The path must be accessible by JobManager. Only the local mode is supported. In the cluster mode, use an HDFS path.	hdfs:///flink/checkpoints	No
state.savepoints.dir	Savepoint storage directory used by Flink to restore and update jobs. When a savepoint is triggered, the metadata of the savepoint is saved to this directory.	hdfs:///flink/savepoint	Mandatory in security mode
restart-strategy	Default restart policy, which is used for jobs for which no restart policy is specified. ● fixed-delay ● failure-rate ● none	fixed-delay	No

Parameter	Description	Default Value	Mandatory
restart-strategy.fixed-delay.attempts	The retry times of the **fixed-delay** policy.	• If the checkpoint is enabled, the default value is the value of **Integer.MAX_VALUE**. • If the checkpoint is disabled, the default value is **3**.	No
restart-strategy.fixed-delay.delay	Retry interval when the fixed-delay strategy is used. The unit is ms/s/m/h/d.	• If the checkpoint is enabled, the default value is 10s. • If the checkpoint is disabled, the default value is the value of **akka.ask.timeout**.	No
restart-strategy.failure-rate.max-failures-per-interval	Maximum number of restart times in a specified period before a job fails when the fault rate policy is used.	1	No

Parameter	Description	Default Value	Mandatory
restart-strategy.failure-rate.failure-rate-interval	Retry interval when the failure-rate strategy is used. The unit is ms/s/m/h/d.	60s	No
restart-strategy.failure-rate.delay	Retry interval when the failure-rate strategy is used. The unit is ms/s/m/h/d.	The default value is the same as the value of **akka.ask.timeout**.	No

Kerberos-based Security

Table 5-9 Kerberos-based security parameters

Parameter	Description	Default Value	Mandatory
security.kerberos.login.keytab	Keytab file path. This parameter is a client parameter.	Configure the parameter based on actual service requirements.	Yes
security.kerberos.login.principal	A parameter on the client. If **security.kerberos.login.keytab** and **security.kerberos.login.principal** are both set, keytab certificate is used by default.	Configure the parameter based on actual service requirements.	No
security.kerberos.login.contexts	Contexts of the jass file generated by Flink. This parameter is a server parameter.	Client, KafkaClient	Yes

HA

Table 5-10 HA parameters

Parameter	Description	Default Value	Mandatory
high-availability	Whether HA is enabled. Only the following two modes are supported currently: ● none: Only a single JobManager is running. The checkpoint is disabled for JobManager. ● ZooKeeper: – In non-Yarn mode, multiple JobManagers are supported and the leader JobManager is elected. – In Yarn mode, only one JobManager exists.	zookeeper	No
high-availability.zookeeper.quorum	ZooKeeper quorum address.	Automatic configuration	No
high-availability.zookeeper.path.root	Root directory that Flink creates on ZooKeeper, storing metadata required in HA mode.	/flink	No
high-availability.storageDir	Directory for storing JobManager metadata of state backend. ZooKeeper stores only pointers to actual data.	hdfs:///flink/recovery	No
high-availability.zookeeper.client.session-timeout	Session timeout duration on the ZooKeeper client. The unit is millisecond.	90000	No
high-availability.zookeeper.client.connection-timeout	Connection timeout duration on the ZooKeeper client. The unit is millisecond.	15000	No
high-availability.zookeeper.client.retry-wait	Retry waiting time on the ZooKeeper client. The unit is millisecond.	5000	No

Parameter	Description	Default Value	Mandatory
high-availability.zookeeper.client.max-retry-attempts	Maximum retry times on the ZooKeeper client.	3	No
high-availability.job.delay	Delay of job restart when JobManager recovers.	The default value is the same as the value of **akka.ask.timeout**.	No
high-availability.zookeeper.client.acl	Set the ACL (open creator) of the ZooKeeper node. The ACL is automatically configured based on the security mode of the cluster.	• Security mode: The default value is **creator**. • Non-security mode: The default value is **open**.	Yes
zookeeper.sasl.disable	Indicates whether to enable SASL authentication. This parameter is automatically configured based on the security mode of the cluster.	• Security mode: **false** • Non-security mode: **true**	Yes
zookeeper.sasl.service-name	• If the ZooKeeper server configures a service whose name is different from **ZooKeeper**, this configuration item can be set. • If service names on the client and server are inconsistent, authentication fails.	zookeeper	Yes

Environment

Table 5-11 Environment parameters

Parameter	Description	Default Value	Mandatory
env.java.opts	JVM parameter, which is transferred to the startup script, JobManager, TaskManager, and Yarn client. For example, transfer remote debugging parameters.	-Xloggc:<LOG_DIR>/gc.log -XX:+PrintGCDetails -XX:-OmitStackTraceInFastThrow -XX:+PrintGCTimeStamps -XX:+PrintGCDateStamps -XX:+UseGCLogFileRotation -XX:NumberOfGCLogFiles=20 -XX:GCLogFileSize=20M -Djdk.tls.ephemeralDHKeySize=2048 -Djava.library.path=${HADOOP_COMMON_HOME}/lib/native -Djava.net.preferIPv4Stack=true -Djava.net.preferIPv6Addresses=false -Dbeetle.application.home.path=/opt/*xxx*/Bigdata/common/runtime/security/config	No

Yarn

Table 5-12 YARN parameters

Parameter	Description	Default Value	Mandatory
yarn.maximum-failed-containers	Maximum number of containers the system is going to reallocate in case of a container failure of TaskManager The default value is the number of TaskManagers when the Flink cluster is started.	5	No

Parameter	Description	Default Value	Mandatory
yarn.application-attempts	Number of ApplicationMaster restarts. The value is the maximum value in the validity interval that is set to Akka's timeout in Flink. After the restart, the IP address and port number of ApplicationMaster will change and you will need to connect to the client manually.	2	No
yarn.heartbeat-delay	Time between heartbeats with the ApplicationMaster and Yarn ResourceManager in seconds. The unit is second.	5	No
yarn.containers.vcores	Number of virtual cores of each Yarn container	Number of TaskManager slots	No
yarn.application-master.port	ApplicationMaster port number setting. A port number range is supported.	32586-32650	No

Pipeline

Table 5-13 Pipeline parameters

Parameter	Description	Default Value	Mandatory
nettyconnector.registerserver.topic.storage	Path (on a third-party server) to information about IP address, port numbers, and concurrency of NettySink. ZooKeeper is recommended for storage.	/flink/nettyconnector	No. However, if pipeline is enabled, the feature is mandatory.
nettyconnector.sinkserver.port.range	Port range of NettySink.	28444-28843	No. However, if pipeline is enabled, the feature is mandatory.

Parameter	Description	Default Value	Mandatory
nettyconnector.ssl.enabled	Whether SSL encryption for the communication between NettySink and NettySource is enabled. For details about the encryption key and protocol, see **SSL**.	false	No. However, if pipeline is enabled, the feature is mandatory.
nettyconnector.message.delimiter	Delimiter used to configure the message sent by NettySink to the NettySource, which is 2-4 bytes long, and cannot contain **\n**, **#**, or space.	The default value is **$_**.	No. However, if pipeline is enabled, the feature is mandatory.

Enabling the Alarm Function for Job Submission on the Client

Table 5-14 Parameters for enabling the alarm function for job submission on the client

Parameter	Description	Value	Mandatory
job.alarm.enable	Whether to enable the alarm function.	true	Yes
flinkserver.host.ip	Service IP addresses of the two FlinkServer instances	*x.x.x.x,x.x.x.x*	Yes

FlinkServer HA

Table 5-15 FlinkServer HA parameters

Parameter	Description	Default Value	Mandatory
flink_ha_enabled	Whether to start FlinkServer in HA mode.	true	Yes

Parameter	Description	Default Value	Mandatory
flink.ha.floatip	Floating IP address used by the FlinkServer, which is configured on the service plane. The IP address must be unique and not in use.	*x.x.x.x*	Yes
flink.ha.mediator.ip	Arbitration IP address of the HA server. The value is the gateway IP address of the service plane.	*x.x.x.x*	Yes
flink.ha.net.timeout	Timeout for FlinkServer network connection The unit is second.	20	No
flink.ha.heartbeat.port	Port for HA heartbeat link	28944	No
flink.ha.rpc.port	Port for HA RPC communication	28946	No
flink.ha.sync.port	Port used to synchronize HA files	28945	No

5.4 Configuring Flink Security Features

5.4.1 Security Features

Flink Authentication and Encryption

- In a Flink cluster, all components support authentication.
  - The kerberos authentication is supported between Flink cluster components and external components, such as YARN, HDFS, and ZooKeeper.
  - The security cookie authentication between Flink cluster components, for example, Flink client and JobManager, JobManager and TaskManager, and TaskManager and TaskManager, are supported.
- In a Flink cluster, components support SSL encrypted transmission. SSL encrypted transmission is supported between components in a cluster, such as Flink client and JobManager, JobManager and TaskManager, and TaskManager and TaskManager.

  For details, see **Authentication and Encryption**.

ACL Control

In HA mode, ACL control is supported.

In HA mode of Flink, ZooKeeper can be used to manage clusters and discover services. Zookeeper supports SASL ACL control. Only users who have passed the SASL (Kerberos) authentication have the permission to operate files on ZooKeeper.

To enable SASL ACL control, perform following configurations in the Flink configuration file.

```
high-availability.zookeeper.client.acl: creator
zookeeper.sasl.disable: false
```

For details about configuration items, see **HA**.

Web Security

Flink web security is hardened. Whitelist filtering is supported. Flink web can be accessed only through the YARN proxy. Security header enhancement is supported. In Flink clusters, listening ports of components can be configured.

- Encoding rules
  - Description: The same encoding mode is used on the web service client and server to prevent garbled characters and to implement input verification.
  - Security hardening: Response messages of web servers are encoded using UTF-8.
- Whitelist-based filter of IP addresses
  - Note: IP filter must be added to the web server to filter unauthorized requests from the source IP address and prevent unauthorized login.
  - Security hardening: Add **jobmanager.web.allow-access-address** to enable the IP filter. By default, only YARN users are supported.

    NOTE

    After the client is installed, you need to add the IP address of the client node to the **jobmanager.web.allow-access-address** configuration item.
- Preventing sending the absolute paths to the client
  - Note: If an absolute path is sent to a client, the directory structure of the server is exposed, increasing the risk that attackers know and attack the system.
  - Security hardening: If the Flink configuration file contains a parameter starting with a slash (/), the first-level directory is deleted.
- Same-origin policy
  - If two URL protocols have same hosts and ports, they are of the same origin. Protocols of different origins cannot access each other, unless the source of the visitor is specified on the host of the service to be visited.
  - Security hardening: The default value of the header of the response header **Access-Control-Allow-Origin** is the IP address of ResourceManager on Yarn clusters. If the IP address is not from Yarn, mutual access is not allowed.
- Preventing sensitive information disclosure
  - Web pages containing sensitive data must not be cached, to avoid leakage of sensitive information or data crosstalk among users who visit the internet through the proxy server.
  - Security hardening: Add **Cache-control**, **Pragma**, **Expires** security header. The default value is **Cache-Control: no-store**, **Pragma: no-cache**, and **Expires: 0**. The security hardening stops contents interacted between Flink and web server from being cached.

- Anti-hijacking
  - Since hotlinking and clickjacking use framing technologies, security hardening is required to prevent attacks.
  - Security hardening: Add **X-Frame-Options** security header to specify whether the browser will load the pages from **iframe**, **frame** or **object**. The default value is **X-Frame-Options: DENY**, indicating that no pages can be nested to **iframe**, **frame** or **object**.
- Logging calls of the Web Service APIs
  - Calls of the **Flink webmonitor restful** APIs are logged.
  - The **jobmanager.web.accesslog.enable** can be added in the **access log**. The default value is **true**. Logs are stored in a separate **webaccess.log** file.
- Cross-site request forgery prevention
  - In **Browser/Server** applications, CSRF must be prevented for operations involving server data modification, such as adding, modifying, and deleting. The CSRF forces end users to execute non-intended operations on the current web application.
  - Security hardening: Only two post APIs, one delete API, and get interfaces are reserve for modification requests. All other APIs are deleted.
- Troubleshooting:
  - When the application is abnormal, exception information is filtered, logged, and returned to the client.
  - Security hardening: A default error message page to filter information and log detailed error information. Four configuration parameters are added to ensure that the error page is switched to a specified URL provided by FusionInsight, preventing exposure of unnecessary information.

Table 5-16 Parameters

Parameter	Description	Default Value	Mandatory
jobmanager.web.403-redirect-url	Web page access error 403. If 403 error occurs, the page switch to a specified page.	-	Yes
jobmanager.web.404-redirect-url	Web page access error 404. If 404 error occurs, the page switch to a specified page.	-	Yes
jobmanager.web.415-redirect-url	Web page access error 415. If 415 error occurs, the page switch to a specified page.	-	Yes
jobmanager.web.500-redirect-url	Web page access error 500. If 500 error occurs, the page switch to a specified page.	-	Yes

- HTML5 security
  - HTML5 is a next generation web development specification that provides new functions and extend the labels for developers. These new labels and functions increase the attack surface and pose attack risks (such as cross-domain resource sharing, client storage, WebWorker, WebRTC, and WebSocket).
  - Security hardening: Add the **Access-Control-Allow-Origin** parameter. For example, if you want to enable the cross-domain resource sharing, configure the **Access-Control-Allow-Origin** parameter of the HTTP response header.

    NOTE

    Flink does not involve security risks of functions such as storage on the client, WebWorker, WebRTC, and WebSocket.

Security Statement

- All security functions of Flink are provided by the open source community or self-developed. Security features that need to be configured by users, such as authentication and SSL encrypted transmission, may affect performance.
- As a big data computing and analysis platform, Flink does not detect sensitive information. Therefore, you need to ensure that the input data is not sensitive.
- You can evaluate whether configurations are secure as required.
- For any security-related problems, contact O&M support.

5.4.2 Authentication and Encryption

Security Authentication

Flink supports the following authentication modes:

- Kerberos authentication: It is used between the Flink Yarn client and Yarn ResourceManager, JobManager and ZooKeeper, JobManager and HDFS, TaskManager and HDFS, Kafka and TaskManager, as well as TaskManager and ZooKeeper.
- Security cookie authentication: Security cookie authentication is used between Flink Yarn client and JobManager, JobManager and TaskManager, as well as TaskManager and TaskManager.
- Internal authentication of Yarn: The Internal authentication mechanism of Yarn is used between Yarn ResourceManager and ApplicationMaster (AM).

  NOTE

  - Flink JobManager and Yarn ApplicationMaster are in the same process.
  - If Kerberos authentication is enabled for the user's cluster, Kerberos authentication is required.

Table 5-17 Authentication modes

Authentication Mode	Description	Configuration Method

Kerberos authentication	Currently, only keytab authentication mode is supported.	1. Download the user keytab file from FusionInsight Manager and save the keytab file to a folder on the host where the Flink client is located.
		2. Configure the following parameters in the **flink-conf.yaml** file:
		a. Keytab path
		`security.kerberos.login.keytab: /home/flinkuser/keytab/abc222.keytab`
		Note:
		/home/flinkuser/keytab/abc222.keytab indicates the user directory.
		b. Principal name
		`security.kerberos.login.principal: abc222`
		c. In HA mode, if ZooKeeper is configured, the Kerberos authentication configuration items must be configured as follows:
		`zookeeper.sasl.disable: false`
		`security.kerberos.login.contexts: Client`
		d. If you want to perform Kerberos authentication between Kafka client and Kafka broker, set the value as follows:
		`security.kerberos.login.contexts: Client,KafkaClient`

Authentication Mode	Description	Configuration Method
Security cookie authentication	-	1. In the **bin** directory of the Flink client, run the **generate_keystore.sh** script to generate security cookie, **flink.keystore**, and **flink.truststore**. Run the **sh generate_keystore.sh** command and enter the user-defined password. The password cannot contain **#**. **NOTE** After the script is executed, the **flink.keystore** and **flink.truststore** files are generated in the **conf** directory on the Flink client. In the **flink-conf.yaml** file, default values are specified for following parameters: ● Set **security.ssl.keystore** to the absolute path of the **flink.keystore** file. ● Set **security.ssl.truststore** to the absolute path of the **flink.truststore** file. ● Set **security.cookie** to a random password automatically generated by the **generate_keystore.sh** script. ● By default, **security.ssl.encrypt.enabled: false** is set in the **flink-conf.yaml** file by default. The **generate_keystore.sh** script sets **security.ssl.key-password**, **security.ssl.keystore-password**, and **security.ssl.truststore-password** to the password entered when the **generate_keystore.sh** script is called. ● If ciphertext is required and **security.ssl.encrypt.enabled** is set to **true** in the **flink-conf.yaml** file, the **generate_keystore.sh** script does not set **security.ssl.key-password**, **security.ssl.keystore-password**, and **security.ssl.truststore-password**. To obtain the values, use the Manager plaintext encryption API by running **curl -k -i -u** *Username*:*Password* **-X POST -HContent-type:application/json -d '{"plainText":"***Password***"}' 'https://***x.x.x.x***:28443/web/api/v2/tools/encrypt'**. In the preceding command, *Username*:*Password* indicates the user name and password for logging in to the system. The password of **"plainText"** is used to call the **generate_keystore.sh** script. *x.x.x.x* indicates the floating IP address of Manager. Commands carrying authentication passwords pose security risks. Disable historical command recording before running such commands to prevent information leakage. 2. Check whether **Security Cookie** is enabled. That is, check **security.enable: true** in the **flink-conf.yaml** file and check whether **security cookie** is configured. An example is as follows: `security.cookie: ae70acc9-9795-4c48-ad35-8b5adc8071744f605d1d-2726-432e-88ae-dd39bfec40a9`

Authentication Mode	Description	Configuration Method
		NOTE The validity period of the SSL certificate obtained by using the **generate_keystore.sh** script preset on the MRS client is 5 years. To disable the default SSL authentication mode, set **security.ssl.enabled** to **false** in the **flink-conf.yaml** file and comment out **security.ssl.key-password**, **security.ssl.keystore-password**, **security.ssl.keystore**, **security.ssl.truststore-password**, and **security.ssl.trustore**.
Internal authentication of Yarn	This authentication mode does not need to be configured by the user.	-

NOTE

One Flink cluster supports only one user. One user can create multiple Flink clusters.

Encrypted Transmission

Flink supports three encrypted transmission modes:

- Encrypted transmission inside Yarn: It is used between the Flink Yarn client and Yarn ResourceManager, as well as Yarn ResourceManager and JobManager.
- SSL transmission: SSL transmission is used between Flink Yarn client and JobManager, JobManager and TaskManager, as well as TaskManager and TaskManager.
- Encrypted transmission inside Hadoop: The internal encrypted transmission mode of Hadoop used between JobManager and HDFS, TaskManager and HDFS, JobManager and ZooKeeper, as well as TaskManager and ZooKeeper.

NOTE

Configuration about SSL encrypted transmission is mandatory while configuration about encryption of Yarn and Hadoop is not required.

To configure SSL encrypted transmission, configure the following parameters in the **flink-conf.yaml** file on the client:

1. Enable SSL and configure the SSL encryption algorithm. see **Table 5-18**. Modify the parameters as required.

Table 5-18 Parameter description

Parameter	Example Value	Description
security.ssl.enabled	true	Enable SSL.
akka.ssl.enabled	true	Enable Akka SSL.
blob.service.ssl.enabled	true	Enable SSL for the Blob channel.
taskmanager.data.ssl.enabled	true	Enable SSL transmissions between TaskManagers.
security.ssl.algorithms	TLS_DHE_RSA_WITH_AES_128_GCM_SHA256,TLS_ECDHE_RSA_WITH_AES_128_GCM_SHA256,TLS_DHE_RSA_WITH_AES_256_GCM_SHA384,TLS_ECDHE_RSA_WITH_AES_256_GCM_SHA384	Configure the SSL encryption algorithm.

NOTE

Enabling SSL for data transmission between TaskManagers may pose great impact on the system performance.

2. In the **bin** directory of the Flink client, run the ***sh generate_keystore.sh <password>*** command. For details, see **Authentication and Encryption**. The configuration items in **Table 5-19** are set by default. You can also configure them manually. Commands carrying authentication passwords pose security risks. Disable historical command recording before running such commands to prevent information leakage.

Table 5-19 Parameter description

Parameter	Example Value	Description
security.ssl.keystore	${path}/flink.keystore	Path for storing the **keystore**. **flink.keystore** indicates the name of the **keystore** file generated by the **generate_keystore.sh*** tool.
security.ssl.keystore-password	-	A user-defined password of **keystore**.
security.ssl.key-password	-	A user-defined password of the SSL key.

Parameter	Example Value	Description
security.ssl.truststore	${path}/flink.truststore	Path for storing the **truststore**. **flink.truststore** indicates the name of the **truststore** file generated by the **generate_keystore.sh*** tool.
security.ssl.truststore-password	-	A user-defined password of **truststore**.

NOTE

The **path** directory is a user-defined directory for storing configuration files of the SSL keystore and truststore.

3. Configure the path for the client to access the keystore or truststore file.
   - Relative path (recommended)

     Perform the following steps to set the file paths of **flink.keystore** and **flink.truststore** to relative paths and ensure that the directory where the Flink client command is executed can directly access the relative paths.

     i. In the **conf/** directory of the Flink client, create a directory, for example, **ssl**.

     cd / *Flink client directory*/**Flink/flink/conf/**

     mkdir ssl

     ii. Move the **flink.keystore** and **flink.truststore** files to the new paths.

     mv flink.keystore ssl/

     mv flink.truststore ssl/

     iii. Change the values of the following parameters to relative paths in the **flink-conf.yaml** file:

     vi / *Flink client directory*/**Flink/flink/conf/flink-conf.yaml**

     ```
     security.ssl.keystore: ssl/flink.keystore
     security.ssl.truststore: ssl/flink.truststore
     ```

   - Absolute path

     After the **generate_keystore.sh** script is executed, the **flink.keystore** and **flink.truststore** file paths are automatically set to absolute paths in the **flink-conf.yaml** file by default. In this case, you need to place the **flink.keystore** and **flink.truststore** files in the **conf** directory to the absolute paths of the Flink client and each Yarn node, respectively.

5.4.3 Configuring Kafka

Sample project data of Flink is stored in Kafka. A user with Kafka permission can send data to Kafka and receive data from it.

Step 1 Ensure that clusters, including HDFS, Yarn, Flink, and Kafka are installed.

Step 2 Create a topic.

- Run Linux command line to create a topic. Before running commands, ensure that the kinit command, for example, **kinit flinkuser**, is run for authentication.

  NOTE

  To create a Flink user, you need to have the permission to create Kafka topics.

  The format of the command is shown as follows, in which **{zkQuorum}** indicates ZooKeeper cluster information and the format is *IP.port*, and **{Topic}** indicates the topic name.

  bin/kafka-topics.sh --create --zookeeper {zkQuorum}/kafka --replication-factor 1 --partitions 5 --topic {Topic}

  Assume the topic name is **topic 1**. The command for creating this topic is displayed as follows:

  ```
  /opt/client/Kafka/kafka/bin/kafka-topics.sh --create --zookeeper 10.96.101.32:2181,10.96.101.251:2181,10.96.101.177:2181,10.91.8.160:2181/kafka --replication-factor 1 --partitions 5 --topic topic1
  ```

  NOTE

  The ZooKeeper cluster information is as follows:

  - Service IP address of the ZooKeeper quorumpeer instance:

    Log in to FusionInsight Manager and choose **Cluster** > **Services** > **ZooKeeper**. On the page that is displayed, click the **Instance** tab and view the service IP addresses of all nodes where the quorumpeer instances reside.

  - Port number of the ZooKeeper client:

    Log in to FusionInsight Manager and choose **Cluster** > **Services** > **ZooKeeper**. On the page that is displayed, click the **Configurations** tab. On this tab page, view the value of **clientPort**.

- Configure the permission of the topic on the server.

  Set the **allow.everyone.if.no.acl.found** parameter of Kafka Broker to **true**.

Step 3 Perform the security authentication.

The Kerberos authentication, SSL encryption authentication, or Kerberos + SSL authentication mode can be used.

- **Kerberos authentication**
  - Client configuration

    In the Flink configuration file **flink-conf.yaml**, add configurations about Kerberos authentication. For example, add **KafkaClient** in **contexts** as follows:

    ```
    security.kerberos.login.keytab: /home/demo/keytab/flinkuser.keytab
    security.kerberos.login.principal: flinkuser
    security.kerberos.login.contexts: Client,KafkaClient
    security.kerberos.login.use-ticket-cache: false
    ```

  - Running parameter

    Running parameters about the **SASL_PLAINTEXT** protocol are as follows:

    --topic topic1 --bootstrap.servers 10.96.101.32:21007 --security.protocol SASL_PLAINTEXT --sasl.kerberos.service.name kafka --kerberos.domain.name hadoop.*System domain name***.com //10.96.101.32:21007** indicates the IP address and port number of the Kafka server.

- **SSL encryption**
  - Configure the server.

Log in to FusionInsight Manager, choose **Cluster** > **Services** > **Kafka** > **Configurations**, and set **Type** to **All**. Search for **ssl.mode.enable** and set it to **true**.

- Configure the client.

  i. Log in to FusionInsight Manager, choose **Cluster** > ***Name of the desired cluster*** > **Services** > **Kafka** > **More** > **Download Client** to download Kafka client.

  ii. Use the **ca.crt** certificate file in the client root directory to generate the **truststore** file for the client.

  Run the following command:

  ```
  keytool -noprompt -import -alias myservercert -file ca.crt -keystore truststore.jks
  ```

  The command execution result is similar to the following:

  ```
  drwx------.  5 zgd  users     4096 Feb  4 16:22 .
  drwxr-xr-x. 10 zgd  users     4096 Jan 22 17:38 ..
  -rwx------.  1 zgd  users      135 Jan 22 17:31 application.properties
  -rwx------.  1 zgd  users      790 Jan 22 17:31 bigdata_env.sample
  -rw-------.  1 zgd  users     1322 Jan 22 17:31 ca.crt
  -rwx------.  1 zgd  users     4508 Jan 22 17:31 conf.py
  -rw-------.  1 zgd  users      120 Jan 22 17:31 hosts
  -rwx------.  1 zgd  users      745 Jan 22 17:31 install.bat
  -rwx------.  1 zgd  users    15082 Jan 22 17:31 install.sh
  drwx------.  2 zgd  users     4096 Jan 22 17:38 JDK
  -rwx------.  1 zgd  users 37021723 Jan 22 17:31 jython-standalone-2.7.0.jar
  drwx------.  5 zgd  users     4096 Jan 22 17:38 Kafka
  drwx------.  3 zgd  users     4096 Jan 22 17:38 KrbClient
  -rwx------.  1 zgd  users      473 Jan 22 17:31 log4j.properties
  -rwx------.  1 zgd  users     2107 Jan 22 17:31 README
  -rwx------.  1 zgd  users     6949 Jan 22 17:31 refreshConfig.sh
  -rwx------.  1 zgd  users     1736 Jan 22 17:31 switchuser.py
  -rw-r--r--   1 root root      1004 Feb  4 16:22 truststore.jks
  ```

  iii. Run parameters.

  The value of **ssl.truststore.password** must be the same as the password you entered when creating **truststore**. Run the following command to run parameters. Commands carrying authentication passwords pose security risks. Disable historical command recording before running such commands to prevent information leakage.

  ```
  --topic topic1 --bootstrap.servers 10.96.101.32:9093 --security.protocol SSL --ssl.truststore.location /home/zgd/software/FusionInsight_Kafka_ClientConfig/truststore.jks --ssl.truststore.password XXX
  ```

- **Kerberos+SSL encryption**

  After completing preceding configurations of the client and server of Kerberos and SSL, modify the port number and protocol type in running parameters to enable the Kerberos+SSL encryption mode.

  --topic topic1 --bootstrap.servers 10.96.101.32:21009 --security.protocol SASL_SSL --sasl.kerberos.service.name kafka --ssl.truststore.location --kerberos.domain.name hadoop.*System domain name***.com /home/zgd/software/FusionInsight_Kafka_ClientConfig/truststore.jks --ssl.truststore.password** *XXX*

----End

5.4.4 Configuring Pipeline

1. Configure files.

   - **nettyconnector.registerserver.topic.storage**: (Mandatory) Configures the path (on a third-party server) to information about IP address, port numbers, and concurrency of NettySink. For example:

     ```
     nettyconnector.registerserver.topic.storage: /flink/nettyconnector
     ```

- **nettyconnector.sinkserver.port.range**: (Mandatory) Configures the range of port numbers of NettySink. For example:
  ```
  nettyconnector.sinkserver.port.range: 28444-28843
  ```
- **nettyconnector.ssl.enabled**: Configures whether to enable SSL encryption between NettySink and NettySource. The default value is **false**. For example:
  ```
  nettyconnector.ssl.enabled: true
  ```

2. Configure security authentication.
   - SASL authentication of ZooKeeper depends on the HA configuration in the **flink-conf.yaml** file.
   - SSL configurations such as keystore, truststore, keystore password, truststore password, and password inherit from **flink-conf.yaml**. For details, see **Encrypted Transmission**.

5.5 Configuring and Developing a Flink Visualization Job

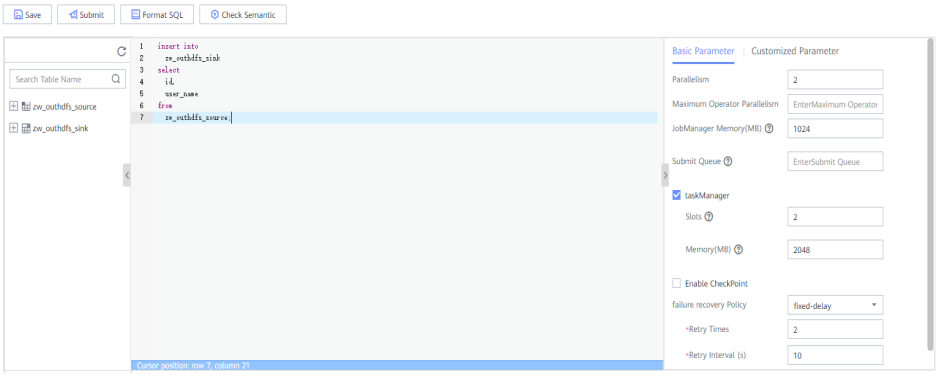
5.5.1 Introduction to Flink Web UI

Flink web UI provides a web-based visual development platform. You only need to compile SQL statements to develop jobs, slashing the job development threshold. In addition, the exposure of platform capabilities allows service personnel to compile SQL statements for job development to quickly respond to requirements, greatly reducing the Flink job development workload.

Flink Web UI Features

The Flink web UI has the following features:

- Enterprise-class visual O&M: GUI-based O&M management, job monitoring, and standardization of Flink SQL statements for job development.



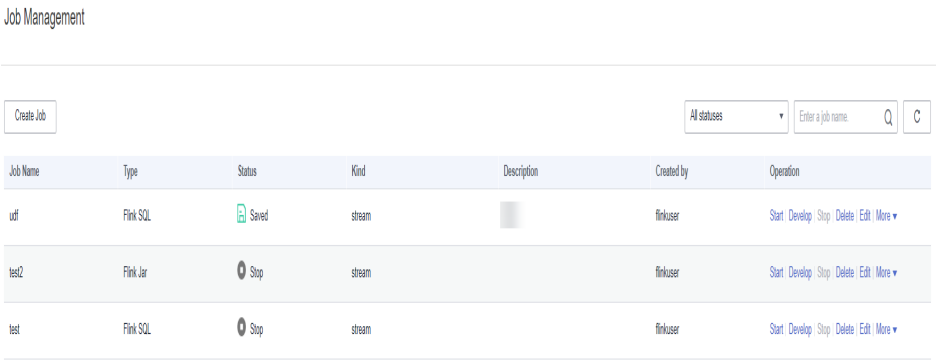
- Quick cluster connection: After configuring the client and user credential key file, you can quickly access a cluster using the cluster connection function.
- Quick data connection: You can access a component by configuring the data connection function. If **Data Connection Type** is set to **HDFS**, you need to create a cluster connection. If **Authentication Mode** is set to **KERBEROS** for other data connection types, you need to create a cluster connection. If

Authentication Mode is set to **SIMPLE**, you do not need to create a cluster connection.

NOTE

If **Data Connection Type** is set to **Kafka**, **Authentication Type** cannot be set to **KERBEROS**.

- Visual development platform: The input/output mapping table can be customized to meet the requirements of different input sources and output destinations.
- Easy to use GUI-based job management



Key Web UI Capabilities

Table 5-20 shows the key capabilities provided by Flink web UI.

Table 5-20 Key web UI capabilities

Item	Description
Batch-Stream convergence	• Batch jobs and stream jobs can be processed with a unified set of Flink SQL statements.
Flink SQL kernel capabilities	• Flink SQL supports customized window size, stream compute within 24 hours, and batch processing beyond 24 hours. • Flink SQL supports reading data from Kafka and HDFS, writing data to Kafka, Redis, and HDFS, and joining Redis dimension tables. • A job can define multiple Flink SQL jobs, and multiple metrics can be combined into one job for computing. If a job contains same primary keys as well as same inputs and outputs, the job supports the computing of multiple windows. • The AVG, SUM, COUNT, MAX, and MIN statistical methods are supported.

Item	Description
Flink SQL functions on the console	• Cluster connection management allows you to configure clusters where services such as Kafka, Redis, and HDFS deployed. • Data connection management allows you to configure services such as Kafka, Redis, and HDFS. • Data table management allows you to define data tables accessed by SQL statements and generate DDL statements. • Flink SQL job definition allows you to verify, parse, optimize, convert a job into a Flink job, and submit the job for running based on the entered SQL statements.
Flink job visual management	• Stream jobs and batch jobs can be defined in a visual manner. • Job resources, fault recovery policies, and checkpoint policies can be configured in a visual manner. • Status monitoring of stream and batch jobs are supported. • The Flink job O&M is enhanced, including redirection of the native monitoring page.
Performance and reliability	• Stream processing supports 24-hour window aggregation computing and millisecond-level performance. • Batch processing supports 90-day window aggregation computing, which can be completed in minutes. • Invalid data of stream processing and batch processing can be filtered out. • When HDFS data is read, the data can be filtered based on the calculation period in advance. • Data in Flink jobs comes from Redis. If fault recovery policies have been set for Flink jobs, data is read from Redis during calculation and no data is lost when a job is faulty. • If the job definition platform is faulty or the service is degraded, jobs cannot be redefined, but the computing of existing jobs is not affected. • The automatic restart mechanism is provided for job failures. You can configure restart policies.

Flink Web UI Application Process

The Flink web UI application process is shown as follows:

Figure 5-2 Flink web UI application process

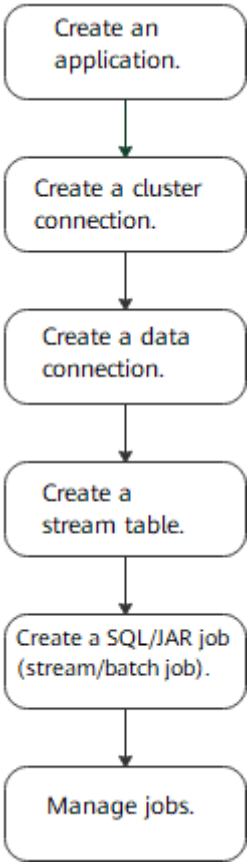


Table 5-21 Description of the Flink web UI application process

Step	Description	Reference
Creating an application	Applications can be used to isolate different upper-layer services.	**Creating an Application**
Creating a cluster connection	Different clusters can be accessed by configuring the cluster connection.	**Creating a Cluster Connection**
Creating a Data Connection	Through data connections, you can access different data services, including HDFS, Redis, and Kafka.	**Creating a Data Connection**
Creating a stream table	Data tables can be used to define basic attributes and parameters of source tables, dimension tables, and output tables.	**Creating a Stream Table**
Creating a SQL/JAR job (stream/batch job)	APIs can be used to define Flink jobs, including Flink SQL and Flink Jar jobs.	**Creating a Job**

Step	Description	Reference
Managing jobs	A created job can be managed, including starting, developing, stopping, deleting, and editing the job.	Creating a Job

5.5.2 Flink Web UI Permission Management

To access and use the Flink web UI to perform service operations, you need to assign FlinkServer-related permissions to users. User **admin** on FusionInsight Manager does not have FlinkServer service operation permissions.

Applications (tenants) in FlinkServer are the maximum management scope, including cluster connection management, data connection management, application management, stream table management, and job management.

There are three types of resource permissions for FlinkServer, as shown in **Table 5-22**.

Table 5-22 FlinkServer resource permissions

Name	Description	Remarks
FlinkServer administrator permission	Users who have the permission can edit and view all applications.	This is the highest-level permission of FlinkServer. If you have the FlinkServer administrator permission, you have the permission on all applications by default.
Application edit permission	Users who have the permission can create, edit, and delete cluster connections and data connections. They can also create stream tables as well as create and run jobs.	In addition, users who have the permission can view current applications.
Application view permission	Users who have the permission can view applications.	-

5.5.3 Creating a FlinkServer Role

Create and configure a FlinkServer role on Manager as an MRS cluster administrator. A FlinkServer role can be configured with the FlinkServer administrator permission and the permissions to edit and view applications.

You need to set permissions for the specified user in FlinkServer so that they can update, query, and delete data.

Prerequisites

The cluster administrator has planned permissions based on service requirements.

Procedure

Step 1 Log in to Manager.

Step 2 Choose **System** > **Permission** > **Role**.

Step 3 On the displayed page, click **Create Role** and specify **Role Name** and **Description**.

Step 4 Set **Configure Resource Permission**.

FlinkServer permissions are as follows:

- **FlinkServer Admin Privilege**: highest-level permission. Users with the permission can perform service operations on all FlinkServer applications.
- **FlinkServer Application**: Users can set **application view** and **applications management** permissions on applications.

Table 5-23 Setting a role

Scenario	Role Authorization
Setting the FlinkServer administrator permission	In **Configure Resource Permission**, choose *Name of the desired cluster* > **Flink** and select **FlinkServer Admin Privilege**.
Setting FlinkServer application permissions	In the **Configure Resource Permission** table, choose *Name of the desired cluster* > **Flink** > **FlinkServer Application**. In the **Permission** column, select **application view** or **applications management**.

Step 5 Click **OK**. Return to role management page.

Step 6 (Optional) Create a user with FlinkServer-related permissions.

After the FlinkServer role is created, create a FlinkServer user and bind the user to the configured FlinkServer role and user group. For details, see "FusionInsight Manager Operation Guide" > "System Configuration" > "Configuring Permission" > "Managing Users" > "Creating a User" in *MapReduce Service User Guide*.

----End

5.5.4 Accessing the Flink Web UI

Scenario

After Flink is installed in an MRS cluster, you can connect to clusters and data as well as manage stream tables and jobs using the Flink web UI.

This section describes how to access the Flink web UI in an MRS cluster.

Impact on the System

Site trust must be added to the browser when you access Manager and the Flink web UI for the first time. Otherwise, the Flink web UI cannot be accessed.

Procedure

Step 1 Log in to FusionInsight Manager as a user with **FlinkServer Admin Privilege**. Choose **Cluster** > **Services** > **Flink**.

NOTE

If your MRS cluster requires Kerberos authentication, create a role with the FlinkServer administrator permission or the application viewing and editing permission, and bind the role to the user. Then, you can access the Flink Web UI. For details about how to create a role, see **Creating a FlinkServer Role**.

Step 2 On the right of **Flink WebUI**, click the link to access the Flink web UI.

The Flink web UI provides the following functions:

- System management:
  - Cluster connection management allows you to create, view, edit, test, and delete a cluster connection.
  - Data connection management allows you to create, view, edit, test, and delete a data connection. Data connection types include HDFS, Redis, and Kafka.
  - The import function allows you to import jobs, UDFs, and stream tables.
  - The export function allows you to export jobs, UDFs, and stream tables.
  - Application management allows you to create, view, and delete an application.
- UDF management allows you to upload and manage UDF JAR packages and customize functions to extend SQL statements to meet personalized requirements.
- Stream table management allows you to create, view, edit, and delete a stream table.
- Job management allows you to create, view, start, develop, edit, stop, and delete a job.

----End

5.5.5 Creating an Application

Scenario

Applications can be used to isolate different upper-layer services.

Creating an Application

Step 1 Access the Flink web UI as a user with **FlinkServer Admin Privilege**. For details, see **Accessing the Flink Web UI**.

Step 2 Choose **System Management** > **Application Management**.

Step 3 Click **Create Application**. On the displayed page, set parameters and click **OK**.

After the application is created, you can switch to the application to be operated in the upper left corner of the Flink web UI and develop jobs.

----End

5.5.6 Creating a Cluster Connection

Scenario

Different clusters can be accessed by configuring the cluster connection.

Creating a Cluster Connection

Step 1 Access the Flink web UI. For details, see **Accessing the Flink Web UI**.

Step 2 Choose **System Management** > **Cluster Connection Management**. The **Cluster Connection Management** page is displayed.

Step 3 Click **Create Cluster Connection**. On the displayed page, set parameters by referring to **Table 5-24** and click **OK**. After the cluster connection is created, you can edit, test, or delete the cluster connection in the **Operation** column.

Table 5-24 Parameters for creating a cluster connection

Parameter	Description
Cluster Connection Name	Enter the name of the cluster connection.
Description	Enter the description of the cluster connection name.
FusionInsight HD Version	Set a cluster version.
Secure Version	• If the secure version is used, select **Yes** for a security cluster. Enter the username and upload the user credential. • If not, select **No**.
Username	The user must have the minimum permissions for accessing services in the cluster. This parameter is available only when **Secure Version** is set to **Yes**.
Client Profile	Client profile of the cluster, in TAR format.
User Credential	User authentication credential in FusionInsight Manager in TAR format. This parameter is available only when **Secure Version** is set to **Yes**. Files can be uploaded only after the username is entered.

NOTE

To obtain the cluster client configuration files, perform the following steps:

1. Log in to FusionInsight Manager.
2. In the upper right area of the dashboard page, choose **Download Client** > **Configuration Files Only**, select a platform type, and click **OK**.

To obtain the user credential, perform the following steps:

1. Log in to FusionInsight Manager and click **System**.
2. In the **Operation** column of the user, choose **More** > **Download Authentication Credential**, select a cluster, and click **OK**.

----End

5.5.7 Creating a Data Connection

Scenario

You can use data connections to access different data services. Currently, FlinkServer supports HDFS, Redis, and Kafka data connections.

Creating a Data Connection

Step 1 Access the Flink web UI. For details, see **Accessing the Flink Web UI**.

Step 2 Choose **System Management** > **Data Connection Management**. The **Data Connection Management** page is displayed.

Step 3 Click **Create Data Connection**. On the displayed page, select a data connection type, enter information by referring to **Table 5-25**, and click **OK**. After the data connection is created, you can edit, test, or delete the data connection in the **Operation** column.

Table 5-25 Parameters for creating a data connection

Parameter	Description	Example Value
Data Connection Type	Type of the data connection, which can be **HDFS**, **Redis**, or **Kafka**.	-
Data Connection Name	Name of the data connection.	-
Cluster Connection	Cluster connection name in configuration management. This parameter is mandatory for HDFS data connections and Redis data connections whose authentication type is **KERBEROS**.	-

Parameter	Description	Example Value
Kafka broker	Connection information about Kafka broker instances. The format is *IP address:Port number*. Use commas (,) to separate multiple instances. This parameter is mandatory for Kafka data connections.	192.168.0.1:21005,192.168.0.2:21005
Redis Deployment Method	Redis deployment mode. Currently, only **Cluster** is supported. This parameter is mandatory for Redis data connections.	Cluster
Redis Server List	Connection information about Redis instances. The format is *IP address:Port number*. Use commas (,) to separate multiple instances. This parameter is mandatory for Redis data connections.	192.168.0.1:22400,192.168.0.2:22400
Authentication Mode	• **SIMPLE**: indicates that the connected service is in non-security mode and does not need to be authenticated. • **KERBEROS**: indicates that the connected service is in security mode and the Kerberos protocol for security authentication is used for authentication. This parameter is mandatory for Redis data connections.	-
Redis SSL ON	Whether to enable SSL. This parameter is mandatory for Redis data connections.	-

----End

5.5.8 Creating a Stream Table

Scenario

Data tables can be used to define basic attributes and parameters of source tables, dimension tables, and output tables.

Creating a Stream Table

Step 1 Access the Flink web UI. For details, see **Accessing the Flink Web UI**.

Step 2 Click **Table Management**. The table management page is displayed.

Step 3 Click **Create Stream Table**. On the stream table creation page, set parameters by referring to **Table 5-26** and click **OK**. After the stream table is created, you can edit or delete the stream table in the **Operation** column.

Table 5-26 Parameters for creating a stream table

Parameter	Description	Remarks
Stream/Table Name	Stream/Table name	Example: **flink_sink**
Description	Stream/Table description information	-
Mapping Table Type	Flink SQL does not provide the data storage function. Table creation is actually the creation of mapping for external data tables or storage. The value can be **Kafka**, **Redis**, or **HDFS**.	-
Type	Includes data source table **Source**, data dimension table **Table**, and data result table **Sink**. Tables included in different mapping table types are as follows: • Kafka: **Source** and **Sink** • HDFS: **Source** and **Sink** • Redis: **Sink** and **Table**	-
Data Connection	Name of the data connection	-
Topic	Kafka topic to be read. Multiple Kafka topics can be read. Use separators to separate topics. This parameter is available when **Mapping Table Type** is set to **Kafka**.	-
File Path	HDFS directory or a single file path to be transferred. This parameter is available when **Mapping Table Type** is set to **HDFS**.	Example: **/user/sqoop/** or **/user/sqoop/example.csv**

Parameter	Description	Remarks
Code	Codes corresponding to different mapping table types are as follows: • Kafka: **CSV** and **JSON** • HDFS: **CSV** • Redis: – If **Type** is set to **Sink**, the value can be **String**, **List**, **Set**, **Zset**, or **Hash**. – If **Type** is set to **Table**, the value can be **String** or **Zset**.	-
Prefix	When **Mapping Table Type** is set to **Kafka**, **Type** is set to **Source**, and **Code** is set to **JSON**, this parameter indicates the hierarchical prefixes of multi-layer nested JSON, which are separated by commas (,).	For example, **data,info** indicates that the content under **data** and **info** in the nested JSON file is used as the data input in JSON format.
	If **Mapping Table Type** is set to **Redis**, prefixes will be automatically added to the key or you can manually enter prefixes.	For example, if the key value is **key1** and the prefix is **test**, the key written to Redis is **test:key1**.
Separator	Has different meanings when **Mapping Table Type** is set to the following values: • **Kafka**: used as the separator of specified CSV fields. This parameter is available when **Code** is set to **CSV**. • **Redis**: used as the field separator.	Example: comma (**,**)
Row Separator	Line break in the file, including **\r**, **\n**, and **\r\n**. This parameter is available when **Mapping Table Type** is set to **HDFS**.	-
Column Separator	Field separator in the file. This parameter is available when **Mapping Table Type** is set to **HDFS**.	Example: comma (**,**)
Data Validity Period	Data validity period, which can be **Permanent**, **Effective Duration**, or **Deadline**. This parameter is available when **Mapping Table Type** is set to **Redis** and **Type** is set to **Sink**.	-

Parameter	Description	Remarks
Stream Table Structure	Stream/Table structure, including **Name** and **Type**.	-
Proctime	System time, which is irrelevant to the data timestamp. That is, the time when the calculation is complete in Flink operators. This parameter is available when **Type** is set to **Source**.	-
Event Time	Time when an event is generated, that is, the timestamp generated during data generation. This parameter is available when **Type** is set to **Source**.	-

----End

5.5.9 Creating a Job

Scenario

Define Flink jobs, including Flink SQL and Flink JAR jobs.

Creating a Job

Step 1 Access the Flink web UI. For details, see **Accessing the Flink Web UI**.

Step 2 Click **Job Management**. The job management page is displayed.

Step 3 Click **Create Job**. Create a Flink SQL job or Flink Jar job, enter job information, and click **OK**. The job is created and the job development page is displayed.

NOTE

An application cannot have duplicate job names.

Step 4 (Optional) To develop a job immediately, configure the job on the job development page.

The system allows you to add a lock to a job. The user who locks the job has all permissions of the job. Other users do not have the permissions to develop, start, or delete the locked job. However, they can forcibly acquire the lock to obtain all permissions. After this function is enabled, you can **Lock** and **Unlock** a job, or click **Acquire Lock** to obtain job permissions.

NOTE

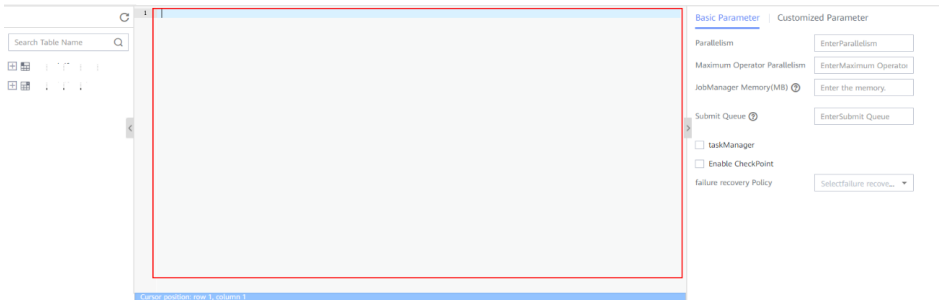
Job locks are enabled by default. You can view the status of this function on FusionInsight Manager.

Log in to FusionInsight Manager, choose **Cluster** > **Service** > **Flink**, click **Configuration** and then **All Configurations**, and search for the **job.edit.lock.enable** parameter. If the parameter value is **true**, the function is enabled. If the parameter value is **false**, the function is disabled.

- Creating a Flink SQL job

  a. Develop the job on the job development page.

  Figure 5-3 Developing a Flink SQL job

  b. Click **Check Semantic** to check the input content and click **Format SQL** to format SQL statements.

  c. After the job SQL statements are developed, set basic and customized parameters as required by referring to **Table 5-27** and click **Save**.

  Table 5-27 Basic parameters

Parameter	Description
Parallelism	Number of parallel jobs
Maximum Operator Parallelism	Maximum degree of parallelism of operators
JobManager Memory (MB)	Memory of JobManager The minimum value is **4096**.
Submit Queue	Queue to which a job is submitted. If this parameter is not set, the **default** queue is used.
taskManager	taskManager running parameters include: ■ **Slots**: The default value is **1**. You are advised to set this parameter to the number of CPU cores. ■ **Memory (MB)**: The minimum value is **4096**.

Parameter	Description
Enable CheckPoint	Whether to enable CheckPoint. After CheckPoint is enabled, you need to configure the following information: ■ **Time Interval (ms)**: This parameter is mandatory. ■ **Mode**: This parameter is mandatory. The options are **EXACTLY_ONCE** and **AT_LEAST_ONCE**. ■ **Minimum Interval (ms)**: The minimum value is **10**. ■ **Timeout Duration**: The minimum value is **10**. ■ **Maximum Parallelism**: The value must be a positive integer containing a maximum of 64 characters. ■ **Whether to clean up**: This parameter can be set to **Yes** or **No**. ■ **Whether to enable incremental checkpoints**: This parameter can be set to **Yes** or **No**.
Failure Recovery Policy	Failure recovery policy of a job. The options are as follows. For details, see **Flink Restart Policy**. ■ **fixed-delay**: You need to configure **Retry Times** and **Retry Interval (s)**. ■ **failure-rate**: You need to configure **Max Retry Times**, **Interval (min)**, and **Retry Interval (s)**. ■ **none**

NOTE

There are two modes available for failure recovery policies: NO_CLAIM and CLAIM.

- **CLAIM** (default mode): CheckPoint files that are not used for restoration are automatically deleted.
- **NO_CLAIM**: CheckPoint files are not automatically deleted.

Table 5-28 Custom parameters

Parameter	Description	Example Value
table.optimizer.enriched-predicate-pushdown-enabled	Whether to enable the predicate pushdown function. When you execute complex Flink SQL jobs, you can add this parameter to improve the execution performance.	true

d. Click **Submit** in the upper left corner to submit the job.

- Creating a Flink JAR job

a. Click **Select** to upload a local JAR file and set parameters by referring to **Table 5-29** or add customized parameters.

Table 5-29 Parameter configuration

Parameter	Description
Local .jar File	Upload a local JAR file. Upload a local file whose size cannot exceed the threshold specified by **flinkserver.upload.jar.max.size**. The default value is **500 MB**. Log in to FusionInsight Manager, choose **Cluster** > **Services** > **Flink** > **Configurations** > **All Configurations**, search for **flinkserver.upload.jar.max.size**, and set the JAR file threshold. The value ranges from **100 MB** to **5,120 MB**.
Main Class	Main-Class type. ▪ **Default**: By default, the class name is specified based on the **Mainfest** file in the JAR file. ▪ **Specify**: Manually specify the class name.
Type	Class name. This parameter is available when **Main Class** is set to **Specify**.
Class Parameter	Class parameters of Main-Class (parameters are separated by spaces).

Parameter	Description
Parallelism	Number of parallel jobs Concurrent tasks of each job operator. Appropriately increasing the value will improve the overall computing performance of a job. Considering switchover overheads due to increasing threads, the maximum value is four times the number of SPUs used by the computing unit. One to two times the number of SPUs of the computing unit is the optimal.
JobManager Memory (MB)	Memory of JobManager The minimum value is **4096**.
Submit Queue	Queue to which a job is submitted. If this parameter is not set, the **default** queue is used.
taskManager	taskManager running parameters include: ▪ **Slots**: The default value is **1**. You are advised to set this parameter to the number of CPU cores. ▪ **Memory (MB)**: The minimum value is **4096**.

b. Click **Save** to save the configuration and click **Submit** to submit the job.

Step 5 Return to the job management page. You can view information about the created job, including job name, type, status, kind, and description.

After a job is created, you can start, develop, stop, edit, and delete the job, view job details, and rectify checkpoint faults in the **Operation** column of the job.

NOTE

- To read files related to the submitted job on the node as another user, ensure that the user and the user who submitted the job belong to the same user group and the user has been assigned the FlinkServer application management role. For example, **application view** is selected by referring to **Creating a FlinkServer Role**.
- You can view details about jobs in the **Running** state.
- You can rectify checkpoint faults for jobs in the **Running failed**, **Running succeeded**, or **Stop** state.

----End

5.5.10 Restoring a Job

If the checkpoint function is enabled for a Flink job that once has run, the job can be restored from a specified checkpoint and re-executed at the checkpoint. You can also restore a Flink job from a specified savepoint or create a savepoint after the job is submitted. You stop the job, create a savepoint, and re-execute the job from that savepoint.

You can delete specified checkpoints and savepoints of jobs in the **Failed**, **Running succeeded**, **Submission failed**, **Stopped**, **Draft**, or **Saved** state.

Restoring a Job from a Checkpoint

You can rectify faults with checkpoints for jobs in the **Failed**, **Running succeeded**, or **Stopped** state.

Step 1 Check that the checkpoint function has been enabled for the job.

You can check whether checkpoint is enabled for the job management page mentioned in **Creating a Job**. If the function is disabled, no checkpoint can be specified to restore the job.

Step 2 (Optional) Set the number of checkpoints.

Log in to FusionInsight Manager, choose **Cluster** > **Services** > **Flink**, click **Configurations** and then **All Configurations**. Search for **state.checkpoints.num-retained**, and set the number of checkpoints. The default value is **5**.

Step 3 Specify a checkpoint to restore the job.

1. Access the Flink web UI by referring to **Accessing the Flink Web UI**.
2. Click **Job Management**. The job management page is displayed.
3. In the **Operation** column of the job you want to restore, click **More** to expand options.
   - **Restore from a Checkpoint**: The checkpoint list of the job is displayed. The number of checkpoints is the same as the value of **state.checkpoints.num-retained** you set in **Step 2**. Select a checkpoint to restore the job.
   - **Restore from Latest Checkpoint**: The job will be restored from the latest checkpoint.

----End

Restoring a Job from a Savepoint

- A job in the **Running** state can be stopped, and a savepoint can be created for the job.
- Savepoint can be used restore jobs in the **Failed**, **Running succeeded**, or **Stopped** state.

Step 1 (Optional) Set the savepoint directory used by Flink to restore and update jobs.

Log in to FusionInsight Manager, choose **Cluster** > **Services** > **Flink**, click **Configurations** > **All Configurations**, and search for **state.backend.fs.savepointdir**. In the **Flink-> FlinkServer** option, set this parameter to the savepoint directory. The default value is **hdfs://hacluster/flink/savepoint**.

Step 2 Specify a savepoint to restore the job.

1. Access the Flink web UI by referring to **Accessing the Flink Web UI**.
2. Click **Job Management**. The job management page is displayed.
3. In the **Operation** column of the target job, choose **More** > **Stop and Keep Savepoint**. Stop the job as prompted and save the savepoint of the job.

NOTE

- If the job has saved a historical savepoint, skip this step and select one to restore the job.
- After you click **Stop and Keep Savepoint**, the system deletes the latest checkpoint. In this case, you cannot restore jobs from the latest checkpoint. Select a historical savepoint instead.

4. Choose **More** > **Restore from a Savepoint** in the **Operation** column and restore the job as prompted.

----End

5.5.11 Configuring Dependency Management

Flink allows you to run user-defined Flink jobs using third-party dependency packages. You can upload and manage dependency JAR packages on the Flink web UI and invoke required dependencies when running jobs. The dependency management function does not support semantic verification. A dependency JAR package name must start with a letter, digit, or underscore (_) and cannot exceed 32 characters. The following third-party dependencies are supported:

- Custom connector dependency: After a custom connector JAR package is uploaded, **Dependency Type** is **connector** on the Flink web UI.
- Non-custom connector dependency: After a non-custom connector JAR package, such as a job dependency package, is uploaded, **Dependency Type** is **normal** on the Flink web UI.

Prerequisites

Prepare dependency files. If you upload dependencies to the cluster by specifying a path, you need to create an HDFS path and upload the JAR package to HDFS.

Uploading Dependency Packages

Step 1 Log in to FusionInsight Manager and access the Flink web UI. For details, see **Accessing the Flink Web UI**.

Step 2 Click **Dependency Management**. The **Dependency Management** page is displayed.

Step 3 Click **Add Dependency**.

Table 5-30 Adding a dependency

Parameter	Description	Example
Customized connector or not	Whether the dependency is a custom connector. Set this parameter based on the site requirements. • **Yes**: The file is a custom connector dependency. • **No**: The file is a non-custom connector dependency.	Yes

Parameter	Description	Example
Name	Name of the dependency, which must be the same as the connection name of connector in the uploaded dependency package Dependency packages with the same name cannot be uploaded.	kafka
Register jar	Upload method of a JAR package: • **Upload File**: Upload a JAR package form the local host. • **Specify Path**: Upload a prepared dependency file from an HDFS path.	Upload File
Upload File	If **Register jar** is set to **Upload File**, select a JAR file from the local host.	-
Specify Path	If **Register jar** is set to **Specify Path**, enter the HDFS path of the dependency file. (The JAR package must have been uploaded to the HDFS.)	/flink_upload_test/flink-connector-kafka-customization.jar
Description	Description of the dependency to be uploaded.	-

Step 4 Click **OK**

----End

Example

- Custom connector dependencies
  a. Upload a custom connector dependency by referring to **Uploading Dependency Packages**.

     For example, the dependency name is **kafka**, and the name of the custom connector JAR package is **flink-connector-kafka-customization.jar**.
  b. Create a SQL job by referring to **Creating a Job**. Set **connector** in the SQL statement to the dependency name, for example, **'connector'='kafka'**.

```
CREATE TABLE KafkaSinkTable (`user_id` INT, `name` VARCHAR) WITH (
  'connector' = 'kafka',
  'topic' = 'test_sink6',
  'properties.bootstrap.servers' = '192.168.20.134:21005',
  'properties.group.id' = 'testGroup',
  'scan.startup.mode' = 'earliest-offset',
  'format' = 'csv'
);
CREATE TABLE datagen (`user_id` INT, `name` VARCHAR) WITH (
  'connector' = 'datagen',
  'rows-per-second' = '5',
  'fields.user_id.kind' = 'sequence',
  'fields.user_id.start' = '1',
  'fields.user_id.end' = '1000'
```

```
);
insert INTO
  KafkaSinkTable
select
  *
from
  datagen;
```

- Non-Custom connector dependencies

  Upload a non-custom connector dependency for a job. For details, see **Uploading Dependency Packages**.

5.5.12 Configuring and Managing UDFs

You can customize functions to extend SQL statements to meet personalized requirements. These functions are called user-defined functions (UDFs). You can upload and manage UDF JAR files on the Flink web UI and call UDFs when running jobs.

Flink supports the following three types of UDFs, as described in **Table 5-31**.

Table 5-31 Function classification

Type	Description
User-defined Scalar function (UDF)	Supports one or more input parameters and returns a single result value. For details, see **UDF Java and SQL Examples**.
User-defined aggregation function (UDAF)	Aggregates multiple records into one value. For details, see **UDAF Java and SQL Examples**.
User-defined table-valued function (UDTF)	Supports one or more input parameters and returns multiple rows or columns. For details, see **UDTF Java and SQL Examples**.

Prerequisites

You have prepared a UDF JAR file whose size does not exceed 200 MB.

Uploading a UDF

Step 1 Access the Flink web UI. For details, see **Accessing the Flink Web UI**.

Step 2 Click **UDF Management**. The **UDF Management** page is displayed.

Step 3 Click **Add UDF**. Select and upload the prepared UDF JAR file for **Local .jar File**.

Step 4 Enter the UDF name and description and click **OK**.

NOTE

- A maximum of 10 UDF names can be added. **Name** can be customized. **Type** must correspond to the UDF in the uploaded UDF JAR file.
- After the UDF JAR file is uploaded, the server retains the file for 5 minutes by default. If you click **OK** within 5 minutes, the UDF creation is complete. If you click **OK** after 5 minutes, the UDF creation fails and an error message is displayed, indicating that the local UDF file path is incorrect.

Step 5 In the UDF list, you can view information about all UDFs in the current application. You can edit or delete UDF information in the **Operation** column. (Only unused UDF items can be deleted.)

Step 6 (Optional) If you need to run or develop a job immediately, configure the job on the **Job Management** page. For details, see **Creating a Job**.

----End

UDF Java and SQL Examples

- UDF Java example

```
package com.xxx.udf;
import org.apache.flink.table.functions.ScalarFunction;
public class UdfClass_UDF extends ScalarFunction {
    public int eval(String s) {
        return s.length();
    }
}
```

- UDF SQL example

```
CREATE TEMPORARY FUNCTION udf as 'com.xxx.udf.UdfClass_UDF';
CREATE TABLE udfSource (a VARCHAR) WITH ('connector' = 'datagen','rows-per-second'='1');
CREATE TABLE udfSink (a VARCHAR,b int) WITH ('connector' = 'print');
INSERT INTO
  udfSink
SELECT
  a,
  udf(a)
FROM
  udfSource;
```

UDAF Java and SQL Examples

- UDAF Java example

```
package com.xxx.udf;
import org.apache.flink.table.functions.AggregateFunction;
public class UdfClass_UDAF {
    public static class AverageAccumulator  {
        public int sum;
    }
    public static class Average extends AggregateFunction<Integer, AverageAccumulator> {
        public void accumulate(AverageAccumulator acc, Integer value) {
            acc.sum += value;
        }
        @Override
        public Integer getValue(AverageAccumulator acc) {
            return acc.sum;
        }
        @Override
        public AverageAccumulator createAccumulator() {
            return new AverageAccumulator();
        }
    }
}
```

- UDAF SQL example

```
CREATE TEMPORARY FUNCTION udaf as 'com.xxx.udf.UdfClass_UDAF$Average';
CREATE TABLE udfSource (a int) WITH ('connector' = 'datagen','rows-per-
second'='1','fields.a.min'='1','fields.a.max'='3');
CREATE TABLE udfSink (b int,c int) WITH ('connector' = 'print');
INSERT INTO
  udfSink
SELECT
  a,
  udaf(a)
FROM
  udfSource group by a;
```

UDTF Java and SQL Examples

- UDTF Java example

```
package com.xxx.udf;
import org.apache.flink.api.java.tuple.Tuple2;
import org.apache.flink.table.functions.TableFunction;
public class UdfClass_UDTF extends TableFunction<Tuple2<String, Integer>> {
    public void eval(String str) {
        Tuple2<String, Integer> tuple2 = Tuple2.of(str, str.length());
        collect(tuple2);
    }
}
```

- UDTF SQL example

```
CREATE TEMPORARY FUNCTION udtf as 'com.xxx.udf.UdfClass_UDTF';
CREATE TABLE udfSource (a VARCHAR) WITH ('connector' = 'datagen','rows-per-second'='1');
CREATE TABLE udfSink (b VARCHAR,c int) WITH ('connector' = 'print');
INSERT INTO
  udfSink
SELECT
  str,
  strLength
FROM
  udfSource,lateral table(udtf(udfSource.a)) as T(str,strLength);
```

5.5.13 Configuring the FlinkServer UDF Sandbox

You can upload third-party JAR packages, such as UDFs and dependencies, on the Flink web UI based on job requirements, and invoke dependencies when verifying and running SQL jobs. To ensure that the uploaded JAR file is secure, the sandbox function is enabled for Flink by default. You can set the sandbox permission by setting the **flinkserver.security.policy** parameter by referring to **Configuring Permission of a Specified JAR Package** and disable the sandbox by setting the **security.manager.enabled** parameter by referring to **Disabling the FlinkServer Sandbox**.

Permissions

A permission consists of the type (mandatory), name, and allowed operation.

- Default permission
  - Property read permission: **permission java.util.PropertyPermission "*", "read"**
  - Socket permission, allowing **connect** and **resolve** to all ports: **permission java.net.SocketPermission "*", "connect,resolve"**
- Standard permission

Table 5-32 File permission

Type	Name	Allowed Operation	Example
java.io.FilePermission	• Name of a specified file • -: all files in the directory and subdirectories • *: all files in the directory	• read • write • delete • execute	• The following permission allows all files to be read, written, deleted, and executed: **permission java.io.FilePermission "<< ALL FILES>>", "read,write,delete,execute";** • The following permission allows the read of the user's home directory: **permission java.io.FilePermission "${user.home}/-", "read";**

Table 5-33 Socket permission

Type	Name	Allowed Operation	Examples
java.net.SocketPermission	• *Hostname*:*Port* • *: all addresses and ports	• accept • listen • connect • resolve	• The following permission allows all socket operations: **permission java.net.SocketPermission ":1-", "accept,listen,connect,resolve";** • The following permission allows the establishment of connections to and resolution of specific websites: **permission java.net.SocketPermission ".abc.com:1-", "connect,resolve";**

Table 5-34 Property permission

Type	Name	Allowed Operation	Examples
java.util.PropertyPermission	JVM property name to be accessed	• read • write	The following permission allows standard read of Java properties: **permission java.util.PropertyPermission "java.", "read";**

Table 5-35 Runtime permission

Type	Name
java.lang.RuntimePermission	• **accessDeclaredMembers**: allows code to use reflection to access private or protected members in other classes. • **createClassLoader**: allows code to create a class loader instance. • **createSecurityManager**: allows code to create a security manager instance, which will allow programmatic implementations to control the sandbox. This is a high-risk operation. With this permission, the UDF can modify or disable the **SecurityManager** of a service. • **exitVM**: allows the code to shut down the entire VM. • **getClassLoader**: allows code to access the class loader to obtain a specific class. • **setContextClassLoader**: allows code to set the context class loader for a thread. • **setFactory**: allows code to create a socket factory. • **setIO**: allows code to redirect **System.in** and **System.out** or **System.err** input and output streams. • **setSecurityManager**: allows code to set the security manager. • **stopThread**: allows code to invoke the **stop()** method of the thread class.

Table 5-36 Security permission

Type	Name
java.security.SecurityPermission	• **createAccessControlContext**: allows you to create a context environment for an access controller. • **getPolicy**: allows the search of classes that can implement sandbox policies. • **setPolicy**: allows you to set a class that can implement the sandbox policy. This is a high-risk operation. With this permission, the UDF can modify the policy of a service.

Table 5-37 Reflection permission

Type	Name
java.lang.reflect.ReflectPermission	**suppressAccessChecks**: allows reflection to be used to check private variables of any class.

Table 5-38 All permission

Type	Name
java.security.AllPermission	None (permission to perform any operation)

NOTE

If a third-party JAR dependency is used and the following error message is displayed, the sandbox permission is required:

```
Caused by: java.security.AccessControlException: access denied ("java.io.FilePermission" "xxxx" "read")
at java.security.AccessControlContext.checkPermission(AccessControlContext.java:472)
at java.security.AccessController.checkPermission(AccessController.java:886)
at java.lang.SecurityManager.checkPermission(SecurityManager.java:549)
at java.lang.SecurityManager.checkRead(SecurityManager.java:888)
at java.io.File.exists(File.java:825)       at com.xxx.ExpireUDF.(ExpireUDF.java:19)
```

Configuring Permission of a Specified JAR Package

Step 1 Log in to FusionInsight Manager and access the Flink web UI. For details, see **Accessing the Flink Web UI**.

Step 2 Check the storage path of the JAR package.

- Record the UDF storage path.

  Click **UDF Management**. In the UDF list, view and record the storage path.

- Record the storage path of the third-party dependency.

  Click **Dependency Management**. In the dependency list, view and record the storage path.

Step 3 Configure permission for the specified dependency.

Return to FusionInsight Manager, choose **Cluster** > **Services** > **Flink** > **Configurations** > **All Configurations** > **FlinkServer (Role)** > **Customization**, set **flinkserver.security.policy** as follows, and save the settings:

- Name: Enter the storage path recorded in **Step 2**. If you need to add more paths, click the plus sign (+).
- Value: permission value, which ends with a semicolon (;). For example, **permission java.util.PropertyPermission "*", "read";permission java.net.SocketPermission "*", "connect,resolve"**. For details, see **Permissions**.

Step 4 Restart the FlinkServer instance.

Click **Instances**, select all FlinkServer instances, choose **More** > **Restart Instance**, and operate as prompted.

----End

Disabling the FlinkServer Sandbox

Step 1 Log in to FusionInsight Manager.

Step 2 Choose **Cluster** > **Services** > **Flink** > **Configurations** > **All Configurations**.

Step 3 Search for the **security.manager.enabled** parameter and set its value to **false**.

Step 4 Click **Save**.

Step 5 Click **Instances**, select all FlinkServer instances, choose **More** > **Restart Instance**, and operate as prompted.

----End

5.5.14 Reusing Flink UDFs

Scenario

The UDF reuse function is added to Flink SQL. When a UDF is executed for multiple times, only the first result is copied for the Nth (N > 1) execution. This ensures data consistency between multiple UDF executions and ensures that the UDF is executed only once, improving operator performance.

How to Use

When configuring a Flink job, you can set **table.optimizer.function-reuse-enabled** to **true** on the Flink job development page of the Flink server web UI to enable the UDF reuse function. For details, see **Creating a Job**.

Example

- UDF:

```
class ItemExist extends ScalarFunction {
  val items: mutable.Set[String] = mutable.Set[String]()

  def eval(item: String): Boolean = {
    val exist = items.contains(item);
    if (!exist) {
      items.add(item)
    }
    exist
  }
}
```

- SQL statement:

  SELECT * FROM (SELECT `a`, IfExist(b) as `exist`, `c` FROM Table1) WHERE exist IS FALSE;

- Execution result:
  - Return value when the UDF reuse function is disabled:

    ```
    a,true,c
    ```

    Because IfExist is executed once in the WHERE condition and the result is **false**, the data has been stored in the cache. When IfExist is executed again in SELECT, **true** is returned.
  - Return value when the UDF reuse function is enabled:

    ```
    a,false,c
    ```

5.5.15 Importing and Exporting Jobs

Scenario

The FlinkServer web UI enables you to import and export jobs, UDFs, stream tables, and dependencies only.

- Jobs, flow tables, and UDFs with the same name cannot be imported to the same cluster.
- When exporting a job, you need to manually select the stream tables, UDFs, and dependencies. Otherwise, a dialog box indicating that the dependent data is not selected will be displayed. The application information of a job will not be exported.
- When you export a stream table, the application information on which the stream table depends will not be exported.
- When you export UDFs, the application information on which the UDFs depend and information about jobs used by UDFs will not be exported.
- When you export dependencies, the application information required by the dependencies and information about the jobs used by the dependencies will not be exported.
- Data import and export between different applications. are supported.

NOTICE

When you import or export FlinkSQL jobs, the **password** field in the jobs will be left blank to meet security requirements. Before you submit jobs, manually enter the password.

Importing a Job

Step 1 Access the Flink web UI as a user with **FlinkServer Admin Privilege**. For details, see **Accessing the Flink Web UI**.

Step 2 Choose **System Management** > **Import Jobs**.

Step 3 Click **Select** to select a local TAR file and click **OK**. Wait until the file is imported.

NOTE

The maximum size of a local TAR file to be uploaded is 200 MB.

----End

Exporting a job

Step 1 Access the Flink web UI as a user with **FlinkServer Admin Privilege**. For details, see **Accessing the Flink Web UI**.

Step 2 Choose **System Management** > **Export Jobs**.

Step 3 Select the data to be exported in either of the following ways. To deselect the content, click **Clear Selected Node**.

- Select the data to be exported as required.
- Click **Query Regular Expression**. On the displayed page, select the type of the data to be exported (**Table Management**, **Job Management**, **UDF Management**, or **Dependency Management**), enter the keyword, and click **Query**. After the data is successfully matched, click **Synchronize**.

  NOTE

  All matched data will be synchronized after you click **Synchronize**. Currently, you cannot select some data for synchronization.

Step 4 Click **Verify**. After the verification is complete, click **OK**. Wait until the data is exported.

----End

5.5.16 Verifying Flink's Job Inspection

Scenario

When a large number of Flink jobs are running in a cluster, the FlinkServer web UI provides the Flink job health management function to help you evaluate the health status of each job. You can view the health status of the current job on the page and export the health information of all jobs with just one click. Job statuses are as follows:

- **Healthy**: The job is healthy and running properly.
- **Subhealthy**:
  - The "ALM-45637 Flink Task Is Continuously Under Back Pressure" alarm is generated. After the alarm is cleared based on the alarm information, the health status automatically recovers to **Healthy**.

  - The "ALM-45639 Checkpointing of a Flink Job Times Out" alarm is generated. After the alarm is cleared based on the alarm information, the health status automatically recovers to **Healthy**.
- **Unhealthy**:
  - The "ALM-45636 Flink Job Checkpoints Keep Failing" alarm is generated. After the alarm is cleared based on the alarm information, the health status automatically recovers to **Healthy**.
  - The "ALM-45638 Number of Restarts After Flink Job Failures Exceeds the Threshold" alarm is generated. After the alarm is cleared based on the alarm information and the job is restarted. The health status automatically recovers to **Healthy**.

Prerequisites

- The cluster is running properly and the cluster client has been installed.
- The function of registering jobs with FlinkServer and the job alarming function have been enabled by configuring the *Client installation path*/**Flink/flink/conf/flink-conf.yaml** file before submitting a job. The parameter settings are as follows:

  Table 5-39 Parameters for enabling job registration and job alarming

Parameter	Value	Description
job.register.enable	true	Whether to enable job registration with FlinkServer. Value options are as follows: ● **true**: Enable this function. ● **false**: Disable this function.
job.alarm.enable	true	Whether to enable job alarming. Value options are as follows: ● **true**: Enable this function. ● **false**: Disable this function.

  NOTE

  If the function of registering jobs with FlinkServer is not enabled, you cannot start, develop, or stop jobs registered with FlinkServer through the client on the FlinkServer web UI.

- Ensure that the job is not submitted in session mode and the job name must be specified.

Procedure

Step 1 Access the Flink web UI by referring to **Accessing the Flink Web UI**.

Step 2 Click **Job Management**. The job management page is displayed.

- Viewing job health

  On the **Job Management** page, view the health status of the current job.
  - Empty: The job is not running and has no health status.
  - Green icon: healthy
  - Yellow icon: subhealthy
  - Red icon: unhealthy
- Exporting all job health reports

  Click **Job Health Report**. The system automatically exports the health status information of all jobs to the local host, including the job name, health status, submission user, alarm information, configuration information, and start time.
  - If the health score is **0**, the job is healthy.
  - If the health score is **1**, the job is subhealthy.
  - If the health score is **2**, the job is unhealthy.

----End

5.6 Configuring Interconnection Between FlinkServer and Other Components

5.6.1 Interconnecting FlinkServer with ClickHouse

Scenario

Flink interconnects with the ClickHouseBalancer instance of ClickHouse to read and write data, preventing ClickHouse traffic distribution problems.

NOTICE

When "FlinkSQL" is displayed in the command output on the FlinkServer web UI, the **password** field in the SQL statement is left blank. Before you submit a job, manually enter the password.

Prerequisites

- Services such as ClickHouse, HDFS, Yarn, Flink, and Kafka have been installed in the cluster. A logical cluster in ClickHouse exists and is running properly.
- The cluster client has been installed in a directory, for example, **/opt/client**.
- Kerberos authentication (security mode) has been enabled for the cluster. A user who has the permission to create ClickHouse data tables and FlinkServer jobs, as well as perform Kafka operations on FusionInsight Manager has been created.

Mapping Between Flink SQL and ClickHouse Data Types

Flink SQL Data Type	ClickHouse Data Type
BOOLEAN	UInt8
TINYINT	Int8
SMALLINT	Int16
INTEGER	Int32
BIGINT	Int64
FLOAT	Float32
DOUBLE	Float64
CHAR	String
VARCHAR	String
VARBINARY	FixedString
DATE	Date
TIMESTAMP	DateTime
DECIMAL	Decimal

Procedure

Step 1 Log in to the node where the client is installed as user **root**.

Step 2 Run the following command to go to the client installation directory:

cd /opt/client

Step 3 Run the following command to configure environment variables:

source bigdata_env

Step 4 If Kerberos authentication is enabled for the current cluster (the cluster is in security mode), run the following command to authenticate the user. The user must have the permission to create ClickHouse tables. If Kerberos authentication is disabled for the current cluster (the cluster is in normal mode), skip this step.

kinit *Component service user*

Example: **kinit clickhouseuser**

Step 5 Run the following commands to connect to the ClickHouse server:

- Clusters with Kerberos authentication disabled (normal mode)

  clickhouse client --host *IP address of the ClickHouseServer instance to be connected* **--user** *Username* **--password** *Password***--port** *ClickHouse port number* **--multiline**

Commands carrying authentication passwords pose security risks. Disable historical command recording before running such commands to prevent information leakage.

- Clusters with Kerberos authentication enabled (security mode)

  clickhouse client --host *IP address of the ClickHouse instance to be connected* **--port** *ClickHouse port number* **--secure --multiline**

For more operations on the ClickHouse client, see **Using ClickHouse from Scratch**.

Step 6 Run commands to create a replication table and a distributed table.

1. For example, if the name of the replication table is **default.test1** and the name of the connected ClickHouse logical cluster is **default_cluster**, run the following commands:

   CREATE TABLE *default.test1* **on cluster** *default_cluster*

   (

   `pid` Int8,

   `uid` UInt8,

   `Int_16` Int16,

   `Int_32` Int32,

   `Int_64` Int64,

   `String_x` String,

   `String_y` String,

   `float_32` Float32,

   `float_64` Float64,

   `Decimal_x` Decimal32(2),

   `Date_x` Date,

   `DateTime_x` DateTime

)

   ENGINE = ReplicatedReplacingMergeTree('/clickhouse/tables/{shard}/*{Database name}/test1***','{replica}')**

   PARTITION BY pid

   ORDER BY (pid, DateTime_x);

2. Create a distributed table **test1_all**.

   CREATE TABLE *test1_all* **on cluster** *default_cluster*

   (

   `pid` Int8,

   `uid` UInt8,

   `Int_16` Int16,

   `Int_32` Int32,

   `Int_64` Int64,

   `String_x` String,

   `String_y` String,

   `float_32` Float32,

`float_64` Float64,

`Decimal_x` Decimal32(2),

`Date_x` Date,

`DateTime_x` DateTime

)

ENGINE = Distributed(*default_cluster***, *default*, *test1*, rand());**

Step 7 Log in to FusionInsight Manager as a user who has the FlinkServer operation permission. Choose **Cluster** > **Services** > **Flink**. On the page that is displayed, click the link next to **Flink WebUI** to access the FlinkServer web UI.

For details about FlinkServer permissions, see **Flink Web UI Permission Management**.

Step 8 On the **Jobs** tab page, click **Create** to create a Flink SQL job and submit it.

Set **Type** to **Stream**, configure parameters on the job development page by referring to the following example statements, and submit the job. In **Basic Parameter**, select **Enable CheckPoint**, set **Time Interval(ms)** to **60000**, and retain the default value for **Mode**.

For details about Flink server job parameters, see **Creating a Job**.

- If Kerberos authentication has been enabled for the current MRS cluster (the cluster is in security mode), example statements are as follows:

```
create table kafkasource(
`pid` TINYINT,
`uid` BOOLEAN,
`Int_16` SMALLINT,
`Int_32` INTEGER,
`Int_64` BIGINT,
`String_x` CHAR,
`String_y` VARCHAR(10),
`float_32` FLOAT,
`float_64` DOUBLE,
`Decimal_x` DECIMAL(9,2),
`Date_x` DATE,
`DateTime_x` TIMESTAMP
) with(
  'connector' = 'kafka',
  'topic' = 'input',
  'properties.bootstrap.servers' = 'IP address of Kafka Broker instance service1:Kafka port number,IP address 2 of Kafka Broker instance service:Kafka port number,IP address 3 of Kafka Broker instance service:Kafka port number',
  'properties.group.id' = 'group1',
  'scan.startup.mode' = 'earliest-offset',
  'format' = 'json',
  'properties.sasl.kerberos.service.name' = 'kafka',
  'properties.security.protocol' = 'SASL_PLAINTEXT',
  'properties.kerberos.domain.name' = 'hadoop.System domain name'
);
CREATE TABLE cksink (
`pid` TINYINT,
`uid` BOOLEAN,
`Int_16` SMALLINT,
`Int_32` INTEGER,
`Int_64` BIGINT,
`String_x` CHAR,
`String_y` VARCHAR(10),
`float_32` FLOAT,
`float_64` DOUBLE,
`Decimal_x` DECIMAL(9,2),
`Date_x` DATE,
```

```
`DateTime_x` TIMESTAMP
) WITH (
'connector' = 'jdbc',
'url' = 'jdbc:clickhouse://IP address 1 of the ClickHouseBalancer instance service:ClickHouseBalancer port number,IP address 2 of the ClickHouseBalancer instance service:ClickHouseBalancer port number/default?ssl=true&sslmode=none',
'username' = 'ClickHouse user',
'password' = 'ClickHouse user password',
'table-name' = 'test1_all',
'driver' = 'com.clickhouse.ClickHouseDriver',
'sink.buffer-flush.max-rows' = '0',
'sink.buffer-flush.interval' = '60s'
);
Insert into cksink
select
*
from
kafkasource;
```

- If Kerberos authentication is disabled for the current MRS cluster (the cluster is in normal mode), example statements are as follows:

```
create table kafkasource(
`pid` TINYINT,
`uid` BOOLEAN,
`Int_16` SMALLINT,
`Int_32` INTEGER,
`Int_64` BIGINT,
`String_x` CHAR,
`String_y` VARCHAR(10),
`float_32` FLOAT,
`float_64` DOUBLE,
`Decimal_x` DECIMAL(9,2),
`Date_x` DATE,
`DateTime_x` TIMESTAMP
) with(
  'connector' = 'kafka',
  'topic' = 'kinput',
  'properties.bootstrap.servers' = 'IP address 1 of Kafka Broker instance service:Broker port number,IP address 2 of Kafka Broker instance service:Kafka port number,IP address 3 of Kafka Broker instance service:Kafka port number',
  'properties.group.id' = 'kafka_test',
  'scan.startup.mode' = 'earliest-offset',
  'format' = 'json'
);
CREATE TABLE cksink (
`pid` TINYINT,
`uid` BOOLEAN,
`Int_16` SMALLINT,
`Int_32` INTEGER,
`Int_64` BIGINT,
`String_x` CHAR,
`String_y` VARCHAR(10),
`float_32` FLOAT,
`float_64` DOUBLE,
`Decimal_x` DECIMAL(9,2),
`Date_x` DATE,
`DateTime_x` TIMESTAMP
) WITH (
'connector' = 'jdbc',
'url' = 'jdbc:clickhouse://IP address 1 of the ClickHouseBalancer instance service:ClickHouseBalancer port number,IP address 2 of the ClickHouseBalancer instance service:ClickHouseBalancer port number/default',
'table-name' = 'test1_all',
'driver' = 'com.clickhouse.ClickHouseDriver',
'sink.buffer-flush.max-rows' = '0',
'sink.buffer-flush.interval' = '60s'
);
Insert into cksink
select
*
```

```
from
kafkasource;
```

NOTE

- The IP address and port number of the Kafka broker instance are as follows:
  - To obtain the instance IP address, log in to FusionInsight Manager, choose **Cluster** > **Services** > **Kafka**, click **Instance**, and query the instance IP address on the instance list page.
  - If Kerberos authentication is enabled for the cluster (the cluster is in security mode), the Broker port number is the value of **sasl.port**. The default value is **21007**.
  - If Kerberos authentication is disabled for the cluster (the cluster is in normal mode), the broker port number is the value of **port**. The default value is **9092**. If the port number is set to **9092**, set **allow.everyone.if.no.acl.found** to **true**. The procedure is as follows:

    Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Kafka**. Click **Configurations** then **All Configurations**. On the page that is displayed, search for **allow.everyone.if.no.acl.found**, set it to **true**, and click **Save**.
- *System domain name*: You can log in to FusionInsight Manager, choose **System** > **Permission** > **Domain and Mutual Trust**, and check the value of **Local Domain**.
- The IP address and port number of the ClickHouseBalancer instance are as follows:

  To obtain the instance IP address, log in to FusionInsight Manager, choose **Cluster** > **Services** > **ClickHouse**, click **Instance**, and query the instance IP address on the instance list page.

  Select the ClickHouseBalancer port number based on the interconnected ClickHouse logical cluster. Log in to FusionInsight Manager, choose **Cluster** > **Services** > **ClickHouse**, click **Logic Cluster**, and view **HTTP Balancer Port**.

  You can configure multiple IP addresses for ClickHouseBalancer instances to avoid single points of failure (SPOFs) of the instances.
- Kerberos authentication has been enabled for the cluster (the cluster is in security mode). The **username** and **password** parameters in the created **cksink** table must be set to the user who has the operation permission on the ClickHouse table and the password. For details, see **ClickHouse User and Permission Management**.
- DELETE messages generated during Flink computing are filtered out when data is written to ClickHouse.
- Parameters for batch write: Flink stores data in the memory and then flushes the data to the database table when the trigger condition is met. The configurations are as follows:

  sink.buffer-flush.max-rows: Number of rows written to ClickHouse. The default value is **100**.

  sink.buffer-flush.interval: Interval for batch write. The default value is **1s**.

  If either of the two conditions is met, a sink operation is triggered. That is, data will be flushed to the database table.
  - Scenario 1: sink every 60s

    'sink.buffer-flush.max-rows' = '0',

    'sink.buffer-flush.interval' = '60s'
  - Scenario 2: sink every 100 rows

    'sink.buffer-flush.max-rows' = '100',

    'sink.buffer-flush.interval' = '0s'
  - Scenario 3: no sink

    'sink.buffer-flush.max-rows' = '0',

    'sink.buffer-flush.interval' = '0s'

Step 9 View the Flink job management page and wait until the job status changes to **Running**.

Step 10 Use the Kafka client to write data to the Kafka topic.

cd /opt/client

source bigdata_env

kinit *Kafka user* (You do not need to run this kinit command if Kerberos authentication is disabled for the cluster (the cluster is in normal mode).)

cd Kafka/kafka/bin

sh kafka-console-producer.sh --broker-list *Service IP address of the Kafka broker instance*:*Broker port number* **--topic** *Topic name* **--producer.config** *Client installation directory*/**Kafka/kafka/config/producer.properties**

In this example, the Kafka topic name is **kinput**. Run the following command:

sh kafka-console-producer.sh --broker-list 192.168.67.136:21007 **--topic kinput --producer.config /opt/client/Kafka/kafka/config/producer.properties**

Add the following content to the topic:

```
{"pid": "3","uid":false,"Int_16": "6533","Int_32": "429496294","Int_64": "1844674407370955614","String_x": "abc1","String_y": "abc1defghi","float_32": "0.1234","float_64": "95.1","Decimal_x": "0.451236414","Date_x": "2021-05-29","DateTime_x": "2021-05-21 10:05:10"}
{"pid": "4","uid":false,"Int_16": "6533","Int_32": "429496294","Int_64": "1844674407370955614","String_x": "abc1","String_y": "abc1defghi","float_32": "0.1234","float_64": "95.1","Decimal_x": "0.4512314","Date_x": "2021-05-29","DateTime_x": "2021-05-21 10:05:10"}
```

Press **Enter** to send the message.

For more operations on the Kafka client, see **Managing Messages in Kafka Topics**.

Step 11 Connect to ClickHouse through the client by referring to **Step 5**, and run the query command to check whether data is written into the ClickHouse table.

In this example, the ClickHouse table is **test1_all**.

select * from test1_all;

pid	uid	Int_16	Int_32	Int_64	String_x	String_y	float_32	float_64	Decimal_x	Date_x	DateTime_x
4	0	6533	429496294	1844674407370955614	abc1	abc1defghi	0.1234	95.1	0.45	2021-05-29	2021-05-21 10:05:10
pid	uid	Int_16	Int_32	Int_64	String_x	String_y	float_32	float_64	Decimal_x	Date_x	DateTime_x
3	0	6533	429496294	1844674407370955614	abc1	abc1defghi	0.1234	95.1	0.45	2021-05-29	2021-05-21 10:05:10

----End

5.6.2 Interconnecting FlinkServer with GaussDB(DWS)

Scenario

FlinkServer can interconnect with GaussDB(DWS) 8.1.*x* or later. This section describes the DDL definitions when GaussDB(DWS) serves as source tables, sink tables, and dimension tables, as well as the **WITH** parameter and code examples used during table creation, and describes how to perform operations on the FlinkServer job management page.

In this example, FlinkServer and Kafka in security mode are used to interconnect with GaussDB(DWS) in security mode.

NOTICE

When "FlinkSQL" is displayed in the command output on the FlinkServer web UI, the **password** field in the SQL statement is left blank. Before you submit a job, manually enter the password.

Mappings between FlinkSQL and ClickHouse data types

FlinkSQL Data Type	GaussDB(DWS) Data Type
BOOLEAN	BOOLEAN
TINYINT	-
SMALLINT	SMALLINT(INT2)
	SMALLSERIAL(SERIAL2)
INTEGER	INTEGER
	SERIAL
BIGINT	BIGINT
	BIGSERIAL
FLOAT	REAL
	FLOAT4
DOUBLE	DOUBLE
	FLOAT8
CHAR	CHAR(n)
VARCHAR	VARCHAR(n)
DATE	DATE
TIMESTAMP	TIMESTAMP[(p)] [WITHOUT TIME ZONE]
DECIMAL	NUMERIC[(p[,s])]
	DECIMAL[(p[,s])]

Prerequisites

- Cluster where FlinkServer resides (security mode):
  - HDFS, YARN, Kafka, ZooKeeper, and Flink have been installed in the cluster.
  - The client that contains the Kafka service has been installed in a directory, for example, **/opt/client**.

  - You have created a user with the **FlinkServer Admin Privilege** (for example, **flinkuser**) for accessing the Flink web UI by referring to **Creating a FlinkServer Role**.
- Cluster of the GaussDB(DWS) to be interconnected (security mode):
  - Whitelist all service IP addresses of the nodes where FlinkServer resides.

    NOTE

    To whitelist the IP addresses, perform the following steps:

    1. Log in to the node where GaussDB(DWS) resides as user **root** and run the following command to switch to user **omm**:

       su - omm

    2. Run the following command to load environment variables:

       source ${BIGDATA_HOME}/mppdb/.mppdbgs_profile

    3. Run the following command to whitelist one IP address. To whitelist multiple IP addresses, run the command for multiple times.

       gs_guc set -Z coordinator -N all -I all -h "host all all *IP address of the FlinkServer node*/**32 sha256"**
  - An empty table for receiving data has been created, for example, **customer_t1**.

    NOTE

    To create a GaussDB(DWS) data table, perform the following steps:

    1. Log in to the node where GaussDB(DWS) resides as user **root** and run the following command to switch to user **omm**:

       su - omm

    2. Run the following command to load environment variables:

       source ${BIGDATA_HOME}/mppdb/.mppdbgs_profile

    3. Run the following command to connect to the database:

       gsql -d *postgres* **-U** *username* **–p** *25308* **-W** *password* **–r**

       - **postgres** indicates the name of the database to be connected.
       - **username** and **password** indicate the username and password for connecting to the database. Commands carrying authentication passwords pose security risks. Disable historical command recording before running such commands to prevent information leakage.
       - **25308** indicates the port number of the Coordinator. Replace it with the actual port number. You can run the **gs_om -t status --detail** command to query the Coordinator data path and view the port number in the **postgresql.conf** file in the path.

    4. Run the following command to create a data table:

       CREATE TABLE customer_t1(*c_customer_sk INTEGER, c_customer_name VARCHAR(32)***);**

GaussDB as a Sink Table

Step 1 Log in to Manager as user **flinkuser** and choose **Cluster** > **Services** > **Flink**. In the **Basic Information** area, click the link next to **Flink WebUI** to access the Flink web UI.

Step 2 Create a FlinkSQL job by referring to **Creating a Job**. On the job development page, configure the job parameters and start the job.

In **Basic Parameter**, select **Enable CheckPoint**, set **Time Interval(ms)** to **60000**, and retain the default value for **Mode**.

```
CREATE TABLE MyUserTable(
  c_customer_sk INTEGER,
  c_customer_name VARCHAR(32)
) WITH(
  'connector' = 'jdbc',
  'url' = 'jdbc:gaussdb://IP address of the GaussDB server:25308/postgres',
'table-name' = 'customer_t1',--If table customer_t1 is created in schema base, the configuration rule is 'table-name' = 'base"."customer_t1'.
  'username' = 'username',--Username for logging in to the GaussDB(DWS) database
  'password' = 'password',--Password for logging in to the GaussDB(DWS) database
  'write.mode' = 'upsert',--When data is written in upsert mode, you can set whether to ignore null values.
  'ignoreNullWhenUpsert' = 'false'--true indicates that null values are ignored, and false indicates that null values are not ignored and written to the database.
);
CREATE TABLE KafkaSource (
  c_customer_sk INTEGER,
  c_customer_name VARCHAR(32)
) WITH (
  'connector' = 'kafka',
  'topic' = 'customer_source',
  'properties.bootstrap.servers' = 'Service IP address of the Kafka Broker instance:Kafka port number',
  'properties.group.id' = 'testGroup',
  'scan.startup.mode' = 'latest-offset',
  'value.format' = 'csv',
  'properties.sasl.kerberos.service.name' = 'kafka',  --Delete this parameter if the cluster where FlinkServer resides is in non-security mode.
  'properties.security.protocol' = 'SASL_PLAINTEXT',  --Delete this parameter if the cluster where FlinkServer resides is in non-security mode.
  'properties.kerberos.domain.name' = 'hadoop.System domain name'  --Delete this parameter if the cluster where FlinkServer resides is in non-security mode.
);
Insert into
  MyUserTable
select
  *
from
  KafkaSource;
```

NOTE

- The IP address and port number of the Kafka broker instance are as follows:
  - To obtain the instance IP address, log in to FusionInsight Manager, choose **Cluster** > **Services** > **Kafka**, click **Instance**, and query the instance IP address on the instance list page.
  - If Kerberos authentication is enabled for the cluster (the cluster is in security mode), the Broker port number is the value of **sasl.port**. The default value is **21007**.
  - If Kerberos authentication is disabled for the cluster (the cluster is in normal mode), the broker port number is the value of **port**. The default value is **9092**. If the port number is set to **9092**, set **allow.everyone.if.no.acl.found** to **true**. The procedure is as follows:

    Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Kafka**. Click **Configurations** then **All Configurations**. On the page that is displayed, search for **allow.everyone.if.no.acl.found**, set it to **true**, and click **Save**.
- *System domain name*: You can log in to FusionInsight Manager, choose **System** > **Permission** > **Domain and Mutual Trust**, and check the value of **Local Domain**.
- **properties.group.id** indicates the Kafka user group ID. This parameter is mandatory when Kafka functions as the source.
- **properties.kerberos.domain.name**: Set it to **hadoop.***System domain name*. You can log in to FusionInsight Manager and choose **System** > **Permission** > **Domain and Mutual Trust** to view the actual domain name of the cluster.

Step 3 On the job management page, check whether the job is in the **Running** status.

Step 4 Execute the following commands to view the topic and write data to Kafka. For details, see **Managing Messages in Kafka Topics**.

./kafka-topics.sh --list --zookeeper *Service IP address of the ZooKeeper quorumpeer instance*:*Port number of the ZooKeeper client*/**kafka**

sh kafka-console-producer.sh --broker-list *IP address of the node where Kafka instances reside*:*Kafka port number* **--topic** *Topic name* **--producer.config** *Client directory*/**Kafka/kafka/config/producer.properties**

In this example, the topic name is **customer_source**.

sh kafka-console-producer.sh --broker-list *IP address of the node where the Kafka instance is located*:*Kafka port number* --**topic customer_source --producer.config /opt/client/Kafka/kafka/config/producer.properties**

Enter the message content.

```
3,zhangsan
4,wangwu
8,zhaosi
```

Press **Enter** to send the message.

NOTE

- Service IP address of the ZooKeeper quorumpeer instance:

  Log in to FusionInsight Manager and choose **Cluster** > **Services** > **ZooKeeper**. On the page that is displayed, click the **Instance** tab and view the service IP addresses of all nodes where the quorumpeer instances reside.
- Port number of the ZooKeeper client:

  Log in to FusionInsight Manager and choose **Cluster** > **Services** > **ZooKeeper**. On the page that is displayed, click the **Configurations** tab and check the value of **clientPort**.

Step 5 Log in to the GaussDB client and run the following command to check whether data has been written to the sink table:

Select * from customer_t1;

```
postgres=> select * from customer_t1;
 c_customer_sk | c_customer_name
---------------+-----------------
             1 | new Data
             8 | zhaosi
             0 | data 0
             3 | zhangsan
             4 | wangwu
             2 | data 2
(6 rows)
```

----End

GaussDB as a Source Table

Step 1 Log in to Manager as user **flinkuser** and choose **Cluster** > **Services** > **Flink**. In the **Basic Information** area, click the link next to **Flink WebUI** to access the Flink web UI.

Step 2 Create a FlinkSQL job by referring to **Creating a Job**. On the job development page, configure the job parameters and start the job.

In **Basic Parameter**, select **Enable CheckPoint**, set **Time Interval(ms)** to **5000**, and retain the default value for **Mode**.

```
CREATE TABLE MyUserTable(
  --GuassDB functions as a source table.
  c_customer_sk INTEGER,
  c_customer_name VARCHAR(32)
) WITH(
  'connector' = 'jdbc',
  'url' = 'jdbc:gaussdb://IP address of the GaussDB server:25308/postgres ',
  'table-name' = 'customer_t1',
  'username' = 'username ',
  'password' = 'password '
);
CREATE TABLE KafkaSink (
  -- Kafka functions as a sink table.
  c_customer_sk INTEGER,
  c_customer_name VARCHAR(32)
) WITH (
  'connector' = 'kafka',
  'topic' = 'customer_sink',
  'properties.bootstrap.servers' = 'Service IP address of the Kafka Broker instance:Kafka port number',
  'properties.group.id' = 'testGroup',
  'scan.startup.mode' = 'latest-offset',
  'value.format' = 'csv',
  'properties.sasl.kerberos.service.name' = 'kafka',  --Delete this parameter if the cluster where FlinkServer resides is in non-security mode.
  'properties.security.protocol' = 'SASL_PLAINTEXT',  --Delete this parameter if the cluster where FlinkServer resides is in non-security mode.
  'properties.kerberos.domain.name' = 'hadoop.System domain name'  --Delete this parameter if the cluster where FlinkServer resides is in non-security mode.
);
Insert into
  KafkaSink
select
  *
from
  MyUserTable;
```

NOTE

- The IP address and port number of the Kafka broker instance are as follows:
  - To obtain the instance IP address, log in to FusionInsight Manager, choose **Cluster** > **Services** > **Kafka**, click **Instance**, and query the instance IP address on the instance list page.
  - If Kerberos authentication is enabled for the cluster (the cluster is in security mode), the Broker port number is the value of **sasl.port**. The default value is **21007**.
  - If Kerberos authentication is disabled for the cluster (the cluster is in normal mode), the broker port number is the value of **port**. The default value is **9092**. If the port number is set to **9092**, set **allow.everyone.if.no.acl.found** to **true**. The procedure is as follows:

    Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Kafka**. Click **Configurations** then **All Configurations**. On the page that is displayed, search for **allow.everyone.if.no.acl.found**, set it to **true**, and click **Save**.
- *System domain name*: You can log in to FusionInsight Manager, choose **System** > **Permission** > **Domain and Mutual Trust**, and check the value of **Local Domain**.
- **properties.group.id** indicates the Kafka user group ID. This parameter is mandatory when Kafka functions as the source.
- **properties.kerberos.domain.name**: Set it to **hadoop.***System domain name*. You can log in to FusionInsight Manager and choose **System** > **Permission** > **Domain and Mutual Trust** to view the actual domain name of the cluster.

Step 3 On the job management page, check whether the job is in the **Running** status.

Step 4 Run the following command to check whether data is received in the sink table, that is, check whether data is properly written to the Kafka topic. For details, see **Managing Messages in Kafka Topics**.

sh kafka-console-consumer.sh --topic customer_sink --bootstrap-server *IP address of the node where the Kafka instance is located*:*Kafka port number* **--consumer.config /opt/client/Kafka/kafka/config/ consumer.properties**

```
[root@... ... bin]# sh kafka-console-consumer.sh --topic customer_sink --bootstrap-server ...:... 21007 --consumer.config /opt/client/Kafka/kafka/config/producer.properties
[2022-04-12 11:49:37,957] WARN The configuration 'acks' was supplied but isn't a known config. (org.apache.kafka.clients.consumer.ConsumerConfig)
1,"new Data"
8,zhaosi
4,wangwu
0,"data 0"
3,zhangsan
2,"data 2"
```

----End

GaussDB as a Dimension Table

kafkaSource is used as the fact table, **customer_t2** is used as the dimension table, and the result is written to kafkaSink.

Step 1 Create dimension table **customer_t2** on the GaussDB client by referring to **Creating an Empty Data Table in the GaussDB(DWS) Cluster in Security Mode**. An example of the table creation statement is as follows:

```
CREATE TABLE customer_t2(
c_customer_sk INTEGER PRIMARY KEY,
c_customer_age INTEGER,
c_customer_address VARCHAR(32)
)DISTRIBUTE BY HASH(c_customer_sk);

INSERT INTO customer_t2 VALUES(1,18,'city a');
INSERT INTO customer_t2 VALUES(2,14,'city b');
INSERT INTO customer_t2 VALUES(3,16,'city c');
INSERT INTO customer_t2 VALUES(4,24,'city d');
INSERT INTO customer_t2 VALUES(5,32,'city e');
```

```
INSERT INTO customer_t2 VALUES(6,27,'city f');
INSERT INTO customer_t2 VALUES(7,41,'city a');
INSERT INTO customer_t2 VALUES(8,35,'city h');
INSERT INTO customer_t2 VALUES(9,16,'city j');
```

Step 2 Log in to Manager as user **flinkuser** and choose **Cluster** > **Services** > **Flink**. In the **Basic Information** area, click the link next to **Flink WebUI** to access the Flink web UI.

Step 3 Create a FlinkSQL job by referring to **Creating a Job**. On the job development page, configure the job parameters and start the job.

In **Basic Parameter**, select **Enable CheckPoint**, set **Time Interval(ms)** to **5000**, and retain the default value for **Mode**.

```
CREATE TABLE KafkaSource (
  -- Kafka as a source table
  c_customer_sk INTEGER,
  c_customer_name VARCHAR(32),
  proctime as proctime()
) WITH (
  'connector' = 'kafka',
  'topic' = 'customer_source',
  'properties.bootstrap.servers' = 'Service IP address of the Kafka Broker instance:Kafka port number',
  'properties.group.id' = 'testGroup',
  'scan.startup.mode' = 'latest-offset',
  'value.format' = 'csv',
  'properties.sasl.kerberos.service.name' = 'kafka',  --Delete this parameter if the cluster where FlinkServer resides is in non-security mode.
  'properties.security.protocol' = 'SASL_PLAINTEXT',  --Delete this parameter if the cluster where FlinkServer resides is in non-security mode.
  'properties.kerberos.domain.name' = 'hadoop.System domain name'  --Delete this parameter if the cluster where FlinkServer resides is in non-security mode.
);
CREATE TABLE KafkaSink (
  -- Kafka as a sink table
  c_customer_sk INTEGER,
  c_customer_name VARCHAR(32),
  c_customer_age INTEGER,
  c_customer_address VARCHAR(32)
) WITH (
  'connector' = 'kafka',
  'topic' = 'customer_sink',
  'properties.bootstrap.servers' = 'Service IP address of the Kafka Broker instance:Kafka port number',
  'properties.group.id' = 'testGroup',
  'scan.startup.mode' = 'latest-offset',
  'value.format' = 'csv',
  'properties.sasl.kerberos.service.name' = 'kafka',  --Delete this parameter if the cluster where FlinkServer resides is in non-security mode.
  'properties.security.protocol' = 'SASL_PLAINTEXT',  --Delete this parameter if the cluster where FlinkServer resides is in non-security mode.
  'properties.kerberos.domain.name' = 'hadoop.System domain name'  --Delete this parameter if the cluster where FlinkServer resides is in non-security mode.
);
CREATE TABLE MyUserTable (
  -- GaussDB as a dimension table
  c_customer_sk INTEGER PRIMARY KEY,
  c_customer_age INTEGER,
  c_customer_address VARCHAR(32)
) WITH (
  'connector' = 'jdbc',
  'url' = 'jdbc:gaussdb://IP address of the GaussDB server:25308/postgres ',
  'table-name' = 'customer_t2',
  'username' = 'username ',
  'password' = 'password '
);
INSERT INTO
  KafkaSink
```

```
SELECT
  t.c_customer_sk,
  t.c_customer_name,
  d.c_customer_age,
  d.c_customer_address
FROM
  KafkaSource as t
  JOIN MyUserTable FOR SYSTEM_TIME AS OF t.proctime as d ON t.c_customer_sk = d.c_customer_sk;
```

NOTE

- The IP address and port number of the Kafka broker instance are as follows:
  - To obtain the instance IP address, log in to FusionInsight Manager, choose **Cluster** > **Services** > **Kafka**, click **Instance**, and query the instance IP address on the instance list page.
  - If Kerberos authentication is enabled for the cluster (the cluster is in security mode), the Broker port number is the value of **sasl.port**. The default value is **21007**.
  - If Kerberos authentication is disabled for the cluster (the cluster is in normal mode), the broker port number is the value of **port**. The default value is **9092**. If the port number is set to **9092**, set **allow.everyone.if.no.acl.found** to **true**. The procedure is as follows:

    Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Kafka**. Click **Configurations** then **All Configurations**. On the page that is displayed, search for **allow.everyone.if.no.acl.found**, set it to **true**, and click **Save**.
- *System domain name*: You can log in to FusionInsight Manager, choose **System** > **Permission** > **Domain and Mutual Trust**, and check the value of **Local Domain**.
- **properties.group.id** indicates the Kafka user group ID. This parameter is mandatory when Kafka functions as the source.
- **properties.kerberos.domain.name**: Set it to **hadoop.***System domain name*. You can log in to FusionInsight Manager and choose **System** > **Permission** > **Domain and Mutual Trust** to view the actual domain name of the cluster.

Step 4 Run the following command to check whether data is received in the sink table, that is, check whether data is properly written to the Kafka topic after **Step 5** is performed. For details, see **Managing Messages in Kafka Topics**.

sh kafka-console-consumer.sh --topic customer_sink --bootstrap-server *IP address of the node where the Kafka instance is located*:*Kafka port number* **--consumer.config /opt/client/Kafka/kafka/config/ consumer.properties**

Step 5 View the topic and write data to the Kafka topic by referring to **Managing Messages in Kafka Topics**. After the data is written, view the execution result in the window in **Step 4**.

./kafka-topics.sh --list --zookeeper *Service IP address of the ZooKeeper quorumpeer instance*:*Port number of the ZooKeeper client*/**kafka**

sh kafka-console-producer.sh --broker-list *IP address of the node where Kafka instances reside*:*Kafka port number* **--topic** *Topic name* **--producer.config** *Client directory*/**Kafka/kafka/config/producer.properties**

NOTE

- Service IP address of the ZooKeeper quorumpeer instance:

  Log in to FusionInsight Manager and choose **Cluster** > **Services** > **ZooKeeper**. On the page that is displayed, click the **Instance** tab and view the service IP addresses of all nodes where the quorumpeer instances reside.

- Port number of the ZooKeeper client:

  Log in to FusionInsight Manager and choose **Cluster** > **Services** > **ZooKeeper**. On the page that is displayed, click the **Configurations** tab and check the value of **clientPort**.

In this example, the topic name is **customer_source**.

sh kafka-console-producer.sh --broker-list *IP address of the node where the Kafka instance is located*:*Kafka port number* **--topic customer_source --producer.config /opt/client/Kafka/kafka/config/producer.properties**

Enter the message content.

```
3,zhangsan
5,zhaosi
1,xiaoming
2,liuyang
7,liubei
10,guanyu
20,zhaoyun
```

Press **Enter** to send the message. The output in the kafka-console-consumer window in **Step 4** is as follows:

```
3,zhangsan,16,city c
5,zhaosi,32,city e
1,xiaoming,18,city a
2,liuyang,14,city b
7,liubei,41,city a
```

----End

5.6.3 Interconnecting FlinkServer with JDBC

Scenario

FlinkServer can interconnect with JDBC. This topic uses FlinkServer and Kafka in security mode as an example to describe the DDL definition for JDBC MySQL source tables, sink tables, and dimension tables. This topic also explains the WITH parameters for creating a table and code examples. You will learn how to connect to JDBC on the FlinkServer job management page.

Mapping between Flink SQL and JDBC data types

Flink SQL	MySQL	Oracle	PostgreSQL	SQL Server
BOOLEAN	BOOLEAN TINYINT(1)	-	BOOLEAN	BIT
TINYINT	TINYINT	-	-	TINYINT

Flink SQL	MySQL	Oracle	PostgreSQL	SQL Server
SMALLINT	SMALLINT TINYINT UNSIGNED	-	SMALLINT INT2 SMALLSERIAL SERIAL2	SMALLINT
INT	INT MEDIUMINT SMALLINT UNSIGNED	-	INTEGER SERIAL	INT
BIGINT	BIGINT INT UNSIGNED	-	BIGINT BIGSERIAL	BIGINT
FLOAT	FLOAT	BINARY_FLOAT	REAL FLOAT4	REAL
DOUBLE	DOUBLE DOUBLE PRECISION	BINARY_DOUBLE	FLOAT8 DOUBLE PRECISION	FLOAT
STRING	CHAR(n) VARCHAR(n) TEXT	CHAR(n) VARCHAR(n) CLOB	CHAR(n) CHARACTER(n) VARCHAR(n) CHARACTER VARYING(n) TEXT	CHAR(n) NCHAR(n) VARCHAR(n) NVARCHAR(n) TEXT NTEXT
BYTES	BINARY VARBINARY BLOB	RAW(s) BLOB	BYTEA	BINARY(n) VARBINARY(n)
ARRAY	-	-	ARRAY	-
DATE	DATE	DATE	DATE	DATE
TIME [(p)] [WITHOUT TIMEZONE]	TIME [(p)]	DATE	TIME [(p)] [WITHOUT TIMEZONE]	TIME(0)
TIMESTAMP [(p)] [WITHOUT TIMEZONE]	DATETIME [(p)]	TIMESTAMP [(p)] [WITHOUT TIMEZONE]	TIMESTAMP [(p)] [WITHOUT TIMEZONE]	DATETIME DATETIME2
DECIMAL(20, 0)	BIGINT UNSIGNED	-	-	-

Flink SQL	MySQL	Oracle	PostgreSQL	SQL Server
DECIMAL(p, s)	NUMERIC(p, s) DECIMAL(p, s)	SMALLINT FLOAT(s) DOUBLE PRECISION REAL NUMBER(p, s)	NUMERIC(p, s) DECIMAL(p, s)	DECIMAL(p, s)

Prerequisites

Cluster where FlinkServer resides:

- HDFS, Yarn, Kafka, ZooKeeper, and Flink have been installed in the cluster.
- The client that contains the Kafka service has been installed, for example, in the **/opt/client** directory.
- You have created a user with the **FlinkServer Admin Privilege** (for example, **flinkuser**) for accessing the Flink web UI.

JDBC Sink Table (MySQL as an Example)

Step 1 Create an empty table for receiving data in a database, for example, MySQL database **customer_t1**.

Step 2 Log in to Manager as user **flinkuser** and choose **Cluster** > **Services** > **Flink**. In the **Basic Information** area, click the link next to **Flink WebUI** to access the Flink web UI.

Step 3 Create a Flink SQL job by referring to **Creating a Job**. On the job development page, configure the job parameters as follows and start the job.

In **Basic Parameter**, select **Enable CheckPoint**, set **Time Interval(ms)** to **60000**, and retain the default value for **Mode**.

```
CREATE TABLE MyUserTable(
  c_customer_sk INTEGER,
  c_customer_name VARCHAR(32)
) WITH(
  'connector' = 'jdbc',
  'url' = 'jdbc:mysql://IP address of the MySQL server:MySQL server port/mysql',
  'table-name' = 'customer_t1',
  'username' ='MySQL database username',
  'password' ='Password of the MySQL database user'
);
CREATE TABLE KafkaSource (
  c_customer_sk INTEGER,
  c_customer_name VARCHAR(32)
) WITH (
  'connector' = 'kafka',
  'topic' = 'customer_source',
  'properties.bootstrap.servers' = 'Service IP address of the Kafka Broker instance:Kafka port number',
  'properties.group.id' = 'testGroup',
  'scan.startup.mode' = 'latest-offset',
  'value.format' = 'csv',
  'properties.sasl.kerberos.service.name' = 'kafka',  --Delete this parameter if the cluster where FlinkServer is
```

```
deployed is in non-security mode.
  'properties.security.protocol' = 'SASL_PLAINTEXT',  --Delete this parameter if the cluster where FlinkServer is deployed is in non-security mode.
  'properties.kerberos.domain.name' = 'hadoop.System domain name'  --Delete this parameter if the cluster where FlinkServer is deployed is in non-security mode.
);
Insert into
  MyUserTable
select
  *
from
  KafkaSource;
```

NOTE

- The IP address and port number of the Kafka broker instance are as follows:
  - To obtain the instance IP address, log in to FusionInsight Manager, choose **Cluster** > **Services** > **Kafka**, click **Instance**, and query the instance IP address on the instance list page.
  - If Kerberos authentication is enabled for the cluster (the cluster is in security mode), the Broker port number is the value of **sasl.port**. The default value is **21007**.
  - If Kerberos authentication is disabled for the cluster (the cluster is in normal mode), the broker port number is the value of **port**. The default value is **9092**. If the port number is set to **9092**, set **allow.everyone.if.no.acl.found** to **true**. The procedure is as follows:

    Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Kafka**. Click **Configurations** then **All Configurations**. On the page that is displayed, search for **allow.everyone.if.no.acl.found**, set it to **true**, and click **Save**.
- *System domain name*: To obtain the value, log in to FusionInsight Manager, choose **System** > **Permission** > **Domain and Mutual Trust**, and check the value of **Local Domain**.
- **properties.group.id** indicates the Kafka user group ID. This parameter is mandatory when Kafka functions as the source.
- **properties.kerberos.domain.name**: Set it to **hadoop.***System domain name*. To obtain the actual domain name of the cluster, log in to FusionInsight Manager and choose **System** > **Permission** > **Domain and Mutual Trust**.

Step 4 On the job management page, check whether the job status is **Running**.

Step 5 Execute the following commands to view the topic and write data to Kafka. For details, see **Managing Messages in Kafka Topics**.

./kafka-topics.sh --list *--bootstrap-server* *Service IP address of the Kafka Broker instance*:*Kafka port* **--command-config** *Client directory*/**Kafka/kafka/config/client.properties**

sh kafka-console-producer.sh --broker-list *IP address of the node where Kafka Broker instances reside*:*Kafka port* **--topic** *Topic name* **--producer.config** *Client directory*/**Kafka/kafka/config/producer.properties**

In this example, the topic name is **customer_source**.

sh kafka-console-producer.sh --broker-list *IP address of the node where the Kafka Broker instance is located*:*Kafka port* --**topic customer_source --producer.config /opt/client/Kafka/kafka/config/producer.properties**

Enter the message content.

```
3,zhangsan
4,wangwu
8,zhaosi
```

Press **Enter** to send the message.

Step 6 Log in to the MySQL client and run the following statement to check whether the sink table received data:

Select * from customer_t1;

----End

JDBC Source Table (MySQL as an Example)

Step 1 Log in to Manager as user **flinkuser** and choose **Cluster** > **Services** > **Flink**. In the **Basic Information** area, click the link next to **Flink WebUI** to access the Flink web UI.

Step 2 Create a Flink SQL job by referring to **Creating a Job**. On the job development page, configure the job parameters as follows and start the job.

In **Basic Parameter**, select **Enable CheckPoint**, set **Time Interval(ms)** to **5000**, and retain the default value for **Mode**.

```
CREATE TABLE MyUserTable(
  --MySQL source table
  c_customer_sk INTEGER,
  c_customer_name VARCHAR(32)
) WITH(
  'connector' = 'jdbc',
  'url' = 'jdbc:mysql://IP address of the MySQL server:MySQL server port/mysql',
  'table-name' = 'customer_t1',
  'username' ='MySQL database username',
  'password' ='Password of the MySQL database user'
);
CREATE TABLE KafkaSink (
  -- Kafka functions as a sink table.
  c_customer_sk INTEGER,
  c_customer_name VARCHAR(32)
) WITH (
  'connector' = 'kafka',
  'topic' = 'customer_sink',
  'properties.bootstrap.servers' = 'Service IP address of the Kafka Broker instance:Kafka port number',
  'properties.group.id' = 'testGroup',
  'scan.startup.mode' = 'latest-offset',
  'value.format' = 'csv',
  'properties.sasl.kerberos.service.name' = 'kafka',  --Delete this parameter if the cluster where FlinkServer is deployed is in non-security mode.
  'properties.security.protocol' = 'SASL_PLAINTEXT',  --Delete this parameter if the cluster where FlinkServer is deployed is in non-security mode.
  'properties.kerberos.domain.name' = 'hadoop.System domain name'  --Delete this parameter if the cluster where FlinkServer is deployed is in non-security mode.
);
Insert into
  KafkaSink
select
  *
from
  MyUserTable;
```

NOTE

- The IP address and port number of the Kafka broker instance are as follows:
  - To obtain the instance IP address, log in to FusionInsight Manager, choose **Cluster** > **Services** > **Kafka**, click **Instance**, and query the instance IP address on the instance list page.
  - If Kerberos authentication is enabled for the cluster (the cluster is in security mode), the Broker port number is the value of **sasl.port**. The default value is **21007**.
  - If Kerberos authentication is disabled for the cluster (the cluster is in normal mode), the broker port number is the value of **port**. The default value is **9092**. If the port number is set to **9092**, set **allow.everyone.if.no.acl.found** to **true**. The procedure is as follows:

    Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Kafka**. Click **Configurations** then **All Configurations**. On the page that is displayed, search for **allow.everyone.if.no.acl.found**, set it to **true**, and click **Save**.
- *System domain name*: You can log in to FusionInsight Manager, choose **System** > **Permission** > **Domain and Mutual Trust**, and check the value of **Local Domain**.
- **properties.group.id** indicates the Kafka user group ID. This parameter is mandatory when Kafka functions as the source.
- **properties.kerberos.domain.name**: Set it to **hadoop.***System domain name*. You can log in to FusionInsight Manager and choose **System** > **Permission** > **Domain and Mutual Trust** to view the actual domain name of the cluster.

Step 3 On the job management page, check whether the job status is **Running**.

Step 4 Obtain the required Kafka IP address and port by referring to **Managing Messages in Kafka Topics**, and run the following command to check whether data is written from the Kafka topic to the sink table:

sh kafka-console-consumer.sh --topic customer_sink --bootstrap-server *IP address of the node where the Kafka instance is deployed*:*Kafka port number* **--consumer.config /opt/client/Kafka/kafka/config/ consumer.properties**

```
[root@... ... bin]# sh kafka-console-consumer.sh --topic customer_sink --bootstrap-server ...:... 21007 --consumer.config /opt/client/Kafka/kafka/config/producer.properties
[2022-04-12 11:49:37,957] WARN The configuration 'acks' was supplied but isn't a known config. (org.apache.kafka.clients.consumer.ConsumerConfig)
1,"new Data"
8,zhaosi
4,wangwu
0,"data_0"
3,zhangsan
2,"data_2"
```

----End

JDBC Dimension Table (MySQL as an Example)

kafkaSource is used as the fact table, **customer_t2** is used as the dimension table, and the result is written to kafkaSink.

Step 1 Create the dimension table **customer_t2** on the MySQL client. An example of the table creation statement is as follows:

```
CREATE TABLE customer_t2(
c_customer_sk INTEGER PRIMARY KEY,
c_customer_age INTEGER,
c_customer_address VARCHAR(32)
);

INSERT INTO customer_t2 VALUES(1,18,'city a');
INSERT INTO customer_t2 VALUES(2,14,'city b');
INSERT INTO customer_t2 VALUES(3,16,'city c');
INSERT INTO customer_t2 VALUES(4,24,'city d');
INSERT INTO customer_t2 VALUES(5,32,'city e');
INSERT INTO customer_t2 VALUES(6,27,'city f');
```

```
INSERT INTO customer_t2 VALUES(7,41,'city a');
INSERT INTO customer_t2 VALUES(8,35,'city h');
INSERT INTO customer_t2 VALUES(9,16,'city j');
```

Step 2 Log in to Manager as user **flinkuser** and choose **Cluster** > **Services** > **Flink**. In the **Basic Information** area, click the link next to **Flink WebUI** to access the Flink web UI.

Step 3 Create a Flink SQL job by referring to **Creating a Job**. On the job development page, configure the job parameters as follows and start the job.

In **Basic Parameter**, select **Enable CheckPoint**, set **Time Interval(ms)** to **5000**, and retain the default value for **Mode**.

```
CREATE TABLE KafkaSource (
  -- Kafka as a source table
  c_customer_sk INTEGER,
  c_customer_name VARCHAR(32),
  proctime as proctime()
) WITH (
  'connector' = 'kafka',
  'topic' = 'customer_source',
  'properties.bootstrap.servers' = 'Service IP address of the Kafka Broker instance:Kafka port',
  'properties.group.id' = 'testGroup',
  'scan.startup.mode' = 'latest-offset',
  'value.format' = 'csv',
  'properties.sasl.kerberos.service.name' = 'kafka',  --Delete this parameter if the cluster where FlinkServer is deployed is in non-security mode.
  'properties.security.protocol' = 'SASL_PLAINTEXT',  --Delete this parameter if the cluster where FlinkServer is deployed is in non-security mode.
  'properties.kerberos.domain.name' = 'hadoop.System domain name'  --Delete this parameter if the cluster where FlinkServer is deployed is in non-security mode.
);
CREATE TABLE KafkaSink (
  -- Kafka sink table.
  c_customer_sk INTEGER,
  c_customer_name VARCHAR(32),
  c_customer_age INTEGER,
  c_customer_address VARCHAR(32)
) WITH (
  'connector' = 'kafka',
  'topic' = 'customer_sink',
  'properties.bootstrap.servers' = 'Service IP address of the Kafka Broker instance:Kafka port',
  'properties.group.id' = 'testGroup',
  'scan.startup.mode' = 'latest-offset',
  'value.format' = 'csv',
  'properties.sasl.kerberos.service.name' = 'kafka',  --Delete this parameter if the cluster where FlinkServer is deployed is in non-security mode.
  'properties.security.protocol' = 'SASL_PLAINTEXT',  --Delete this parameter if the cluster where FlinkServer is deployed is in non-security mode.
  'properties.kerberos.domain.name' = 'hadoop.System domain name'  --Delete this parameter if the cluster where FlinkServer is deployed is in non-security mode.
);
CREATE TABLE MyUserTable (
  -- MySQL dimension table
  c_customer_sk INTEGER PRIMARY KEY NOT ENFORCED,
  c_customer_age INTEGER,
  c_customer_address VARCHAR(32)
) WITH (
  'connector' = 'jdbc',
  'url' = 'jdbc:mysql://IP address of the MySQL server:MySQL server port/mysql',
  'table-name' = 'customer_t2',
  'username' ='MySQL database username',
  'password' ='Password of the MySQL database user'
);
INSERT INTO
  KafkaSink
SELECT
```

```
  t.c_customer_sk,
  t.c_customer_name,
  d.c_customer_age,
  d.c_customer_address
FROM
  KafkaSource as t
  JOIN MyUserTable FOR SYSTEM_TIME AS OF t.proctime as d ON t.c_customer_sk = d.c_customer_sk;
```

NOTE

- The IP address and port number of the Kafka broker instance are as follows:
  - To obtain the instance IP address, log in to FusionInsight Manager, choose **Cluster** > **Services** > **Kafka**, click **Instance**, and query the instance IP address on the instance list page.
  - If Kerberos authentication is enabled for the cluster (the cluster is in security mode), the Broker port number is the value of **sasl.port**. The default value is **21007**.
  - If Kerberos authentication is disabled for the cluster (the cluster is in normal mode), the broker port number is the value of **port**. The default value is **9092**. If the port number is set to **9092**, set **allow.everyone.if.no.acl.found** to **true**. The procedure is as follows:

    Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Kafka**. Click **Configurations** then **All Configurations**. On the page that is displayed, search for **allow.everyone.if.no.acl.found**, set it to **true**, and click **Save**.
- *System domain name*: You can log in to FusionInsight Manager, choose **System** > **Permission** > **Domain and Mutual Trust**, and check the value of **Local Domain**.
- **properties.group.id** indicates the Kafka user group ID. This parameter is mandatory when Kafka functions as the source.
- **properties.kerberos.domain.name**: Set it to **hadoop.***System domain name*. You can log in to FusionInsight Manager and choose **System** > **Permission** > **Domain and Mutual Trust** to view the actual domain name of the cluster.

Step 4 Run the following command to check whether data is received in the sink table, that is, check whether data is properly written to the Kafka topic after **Step 5** is performed. For details, see **Managing Messages in Kafka Topics**.

sh kafka-console-consumer.sh --topic customer_sink --bootstrap-server *IP address of the node where the Kafka instance is deployed*:*Kafka port number* **--consumer.config /opt/client/Kafka/kafka/config/ consumer.properties**

Step 5 View the topic and write data to the Kafka topic by referring to **Managing Messages in Kafka Topics**. After the data is written, view the execution result in the window in **Step 4**.

./kafka-topics.sh --list *Service IP address of the Kafka Broker instance*:*Kafka port* **--command-config** *Client directory*/**Kafka/kafka/config/client.properties**

sh kafka-console-producer.sh --broker-list *IP address of the node where Kafka Broker instances are deployed*:*Kafka port* **--topic** *Topic name* **--producer.config** *Client directory*/**Kafka/kafka/config/producer.properties**

In this example, the topic name is **customer_source**.

sh kafka-console-producer.sh --broker-list *IP address of the node where the Kafka Broker instance is deployed*:*Kafka port* **--topic customer_source --producer.config /opt/client/Kafka/kafka/config/producer.properties**

Enter the message content.

```
3,zhangsan
5,zhaosi
```

```
1,xiaoming
2,liuyang
7,liubei
10,guanyu
20,zhaoyun
```

Press **Enter** to send the message. The output in the kafka-console-consumer window in **Step 4** is as follows:

```
3,zhangsan,16,city c
5,zhaosi,32,city e
1,xiaoming,18,city a
2,liuyang,14,city b
7,liubei,41,city a
```

----End

5.6.4 Interconnecting FlinkServer with HBase

Scenario

FlinkServer can be interconnected with HBase. The details are as follows:

- It can be interconnected with dimension tables and sink tables.
- When HBase and Flink are in the same cluster or clusters with mutual trust, FlinkServer can be interconnected with HBase.
- If HBase and Flink are in different clusters without mutual trust, Flink in a normal cluster can be interconnected with HBase in a normal cluster.

Prerequisites

- The HDFS, Yarn, Flink, and HBase services have been installed in a cluster.
- The client that contains the HBase service has been installed in a directory, for example, **/opt/client**.
- Log in to the HBase client by referring to **Using an HBase Client** and run the **create'dim_province', "f1"** command to create the **dim_province** table.

Procedure

Step 1 Log in to the node where the client is installed as the client installation user and copy all configuration files in the **/opt/client/HBase/hbase/conf/** directory of HBase to an empty directory of all nodes where FlinkServer is deployed, for example, **/tmp/client/HBase/hbase/conf/**.

Change the owner of the configuration file directory and its upper-layer directory on the FlinkServer node to **omm**.

chown omm: /tmp/client/HBase/ -R

NOTE

- FlinkServer nodes:

  Log in to Manager, choose **Cluster** > **Services** > **Flink** > **Instance**, and check the **Service IP Address** of FlinkServer.
- If the node where a FlinkServer instance is located is the node where the HBase client is installed, skip this step on this node.

Step 2 Log in to Manager and choose **Cluster** > **Services** > **Flink**. Click **Configurations** then **All Configurations**, search for the **HBASE_CONF_DIR** parameter, and enter the FlinkServer directory (for example, **/tmp/client/HBase/hbase/conf/**) to which the HBase configuration files are copied in **Step 1** in **Value**.

NOTE

If the node where a FlinkServer instance resides is the node where the HBase client is installed, enter the **/opt/client/HBase/hbase/conf/** directory of HBase in **Value** of the **HBASE_CONF_DIR** parameter.

Step 3 After the parameters are configured, click **Save**. After confirming the modification, click **OK**.

Step 4 Click **Instance**, select all FlinkServer instances, choose **More** > **Restart Instance**, enter the password, and click **OK** to restart the instances.

Step 5 Log in to Manager and choose **Cluster** > **Services** > **Flink**. In the **Basic Information** area, click the link on the right of **Flink WebUI** to access the Flink web UI.

Step 6 Create a Flink SQL job and set Task Type to Stream job. For details, see **Creating a Job**. On the job development page, configure the job parameters as follows and start the job.

In **Basic Parameter**, select **Enable CheckPoint**, set **Time Interval(ms)** to **60000**, and retain the default value for **Mode**.

If the cluster is in security mode and the HBase authentication setting is **hbase.rpc.protection=authentication**, create a Flink SQL job by referring to the following example:

```
CREATE TABLE ksource1 (
user_id STRING,
item_id STRING,
proctime as PROCTIME()
) WITH (
'connector' = 'kafka',
'topic' = 'ksource1',
'properties.group.id' = 'group1',
'properties.bootstrap.servers' = 'IP address of the Kafka broker instance 1:Kafka port number,IP address of the Kafka broker instance 2:Kafka port number',
'format' = 'json',
'properties.sasl.kerberos.service.name' = 'kafka',--This parameter is not required for clusters in normal mode.
'properties.security.protocol' = 'SASL_PLAINTEXT',--This parameter is not required for clusters in normal mode.
'properties.kerberos.domain.name' = 'hadoop.System domain name'--This parameter is not required for clusters in normal mode.
);

CREATE TABLE hsink1 (
rowkey STRING,
f1 ROW < item_id STRING >,
PRIMARY KEY (rowkey) NOT ENFORCED
) WITH (
'connector' = 'hbase-2.2',
'table-name' = 'dim_province',
'zookeeper.quorum' = 'IP address of the ZooKeeper quorumpeer instance 1:ZooKeeper port number,IP address of the ZooKeeper quorumpeer instance 2:ZooKeeper port number'
);

INSERT INTO
hsink1
SELECT
user_id as rowkey,
ROW(item_id) as f1
```

```
FROM
ksource1;
```

NOTE

- The IP address and port number of the Kafka broker instance are as follows:
  - To obtain the instance IP address, log in to FusionInsight Manager, choose **Cluster** > **Services** > **Kafka**, click **Instance**, and query the instance IP address on the instance list page.
  - If Kerberos authentication is enabled for the cluster (the cluster is in security mode), the Broker port number is the value of **sasl.port**. The default value is **21007**.
  - If Kerberos authentication is disabled for the cluster (the cluster is in normal mode), the broker port number is the value of **port**. The default value is **9092**. If the port number is set to **9092**, set **allow.everyone.if.no.acl.found** to **true**. The procedure is as follows:

    Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Kafka**. Click **Configurations** then **All Configurations**. On the page that is displayed, search for **allow.everyone.if.no.acl.found**, set it to **true**, and click **Save**.
- *System domain name*: You can log in to FusionInsight Manager, choose **System** > **Permission** > **Domain and Mutual Trust**, and check the value of **Local Domain**.
- IP address of the ZooKeeper quorumpeer instance

  To obtain IP addresses of all ZooKeeper quorumpeer instances, log in to FusionInsight Manager and choose **Cluster** > **Services** > **ZooKeeper**. On the displayed page, click **Instance** and view the IP addresses of all the hosts where the quorumpeer instances locate.
- Port number of the ZooKeeper client

  Log in to FusionInsight Manager and choose **Cluster** > **Service** > **ZooKeeper**. On the displayed page, click **Configurations** and check the value of **clientPort**.
- HBase authentication

  Log in to FusionInsight Manager, choose **Cluster** > **Services** > **HBase**, click **Configuration** and then **All Configurations**, search for **hbase.rpc.protection**, and check the HBase authentication mode. If the authentication mode is **integrity** or **privacy**, add the following parameters:

  'properties.hbase.rpc.protection' = '*HBase authentication mode*'

  'properties.zookeeper.znode.parent' = '/hbase'

  'properties.hbase.security.authorization' = 'true'

  'properties.hbase.security.authentication' = 'kerberos'
- Separator of a composite RowKey:

  If data is imported using HBase BulkLoad or written by concatenating multiple fields with separators, add the following parameters when Flink reads HBase data as a source table or dimension table:

  'rowkey.delimiter'='...'

  If data is written through Flink and service applications read data through HBase, ensure that all values of the preceding parameters are strings.

Step 7 On the job management page, check whether the job status is **Running**.

Step 8 Execute the following script to write data to Kafka. For details, see **Managing Messages in Kafka Topics**.

sh kafka-console-producer.sh --broker-list *IP address of the node where Kafka instances reside*:*Kafka port number* **--topic** *Topic name* **--producer.config** *Client directory*/**Kafka/kafka/config/producer.properties**

For example, if the topic name is **ksource1**, the script is **sh kafka-console-producer.sh --broker-list** *IP address of the node where the Kafka instance is located*:*Kafka port number* **--topic ksource1 --producer.config /opt/client/Kafka/kafka/config/producer.properties**

Enter the message content.

```
{"user_id": "3","item_id":"333333"}
{"user_id": "4","item_id":"44444444"}
```

Press **Enter** to send the message.

Step 9 Log in to the HBase client and view the table data. For details, see **Using an HBase Client**.

hbase shell

scan 'dim_province'

----End

Submitting a Job Using the Application

- If the Flink run mode is used, you are advised to use the **export HBASE_CONF_DIR=** *HBase configuration directory*, for example, **export HBASE_CONF_DIR=/opt/hbaseconf**.
- If the Flink run-application mode is used, you can use either of the following methods to submit jobs:
  - (Recommended) Add the following configurations to a table creation statement.

Parameter	Description
'properties.hbase.rpc.protection' = 'authentication'	This parameter must be consistent with that on the HBase server.
'properties.zookeeper.znode.parent' = '/hbase'	If there are multiple services, hbase1 and hbase2 coexist. You must clarify the cluster to be accessed.
'properties.hbase.security.authorization' = 'true'	Authentication is enabled.
'properties.hbase.security.authentication' = 'kerberos'	Kerberos authentication is enabled.

Example:

```
CREATE TABLE hsink1 (
    rowkey STRING,
    f1 ROW < q1 STRING >,
    PRIMARY KEY (rowkey) NOT ENFORCED
   ) WITH (
     'connector' = 'hbase-2.2',
     'table-name' = 'cc',
     'zookeeper.quorum' = 'x.x.x.x:clientPort',
     'properties.hbase.rpc.protection' = 'authentication',
     'properties.zookeeper.znode.parent' = '/hbase',
     'properties.hbase.security.authorization' = 'true',
```

```
  'properties.hbase.security.authentication' = 'kerberos'
);
```

- Add the HBase configuration to YarnShip.

  Example: Dyarn.ship-files=/opt/hbaseconf

5.6.5 Interconnecting FlinkServer with HDFS

Scenario

This section describes the data definition language (DDL) of HDFS as a sink table, as well as the WITH parameters and example code for creating a sink table, and provides guidance on how to perform operations on the FlinkServer job management page.

Kafka in security mode is used as an example.

Prerequisites

- The HDFS, Yarn, and Flink services have been installed in a cluster.
- The client that contains the HDFS service has been installed in a directory, for example, **/opt/client**.
- You have created a user assigned with the **FlinkServer Admin Privilege** (for example, **flink_admin**) for accessing the Flink web UI by referring to **Creating a FlinkServer Role**.

Procedure

Step 1 Log in to Manager as user **flink_admin** and choose **Cluster** > **Services** > **Flink**. In the **Basic Information** area, click the link on the right of **Flink WebUI** to access the Flink web UI.

Step 2 Create a Flink SQL job by referring to **Creating a Job**. On the job development page, configure the job parameters as follows and start the job.

In **Basic Parameter**, select **Enable CheckPoint**, set **Time Interval(ms)** to **60000**, and retain the default value for **Mode**.

```
CREATE TABLE kafka_table (
  user_id STRING,
  order_amount DOUBLE,
  log_ts TIMESTAMP(3),
  WATERMARK FOR log_ts AS log_ts - INTERVAL '5' SECOND
) WITH (
  'connector' = 'kafka',
  'topic' = 'user_source',
  'properties.bootstrap.servers' = '<IP address of the Kafka broker instance:Kafka port number>',
  'properties.group.id' = 'testGroup',
  'scan.startup.mode' = 'latest-offset',
  'format' = 'csv',
   --Ignore the CSV data that fails to be parsed.
  'csv.ignore-parse-errors' = 'true',--If the data is in JSON format, set json.ignore-parse-errors to true.
  'properties.sasl.kerberos.service.name' = 'kafka',
  'properties.security.protocol' = 'SASL_PLAINTEXT',
  'properties.kerberos.domain.name' = 'hadoop.<System domain name>'

);

CREATE TABLE fs_table (
  user_id STRING,
  order_amount DOUBLE,
```

```
 dt STRING,
 `hour` STRING
) PARTITIONED BY (dt, `hour`) WITH ( --Date-specific file partitioning
 'connector'='filesystem',
 'path'='hdfs://hacluster/tmp/parquet',
 'format'='parquet',
 'sink.partition-commit.delay'='0 s',-- Partitions will not be committed before the delay time. If the files are partitioned by day, set this parameter to '1 d'. If the files are partitioned by hour, set this parameter to '1 h'.
 'sink.partition-commit.policy.kind'='success-file'
);
-- streaming sql, insert into file system table
INSERT INTO fs_table SELECT user_id, order_amount, DATE_FORMAT(log_ts, 'yyyy-MM-dd'), DATE_FORMAT(log_ts, 'HH') FROM kafka_table;
```

NOTE

Kafka port number

- If Kerberos authentication is enabled for the cluster (the cluster is in security mode), the Broker port number is the value of **sasl.port**. The default value is **21007**.
- If Kerberos authentication is disabled for the cluster (the cluster is in normal mode), the broker port number is the value of **port**. The default value is **9092**. If the port number is set to **9092**, set **allow.everyone.if.no.acl.found** to **true**. The procedure is as follows:

  Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Kafka**. Click **Configurations** then **All Configurations**. On the page that is displayed, search for **allow.everyone.if.no.acl.found**, set it to **true**, and click **Save**.
- *System domain name*: You can log in to FusionInsight Manager, choose **System** > **Permission** > **Domain and Mutual Trust**, and check the value of **Local Domain**.

Step 3 On the job management page, check whether the job status is **Running**.

Step 4 Execute the following commands to view the topic and write data to Kafka. For details, see **Managing Messages in Kafka Topics**.

./kafka-topics.sh --list --zookeeper *IP address of the ZooKeeper quorumpeer instance*:*ZooKeeper port number*/**kafka**

sh kafka-console-producer.sh --broker-list *IP address of the node where Kafka instances reside*:*Kafka port number* **--topic** *Topic name* **--producer.config** *Client directory*/**Kafka/kafka/config/producer.properties**

For example, if the topic name is **user_source**, the script is **sh kafka-console-producer.sh --broker-list** *IP address of the node where the Kafka instance is located*:*Kafka port number* **--topic user_source** --**producer.config /opt/client/Kafka/kafka/config/producer.properties**

Enter the message content.

```
3,3333,"2021-09-10 14:00"
4,4444,"2021-09-10 14:01"
```

Press **Enter** to send the message.

NOTE

- IP address of the ZooKeeper quorumpeer instance

  To obtain IP addresses of all ZooKeeper quorumpeer instances, log in to FusionInsight Manager and choose **Cluster** > **Services** > **ZooKeeper**. On the displayed page, click **Instance** and view the IP addresses of all the hosts where the quorumpeer instances locate.
- Port number of the ZooKeeper client

  Log in to FusionInsight Manager and choose **Cluster** > **Service** > **ZooKeeper**. On the displayed page, click **Configurations** and check the value of **clientPort**.

Step 5 Run the following command to check whether data is written from the HDFS directory to the sink table:

hdfs dfs -ls -R /sql/parquet

----End

Interconnecting Flink with HDFS Partitions

- Customized partitioning

  Flink's file system supports partitions in the standard Hive format. You do not need to register partitions with a table catalog. Partitions are inferred based on the directory structure.

  For example, a table that is partitioned based on the following directory is inferred to contain datetime and hour partitions.

```
path
└── datetime=2021-09-03
    └── hour=11
        ├── part-0.parquet
        ├── part-1.parquet
    └── hour=12
        ├── part-0.parquet
└── datetime=2021-09-24
    └── hour=6
        ├── part-0.parquet
```

- Rolling policy of partition files

  Data in the partition directories is split into part files. Each partition contains at least one part file, which is used to receive the data written by the subtask of the sink.

  The following parameters describe the rolling policies of partition files.

Parameter	Default Value	Type	Description
sink.rolling-policy.file-size	128 MB	Memory Size	Maximum size of a partition file before it is rolled.
sink.rolling-policy.rollover-interval	30 minutes	Duration	Maximum duration that a partition file can stay open before it is rolled.
sink.rolling-policy.check-interval	1 minute	Duration	Interval for checking time-based rolling policies.

- File merging

  File compression is supported, allowing applications to have a shorter checkpoint interval without generating a large number of files.

  NOTE

  Only files in a single checkpoint are compressed. That is, the number of generated files is at least the same as the number of checkpoints. Files are invisible before merged. They are visible after both the checkpoint and compression are complete. If file compression takes too much time, the checkpoint will be prolonged.

Parameter	Default Value	Type	Description
auto-compaction	false	Boolean	Whether to enable automatic compression. Data will be written to temporary files. After a checkpoint is complete, the temporary files generated by the checkpoint are compressed. These temporary files are invisible before compression.
compaction.file-size	none	Memory Size	Size of the target file to be compressed. The default value is the size of the file to be rolled.

- Partition commit

  After a file is written to a partition, for example, a partition is added to Hive metastore (HMS) or a _**SUCCESS** file is written to a directory, the downstream application needs to be notified. Triggers and policies are used to commit partition files.

  – Trigger parameters for committing partition files

Parameter	Default Value	Type	Description
sink.partition-commit.trigger	process-time	String	• process-time: System time of the compute node. It does not need to extract the partition time or generate watermarks. If the current system time exceeds the system time generated when a partition is created plus the delay time, the partition should be submitted. • partition-time: Time extracted from the partition. Watermarks are required. If the time for generating watermarks exceeds the time extracted from a partition plus the delay time, the partition should be submitted.
sink.partition-commit.delay	0 s	Duration	Partitions will not be committed before the delay time. If it is a daily partition, the value is **1 d**. If it is an hourly one, the value is **1 h**.

  – Policy parameters for committing partition files

Parameter	Default Value	Type	Description
sink.partition-commit.policy.kind	-	String	Policy for committing partitions: • **metastore**: used to add partitions to metastore. Only Hive tables support the metastore policy. The file system manages partitions based on the directory structure. • **success-file**: used to add **success-file** files to a directory. • The two policies can be configured at the same time, that is, **'sink.partition-commit.policy.kind'='metastore,success-file'**.
sink.partition-commit.policy.class	-	String	Class that implements partition commit policy interfaces. This parameter takes effect only in the customized submission policies.
sink.partition-commit.success-file.name	_SUCCESS	String	File name of the success-file partition commit policy. The default value is **_SUCCESS**.

5.6.6 Interconnecting FlinkServer with Hive

Scenario

Currently, FlinkServer interconnects with Hive MetaStore. Therefore, the MetaStore function must be enabled for Hive. Hive can be used as source, sink, and dimension tables.

Kafka in security mode is used as an example.

Prerequisites

- Services such as HDFS, Yarn, Kafka, Flink, and Hive have been installed in the cluster.
- The client that contains the Hive service has been installed in a directory, for example, **/opt/client**.
- Flink 1.12.2 or later and Hive 3.1.0 or later are supported.
- You have created a user assigned with the **FlinkServer Admin Privilege** (for example, **flink_admin**) for accessing the Flink web UI by referring to **Creating a FlinkServer Role**.
- You have obtained the client configuration file and credential of the user for accessing the Flink web UI. For details, see "Note" in **Creating a Cluster Connection**.

Procedure

The following uses the process of interconnecting a Kafka mapping table to Hive as an example.

Step 1 Log in to the Flink web UI as user **flink_admin**. For details, see **Accessing the Flink Web UI**.

Step 2 Create a cluster connection, for example, **flink_hive**.

1. Choose **System Management** > **Cluster Connection Management**. The **Cluster Connection Management** page is displayed.
2. Click **Create Cluster Connection**. On the displayed page, enter information by referring to **Table 5-40** and click **Test**. After the test is successful, click **OK**.

Table 5-40 Parameters for creating a cluster connection

Parameter	Description	Example Value
Cluster Connection Name	Name of the cluster connection, which can contain a maximum of 100 characters. Only letters, digits, and underscores (_) are allowed.	flink_hive
Description	Description of the cluster connection name.	-
Version	Select a cluster version.	MRS 3
Secure Version	– If the secure version is used, select **Yes** for a security cluster. Enter the username and upload the user credential. – If not, select **No**.	Yes
Username	The user must have the minimum permissions for accessing services in the cluster. The name can contain a maximum of 100 characters. Only letters, digits, and underscores (_) are allowed. This parameter is available only when **Secure Version** is set to **Yes**.	flink_admin
Client Profile	Client profile of the cluster, in TAR format.	-
User Credential	User authentication credential in FusionInsight Manager in TAR format. This parameter is available only when **Secure Version** is set to **Yes**. Files can be uploaded only after the username is entered.	User credential of **flink_admin**

Step 3 Create a Flink SQL job, for example, **flinktest1**.

1. Click **Job Management**. The job management page is displayed.

2. Click **Create Job**. On the displayed job creation page, set parameters by referring to **Table 5-41** and click **OK**. The job development page is displayed.

Table 5-41 Parameters for creating a job

Parameter	Description	Example Value
Type	Job type, which can be **Flink SQL** or **Flink Jar**.	Flink SQL
Name	Job name, which can contain a maximum of 64 characters. Only letters, digits, and underscores (_) are allowed.	flinktest1
Task Type	Type of the job data source, which can be a stream job or a batch job.	Stream job
Description	Job description, which can contain a maximum of 100 characters.	-

Step 4 On the job development page, enter the following statements and click **Check Semantic** to check the input content.

```
CREATE TABLE test_kafka (
  user_id varchar,
  item_id varchar,
  cat_id varchar,
  zw_test timestamp
) WITH (
  'properties.bootstrap.servers' = 'IP address of the Kafka broker instance:Kafka port number',
  'format' = 'json',
  'topic' = 'zw_tset_kafka',
  'connector' = 'kafka',
  'scan.startup.mode' = 'latest-offset',
  'properties.sasl.kerberos.service.name' = 'kafka',
  'properties.security.protocol' = 'SASL_PLAINTEXT',
  'properties.kerberos.domain.name' = 'hadoop.System domain name'

);
CREATE CATALOG myhive WITH (
  'type' = 'hive',
  'hive-version' = '3.1.0',
  'default-database' = 'default',
  'cluster.name' = 'flink_hive'
);
use catalog myhive;
set table.sql-dialect = hive;create table user_behavior_hive_tbl_no_partition (
    user_id STRING,
    item_id STRING,
    cat_id STRING,
    ts timestamp
  ) PARTITIONED BY (dy STRING, ho STRING, mi STRING) stored as textfile TBLPROPERTIES (
    'partition.time-extractor.timestamp-pattern' = '$dy $ho:$mi:00',
    'sink.partition-commit.trigger' = 'process-time',
    'sink.partition-commit.delay' = '0S',
    'sink.partition-commit.policy.kind' = 'metastore,success-file'
  );
INSERT into
  user_behavior_hive_tbl_no_partition
SELECT
  user_id,
  item_id,
  cat_id,
  zw_test,
```

```
 DATE_FORMAT(zw_test, 'yyyy-MM-dd'),
 DATE_FORMAT(zw_test, 'HH'),
 DATE_FORMAT(zw_test, 'mm')
FROM
 default_catalog.default_database.test_kafka;
```

NOTE

- The IP address and port number of the Kafka broker instance are as follows:
  - To obtain the instance IP address, log in to FusionInsight Manager, choose **Cluster** > **Services** > **Kafka**, click **Instance**, and query the instance IP address on the instance list page.
  - If Kerberos authentication is enabled for the cluster (the cluster is in security mode), the Broker port number is the value of **sasl.port**. The default value is **21007**.
  - If Kerberos authentication is disabled for the cluster (the cluster is in normal mode), the broker port number is the value of **port**. The default value is **9092**. If the port number is set to **9092**, set **allow.everyone.if.no.acl.found** to **true**. The procedure is as follows:

    Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Kafka**. Click **Configurations** then **All Configurations**. On the page that is displayed, search for **allow.everyone.if.no.acl.found**, set it to **true**, and click **Save**.
- The value of **'cluster.name'** is the name of the cluster connection created in **Step 2**.
- *System domain name*: You can log in to FusionInsight Manager, choose **System** > **Permission** > **Domain and Mutual Trust**, and check the value of **Local Domain**.

Step 5 After the job is developed, in **Basic Parameter**, select **Enable CheckPoint**, set **Time Interval(ms)** to **60000**, and retain the default value for **Mode**.

Step 6 Click **Submit** in the upper left corner to submit the job.

Step 7 After the job is successfully executed, choose **More** > **Job Monitoring** to view the job running details.

Step 8 Execute the following commands to view the topic and write data to Kafka. For details, see **Managing Messages in Kafka Topics**.

./kafka-topics.sh --list --zookeeper *IP address of the ZooKeeper quorumpeer instance*:*ZooKeeper port number*/**kafka**

sh kafka-console-producer.sh --broker-list *IP address of the node where Kafka instances reside*:*Kafka port number* **--topic** *Topic name* **--producer.config** *Client directory*/**Kafka/kafka/config/producer.properties**

For example, if the topic name is **zw_tset_kafka**, the script is **sh kafka-console-producer.sh --broker-list** *IP address of the node where the Kafka instance is located*:*Kafka port number* **--topic zw_tset_kafka** --**producer.config /opt/client/Kafka/kafka/config/producer.properties**

Enter the message content.

```
{"user_id": "3","item_id":"333333","cat_id":"cat333","zw_test":"2021-09-08 09:08:01"}
{"user_id": "4","item_id":"444444","cat_id":"cat444","zw_test":"2021-09-08 09:08:01"}
```

Press **Enter** to send the message.

NOTE

- IP address of the ZooKeeper quorumpeer instance

  To obtain IP addresses of all ZooKeeper quorumpeer instances, log in to FusionInsight Manager and choose **Cluster** > **Services** > **ZooKeeper**. On the displayed page, click **Instance** and view the IP addresses of all the hosts where the quorumpeer instances locate.

- Port number of the ZooKeeper client

  Log in to FusionInsight Manager and choose **Cluster** > **Service** > **ZooKeeper**. On the displayed page, click **Configurations** and check the value of **clientPort**.

Step 9 Run the following command to check whether data is written from the Hive table to the sink table:

beeline

select * from user_behavior_hive_tbl_no_partition;

----End

5.6.7 Interconnecting FlinkServer with Hudi

Scenario

This section describes how to interconnect FlinkServer with Hudi through Flink SQL jobs.

Prerequisites

- The HDFS, Yarn, Hive, Spark, Flink, and Kafka services have been installed in a cluster.
- The client that contains the Flink and Kafka services has been installed in a directory, for example, **/opt/client**.
- Flink 1.12.2 or later and Hudi 0.9.0 or later are required.
- You have created a user assigned with the **FlinkServer Admin Privilege** (for example, **flink_admin**) for accessing the Flink web UI by referring to **Creating a FlinkServer Role**. The user has been added to the **hadoop**, **hive**, and **kafkaadmin** user groups and granted the **Manager_administrator** role.

Flink Support for Read and Write Operations on Hudi Tables

Table 5-42 lists the read and write operations supported by Flink on Hudi COW and MOR tables.

Table 5-42 Flink support for read and write operations on Hudi tables

Flink SQL	COW table	MOR table
Batch write	Supported	Supported
Batch read	Supported	Supported
Stream write	Supported	Supported

Flink SQL	COW table	MOR table
Stream read	Supported	Supported

Procedure

Step 1 Log in to Manager as user **flink_admin** and choose **Cluster** > **Services** > **Flink**. In the **Basic Information** area, click the link on the right of **Flink WebUI** to access the Flink web UI.

Step 2 Create a Flink SQL job by referring to **Creating a Job**. On the job development page, configure the job as follows: Enter the SQL statement. After the SQL statement passes the verification, start the job. The following SQL examples are added as three jobs and run in sequence.

In **Basic Parameter**, select **Enable CheckPoint**, set **Time Interval(ms)** to **60000**, and retain the default value for **Mode**. This operation is required for all jobs.

Enable the fault recovery policy to improve job reliability. For example, set **Failure Recovery Policy** to **fixed-delay**, **Retry Times** to **3**, and **Retry Interval** to **30**. You can set the latter two parameters based on service requirements.

Wait until the job is started and its status is **Running**, choose **More** > **Job Monitoring** to go to the native UI of Flink, and view the job status.

NOTE

- CheckPoint should be enabled on the Flink web UI because data is written to a Hudi table only when a Flink SQL job triggers CheckPoint. Adjust the CheckPoint interval based on service requirements. You are advised to set the interval to a large number.
- If the CheckPoint interval is too short, job exceptions may occur due to untimely data updates. It is recommended that the CheckPoint interval be configured at the minute level.
- Asynchronous compaction is required when a Flink SQL job writes an MOR table. For details about the parameter for controlling the compaction interval, visit Hudi official website **https://hudi.apache.org/docs/configurations.html**.
- By default, writing data to a Hudi table is to save Flink's state indexes to the backend. To use bucket indexes, add the following parameters to the Hudi table:

```
'index.type'='BUCKET',
'hoodie.bucket.index.num.buckets'='Number of buckets in each partition of a Hudi table'
'hoodie.bucket.index.hash.field'='recordkey.field'
```

  - **hoodie.bucket.index.num.buckets**: Number of buckets in each partition of a Hudi table. Data in each partition is stored in each bucket in hash mode. This parameter cannot be modified after being set during table creation or data writing for the first time. Otherwise, an exception occurs during data update.
  - **hoodie.bucket.index.hash.field**: Field for calculating the hash value during bucketing. The field must be a subset of the primary key. The default value is the primary key of the Hudi table. If this parameter is left blank, the default value **recordkey.field** is used.
- For a Hudi table, bucket indexes of Flink and Spark can be saved to the backend together.

1. Job 1: This Flink SQL job writes data to an MOR table in streams.

```
CREATE TABLE stream_mor(
uuid VARCHAR(20),
name VARCHAR(10),
```

```
age INT,
ts INT,
`p` VARCHAR(20)
) PARTITIONED BY (`p`) WITH (
'connector' = 'hudi',
'path' = 'hdfs://hacluster/tmp/hudi/stream_mor',
'table.type' = 'MERGE_ON_READ',
'hoodie.datasource.write.recordkey.field' = 'uuid',
'write.precombine.field' = 'ts',
'write.tasks' = '4'
);

CREATE TABLE kafka(
uuid VARCHAR(20),
name VARCHAR(10),
age INT,
ts INT,
`p` VARCHAR(20)
) WITH (
'connector' = 'kafka',
'topic' = 'writehudi',
'properties.bootstrap.servers' = 'IP address of the Kafka broker instance:Kafka port number',
'properties.group.id' = 'testGroup1',
'scan.startup.mode' = 'latest-offset',
'format' = 'json',
'properties.sasl.kerberos.service.name' = 'kafka',--This parameter is not required for clusters in normal mode. Delete the comma (,) in the previous line.
'properties.security.protocol' = 'SASL_PLAINTEXT',--This parameter is not required for clusters in normal mode.
'properties.kerberos.domain.name' = 'hadoop.System domain name'--This parameter is not required for clusters in normal mode.
);

insert into
stream_mor
select
*
from
kafka;
```

2. Job 2: This Flink SQL job writes data to a COW table in streams.

```
CREATE TABLE stream_write_cow(
uuid VARCHAR(20),
name VARCHAR(10),
age INT,
ts INT,
`p` VARCHAR(20)
) PARTITIONED BY (`p`) WITH (
'connector' = 'hudi',
'path' = 'hdfs://hacluster/tmp/hudi/stream_cow',
'hoodie.datasource.write.recordkey.field' = 'uuid',
'write.precombine.field' = 'ts',
'write.tasks' = '4'
);

CREATE TABLE kafka(
uuid VARCHAR(20),
name VARCHAR(10),
age INT,
ts INT,
`p` VARCHAR(20)
) WITH (
'connector' = 'kafka',
'topic' = 'writehudi',
'properties.bootstrap.servers' = 'IP address of the Kafka broker instance:Kafka port number',
'properties.group.id' = 'testGroup1',
'scan.startup.mode' = 'latest-offset',
'format' = 'json',
'properties.sasl.kerberos.service.name' = 'kafka',--This parameter is not required for clusters in normal mode. Delete the comma (,) in the previous line.
```

```
'properties.security.protocol' = 'SASL_PLAINTEXT',--This parameter is not required for clusters in
normal mode.
'properties.kerberos.domain.name' = 'hadoop.System domain name'--This parameter is not required
for clusters in normal mode.
);

insert into
stream_write_cow
select
*
from
kafka;
```

3. Job 3: This Flink SQL job reads MOR and COW tables in streams, merges data, and outputs the merged data to Kafka. Verify the SQL statement of job 3 and start it after job 1 and job 2 are started and their status is running. Otherwise, an error message may be displayed during SQL verification, indicating that the Hudi table directory cannot be found.

```
CREATE TABLE stream_mor(
uuid VARCHAR(20),
name VARCHAR(10),
age INT,
ts INT,
`p` VARCHAR(20)
) PARTITIONED BY (`p`) WITH (
'connector' = 'hudi',
'path' = 'hdfs://hacluster/tmp/hudi/stream_mor',
'table.type' = 'MERGE_ON_READ',
'hoodie.datasource.write.recordkey.field' = 'uuid',
'write.precombine.field' = 'ts',
'read.tasks' = '4',
'read.streaming.enabled' = 'true',
'read.streaming.check-interval' = '5',
'read.streaming.start-commit' = 'earliest'
);
CREATE TABLE stream_write_cow(
uuid VARCHAR(20),
name VARCHAR(10),
age INT,
ts INT,
`p` VARCHAR(20)
) PARTITIONED BY (`p`) WITH (
'connector' = 'hudi',
'path' = 'hdfs://hacluster/tmp/hudi/stream_cow',
'hoodie.datasource.write.recordkey.field' = 'uuid',
'write.precombine.field' = 'ts',
'read.tasks' = '4',
'read.streaming.enabled' = 'true',
'read.streaming.check-interval' = '5',
'read.streaming.start-commit' = 'earliest'
);

CREATE TABLE kafka(
uuid VARCHAR(20),
name VARCHAR(10),
age INT,
ts INT,
`p` VARCHAR(20)
) WITH (
'connector' = 'kafka',
'topic' = 'readhudi',
'properties.bootstrap.servers' = 'IP address of the Kafka broker instance:Kafka port number',
'properties.group.id' = 'testGroup1',
'scan.startup.mode' = 'latest-offset',
'format' = 'json',
'properties.sasl.kerberos.service.name' = 'kafka',--This parameter is not required for clusters in normal
mode. Delete the comma (,) in the previous line.
'properties.security.protocol' = 'SASL_PLAINTEXT',--This parameter is not required for clusters in
normal mode.
```

```
'properties.kerberos.domain.name' = 'hadoop.System domain name'--This parameter is not required
for clusters in normal mode.
);

insert into
kafka
select
*
from
stream_mor union all select * from stream_write_cow;
```

NOTE

- The IP address and port number of the Kafka broker instance are as follows:
  - To obtain the instance IP address, log in to FusionInsight Manager, choose **Cluster** > **Services** > **Kafka**, click **Instance**, and query the instance IP address on the instance list page.
  - If Kerberos authentication is enabled for the cluster (the cluster is in security mode), the Broker port number is the value of **sasl.port**. The default value is **21007**.
  - If Kerberos authentication is disabled for the cluster (the cluster is in normal mode), the broker port number is the value of **port**. The default value is **9092**. If the port number is set to **9092**, set **allow.everyone.if.no.acl.found** to **true**. The procedure is as follows:

    Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Kafka**. Click **Configurations** then **All Configurations**. On the page that is displayed, search for **allow.everyone.if.no.acl.found**, set it to **true**, and click **Save**.
- *System domain name*: You can log in to FusionInsight Manager, choose **System** > **Permission** > **Domain and Mutual Trust**, and check the value of **Local Domain**.

Step 3 Execute the following script to write data to Kafka. For details, see **Managing Messages in Kafka Topics**.

sh kafka-console-producer.sh --broker-list *IP address of the node where Kafka instances reside*:*Kafka port number* **--topic** *Topic name* **--producer.config** *Client directory*/**Kafka/kafka/config/producer.properties**

In this example, the topic name is **writehudi**.

sh kafka-console-producer.sh --broker-list *IP address of the node where the Kafka instance is located*:*Kafka port number* **----topic writehudi --producer.config /opt/client/Kafka/kafka/config/producer.properties**

Enter the message content.

```
{"uuid": "1","name":"a01","age":10,"ts":10,"p":"1"}
{"uuid": "2","name":"a02","age":20,"ts":20,"p":"2"}
```

Press **Enter** to send the message.

Step 4 Consumes Kafka topic data and reads the result of reading the Hudi table from Flink streams.

sh kafka-console-consumer.sh --bootstrap-server *IP address of the node where Kafka instances reside*:*Kafka port number* **--topic** *Topic name* **--consumer.config** *Client directory*/**Kafka/kafka/config/consumer.properties --from-beginning**

In this example, the topic name is **readhudi**.

sh kafka-console-consumer.sh --bootstrap-server *IP address of the Kafka role instance*:*Kafka port* **--topic readhudi --consumer.config /opt/client/Kafka/kafka/config/consumer.properties --from-beginning**

The read result is as follows (the sequence is not fixed):

```
{"uuid": "1","name":"a01","age":10,"ts":10,"p":"1"}
{"uuid": "2","name":"a02","age":20,"ts":20,"p":"2"}
{"uuid": "1","name":"a01","age":10,"ts":10,"p":"1"}
{"uuid": "2","name":"a02","age":20,"ts":20,"p":"2"}
```

----End

WITH Parameters

Table 5-43 WITH parameters

Mode	Parameter	Mandatory	Default Value	Description
Read	read.tasks	No	4	Parallelism of the tasks for reading the Hudi table.
	read.streaming.enabled	No	false	Whether to enable stream read.
	read.streaming.start-commit	No	By default, data is read from the latest commit.	Start position (closed interval) of incremental stream and batch consumption in **yyyyMMddHHmmss** format.
	read.end-commit	No	By default, data is read to the latest commit.	End position (closed interval) of incremental stream and batch consumption in **yyyyMMddHHmmss** format.
Write	write.tasks	No	4	Parallelism of the tasks for reading data from the Hudi table.
	index.bootstrap.enabled	No	false	Whether to enable index loading. If it is enabled, the latest data in the stored table is loaded to the state at a time. If incremental data needs to be synchronized to full data and there are offline Hoodie tables available, you can enable the index loading function to write data in real time and ensure that data is unique.

Mode	Parameter	Mandatory	Default Value	Description
	write.index_bootstrap.tasks	No	4	If indexes are loaded slowly when a job is started, you can choose a larger value for this parameter. After that, the efficiency is improved, but checkpoints are blocked in the bootstrap phase.
	compaction.async.enabled	No	true	Whether to enable online compaction
	compaction.schedule.enabled	No	true	Whether to generate a compression plan periodically. You are advised to enable this function even if online compaction is disabled.
	compaction.tasks	No	10	Parallelism of the tasks for compacting data in the Hudi table.
	index.state.ttl	No	7D	Duration for storing indexes. The default value is 7 days. If the value is less than 0, indexes are stored permanently. Indexes are the core data structure for determining whether data is duplicate. For long-time updates, for example, updating data generated one month ago, you need to increase the value of this parameter.

Synchronizing Metadata from Flink On Hudi to Hive

After this feature is enabled, Flink automatically creates a Hudi table on Hive and adds partitions to the Hudi table when writing data to it. Then services such as SparkSQL and Hive can read data form the Hudi table.

The metadata can be synchronized with either of the following methods. The JDBC mode is used as an example in the following steps.

- Synchronizing metadata to Hive in JDBC mode

```
CREATE TABLE stream_mor(
uuid VARCHAR(20),
name VARCHAR(10),
age INT,
ts INT,
`p` VARCHAR(20)
) PARTITIONED BY (`p`) WITH (
'connector' = 'hudi',
'path' = 'hdfs://hacluster/tmp/hudi/stream_mor',
'table.type' = 'MERGE_ON_READ',
'hive_sync.enable' = 'true',
'hive_sync.table' = 'Name of the table to be synchronized to Hive',
'hive_sync.db' = 'Name of the database to be synchronized to Hive',
'hive_sync.metastore.uris' = 'Value of hive.metastore.uris in the hive-site.xml file on the Hive
```

```
client',
'hive_sync.jdbc_url' = 'Value of CLIENT_HIVE_URI in the component_env file on the Hive client'
);
```

NOTICE

- **hive_sync.jdbc_url**: If the value of **CLIENT_HIVE_URI** contains \, delete \.
- To use the Hive style partitioning, add the following parameters:
  - 'hoodie.datasource.write.hive_style_partitioning' = 'true'
  - 'hive_sync.partition_extractor_class' = 'org.apache.hudi.hive.MultiPartKeysValueExtractor'
- Flink on Hudi synchronizes data to Hive. Hudi is case sensitive, while Hive is case insensitive. You are not advised to use uppercase letters in fields of Hudi tables. Otherwise, data may fail to be read or written.

- Synchronizing metadata to Hive in HMS mode

```
CREATE TABLE stream_mor(
uuid VARCHAR(20),
name VARCHAR(10),
age INT,
ts INT,
`p` VARCHAR(20)
) PARTITIONED BY (`p`) WITH (
'connector' = 'hudi',
'path' = 'hdfs://hacluster/tmp/hudi/stream_mor',
'table.type' = 'MERGE_ON_READ',
'hive_sync.enable' = 'true',
'hive_sync.table' = 'Name of the table to be synchronized to Hive',
'hive_sync.db' = 'Name of the database to be synchronized to Hive',
'hive_sync.mode' = 'hms',
'hive_sync.metastore.uris' = 'Value of hive.metastore.uris in the hive-site.xml file on the Hive client',
'properties.hive.metastore.kerberos.principal' = 'Value of hive.metastore.kerberos.principal in the hive-site.xml file on the Hive client'
);
```

Step 1 Log in to Manager as user **flink_admin** and choose **Cluster** > **Services** > **Flink**. In the **Basic Information** area, click the link on the right of **Flink WebUI** to access the Flink web UI.

Step 2 Create a Flink SQL job by referring to **Creating a Job**. On the job development page, configure the job. Enter the SQL statement. After the SQL statement passes the verification, start the job.

In **Basic Parameter**, select **Enable CheckPoint**, set **Time Interval(ms)** to **60000**, and retain the default value for **Mode**.

```
CREATE TABLE stream_mor2(
uuid VARCHAR(20),
name VARCHAR(10),
age INT,
ts INT,
`p` VARCHAR(20)
) PARTITIONED BY (`p`) WITH (
'connector' = 'hudi',
'path' = 'hdfs://hacluster/tmp/hudi/stream_mor2',
'table.type' = 'MERGE_ON_READ',
'hoodie.datasource.write.recordkey.field' = 'uuid',
'write.precombine.field' = 'ts',
'write.tasks' = '4',
```

```
'hive_sync.enable' = 'true',
'hive_sync.table' = 'Name of the table to be synchronized to Hive, for example, stream_mor2',
'hive_sync.db' = 'Name of the database to be synchronized to Hive, for example, default',
'hive_sync.metastore.uris' = 'Value of hive.metastore.uris in the hive-site.xml file on the Hive client',
'hive_sync.jdbc_url' = 'Value of CLIENT_HIVE_URI in the component_env file on the Hive client'
);
CREATE TABLE datagen (
uuid varchar(20), name varchar(10), age int, ts INT, p varchar(20)
) WITH (
'connector' = 'datagen',
'rows-per-second' = '1',
'fields.p.length' = '1'
);insert into stream_mor2 select * from datagen;
```

Step 3 Wait for the Flink job to run for a period of time and continuously write the random test data generated by datagen to the Hudi table. You can click **More** > **Job Monitoring** to go to the native UI of Flink and view the job status.

Step 4 Log in to the node where the client is deployed, load environment variables, run the beeline command to log in to the Hive client, and run SQL statements to check whether the Hudi Sink table is successfully created on Hive and whether data can be read from the table.

cd /opt/hadoopclient

source bigdata_env

beeline

desc formatted default.stream_mor2;

select * from default.stream_mor2 limit 5;

show partitions default.stream_mor2;

----End

5.6.8 Interconnecting FlinkServer with Kafka

Scenario

This section describes the data definition language (DDL) of Kafka as a source or sink table, as well as the WITH parameters and example code for creating a table, and provides guidance on how to perform operations on the FlinkServer job management page.

Kafka in security mode is used as an example.

Prerequisites

- The HDFS, Yarn, Kafka, and Flink services have been installed in a cluster.
- The client that contains the Kafka service has been installed in a directory, for example, **/opt/client**.
- You have created a user assigned with the **FlinkServer Admin Privilege** (for example, **flink_admin**) for accessing the Flink web UI by referring to **Creating a FlinkServer Role**.

Procedure

Step 1 Log in to Manager as user **flink_admin** and choose **Cluster** > **Services** > **Flink**. In the **Basic Information** area, click the link on the right of **Flink WebUI** to access the Flink web UI.

Step 2 Create a Flink SQL job by referring to **Creating a Job**. On the job development page, configure the job parameters as follows and start the job.

In **Basic Parameter**, select **Enable CheckPoint**, set **Time Interval(ms)** to **60000**, and retain the default value for **Mode**.

```
CREATE TABLE KafkaSource (
  `user_id` VARCHAR,
  `user_name` VARCHAR,
  `age` INT
) WITH (
  'connector' = 'kafka',
  'topic' = 'test_source',
  'properties.bootstrap.servers' = 'IP address of the Kafka broker instance:Kafka port number',
  'properties.group.id' = 'testGroup',
  'scan.startup.mode' = 'latest-offset',
  'format' = 'csv',
  'properties.sasl.kerberos.service.name' = 'kafka',
  'properties.security.protocol' = 'SASL_PLAINTEXT',
  'properties.kerberos.domain.name' = 'hadoop.System domain name'
);
CREATE TABLE KafkaSink(
  `user_id` VARCHAR,
  `user_name` VARCHAR,
  `age` INT
) WITH (
  'connector' = 'kafka',
  'topic' = 'test_sink',
  'properties.bootstrap.servers' = 'IP address of the Kafka broker instance:Kafka port number',
  'scan.startup.mode' = 'latest-offset',
  'value.format' = 'csv',
  'properties.sasl.kerberos.service.name' = 'kafka',
  'properties.security.protocol' = 'SASL_PLAINTEXT',
  'properties.kerberos.domain.name' = 'hadoop.System domain name'
);
Insert into
  KafkaSink
select
  *
from
  KafkaSource;
```

NOTE

- Kafka port
  - If Kerberos authentication is enabled for the cluster (the cluster is in security mode), the Broker port number is the value of **sasl.port**. The default value is **21007**.
  - If Kerberos authentication is disabled for the cluster (the cluster is in normal mode), the broker port number is the value of **port**. The default value is **9092**. If the port number is set to **9092**, set **allow.everyone.if.no.acl.found** to **true**. The procedure is as follows:

    Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Kafka**. Click **Configurations** then **All Configurations**. On the page that is displayed, search for **allow.everyone.if.no.acl.found**, set it to **true**, and click **Save**.
- *System domain name*: You can log in to FusionInsight Manager, choose **System** > **Permission** > **Domain and Mutual Trust**, and check the value of **Local Domain**.

Step 3 On the job management page, check whether the job status is **Running**.

Step 4 Run the following command to check whether data is received in the sink table, that is, check whether data is properly written to the Kafka topic after **Step 5** is performed. For details, see **Managing Messages in Kafka Topics**.

sh kafka-console-consumer.sh --topic test_sink --bootstrap-server *Service IP address of the Kafka broker instance*:*Kafka port number* --**consumer.config /opt/client/Kafka/kafka/config/consumer.properties**

Step 5 View the topic and write data to the Kafka topic by referring to **Managing Messages in Kafka Topics**. After the data is written, view the execution result in the window in **Step 4**.

./kafka-topics.sh --list --zookeeper *IP address of the ZooKeeper quorumpeer instance*:*ZooKeeper port number*/**kafka**

sh kafka-console-producer.sh --broker-list *IP address of the node where Kafka instances reside*:*Kafka port number* **--topic** *Topic name* **--producer.config** *Client directory*/**Kafka/kafka/config/producer.properties**

For example, if the topic name is **test_source**, the script is **sh kafka-console-producer.sh --broker-list** *IP address of the node where the Kafka instance is located*:*Kafka port number* **--topic test_source** --**producer.config /opt/client/Kafka/kafka/config/producer.properties**

Enter the message content.

```
1,clw,33
```

Press **Enter** to send the message.

NOTE

- IP address of the ZooKeeper quorumpeer instance

  To obtain IP addresses of all ZooKeeper quorumpeer instances, log in to FusionInsight Manager and choose **Cluster** > **Services** > **ZooKeeper**. On the displayed page, click **Instance** and view the IP addresses of all the hosts where the quorumpeer instances locate.
- Port number of the ZooKeeper client

  Log in to FusionInsight Manager and choose **Cluster** > **Service** > **ZooKeeper**. On the displayed page, click **Configurations** and check the value of **clientPort**.

----End

WITH Parameters

Table 5-44 WITH Parameters

Parameter	Mandatory	Type	Description
connector	Yes	String	Connector to be used. **kafka** is used for Kafka.

Parameter	Mandatory	Type	Description
topic	• Yes (Kafka functions as a sink table.) • No (Kafka functions as a source table.)	String	Topic name. • When the Kafka is used as a source table, this parameter indicates the name of the topic from which data is read. Topic list is supported. Topics are separated by semicolons (;), for example, **Topic-1; Topic-2**. • When Kafka is used as a sink table, this parameter indicates the name of the topic to which data is written. Topic list is not supported for sinks.
topic-pattern	No (Kafka functions as a source table.)	String	Topic pattern. This parameter is available when Kafka is used as a source table. The topic name must be a regular expression. **NOTE** **topic-pattern** and **topic** cannot be set at the same time.
properties.bootstrap.servers	Yes	String	List of Kafka brokers, which are separated by commas (,).
properties.group.id	Yes (Kafka functions as a source table.)	String	Kafka user group ID.
format	Yes	String	Format of the value used for deserializing and serializing Kafka messages.
properties.*	No	String	Authentication-related parameters that need to be added in security mode.

5.6.9 Interconnecting FlinkServer with Redis

Scenario

This section describes the data definition language (DDL) of Redis as a sink or dimension table, as well as the WITH parameters and example code for creating a table, and provides guidance on how to perform operations on the FlinkServer job management page.

Kafka in security mode is used as an example.

Prerequisites

- The HDFS, Yarn, Redis, and Flink services have been installed in a cluster.
- The client that contains the Redis service has been installed in a directory, for example, **/opt/client**.
- You have created a user assigned with the **FlinkServer Admin Privilege** (for example, **flink_admin**) for accessing the Flink web UI by referring to **Creating a FlinkServer Role**.

Procedure

Scenario 1: Redis functions as a sink table.

Step 1 Log in to Manager as user **flink_admin** and choose **Cluster** > **Services** > **Flink**. In the **Basic Information** area, click the link on the right of **Flink WebUI** to access the Flink web UI.

Step 2 Create a Flink SQL job by referring to **Creating a Job**. On the job development page, configure the job parameters as follows and start the job.

In **Basic Parameter**, select **Enable CheckPoint**, set **Time Interval(ms)** to **60000**, and retain the default value for **Mode**.

```
CREATE TABLE kafka_source (
  account varchar(10),
  costs int,
  ts AS PROCTIME()
) WITH (
  'connector' = 'kafka',
  'topic' = 'user_source',
  'properties.bootstrap.servers' = 'IP address of the Kafka broker instance:Kafka port number',
  'properties.group.id' = 'testGroup',
  'scan.startup.mode' = 'latest-offset',
  'format' = 'json',
  'properties.sasl.kerberos.service.name' = 'kafka',
  'properties.security.protocol' = 'SASL_PLAINTEXT',
  'properties.kerberos.domain.name' = 'hadoop.System domain name'
);
CREATE table redis_sink(
  account varchar,
  costs int,
  PRIMARY KEY(account) NOT ENFORCED
) WITH (
  'connector' = 'redis',
  'deploy-mode'='cluster',
  'need-kerberos-auth' = 'true',
  'service-kerberos-name' = 'redis/hadoop.System domain name',
  'login-context-name' = 'Client',
  'host' = '10.10.10.169',
  'port' = '22400',
  'isSSLMode' = 'true',
  'data-type' = 'string',
  'namespace' = 'redis_table_2',
  'sink.batch.max-size' = '-1',--Indicates whether to enable batch write to Redis and the number of writes in a batch. The value -1 indicates that batch write to Redis is disabled. To enable batch write to Redis, you need to enable checkpointing.
  'sink.flush-buffer.timeout' = '1000'--After batch write to Redis is enabled, data in the queue can be updated to Redis at a specified time, in milliseconds.

);
INSERT INTO
  redis_sink
SELECT
  account,
  SUM(costs)
```

```
FROM
  kafka_source
GROUP BY
  TUMBLE(ts, INTERVAL '90' SECOND),
  --This allows you to quickly view the calculation result.
  account;
```

NOTE

- The IP address and port number of the Kafka broker instance are as follows:
  - To obtain the instance IP address, log in to FusionInsight Manager, choose **Cluster** > **Services** > **Kafka**, click **Instance**, and query the instance IP address on the instance list page.
  - If Kerberos authentication is enabled for the cluster (the cluster is in security mode), the Broker port number is the value of **sasl.port**. The default value is **21007**.
  - If Kerberos authentication is disabled for the cluster (the cluster is in normal mode), the broker port number is the value of **port**. The default value is **9092**. If the port number is set to **9092**, set **allow.everyone.if.no.acl.found** to **true**. The procedure is as follows:

    Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Kafka**. Click **Configurations** then **All Configurations**. On the page that is displayed, search for **allow.everyone.if.no.acl.found**, set it to **true**, and click **Save**.
- *System domain name*: You can log in to FusionInsight Manager, choose **System** > **Permission** > **Domain and Mutual Trust**, and check the value of **Local Domain**.
- **host** and **port** indicate the IP address and port number of an instance in the Redis cluster, respectively.

  The formula for calculating the port number of the Redis instance is: 22400 + Instance ID – 1.

  To view the instance ID, choose **Cluster** > *Name of the desired cluster* > **Service** > **Redis** > **Redis Manager** on FusionInsight Manager and click the target Redis cluster name.

  For example, in the Redis cluster, the port number of the Redis instance that corresponds to the role **R1** port is 22400 (22400 + 1 – 1 = 22400).
- **namespace**: Key used to concatenate the Redis database. Set it to a value in the format of *Namespace value*:*Account value*. For example, if the account value is **A1** and the namespace value is **redis_table_2**, the value of this key in the Redis database is **redis_table_2:A1**.
- **sink.batch.max-size**:
  - Enable batch write to Redis and set the number (positive integer) of records to be written in a batch. The value **-1** indicates that batch write to Redis is disabled.

    Enabling this function can improve the performance in big data scenarios, but it is not suitable for scenarios that have high requirements on real-time performance. It is recommended that the number of batch writes be no more than 30,000.
  - To set this parameter, you need to enable checkpointing.
- **sink.flush-buffer.timeout**: After batch write to Redis is enabled, data in the queue can be updated to Redis at a specified time, in milliseconds.

Step 3 On the job management page, check whether the job status is **Running**.

Step 4 Run the following command to check whether data is received in the sink table, that is, check whether data is properly written to the Kafka topic after **Step 5** is performed. For details, see **Managing Messages in Kafka Topics**.

sh kafka-console-consumer.sh --topic *Topic name* **--bootstrap-server** *Service IP address of the Kafka broker instance*:*Kafka port number* --**consumer.config /opt/client/Kafka/kafka/config/consumer.properties**

Step 5 View the topic and write data to the Kafka topic by referring to **Managing Messages in Kafka Topics**. After the data is written, view the execution result in the window in **Step 4**.

./kafka-topics.sh --list --zookeeper *IP address of the ZooKeeper quorumpeer instance*:*ZooKeeper port number*/**kafka**

sh kafka-console-producer.sh --broker-list *IP address of the node where Kafka instances reside*:*Kafka port number* **--topic** *Topic name* **--producer.config** *Client directory*/**Kafka/kafka/config/producer.properties**

For example, if the topic name is **user_source**, the script is **sh kafka-console-producer.sh --broker-list** *IP address of the node where the Kafka instance is located*:*Kafka port number* **--topic user_source** --**producer.config /opt/client/Kafka/kafka/config/producer.properties**

Enter the message content.

```
{"account": "A1","costs":"11"}
{"account": "A1","costs":"22"}
{"account": "A2","costs":"33"}
{"account": "A3","costs":"44"}
```

Press **Enter** to send the message.

NOTE

- IP address of the ZooKeeper quorumpeer instance

  To obtain IP addresses of all ZooKeeper quorumpeer instances, log in to FusionInsight Manager and choose **Cluster** > **Services** > **ZooKeeper**. On the displayed page, click **Instance** and view the IP addresses of all the hosts where the quorumpeer instances locate.
- Port number of the ZooKeeper client

  Log in to FusionInsight Manager and choose **Cluster** > **Service** > **ZooKeeper**. On the displayed page, click **Configurations** and check the value of **clientPort**.

Step 6 Run the following command to log in to the Redis client and query the result. **redis_table_2:A1** is used as an example.

redis-cli -c -h *Service IP address of one instance in the Redis cluster* **-p** *Redis port number*

get *redis_table_2:A1*

----End

Scenario 2: Redis functions as a dimension table.

Step 1 Log in to Manager as user **flink_admin** and choose **Cluster** > **Services** > **Flink**. In the **Basic Information** area, click the link on the right of **Flink WebUI** to access the Flink web UI.

Step 2 Create a Flink SQL job by referring to **Creating a Job**. On the job development page, configure the job parameters as follows and start the job.

In **Basic Parameter**, select **Enable CheckPoint**, set **Time Interval(ms)** to **60000**, and retain the default value for **Mode**.

```
CREATE TABLE KafkaSource ( -- Kafka functions as a source table.
  `user_id` VARCHAR,
  `user_name` VARCHAR,
  `age` double,
```

```
  proctime as proctime()
) WITH (
  'connector' = 'kafka',
  'topic' = 'user_source',
  'properties.bootstrap.servers' = 'IP address of the Kafka broker instance:Kafka port',
  'properties.group.id' = 'testGroup',
  'scan.startup.mode' = 'latest-offset',
  'value.format' = 'csv',
  'properties.sasl.kerberos.service.name' = 'kafka',
  'properties.security.protocol' = 'SASL_PLAINTEXT',
  'properties.kerberos.domain.name' = 'hadoop.System domain name'
);
CREATE TABLE KafkaSink ( -- Kafka functions as a sink table.
  `user_id` VARCHAR,
  `user_name` VARCHAR,
  `age` double,
  `phone_number` VARCHAR,
  `address` VARCHAR
) WITH (
  'connector' = 'kafka',
  'topic' = 'user_sink',
  'properties.bootstrap.servers' = 'IP address of the Kafka broker instance:Kafka port',
  'properties.group.id' = 'testGroup',
  'scan.startup.mode' = 'latest-offset',
  'value.format' = 'csv',
  'properties.sasl.kerberos.service.name' = 'kafka',
  'properties.security.protocol' = 'SASL_PLAINTEXT',
  'properties.kerberos.domain.name' = 'hadoop.System domain name'
);
CREATE TABLE RedisTable ( -- Redis functions as a dimension table.
  user_name VARCHAR,
  score double,
  phone_number VARCHAR,
  address VARCHAR
) WITH (
  'connector' = 'redis',
  'deploy-mode'='cluster',
  'need-kerberos-auth' = 'true',
  'service-kerberos-name' = 'redis/hadoop.System domain name',
  'login-context-name' = 'Client',
  'zset-score-column' = 'score',
  'host' = '10.10.10.169',
  'port' = '22400',
  'isSSLMode' = 'true',
  'key-ttl-mode' = 'no-ttl',
  'data-type' = 'sorted-set',
  'namespace' = 'redis_zset',
  'zset-delimiter' = ',',
  'key-column' = 'user_name',
  'schema-syntax' = 'concatenate-fields'
);

INSERT INTO
  KafkaSink
SELECT
  t.user_id,
  t.user_name,
  t.age,
  d.phone_number,
  d.address
FROM
  KafkaSource as t
  JOIN RedisTable FOR SYSTEM_TIME AS OF t.proctime as d ON t.user_name = d.user_name;
  -- FOR SYSTEM_TIME AS OF t.proctime must be added, indicating the current data in the JOIN dimension
table.
```

Step 3 Run the following commands to write test data to the Redis dimension table:

cd /opt/client/Redis/bin

./redis-cli -h *10.10.10.11* **-p** *22400* **-c**

Enter the message content.

```
ZADD redis_zset:zhangsan 80 153xxxx1111,city1
ZADD redis_zset:lisi 70 153xxxx2222,city2
ZADD redis_zset:wangwu 90 153xxxx3333,city3
```

NOTE

If channel encryption is enabled for Redis, replace the second command with **./redis-cli -h** *10.10.10.11* **-p** *22400* **--tls -c**.

To enable SSL channel encryption for Redis, log in to FusionInsight Manager and choose **Cluster** > **Services** > **Redis**. On the displayed page, click **Configurations** and then **All Configurations**, search for **REDIS_SSL_ON**, and set this parameter to **true**. Channel encryption encrypts data during data transfer but affects performance. Do not enable this function (set **REDIS_SSL_ON** to **false**) when Redis does not contain important or sensitive data.

Step 4 Run the following command to generate data and then write it into the Kafka source table.

sh kafka-console-producer.sh --broker-list *IP address of the node where Kafka instances reside*:*Kafka port number* **--topic** *Topic name* **--producer.config** *Client directory*/**Kafka/kafka/config/producer.properties**

Enter the message content.

```
1,zhangsan,20
2,lisi,25
3,wangwu,28
```

Step 5 Run the following commands to check whether data is written from the Kafka topic to the sink table:

sh kafka-console-consumer.sh --topic *Topic name* **--bootstrap-server** *Service IP address of the Kafka broker instance*:*Kafka port number* --**consumer.config** *Client directory*/**Kafka/kafka/config/consumer.properties**

The output will be displayed as follows:

```
1,zhangsan,20,153xxxx1111,city1
2,lisi,25,153xxxx2222,city2
3,wangwu,28,153xxxx3333,city3
```

----End

WITH Parameters

Table 5-45 WITH parameters

Parameter	Mandatory	Type	Description
zSetScoreColumn	No	String	Column name corresponding to the **score** field when Redis functions as a dimension table in Zset format.
hashKeyColumn	No	String	Column name corresponding to the **Hash** field, in hash format.

Parameter	Mandatory	Type	Description
host	Yes	String	IP address for connecting to the Redis cluster, which is the instance IP address (service plane) of the Redis cluster.
port	Yes	String	Port number of the Redis instance. The formula for calculating the port number of the Redis instance is: 22400 + Instance ID – 1. To view the instance ID, log in to FusionInsight Manager and choose **Cluster** > *Name of the desired cluster* > **Services**. On the page that is displayed, choose **Redis** > **Redis Manager** and click the target Redis cluster name. For example, in the Redis cluster, the port number of the Redis instance that corresponds to the role **R1** port is 22400 (22400 + 1 – 1 = 22400).
separator	No	String	Separator for the fields in a value when Redis is used as a dimension table, for example, **(,)** and **(\u200b)**.
key-ttl-mode	No	String	Redis data expiration policy. Value options are as follows: ● **no-ttl**: Data does not expire. ● **expire-msec**: the period after which data expires, in milliseconds. ● **expire-at-date**: Data expires at a specified time, accurate to seconds. ● **expire-at-timestamp**: Data expires at a specified time, accurate to milliseconds.
key-ttl	No	String	This parameter is mandatory when **key-ttl-mode** is set to a value other than **no-ttl**. The value does not need to contain a unit.
isSSLMode	No	String	Whether to enable SSL. ● **true**: The SSL mode is enabled. ● **false**: The SSL mode is disabled.
keyPrefix	No	String	Prefix of the Redis key.

5.7 Flink Log Overview

Log Description

Log path:

- Run logs of a Flink job: **${BIGDATA_DATA_HOME}/hadoop/data${i}/nm/containerlogs/application_${appid}/container_{$contid}**

  NOTE

  The logs of executing tasks are stored in the preceding path. After the execution is complete, the Yarn configuration determines whether these logs are gathered to the HDFS directory.

- FlinkResource run logs: **/var/log/Bigdata/flink/flinkResource**
- FlinkServer run logs: **/var/log/Bigdata/flink**
- FlinkServer audit logs: **/var/log/Bigdata/audit/flink/flinkserver**
- Run logs related to FlinkServer HA scripts: **/var/log/Bigdata/audit/flink/flinkserver/ha**

Log archive rules:

1. FlinkResource run logs:
   - By default, service logs are backed up each time when the log size reaches 20 MB. A maximum of 20 logs can be reserved without being compressed.
   - You can set the log size and number of compressed logs on the Manager page or modify the corresponding configuration items in **log4j-cli.properties**, **log4j.properties**, and **log4j-session.properties** in *Client installation directory*/**Flink/flink/conf/** on the client.

   Table 5-46 FlinkResource log list

Type	Name	Description
FlinkResource run logs	checkService.log	Health check log
	kinit.log	Initialization log
	postinstall.log	Service installation log
	prestart.log	Prestart script log
	start.log	Startup log

2. FlinkServer service logs, HA-related logs, and audit logs.
   - By default, FlinkServer service logs, HA-related logs, and audit logs are backed up each time when the log size reaches 100 MB. The service logs are stored for a maximum of 30 days, and audit logs are stored for a maximum of 90 days.
   - You can set the log size and number of compressed logs on the Manager page or modify the corresponding configuration items in **log4j-cli.properties**, **log4j.properties**, and **log4j-session.properties** in *Client installation directory*/**Flink/flink/conf/** on the client.

Table 5-47 FlinkServer log list

Type	Name	Description
FlinkServer run logs	checkService.log	Health check log
	checkFlinkServer.log	Health check log of FlinkServer
	localhost_access_log..*yyyy-mm-dd*.txt	URL log of FlinkServer
	start_thrift_server.out	Thrift server startup log
	thrift_server_thriftServer_*xxx*.log.last	
	cleanup.log	Cleanup log file for instance installation and uninstallation
	flink-omm-client-*IP*.log	Job startup log
	flinkserver_*yyyymmdd-x*.log.gz	Service archive log
	flinkserver.log	Service log
	flinkserver---*pidxxxx*-gc.log.*x*.current	GC log
	kinit.log	Initialization log
	postinstall.log	Service installation log
	prestart.log	Prestart script log
	start.log	Startup log
	stop.log	Stop log
	catalina.*yyyy-mm-dd*.log	Tomcat run log
	catalina.out	
	host-manager.*yyyy-mm-dd*.log	
	localhost.*yyyy-mm-dd*.log	
	manager.*yyyy-mm-dd*.log	
Run log file related to FlinkServer HA scripts	ha.log	HA run log
	ha_monitor.log	HA process monitoring log
	floatip_ha.log	Floating IP address resource script log

Type	Name	Description
	rcommflinkserver.log	FlinkServer resource script log
	checkHaStatus.log	HA process log
	checknode.log	HA health status log
	rs-sendAlarm.log	HA alarm sending log
	flink_roll.log	FlinkServer active/standby switchover log (active/standby switchover required)
FlinkServer audit logs	flinkserver_audit_*yyyymmdd-x*.log.gz	Audit archive log
	flinkserver_audit.log	Audit log
Stack information log	threadDump-<*DATE*>.log	Log printed when instances are restarted or stopped

Log Level

Table 5-48 describes the log levels supported by Flink. The priorities of log levels are ERROR, WARN, INFO, and DEBUG in descending order. Logs whose levels are higher than or equal to the specified level are printed. The number of printed logs decreases as the specified log level increases.

Table 5-48 Log levels

Level	Description
ERROR	Error information about the current event processing
WARN	Exception information about the current event processing
INFO	Normal running status information about the system and events
DEBUG	System information and system debugging information

To modify log levels, perform the following steps:

Step 1 Go to the **All Configurations** page of Flink by referring to **Modifying Cluster Service Configuration Parameters**.

Step 2 On the menu bar on the left, select the log menu of the target role.

Step 3 Select a desired log level.

Step 4 Save the configuration. In the displayed dialog box, click **OK** to make the configurations take effect.

----End

NOTE

- After the configuration is complete, you do not need to restart the service. Download the client again for the configuration to take effect.
- You can also change the configuration items corresponding to the log level in **log4j-cli.properties**, **log4j.properties**, and **log4j-session.properties** in *Client installation directory*/**Flink/flink/conf/** on the client.
- When a job is submitted using a client, a log file is generated in the **log** folder on the client. The default umask value is **0022**. Therefore, the default log permission is **644**. To change the file permission, you need to change the umask value. For example, to change the umask value of user **omm**:
  - Add **umask 0026** to the end of the **/home/omm/.baskrc** file.
  - Run the **source /home/omm/.baskrc** command to make the file permission take effect.

Log Format

Table 5-49 Log formats

Type	Format	Example
Run log	*<yyyy-MM-dd HH:mm:ss,SSS>*|*<Log level>*|*<Name of the thread that generates the log>*|*<Message in the log>*|*<Location where the log event occurs>*	2019-06-27 21:30:31,778 | INFO | [flink-akka.actor.default-dispatcher-3] | TaskManager container_e10_1498290698388_0004_02_000007 has started. | org.apache.flink.yarn.YarnFlinkResourceManager (FlinkResourceManager.java:368)

5.8 Flink Performance Tuning

5.8.1 Memory Configuration Optimization

Scenarios

The computing of Flink depends on memory. If the memory is insufficient, the performance of Flink will be greatly deteriorated. One solution is to monitor garbage collection (GC) to evaluate the memory usage. If the memory becomes the performance bottleneck, optimize the memory usage according to the actual situation.

If **Full GC** is frequently reported in the Container GC on the Yarn that monitors the node processes, the GC needs to be optimized.

NOTE

In the **env.java.opts** configuration item of the **conf/flink-conf.yaml** file on the client, add the **-Xloggc:<LOG_DIR>/gc.log -XX:+PrintGCDetails -XX:-OmitStackTraceInFastThrow -XX:+PrintGCTimeStamps -XX:+PrintGCDateStamps -XX:+UseGCLogFileRotation -XX:NumberOfGCLogFiles=20 -XX:GCLogFileSize=20M** parameter. The GC log is configured by default.

Procedure

- Optimize GC.

  Adjust the ratio of tenured generation memory to young generation memory. In the **conf/flink-conf.yaml** configuration file on the client, add the **-XX:NewRatio** parameter to the **env.java.opts** configuration item. For example, **-XX:NewRatio=2** indicates that ratio of tenured generation memory to young generation memory is 2:1, that is, the young generation memory occupies one third and tenured generation memory occupies two thirds.
- When developing Flink applications, optimize the partitioning or grouping operation of DataStream.
  - If partitioning causes data skew, partitions need to be optimized.
  - Do not perform concurrent operations, because some operations, WindowAll for example, to DataStream do not support parallelism.
  - Do not use set keyBy to string type.

5.8.2 Configuring DOP

Scenario

The degree of parallelism (DOP) indicates the number of tasks to be executed concurrently. It determines the number of data blocks after the operation. Configuring the DOP will optimize the number of tasks, data volume of each task, and the host processing capability.

Query the CPU and memory usage. If data and tasks are not evenly distributed among nodes, increase the DOP for even distribution.

Procedure

Configure the DOP at one of the following layers (the priorities of which are in the descending order) based on the actual memory, CPU, data, and application logic conditions:

- Operator

  Call the **setParallelism()** method to specify the DOP of an operator, data source, and sink. For example:

```
final StreamExecutionEnvironment env = StreamExecutionEnvironment.getExecutionEnvironment();

DataStream<String> text = [...]
DataStream<Tuple2<String, Integer>> wordCounts = text
    .flatMap(new LineSplitter())
    .keyBy(0)
    .timeWindow(Time.seconds(5))
    .sum(1).setParallelism(5);

wordCounts.print();
```

```
env.execute("Word Count Example");
```

- Execution environment

  Flink runs in the execution environment which defines a default DOP for operators, data source and data sink.

  Call the **setParallelism()** method to specify the default DOP of the execution environment. Example:

  ```
  final StreamExecutionEnvironment env = StreamExecutionEnvironment.getExecutionEnvironment();
  env.setParallelism(3);
  DataStream<String> text = [...]
  DataStream<Tuple2<String, Integer>> wordCounts = [...]
  wordCounts.print();
  env.execute("Word Count Example");
  ```

- Client

  Specify the DOP when submitting jobs to Flink on the client. If you use the CLI client, specify the DOP using the **-p** parameter. Example:

  ```
  ./bin/flink run -p 10 ../examples/*WordCount-java*.jar
  ```

- System

  On the Flink client, modify the **parallelism.default** parameter in the **flink-conf.yaml** file under the conf to specify the DOP for all execution environments.

5.8.3 Configuring Process Parameters

Scenario

In Flink on Yarn mode, there are JobManagers and TaskManagers. JobManagers and TaskManagers schedule and run tasks.

Therefore, configuring parameters of JobManagers and TaskManagers can optimize the execution performance of a Flink application. Perform the following steps to optimize the Flink cluster performance.

Procedure

Step 1 Configure JobManager memory.

JobManagers are responsible for task scheduling and message communications between TaskManagers and ResourceManagers. JobManager memory needs to be increased as the number of tasks and the DOP increases.

JobManager memory needs to be configured based on the number of tasks.

- When running the **yarn-session** command, add the **-jm MEM** parameter to configure the memory.
- When running the **yarn-cluster** command, add the **-yjm MEM** parameter to configure the memory.

Step 2 Configure the number of TaskManagers.

Each core of a TaskManager can run a task at the same time. Increasing the number of TaskManagers has the same effect as increasing the DOP. Therefore, you can increase the number of TaskManagers to improve efficiency when there are sufficient resources.

Step 3 Configure the number of TaskManager slots.

Multiple cores of a TaskManager can process multiple tasks at the same time. This has the same effect as increasing the DOP. However, the balance between the number of cores and the memory must be maintained, because all cores of a TaskManager share the memory.

- When running the **yarn-session** command, add the **-s NUM** parameter to configure the number of slots.
- When running the **yarn-cluster** command, add the **-ys NUM** parameter to configure the number of slots.

Step 4 Configure TaskManager memory.

TaskManager memory is used for task execution and communication. A large-size task requires more resources. In this case, you can increase the memory.

- When running the **yarn-session** command, add the **-tm MEM** parameter to configure the memory.
- When running the **yarn-cluster** command, add the **-ytm MEM** parameter to configure the memory.

----End

5.8.4 Optimizing the Design of Partitioning Method

Scenarios

The divide of tasks can be optimized by optimizing the partitioning method. If data skew occurs in a certain task, the whole execution process is delayed. Therefore, when designing the partitioning method, ensure that partitions are evenly assigned.

Procedure

Partitioning methods are as follows:

- **Random partitioning**: randomly partitions data.
  ```
  dataStream.shuffle();
  ```
- **Rebalancing (round-robin partitioning)**: evenly partitions data based on round-robin. The partitioning method is useful to optimize data with data skew.
  ```
  dataStream.rebalance();
  ```
- **Rescaling**: assign data to downstream subsets in the form of round-robin. The partitioning method is useful if you want to deliver data from each parallel instance of a data source to subsets of some mappers without the using rebalance (), that is, the complete rebalance operation.
  ```
  dataStream.rescale();
  ```
- **Broadcast**: broadcast data to all partitions.
  ```
  dataStream.broadcast();
  ```
- **User-defined partitioning**: use a user-defined partitioner to select a target task for each element. The user-defined partitioning allows user to partition data based on a certain feature to achieve optimized task execution.

  The following is an example:

```
// fromElements builds simple Tuple2 stream
DataStream<Tuple2<String, Integer>> dataStream = env.fromElements(Tuple2.of("hello",1),
Tuple2.of("test",2), Tuple2.of("world",100));

// Defines the key value used for partitioning. Adding one to the value equals to the id.
Partitioner<Tuple2<String, Integer>> strPartitioner = new Partitioner<Tuple2<String, Integer>>() {
    @Override
    public int partition(Tuple2<String, Integer> key, int numPartitions) {
        return (key.f0.length() + key.f1) % numPartitions;
    }
};

// The Tuple2 data is used as the basis for partitioning.

dataStream.partitionCustom(strPartitioner, new KeySelector<Tuple2<String, Integer>, Tuple2<String,
Integer>>() {
    @Override
    public Tuple2<String, Integer> getKey(Tuple2<String, Integer> value) throws Exception {
        return value;
    }
}).print();
```

5.8.5 Configuring the Netty Network Communication

Scenarios

The communication of Flink is based on Netty network. The network performance determines the data switching speed and task execution efficiency. Therefore, the performance of Flink can be optimized by optimizing the Netty network.

Procedure

In the **conf/flink-conf.yaml** file on the client, change configurations as required. Exercise caution when changing default values, because default values are optimal.

- **taskmanager.network.netty.num-arenas**: Specifies the number of arenas of Netty. The default value is **taskmanager.numberOfTaskSlots**.
- **taskmanager.network.netty.server.numThreads** and **taskmanager.network.netty.client.numThreads**: specify the number of threads on the client and server. The default value is **taskmanager.numberOfTaskSlots**.
- **taskmanager.network.netty.client.connectTimeoutSec**: specifies the timeout interval for connection of TaskManager client. The default value is **120s**.
- **taskmanager.network.netty.sendReceiveBufferSize**: specifies the buffer size of the Netty network. The default value is the buffer size (cat /proc/sys/net/ipv4/tcp_[rw]mem) of the system and the value is usually 4 MB.
- **taskmanager.network.netty.transport**: specifies the transmission method of the Netty network. The default value is **nio**. The value can only be **nio** and **epoll**.

5.8.6 State Backend Optimization

5.8.6.1 RocksDB State Backend Optimization

Scenario

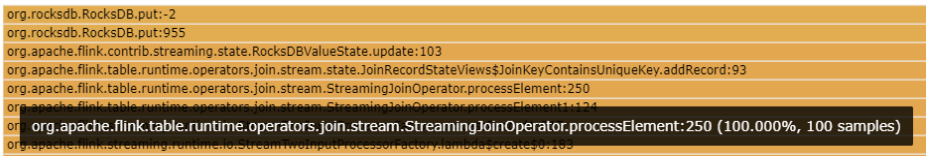
When RocksDB is enabled as the state backend for jobs, a large amount of state data causes poor read and write performance of RocksDB. You can perform the following operations to check whether the operator performance is affected by RocksDB:

- On the ThreadDump of TaskManager, check whether the operator is executed on the RocksDB operation interface for a long time. If the following information is displayed after multiple refreshes, the operator is executed on the RocksDB operation interface for a long time.

```
Join[5] -> Calc[6] -> Sink: print[7] (1/1)#0" Id=113 RUNNABLE (in native)
    at org.rocksdb.RocksDB.put(Native Method)
    at org.rocksdb.RocksDB.put(RocksDB.java:955)
    at org.apache.flink.contrib.streaming.state.RocksDBValueState.update(RocksDBValueState.java:103)
```

- Enable the flame graph (set **rest.flamegraph.enabled** to **true**) and submit the job again to view operator hotspots. Operator hotspots reach 100% in the figure below.

  Figure 5-4 Viewing operator hotspots in a flame graph



When the RockDB read/write latency is long, you can enable RocksDB monitoring and alarm reporting to optimize RockDB parameters based on the monitoring and alarm items. After job optimization, you are advised to disable RockDB monitoring and alarm reporting because they will deteriorate RocksDB performance by 5% to 10%.

To avoid impact on other jobs, RocksDB monitoring is configured by setting user-defined parameters. This section describes how to enable RocksDB monitoring, alarm reporting, and optimization parameters.

Procedure

Step 1 Log in to FusionInsight Manager as a user with the FlinkServer administrator rights.

Step 2 Choose **Cluster** > **Services** > **Flink**. In the **Basic Information** area, click the link next to **Flink WebUI** to access the Flink web UI.

Step 3 Click **Job Management**. The job management page is displayed.

Step 4 Locate the job that is to be optimized and is not in the **Running** state, and click **Develop** in the **Operation** column to go to the job development page.

Step 5 In the **Custom Configuration** area on the job development page, add the following parameters and save the settings:

- Enabling RocksDB monitoring

Table 5-50 RocksDB monitoring configuration

Parameter	Value	Description
state.backend.rocksdb.metrics.hot.enabled	true	Non-statistical monitoring of RocksDB includes the monitoring items contained in RocksDB Property.
state.backend.rocksdb.metrics.statistics.enabled	true	RocksDB statistics
state.backend.rocksdb.metrics.num-immutable-mem-table	true	Monitors the number of immutable memtables in RocksDB. If the value keeps increasing or exceeds the threshold, the write performance will be affected.
state.backend.rocksdb.metrics.mem-table-flush-pending	true	Monitors the number of pending memtable flushes in RocksDB.
state.backend.rocksdb.metrics.compaction-pending	true	Monitors the number of pending compactions in RocksDB. If there are any pending compactions, **1** is returned. Otherwise, **0** is returned.
state.backend.rocksdb.metrics.background-errors	true	Monitors the number of metrics.background-errors in RocksDB.
state.backend.rocksdb.metrics.cur-size-active-mem-table	true	Monitors the approximate size of the active memtable, in bytes.
state.backend.rocksdb.metrics.cur-size-all-mem-tables	true	Monitors the approximate size of active and unflushed immutable memtables, in bytes.
state.backend.rocksdb.metrics.size-all-mem-tables	true	Monitors the approximate size of active, unflushed, and pinned memtables, in bytes.
state.backend.rocksdb.metrics.num-entries-active-mem-table	true	Monitors the total number of entries in active memtables.
state.backend.rocksdb.metrics.num-entries-imm-mem-tables	true	Monitors the total number of entries in immutable memtables.
state.backend.rocksdb.metrics.num-deletes-active-mem-table	true	Monitors the total number of deleted entries in active memtables.

Parameter	Value	Description
state.backend.rocksdb.metrics.num-deletes-imm-mem-tables	true	Monitors the total number of deleted entries in unflushed immutable memtables.
state.backend.rocksdb.metrics.estimate-num-keys	true	Monitors the number of keys in RocksDB.
state.backend.rocksdb.metrics.estimate-table-readers-mem	true	Monitors the memory used to read SST tables, excluding the memory used in the block cache (such as filters and index blocks), in bytes.
state.backend.rocksdb.metrics.num-snapshots	true	Monitors the number of unpublished snapshots in the database.
state.backend.rocksdb.metrics.num-live-versions	true	Monitors the number of real-time versions. A version is an internal data schema. If there are too many versions, RocksDB may fail to delete old versions due to query or compaction operations.
state.backend.rocksdb.metrics.estimate-live-data-size	true	Monitors the real-time data volume, in bytes (usually smaller than the size of an SST file due to space amplification).
state.backend.rocksdb.metrics.total-sst-files-size	true	Monitors the total size of SST files of all versions, in bytes. Too many files may slow down query.
state.backend.rocksdb.metrics.live-sst-files-size	true	Monitors the total size of all SST files of the latest version, in bytes. Too many files may slow down query.
state.backend.rocksdb.metrics.estimate-pending-compaction-bytes	true	Monitors the total size of compaction data, in bytes. This ensures that the size of compaction data at all levels is smaller than the target size, and other compactions beyond the levels are invalid.
state.backend.rocksdb.metrics.num-running-compactions	true	Monitors the number of running compactions. If all threads are in the **Running** state, the write performance may be affected.
state.backend.rocksdb.metrics.num-running-flushes	true	Monitors the number of running flush tasks. If all threads are in the **Running** state, the write performance may be affected.
state.backend.rocksdb.metrics.actual-delayed-write-rate	true	Monitors the actual delayed write rate. If **0** is returned, there is no delay.

Parameter	Value	Description
state.backend.rocksdb.metrics.is-write-stopped	true	Monitors whether write to RocksDB is stopped. If the write is stopped, **1** is returned. Otherwise, **0** is returned.
state.backend.rocksdb.metrics.block-cache-capacity	true	Monitors the block cache capacity.
state.backend.rocksdb.metrics.block-cache-usage	true	Monitors the memory occupied by data in the block cache.
state.backend.rocksdb.metrics.block-cache-pinned-usage	true	Monitors the memory occupied by pinned data in the block cache.
state.backend.rocksdb.metrics.compression-ratio	true	Monitors the compression ratio of each layer.
state.backend.rocksdb.metrics.compression-ratio-levelN	7	Number of layers whose compression ratio is to be monitored. The value must be at least 0 and not greater than the configured number of layers.
state.backend.rocksdb.metrics.num-files	true	Monitors the number of files at each layer.
state.backend.rocksdb.metrics.num-files-levelN	7	Number of layers whose file quantity is to be monitored. The value must be at least 0 and not greater than the configured number of layers.

Parameter	Value	Description
state.backend.rocksdb.metrics.statistics.ticker	block.cache.miss,block.cache.hit,block.cache.index.miss,block.cache.index.hit,block.cache.filter.miss,block.cache.filter.hit,block.cache.data.miss,block.cache.data.hit,bloom.filter.useful,memtable.hit,memtable.miss,l0.hit,l1.hit,l2andup.hit,stall.micros	Statistics ticker monitoring item To add a monitoring item, add it to the end of the value and separate monitoring items with commas (,).
state.backend.rocksdb.metrics.statistics.histogram	db.get.micros,db.write.micros,db.flush.micros,compaction.times.micros	Statistics straight square monitoring item To add a monitoring item, add it to the end of the value and separate monitoring items with commas (,).

- Enabling the RocksDB alarm function

Table 5-51 RocksDB alarm configuration

Parameter	Default Value	Description
metrics.reporter.alarm.job.alarm.rocksdb.metrics.enable	true	Whether to enable RocksDB monitoring. This function is disabled by default. This configuration is valid only when the state backend is RocksDB.
metrics.reporter.alarm.job.alarm.rocksdb.metrics.duration	180s	Interval for RocksDB to monitor alarms
metrics.reporter.alarm.job.alarm.rocksdb.metrics.print.enabled	true	Whether to print RocksDB monitoring information to TaskManager If **metrics.reporter.alarm.job.alarm.rocksdb.metrics.enable** is set to **true**, this parameter is automatically set to **true** by default.
metrics.reporter.alarm.job.alarm.rocksdb.metrics.print.interval	5min	Interval for printing RocksDB monitoring information to TaskManager
metrics.reporter.alarm.job.alarm.rocksdb.get.micros.threshold	1000	Get time threshold, in μs. If the time consumed by a job exceeds the threshold consecutively within the period specified by **metrics.reporter.alarm.job.alarm.rocksdb.metrics.duration**, an alarm is reported.
metrics.reporter.alarm.job.alarm.rocksdb.write.micros.threshold	3000	Write time threshold, in μs. If the time consumed by a job exceeds the threshold consecutively within the period specified by **metrics.reporter.alarm.job.alarm.rocksdb.metrics.duration**, an alarm is reported.
metrics.reporter.alarm.job.alarm.actual-delayed-write-rate.threshold	0	If the write rate of a job is limited consecutively within the period specified by **metrics.reporter.alarm.job.alarm.rocksdb.metrics.duration**, an alarm is reported. The value **0** indicates that the write rate is not limited.
metrics.reporter.alarm.job.alarm.rocksdb.background.jobs.multiplier	2	An alarm is reported when the number of flush or compaction requests exceeds the multiplier of **state.backend.rocksdb.thread.num**.

Step 6 On the **Job Management** page, click **Start** to run the job. Based on the RocksDB monitoring and alarm information, add the following parameters in the **Custom Parameters** area on the job development page to optimize the job. After job optimization is complete, you are advised to disable RocksDB monitoring and alarm reporting.

Table 5-52 RocksDB optimization parameters

Parameter	Value	Description
state.backend.rocksdb.writebuffer.count	2	Sets the number of active and immutable memtables. If the write speed is too fast or the number of Flink threads is too small, the write is blocked. When **SPINNING_DISK_OPTIMIZED_HIGH_MEM** is enabled, the default value is **4**. It is recommended that the value be greater than or equal to the value of **state.backend.rocksdb.writebuffer.number-to-merge** plus 2.
state.backend.rocksdb.writebuffer.size	64MB	Memtable size
state.backend.rocksdb.thread.num	2	Number of RocksDB flush and compaction threads. When **SPINNING_DISK_OPTIMIZED_HIGH_MEM** is enabled, the default value is **4**.
state.backend.rocksdb.writebuffer.number-to-merge	1	Number of immutable flushes. Deduplication is performed when *n* immutable flushes are performed. When **SPINNING_DISK_OPTIMIZED_HIGH_MEM** is enabled, the default value is **3**.
state.backend.rocksdb.compaction.level.max-size-level-base	256MB	Total size of SSL files at level 1. When **SPINNING_DISK_OPTIMIZED_HIGH_MEM** is enabled, the default value is **1 GB**.
state.backend.rocksdb.compaction.level.target-file-size-base	64MB	Size of SSL files at level 1+. When **SPINNING_DISK_OPTIMIZED_HIGH_MEM** is enabled, the default value is **128 MB**.
state.backend.rocksdb.num_levels	7	Number of RocksDB levels
state.backend.rocksdb.level0_slowdown_writes_trigger	20	Number of files that trigger slowdown at level 0. If the value is smaller than 0, slowdown will never be triggered.
state.backend.rocksdb.level0_stop_writes_trigger	36	Maximum number of files that trigger stop at level 0

Parameter	Value	Description
state.backend.rocksdb.max_compaction_bytes	-	Maximum number of bytes in a compaction. The default value is the **state.backend.rocksdb.compaction.level.target-file-size-base** value x 25.
state.backend.rocksdb.level0_file_num_compaction_trigger	4	Compaction from level 0 to level 1 is triggered when the number of Level 0 SSTs reaches the threshold.
state.backend.rocksdb.compression	snappy	SST file compression algorithm The value can be **null**, **snapp**, **zlib**, **bzip2**, **lz4**, **lz4hc**, **xpress**, or **zstd**.
state.backend.rocksdb.bottommost_compression	snappy	The bottom layer uses heavyweight compression types to reduce space. The underlying data may be cold data. To enable this function, you are advised to use **zstd** or **zlib**. The value can be **null**, **snapp**, **zlib**, **bzip2**, **lz4**, **lz4hc**, **xpress**, or **zstd**.
state.backend.rocksdb.max_bytes_for_level_multiplier	10	Data volume multiplier factor of level 1 plus two adjacent layers
state.backend.rocksdb.hard-pending-compaction-bytes-limit	256GB	When the pending compaction size exceeds the threshold, write operations are stopped.
state.backend.rocksdb.soft-pending-compaction-bytes-limit	64GB	When the pending compaction size exceeds the threshold, the write traffic is limited.
state.backend.rocksdb.use-bloom-filter	true	Bloom filter. After this function is enabled, each newly created SST file contains a Bloom filter.
state.backend.rocksdb.block.cache-size	8MB	Cache size. When **SPINNING_DISK_OPTIMIZED_HIGH_MEM** is enabled, the default value is **256MB**.
state.backend.rocksdb.block.blocksize	4KB	Block size. When **SPINNING_DISK_OPTIMIZED_HIGH_MEM** is enabled, the default value is **128KB**.
state.backend.rocksdb.files.open	-1	Maximum number of opened handles, which is mainly used for SST file handles. The value **-1** indicates that the number is not limited.

----End

5.8.6.2 Enabling Hot-Cold Separation for State Backends

In wide table joins, each table contains a large number of fields. State backends hold a large volume of data and the processing speed is severely lowered. To solve this problem, you can enable tiered storage for hot-cold separation.

Prerequisites

- HDFS, Yarn, Flink, and HBase services have been installed in a cluster.
- The client that contains the HBase service has been installed, for example, in the **/opt/hadoopclient** directory.

Procedure

Step 1 Log in to the node where the client is installed as the client installation user and copy all configuration files in the **/opt/client/HBase/hbase/conf/** directory of HBase to an empty directory of all nodes where FlinkServer is deployed, for example, **/tmp/client/HBase/hbase/conf/**.

Change the owner of the configuration file directory and its upper-layer directory on the FlinkServer node to **omm**.

chown omm: /tmp/client/HBase/ -R

NOTE

- FlinkServer nodes:

  Log in to Manager, choose **Cluster** > **Services** > **Flink** > **Instance**, and check the **Service IP Address** of FlinkServer.
- If the node where a FlinkServer instance is located is the node where the HBase client is installed, skip this step on this node.

Step 2 Log in to Manager and choose **Cluster** > **Services** > **Flink**. Click **Configurations** then **All Configurations**, search for the **HBASE_CONF_DIR** parameter, and enter the FlinkServer directory (for example, **/tmp/client/HBase/hbase/conf/**) to which the HBase configuration files are copied in **Step 1** from **Value**.

Step 3 After the parameters are configured, click **Save**. After confirming the modification, click **OK**.

Step 4 Click **Instance**, select all FlinkServer instances, choose **More** > **Restart Instance**, enter the password, and click **OK** to restart the instances.

Step 5 Log in to FusionInsight Manager as a user with the FlinkServer administrator rights.

Step 6 Choose **Cluster** > **Services** > **Flink**. In the **Basic Information** area, click the link next to **Flink WebUI** to access the Flink web UI.

Step 7 Click **Job Management**. The job management page is displayed.

Step 8 Locate the job that is to be optimized and is not in the **Running** state, and click **Develop** in the **Operation** column to go to the job development page.

Step 9 In the **Custom Parameters** area on the **Job Development** page, add the following parameters as required and save the settings. For details about hot data (regularly used data), see **Table 5-53**. For details about cold data (data that is not required often), see **Table 5-54**.

Table 5-53 RocksDB state backend storage

Parameter	Description	Example Value
table.exec.state.cold.enabled	Whether to enable RocksDB that stores hot and cold data separately • **false** (default value): Hot-cold separation is disabled. • **true**: Hot-cold separation is enabled.	false
state.backend.rocksdb.cold.localdir	Directory for storing cold data	-
state.backend.rocksdb.cold.predefined-options	Predefined configuration of cold data RocksDB: • **DEFAULT** (default value): RocksDB disk is not written forcibly. You are advised to use this value. • **SPINNING_DISK_OPTIMIZED_HIGH_MEM**: Parameters for optimizing RocksDB disk write. Flink job recovery does not depend on RocksDB, so you are not advised to use the current configuration.	DEFAULT
state.backend	State backend storage medium. Set this parameter to **rocksdb**.	rocksdb

Table 5-54 HBase serves as the state backend storage for level-2 cold data

Parameter	Description	Example Value
table.exec.state.cold.enabled	Whether to enable tiered storage for hot and cold data • **false** (default value): hot-cold separation is disabled. • **true**: hot-cold separation is enabled.	false
state.backend.cold	State backend storage for cold data. Currently, only **hbase** is supported.	hbase

Parameter	Description	Example Value
table.exec.state.ttl	Timeout interval for data status changes • If **table.exec.state.cold.enabled** is **true**, this parameter indicates when hot data expires. When hot data is stored longer than the value, it becomes cold data. • If **table.exec.state.cold.enabled** is **false**, all expired data will be deleted. • Default value: 0, indicating that the data never expires.	0
state.backend.hbase.zookeeper.quorum	ZooKeeper connection address used to access HBase. Format: *Service IP address of the ZooKeeper quorumpeer instance*:*ZooKeeper client port* ,*Service IP address of the ZooKeeper quorumpeer instance*:*ZooKeeper client port* ,*Service IP address of the ZooKeeper quorumpeer instance*:*ZooKeeper client port*	192.168.10.10:24002,192.168.10.11:24002,192.168.10.12:24002
state.backend	State backend storage medium. Set this parameter to **rocksdb**.	rocksdb

NOTE

- IP address of the ZooKeeper quorumpeer instance

  To obtain IP addresses of all ZooKeeper quorumpeer instances, log in to FusionInsight Manager and choose **Cluster** > **Services** > **ZooKeeper**. On the displayed page, click **Instance** and view the IP addresses of all the hosts where the quorumpeer instances locate.
- Port number of the ZooKeeper client

  Log in to FusionInsight Manager and choose **Cluster** > **Service** > **ZooKeeper**. On the displayed page, click **Configurations** and check the value of **clientPort**.

----End

5.8.7 Experience Summary

Avoiding Data Skew

If data skew occurs (certain data volume is extremely large), the execution time of tasks is inconsistent even though no GC is performed.

- Redefine keys. Use keys of smaller granularity to optimize the task size.
- Modify the DOP.
- Call the rebalance operation to balance data partitions.

Setting Timeout Interval for the Buffer

- During the execution of tasks, data is exchanged through network. You can set the **setBufferTimeout** parameter to specify a buffer timeout interval for data exchanging among different servers.
- If **setBufferTimeout** is set to **-1**, the refreshing operation is performed when the buffer is full to maximize the throughput. If **setBufferTimeout** is set to **0**, the refreshing operation is performed each time data is received to minimize the delay. If **setBufferTimeout** is set to a value greater than **0**, the refreshing operation is performed after the buffer times out.

  The following is an example:

```
env.setBufferTimeout(timeoutMillis);

env.generateSequence(1,10).map(new MyMapper()).setBufferTimeout(timeoutMillis);
```

5.9 Common Flink Shell Commands

Before you use the Flink shell script, perform the following operations. For details, see to run a wordcount job.

Step 1 Install the Flink client in **/opt/client**.

Step 2 Run the following command to initialize environment variables:

source /opt/client/bigdata_env

Step 3 If Kerberos authentication has been enabled for the cluster, configure client authentication by referring to . If Kerberos authentication is disabled, skip this step.

Step 4 Run the related commands according to **Table 5-55**.

Table 5-55 Flink Shell commands

Command	Description	Description
yarn-session.sh	**-at,--applicationType <arg>**: Defines the Yarn application type. **-D <property=value>**: Configures dynamic parameter. **-d,--detached**: Disables the interactive mode and starts a separate Flink Yarn session. **-h,--help**: Displays the help information about the Yarn session CLI. **-id,--applicationId <arg>**: Binds to a running Yarn session. **-j,--jar <arg>**: Sets the path of the user's JAR file. **-jm,--jobManagerMemory <arg>**: Sets the JobManager memory. **-m,--jobmanager <arg>**: Address of the JobManager (master) to which to connect. Use this parameter to connect to a specified JobManager. **-nl,--nodeLabel <arg>**: Specifies the nodeLabel of the Yarn application. **-nm,--name <arg>**: Customizes a name for the application on Yarn. **-q,--query**: Queries available Yarn resources. **-qu,--queue <arg>**: Specifies a Yarn queue. **-s,--slots <arg>**: Sets the number of slots for each TaskManager. **-t,--ship <arg>**: specifies the directory of the file to be sent. **-tm,--taskManagerMemory <arg>**: sets the TaskManager memory. **-yd,--yarndetached**: starts Yarn in the detached mode. **-z,--zookeeperNamespace <args>**: specifies the namespace of ZooKeeper. **-h**: Gets help information.	Start a resident Flink cluster to receive tasks from the Flink client.

Command	Description	Description
flink run	**-c,--class <classname>**: Specifies a class as the entry for running programs. **-C,--classpath <url>**: Specifies **classpath**. **-d,--detached**: Runs a job in the detached mode. **-files,--dependencyFiles <arg>**: File on which the Flink program depends. **-n,--allowNonRestoredState**: A state that cannot be restored can be skipped during restoration from a snapshot point in time. For example, if an operator in the program is deleted, you need to add this parameter when restoring the snapshot point. **-m,--jobmanager <host:port>**: Specifies the JobManager. **-p,--parallelism <parallelism>**: Specifies the job DOP, which will overwrite the DOP parameter in the configuration file. **-q,--sysoutLogging**: Disables the function of outputting Flink logs to the console. **-s,--fromSavepoint <savepointPath>**: Specifies a savepoint path for recovering jobs. **-z,--zookeeperNamespace <zookeeperNamespace>**: specifies the namespace of ZooKeeper. **-yat,--yarnapplicationType <arg>**: Defines the Yarn application type. **-yD <arg>**: Dynamic parameter configuration. **-yd,--yarndetached**: Starts Yarn in the detached mode. **-yh,--yarnhelp**: Obtains the Yarn help. **-yid,--yarnapplicationId <arg>**: Binds a job to a Yarn session. **-yj,--yarnjar <arg>**: Sets the path to Flink jar file. **-yjm,--yarnjobManagerMemory <arg>**: Sets the JobManager memory (MB). **-ynm,--yarnname <arg>**: Customizes a name for the application on Yarn. **-yq,--yarnquery**: Queries available Yarn resources (memory and CPUs).	Submit a Flink job. 1. The **-y*** parameter is used in the **yarn-cluster** mode. 2. If the parameter is not **-y***, you need to run the **yarn-session** command to start the Flink cluster before running this command to submit a task.

Command	Description	Description
	-yqu,--yarnqueue <arg>: Specifies a Yarn queue. **-ys,--yarnslots**: Sets the number of slots for each TaskManager. **-yt,--yarnship <arg>**: Specifies the path of the file to be sent. **-ytm,--yarntaskManagerMemory <arg>**: Sets the TaskManager memory (MB). **-yz,--yarnzookeeperNamespace <arg>**: Specifies the namespace of ZooKeeper. The value must be the same as the value of **yarn-session.sh -z**. **-h**: Gets help information.	
flink run-application	-D<property=value>: Multiple general configuration options can be specified. -t,–target: deployment target of a specified application, for example, yarn-application or yarn-per-job. **-h**: Gets help information.	Submit Flink run-application jobs.
flink info	**-c,--class <classname>**: Specifies a class as the entry for running programs. **-p,--parallelism <parallelism>**: Specifies the DOP for running programs. **-h**: Gets help information.	Display the execution plan (JSON) of the running program.
flink list	**-a,--all**: displays all jobs. **-m,--jobmanager <host:port>**: specifies the JobManager. **-r,--running:** displays only jobs in the running state. **-s,--scheduled**: displays only jobs in the scheduled state. **-z,--zookeeperNamespace <zookeeperNamespace>**: specifies the namespace of ZooKeeper. **-yid,--yarnapplicationId <arg>**: binds a job to a Yarn session. **-h**: gets help information.	Query running programs in the cluster.

Command	Description	Description
flink stop	**-d,--drain**: sends MAX_WATERMARK before the savepoint is triggered and the job is stopped. **-p,--savepointPath <savepointPath>**: path for storing savepoints. The default value is **state.savepoints.dir**. **-m,--jobmanager <host:port>**: specifies the JobManager. **-z,--zookeeperNamespace <zookeeperNamespace>**: specifies the namespace of ZooKeeper. **-yid,--yarnapplicationId <arg>**: binds a job to a Yarn session. **-h**: gets help information.	Forcibly stop a running job (only streaming jobs are supported. **StoppableFunction** needs to be implemented on the source side in service code).
flink cancel	**-m,--jobmanager <host:port>**: specifies the JobManager. **-s,--withSavepoint <targetDirectory>**: triggers a savepoint when a job is canceled. The default directory is **state.savepoints.dir**. **-z,--zookeeperNamespace <zookeeperNamespace>**: specifies the namespace of ZooKeeper. **-yid,--yarnapplicationId <arg>**: binds a job to a Yarn session. **-h**: gets help information.	Cancel a running job.
flink savepoint	**-d,--dispose <arg>**: specifies a directory for storing the savepoint. **-m,--jobmanager <host:port>**: specifies the JobManager. **-z,--zookeeperNamespace <zookeeperNamespace>**: specifies the namespace of ZooKeeper. **-yid,--yarnapplicationId <arg>**: binds a job to a Yarn session. **-h**: gets help information.	Trigger a savepoint.

Command	Description	Description
source *Client installation directory*/**bigdata_env**	None	Import client environment variables. Restriction: If the user uses a custom script (for example, **A.sh**) and runs this command in the script, variables cannot be imported to the **A.sh** script. If variables need to be imported to the custom script **A.sh**, the user needs to use the secondary calling method. For example, first call the **B.sh** script in the **A.sh** script, and then run this command in the **B.sh** script. Parameters can be imported to the **A.sh** script but cannot be imported to the **B.sh** script.
start-scala-shell.sh	local | remote <host> <port> | yarn: running mode	Start the scala shell.
sh generate_keystore.sh	-	Run the **generate_keystore.sh** script to generate security cookie, **flink.keystore**, and **flink.truststore**. You need to enter a user-defined password that does not contain number signs (#).

----End

5.10 Reference

5.10.1 Example of Issuing a Certificate

Generate the **generate_keystore.sh** script based on the sample code and save the script to the **bin** directory on the Flink client.

```
#!/bin/bash

KEYTOOL=${JAVA_HOME}/bin/keytool
KEYSTOREPATH="$FLINK_HOME/conf/"
CA_ALIAS="ca"
CA_KEYSTORE_NAME="ca.keystore"
CA_DNAME="CN=Flink_CA"
CA_KEYALG="RSA"
CLIENT_CONF_YAML="$FLINK_HOME/conf/flink-conf.yaml"
KEYTABPRINCEPAL=""

function getConf()
{
    if [ $# -ne 2 ]; then
        echo "invalid parameters for getConf"
        exit 1
    fi

    confName="$1"
    if [ -z "$confName" ]; then
        echo "conf name is empty."
        exit 2
    fi

    configFile=$FLINK_HOME/conf/client.properties
    if [ ! -f $configFile ]; then
        echo $configFile" is not exist."
        exit 3
    fi

    defaultValue="$2"
    cnt=$(grep $1 $configFile | wc -l)
    if [ $cnt -gt 1 ]; then
        echo $confName" has multi values in "$configFile
        exit 4
    elif [ $cnt -lt 1 ]; then
        echo $defaultValue
    else
        line=$(grep $1 $configFile)
        confValue=$(echo "${line#*=}")
        echo "$confValue"
    fi
}

function createSelfSignedCA()
{
    #varible from user input
    keystorePath=$1
    storepassValue=$2
    keypassValue=$3

    #generate ca keystore
    rm -rf $keystorePath/$CA_KEYSTORE_NAME
    $KEYTOOL -genkeypair -alias $CA_ALIAS -keystore $keystorePath/$CA_KEYSTORE_NAME -dname
$CA_DNAME -storepass $storepassValue -keypass $keypassValue -validity 3650 -keyalg $CA_KEYALG -
keysize 3072 -ext bc=ca:true
    if [ $? -ne 0 ]; then
        echo "generate ca.keystore failed."
        exit 1
    fi

    #generate ca.cer
    rm -rf "$keystorePath/ca.cer"
    $KEYTOOL -keystore "$keystorePath/$CA_KEYSTORE_NAME" -storepass "$storepassValue" -alias
```

```
$CA_ALIAS -validity 3650 -exportcert > "$keystorePath/ca.cer"
    if [ $? -ne 0 ]; then
        echo "generate ca.cer failed."
        exit 1
    fi

    #generate ca.truststore
    rm -rf "$keystorePath/flink.truststore"
    $KEYTOOL -importcert -keystore "$keystorePath/flink.truststore" -alias $CA_ALIAS -storepass
"$storepassValue" -noprompt -file "$keystorePath/ca.cer"
    if [ $? -ne 0 ]; then
        echo "generate ca.truststore failed."
        exit 1
    fi
}

function generateKeystore()
{
    #get path/pass from input
    keystorePath=$1
    storepassValue=$2
    keypassValue=$3

    #get value from conf
    aliasValue=$(getConf "flink.keystore.rsa.alias" "flink")
    validityValue=$(getConf "flink.keystore.rsa.validity" "3650")
    keyalgValue=$(getConf "flink.keystore.rsa.keyalg" "RSA")
    dnameValue=$(getConf "flink.keystore.rsa.dname" "CN=flink.com")
    SANValue=$(getConf "flink.keystore.rsa.ext" "ip:127.0.0.1")
    SANValue=$(echo "$SANValue" | xargs)
    SANValue="ip:$(echo "$SANValue"| sed 's/,/,ip:/g')"

    #generate keystore
    rm -rf $keystorePath/flink.keystore
    $KEYTOOL -genkeypair -alias $aliasValue -keystore $keystorePath/flink.keystore -dname $dnameValue -
ext SAN=$SANValue -storepass $storepassValue -keypass $keypassValue -keyalg $keyalgValue -keysize
3072 -validity 3650
    if [ $? -ne 0 ]; then
        echo "generate flink.keystore failed."
        exit 1
    fi

    #generate cer
    rm -rf $keystorePath/flink.csr
    $KEYTOOL -certreq -keystore $keystorePath/flink.keystore -storepass $storepassValue -alias $aliasValue -
file $keystorePath/flink.csr
    if [ $? -ne 0 ]; then
        echo "generate flink.csr failed."
        exit 1
    fi

    #generate flink.cer
    rm -rf $keystorePath/flink.cer
    $KEYTOOL -gencert -keystore $keystorePath/ca.keystore -storepass $storepassValue -alias $CA_ALIAS -
ext SAN=$SANValue -infile $keystorePath/flink.csr -outfile $keystorePath/flink.cer -validity 3650
    if [ $? -ne 0 ]; then
        echo "generate flink.cer failed."
        exit 1
    fi

    #import cer into keystore
    $KEYTOOL -importcert -keystore $keystorePath/flink.keystore -storepass $storepassValue -file
$keystorePath/ca.cer -alias $CA_ALIAS -noprompt
    if [ $? -ne 0 ]; then
        echo "importcert ca."
        exit 1
    fi

    $KEYTOOL -importcert -keystore $keystorePath/flink.keystore -storepass $storepassValue -file
```

```
$keystorePath/flink.cer -alias $aliasValue -noprompt;
    if [ $? -ne 0 ]; then
        echo "generate flink.truststore failed."
        exit 1
    fi
}

function configureFlinkConf()
{
    # set config
    if [ -f "$CLIENT_CONF_YAML" ]; then
        SSL_ENCRYPT_ENABLED=$(grep "security.ssl.encrypt.enabled" "$CLIENT_CONF_YAML" | awk '{print
$2}')
        if [ "$SSL_ENCRYPT_ENABLED" = "false" ];then

            sed -i s/"security.ssl.key-password:".*/"security.ssl.key-password:"\ "${keyPass}"/g
"$CLIENT_CONF_YAML"
            if [ $? -ne 0 ]; then
                echo "set security.ssl.key-password failed."
                return 1
            fi

            sed -i s/"security.ssl.keystore-password:".*/"security.ssl.keystore-password:"\ "${storePass}"/g
"$CLIENT_CONF_YAML"
            if [ $? -ne 0 ]; then
                echo "set security.ssl.keystore-password failed."
                return 1
            fi

            sed -i s/"security.ssl.truststore-password:".*/"security.ssl.truststore-password:"\ "${storePass}"/g
"$CLIENT_CONF_YAML"
            if [ $? -ne 0 ]; then
                echo "set security.ssl.keystore-password failed."
                return 1
            fi

            echo "security.ssl.encrypt.enabled is false, set security.ssl.key-password security.ssl.keystore-
password security.ssl.truststore-password success."
        else
            echo "security.ssl.encrypt.enabled is true, please enter security.ssl.key-password security.ssl.keystore-
password security.ssl.truststore-password encrypted value in flink-conf.yaml."
        fi

        keystoreFilePath="${keystorePath}"/flink.keystore
        sed -i 's#'"security.ssl.keystore:".*'#'"security.ssl.keystore:"\ "$keystoreFilePath"'#g'
"$CLIENT_CONF_YAML"
        if [ $? -ne 0 ]; then
            echo "set security.ssl.keystore failed."
            return 1
        fi


        truststoreFilePath="${keystorePath}/flink.truststore"
        sed -i 's#'"security.ssl.truststore:".*'#'"security.ssl.truststore:"\ "$truststoreFilePath"'#g'
"$CLIENT_CONF_YAML"
        if [ $? -ne 0 ]; then
            echo "set security.ssl.truststore failed."
            return 1
        fi

        command -v sha256sum >/dev/null
        if [ $? -ne 0 ];then
            echo "sha256sum is not exist, it will produce security.cookie with date +%F-%H-%M-%s-%N."
            cookie=$(date +%F-%H-%M-%s-%N)
        else
            cookie="$(echo "${KEYTABPRINCEPAL}"| sha256sum | awk '{print $1}')"
        fi

        sed -i s/"security.cookie:".*/"security.cookie:"\ "${cookie}"/g "$CLIENT_CONF_YAML"
```

```
        if [ $? -ne 0 ]; then
            echo "set security.cookie failed."
            return 1
        fi
    fi
    return 0;
}

main()
{
    #check environment variable is set or not
    if [ -z ${FLINK_HOME+x} ]; then
        echo "errro: environment variables are not set."
        exit 1
    fi
    stty -echo
    read -rp "Enter password:" password
    stty echo
    echo


    KEYTABPRINCEPAL=$(grep "security.kerberos.login.principal" "$CLIENT_CONF_YAML" | awk '{print $2}')
    if [ -z "$KEYTABPRINCEPAL" ];then
        echo "please config security.kerberos.login.principal info first."
        exit 1
    fi


    #get input
    keystorePath="$KEYSTOREPATH"
    storePass="$password"
    keyPass="$password"

    #generate self signed CA
    createSelfSignedCA "$keystorePath" "$storePass" "$keyPass"
    if [ $? -ne 0 ]; then
        echo "create self signed ca failed."
        exit 1
    fi

    #generate keystore
    generateKeystore "$keystorePath" "$storePass" "$keyPass"
    if [ $? -ne 0 ]; then
        echo "create keystore failed."
        exit 1
    fi

    echo "generate keystore/truststore success."

    # set flink config
    configureFlinkConf "$keystorePath" "$storePass" "$keyPass"
    if [ $? -ne 0 ]; then
        echo "configure Flink failed."
        exit 1
    fi

    return 0;
}

#the start main
main "$@"

exit 0
```

NOTE

Run the **sh generate_keystore.sh** *<password>* command. *<password>* is user-defined.

- If *<password>* contains the special character **$**, use the following method to avoid the password being escaped: **sh generate_keystore.sh 'Bigdata_2013'**.
- The password cannot contain **#**.
- Before using the **generate_keystore.sh** script, run the **source bigdata_env** command in the client directory.
- When the **generate_keystore.sh** script is used, the absolute paths of **security.ssl.keystore** and **security.ssl.truststore** are automatically filled in **flink-conf.yaml**. Therefore, you need to manually change the paths to relative paths as required. Example:
  - Change **/opt/client/Flink/flink/conf//flink.keystore** to **security.ssl.keystore: ssl/flink.keystore**.
  - Change **/opt/client/Flink/flink/conf//flink.truststore** to **security.ssl.truststore: ssl/flink.truststore**.
  - Create the **ssl** folder in any directory on the Flink client. For example, create the **ssl** folder in the **/opt/client/Flink/flink/conf/** directory and save the **flink.keystore** and **flink.truststore** files to the **ssl** folder.
  - When you run the **yarn-session** or **flink run -m yarn-cluster** command, run the **yarn-session.sh -t ssl -d** or **flink run -m yarn-cluster -yt ssl -d WordCount.jar** command in the same directory as the **ssl** folder.

5.11 Flink Restart Policy

Overview

Flink supports different restart policies to control whether and how to restart a job when a fault occurs. If no restart policy is specified, the cluster uses the default restart policy. You can also specify a restart policy when submitting a job. For details about how to configure such a policy on the job development page, see **Creating a Job**.

The restart policy can be specified by configuring the **restart-strategy** parameter in the Flink configuration file *Client installation directory*/**Flink/flink/conf/flink-conf.yaml** or can be dynamically specified in the application code. The configuration takes effect globally. Restart policies include **failure-rate** and the following two default policies:

- **No restart**: If CheckPoint is not enabled, this policy is used by default.
- **Fixed-delay**: If CheckPoint is enabled but no restart policy is configured, this policy is used by default.

No restart Policy

When a fault occurs, the job fails and does not attempt to restart.

Configure the parameter as follows:

```
restart-strategy: none
```

fixed-delay Policy

When a fault occurs, the job attempts to restart for a fixed number of times. If the number of attempts exceeds the times you specified, the job fails. The restart policy waits for a fixed period of time between two consecutive restart attempts.

In the following example, a job fails if the job attempts to restart for three times at an interval of 10 seconds. Configure the parameters as follows:

```
restart-strategy: fixed-delay
restart-strategy.fixed-delay.attempts: 3
restart-strategy.fixed-delay.delay: 10 s
```

failure-rate Policy

When a job fails, the job restarts directly. If the failure rate exceeds the value you configured, the job is considered as failed. The restart policy waits for a fixed period of time between two consecutive restart attempts.

In the following example, a job is considered as failed if the job attempts to restart for three times at an interval of 10 minutes. Configure the parameters as follows:

```
restart-strategy: failure-rate
restart-strategy.failure-rate.max-failures-per-interval: 3
restart-strategy.failure-rate.failure-rate-interval: 10 min
restart-strategy.failure-rate.delay: 10 s
```

Choosing a Restart Policy

- If you do not want to retry a failed job, select the **No restart** policy.
- To retry a failed job, select the **failure-rate** policy. If the fixed-delay policy is used, the number of job failures may reach the maximum number of retries due to hardware faults such as network and memory faults. As a result, the job fails.

  To prevent repeated restarts when the failure-rate policy is used, configure parameters as follows:

  ```
  restart-strategy: failure-rate
  restart-strategy.failure-rate.max-failures-per-interval: 3
  restart-strategy.failure-rate.failure-rate-interval: 10 min
  restart-strategy.failure-rate.delay: 10 s
  ```

5.12 Enhancements to Flink SQL

5.12.1 Using the DISTRIBUTEBY Feature

The DISTRIBUTEBY feature is added to Flink SQL to partition data based on specified fields. A single or multiple fields are supported, solving the problem where only data needs to be partitioned. Example:

```
SELECT /*+ DISTRIBUTEBY('id') */ id, name FROM t1;
SELECT /*+ DISTRIBUTEBY('id', 'name') */ id, name FROM t1;
SELECT /*+ DISTRIBUTEBY('id1') */ id as id1, name FROM t1;
```

5.12.2 Supporting Late Data in Flink SQL Window Functions

Window functions are added to Flink SQL to support late data processing. Currently, late data is supported in the TUMBLE, HOP, OVER, and CUMULATE window functions. An example is as follows:

```
CREATE TABLE T1 (
 `int` INT,
 `double` DOUBLE,
 `float` FLOAT,
 `bigdec` DECIMAL(10, 2),
 `string` STRING,
 `name` STRING,
 `rowtime` TIMESTAMP(3),
 WATERMARK for `rowtime` AS `rowtime` - INTERVAL '1' SECOND
) WITH (
 'connector' = 'values',
);

-- The fields of the sink must be the same as the input data of the window, but the sequence can be
different.
CREATE TABLE LD_SINK(
 `float` FLOAT, `string` STRING, `name` STRING,  `rowtime` TIMESTAMP(3)
) WITH (
 'connector' = 'print',
);

SELECT  /*+ LATE_DATA_SINK('sink.name'='LD_SINK') */
  `name`,
  MIN(`float`),
  COUNT(DISTINCT `string`)
FROM TABLE(
  TUMBLE(TABLE T1, DESCRIPTOR(rowtime), INTERVAL '5' SECOND))
GROUP BY `name`, window_start, window_end
```

This feature also supports the output of the start time and end time of the current window when the window receives late data. The time can be output by adding **window.start.field** and **window.end.field** to the hint. The field type must be **timestamp**. An example is as follows:

```
CREATE TABLE LD_SINK(
 `float` FLOAT, `string` STRING, `name` STRING,  `rowtime` TIMESTAMP(3), `windowStart` TIMESTAMP(3),
`windowEnd` TIMESTAMP(3)
) WITH (
 'connector' = 'print',
);

SELECT  /*+ LATE_DATA_SINK('sink.name'='LD_SINK', 'window.start.field'='windowStart',
'window.end.field'='windowEnd') */
  `name`,
  MIN(`float`),
  COUNT(DISTINCT `string`)
FROM TABLE(
  TUMBLE(TABLE T1, DESCRIPTOR(rowtime), INTERVAL '5' SECOND))
GROUP BY `name`, window_start, window_end
```

5.12.3 Configuring Table-Level Time To Live (TTL) for Joining Multiple Flink Streams

When you join two Flink streams, there is a possibility that data in one table changes rapidly (short TTL) and data in the other table changes slowly (long TTL). Currently, Flink supports only table-level TTL. To ensure join accuracy, you need to set the table-level TTL to a long expiration time. In this case, a large amount of expired data is stored in state backends, causing great workload pressure. To

reduce the pressure, you can use Hints to set different expiration time for the left and right tables. WHERE clauses are not supported.

For example, set the TTL of the left table (**state.ttl.left**) to 60 seconds and that of the right table (**state.ttl.right**) to 120 seconds.

- Use Hints in the following format:

```
/*+ OPTIONS('state.ttl.left'='60S', 'state.ttl.right'='120S') */
```

- The following is a configuration example with a SQL statement:
  - Example 1:

```
CREATE TABLE user_info (`user_id` VARCHAR, `user_name` VARCHAR) WITH (
  'connector' = 'kafka',
  'topic' = 'user_info_001',
  'properties.bootstrap.servers' = '192.168.64.138:21005',
  'properties.group.id' = 'testGroup',
  'scan.startup.mode' = 'latest-offset',
  'value.format' = 'csv'
);
CREATE table print(
  `user_id` VARCHAR,
  `user_name` VARCHAR,
  `score` INT
) WITH ('connector' = 'print');
CREATE TABLE user_score (user_id VARCHAR, score INT) WITH (
  'connector' = 'kafka',
  'topic' = 'user_score_001',
  'properties.bootstrap.servers' = '192.168.64.138:21005',
  'properties.group.id' = 'testGroup',
  'scan.startup.mode' = 'latest-offset',
  'value.format' = 'csv'
);
INSERT INTO
  print
SELECT
  t.user_id,
  t.user_name,
  d.score
FROM
  user_info as t
  JOIN
  -- Set different TTLs for the left and right tables.
  /*+ OPTIONS('state.ttl.left'='60S', 'state.ttl.right'='120S') */
  user_score as d ON t.user_id = d.user_id;
```

  - Example 2

```
INSERT INTO
  print
SELECT
  t1.user_id,
  t1.user_name,
  t3.score
FROM
  t1
  JOIN
  -- Set different TTLs for the left and right tables.
  /*+ OPTIONS('state.ttl.left' = '60S', 'state.ttl.right' = '120S') */
  (
    select
      UPPER(t2.user_id) as user_id,
      t2.score
    from
      t2
  ) as t3 ON t1.user_id = t3.user_id;
```

5.12.4 Verifying SQL Statements with the FlinkSQL Client

Scenarios

You can verify SQL syntax during SQL job development on the SQL Client. Running SQL commands in verification mode does not start Flink jobs.

How to Use

- Verifying SQL statements
  - When you run the SQL shell command, add **-v** or **--validate** to enter the verification mode.

    sql-client.sh -v
  - When you run the SQL shell command, you can run SET to enter or exit the verification mode.
    - Enter the verification mode: **SET table.validate = true;**
    - Exit the verification mode: **SET table.validate = false;**
- Verifying SQL scripts

  When the **-f** parameter is used to specify a SQL script, you can add **-v** to enter the verification mode.

  sql-client.sh -f *test.sql* **-v**

5.12.5 Submitting a Job on the FlinkSQL Client

Scenario

This section describes how to use FlinkSQL Client to submit jobs.

Prerequisites

- Flink has been installed in the MRS cluster and all components in the cluster are running properly.
- The cluster client has been installed, for example, in **/opt/hadoopclient**.

Procedure

Step 1 Log in to the node where the client is installed as the client installation user.

Step 2 Run the following command to go to the client installation directory:

cd /opt/hadoopclient

Step 3 Run the following command to initialize environment variables:

source /opt/hadoopclient/bigdata_env

Step 4 Log in to the FlinkSQL Client and submit a job.

1. Start yarn-session by referring to **Using Flink from Scratch** and record yarn-session ID (**yid**).

   yarn-session.sh -nm "*session-name***"**

2. Run the following command to access the FlinkSQL Client:

   cd /opt/hadoopclient/Flink/flink/bin

   ./sql-client.sh

   Figure 5-5 Accessing the FlinkSQL Client

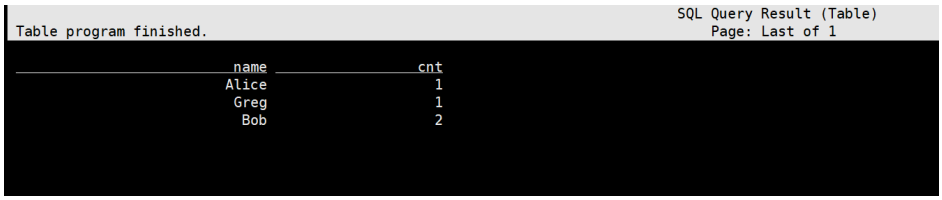
3. Set **high-availability.cluster-id** to the yarn-session ID.

   SET high-availability.cluster-id=*yarn-session ID***;**

4. Run the following SQL statement. If the execution is successful, the following information is displayed on the console.

   SELECT name, COUNT(*) AS cnt FROM (VALUES ('Bob'), ('Alice'), ('Greg'), ('Bob')) AS NameTable(name) GROUP BY name;

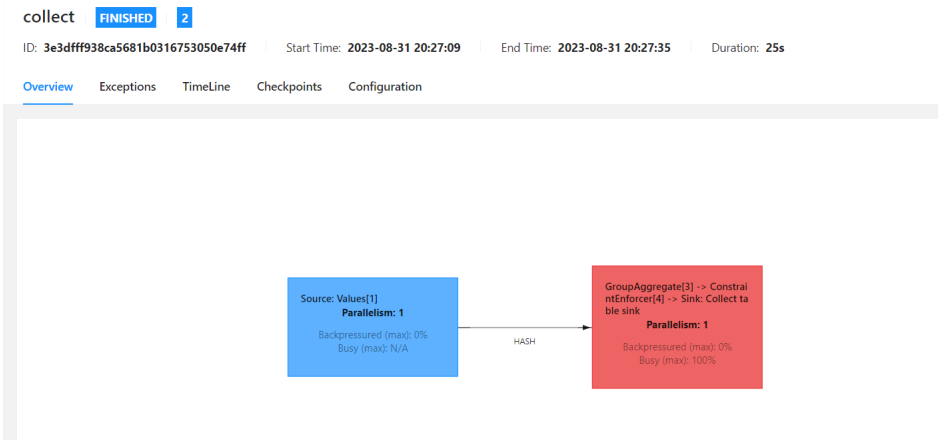
   Figure 5-6 Execution result



5. View the executed job on Yarn.

Log in to FusionInsight Manager, choose **Cluster** > **Services** > **Yarn** > **Dashboard**, and click the link next to **ResourceManager WebUI** to go to the Yarn web UI and view the job.

Figure 5-7 Job

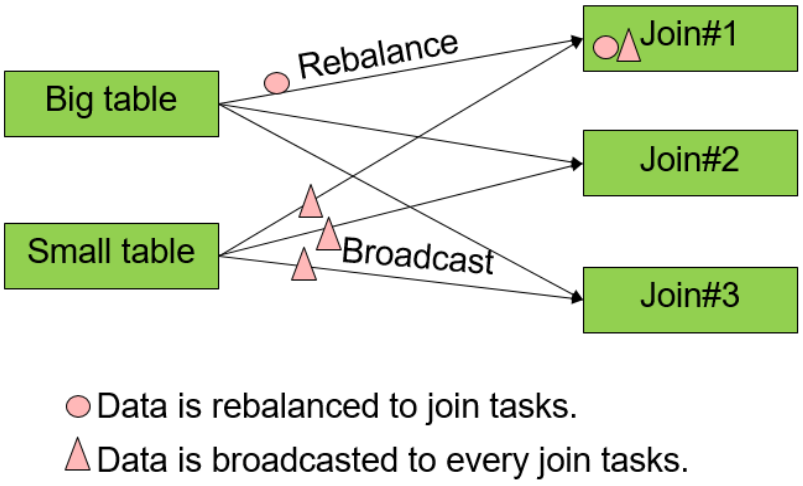


----End

5.12.6 Joining Big and Small Tables

Scenarios

There are big tables and small tables when you join two Flink streams. Small table data is broadcasted to every join task, and large table data is rebalanced (distribute the data in a round robin fashion) to join tasks. This way, Flink SQL usability and job stability are improved.



How to Use

You can use Flink SQL Hints to specify the left or right table in a join as a broadcasted table and the other table as a rebalanced table. The following SQL statement examples use table A and table C as small tables:

- Use table A as the broadcasted table.
  - Join
    ```
    SELECT /*+ BROADCAST(A) */ a2, b2 FROM A JOIN B ON a1 = b1
    ```
  - Where
    ```
    SELECT /*+ BROADCAST(A) */ a2, b2 FROM A, B WHERE a1 = b1
    ```
- Use table A and table C as broadcasted tables.
  ```
  SELECT /*+ BROADCAST(A, C) */ a2, b2, c2 FROM A JOIN B ON a1 = b1 JOIN C ON a1 = c1
  ```

NOTE

- This feature can be used with **/*+ BROADCAST(smallTable1, smallTable2) */** to be compatible with the open-source joins of two streams.
- Switching between open-source joins and this feature is not supported because this feature broadcasts data to each join task.
- Using a small table as the left table of a LEFT JOIN or a small table as the right table of a RIGHT JOIN is not supported.

5.12.7 Deduplicating Data When Joining Big and Small Tables

When you join two streams, there is a possibility that the join operator receives a large amount of duplicate data sent by one stream. Downstream operators need to process a large amount of duplicate data, affecting job performance.

For example, join fields (P1, A1, and A2) in table A with fields (P1, B1, B2, and B3) in table B to generate field C. A large amount of data in table B is updated but the fields are remain unchanged. Assume that only the B1 and B2 fields are used in the join and only the B3 field is updated. When you update table B, B1 and B2 fields should be ignored with the deduplication function.

```
select  A.A1,B.B1,B.B2 from A join B on A.P1=B.P1
```

To deduplicate table B updates, you can use Hints to set deduplication for the left table (duplicate.left) or right table (duplicate.right).

- Format
  - Set deduplication for the left table.
    ```
    /*+ OPTIONS('duplicate.left'='true')*/
    ```
  - Set deduplication for the right table.
    ```
    /*+ OPTIONS('duplicate.right'='true')*/
    ```
  - Set deduplication for both the left and right tables.
    ```
    /*+ OPTIONS('duplicate.left'='true','duplicate.right'='true')*/
    ```
- The following is an example with a SQL statement:

  For example, set deduplication for both the left table **user_info** and the right table **user_score**.

  ```
  CREATE TABLE user_info (`user_id` VARCHAR, `user_name` VARCHAR) WITH (
    'connector' = 'kafka',
    'topic' = 'user_info_001',
    'properties.bootstrap.servers' = '192.168.64.138:21005',
    'properties.group.id' = 'testGroup',
    'scan.startup.mode' = 'latest-offset',
    'value.format' = 'csv'
  );
  CREATE table print(
    `user_id` VARCHAR,
    `user_name` VARCHAR,
    `score` INT
  ) WITH ('connector' = 'print');
  CREATE TABLE user_score (user_id VARCHAR, score INT) WITH (
  ```

```
  'connector' = 'kafka',
  'topic' = 'user_score_001',
  'properties.bootstrap.servers' = '192.168.64.138:21005',
  'properties.group.id' = 'testGroup',
  'scan.startup.mode' = 'latest-offset',
  'value.format' = 'csv'
);
INSERT INTO
  print
SELECT
  t.user_id,
  t.user_name,
  d.score
FROM
  user_info as t
  JOIN
  -- Set deduplication for left and right tables.
  user_score /*+ OPTIONS('duplicate.left'='true','duplicate.right'='true')*/ as d ON t.user_id =
d.user_id;
```

5.12.8 Setting Source Parallelism

Flink SQL allows you to use the **source.parallelism** parameter to set the number of concurrent source operators to deal with data skew and back pressure and improve job performance.

This feature changes the Forward partition of source and downstream operators to the Rebalance partition. When the number of concurrent source operators is different from the number of concurrent downstream operators (**parallelisms**) and data disorder is not allowed, enable the **DISTRIBUTEBY** feature together with this feature. For details, see **Using the DISTRIBUTEBY Feature**.

The following example sets the number of concurrent source operators to 2 and enables the **DISTRIBUTEBY** feature:

```
CREATE TABLE KafkaSource (
`user_id` VARCHAR,
`user_name` VARCHAR,
 `age` INT
 ) WITH (
 'connector' = 'kafka',
 'topic' = 'test_source',
 'properties.bootstrap.servers' = 'Service IP address of the Kafka broker instance:Kafka port',
 'properties.group.id' = 'testGroup',
 'scan.startup.mode' = 'latest-offset',
 'format' = 'csv',
 'properties.sasl.kerberos.service.name' = 'kafka',
 'properties.security.protocol' = 'SASL_PLAINTEXT',
  'properties.kerberos.domain.name' = 'hadoop.System domain name',
 -- Set the number of concurrent source operators.
 'source.parallelism' = '2'
 );
CREATE TABLE KafkaSink(
  `user_id` VARCHAR,
  `user_name` VARCHAR,
 `age` INT
 ) WITH (
  'connector' = 'kafka',
  'topic' = 'test_sink',
  'properties.bootstrap.servers' = 'Service IP address of the Kafka broker instance:Kafka port',
  'value.format' = 'csv',
  'properties.sasl.kerberos.service.name' = 'kafka',
   'properties.security.protocol' = 'SASL_PLAINTEXT',
   'properties.kerberos.domain.name' = 'hadoop.System domain name'
 );
--  Insert into KafkaSink select user_id, user_name, age from KafkaSource (DISTRIBUTEBY disabled)
```

```
-- Enable DISTRIBUTEBY.
Insert into KafkaSink select/*+ DISTRIBUTEBY('user_id') */ user_id, user_name, age from KafkaSource;
```

5.12.9 Limiting Read Rate for Flink SQL Kafka and Upsert-Kafka Connector

Scenarios

Traffic limiting is required when Kafka and upsert-kafka connector consume data.

How to Use

Add the **subtask.scan.records-per-second.limit** parameter to the created source stream table. This parameter indicates the number of Kafka records consumed in a single partition per second. The overall traffic on the source end is **min(source parallelism * subtask.scan.records-per-second.limit, kafka partitions num * subtask.scan.records-per-second.limit)**.

The following is a SQL example:

```
CREATE TABLE KafkaSource (
  `user_id` VARCHAR,
  `user_name` VARCHAR,
  `age` INT
) WITH (
  'connector' = 'kafka',
  'topic' = 'test_source',
  'properties.bootstrap.servers' = 'IP address of the Kafka broker instance:Kafka port',
  'properties.group.id' = 'testGroup',
  'scan.startup.mode' = 'latest-offset',
  'format' = 'csv',
  'subtask.scan.records-per-second.limit' = '1000',
  'properties.sasl.kerberos.service.name' = 'kafka',
  'properties.security.protocol' = 'SASL_PLAINTEXT',
  'properties.kerberos.domain.name' = 'hadoop.System domain name'
);
CREATE TABLE KafkaSink(
  `user_id` VARCHAR,
  `user_name` VARCHAR,
  `age` INT
) WITH (
  'connector' = 'kafka',
  'topic' = 'test_sink',
  'properties.bootstrap.servers' = 'IP address of the Kafka broker instance:Kafka port',
  'scan.startup.mode' = 'latest-offset',
  'format' = 'csv',
  'properties.sasl.kerberos.service.name' = 'kafka',
  'properties.security.protocol' = 'SASL_PLAINTEXT',
  'properties.kerberos.domain.name' = 'hadoop.System domain name'
);
Insert into
  KafkaSink
select
  *
from
  KafkaSource;
```

5.12.10 Consuming Data in drs-json Format with FlinkSQL Kafka Connector

Scenarios

FlinkSQL needs to consume data in drs-json format (a CDC message format) in Kafka.

How to Use

In the created Kafka Connector Source stream table, set **format** to **drs-json**.

The following is a SQL example:

```
CREATE TABLE KafkaSource (
  `user_id` VARCHAR,
  `user_name` VARCHAR,
  `age` INT
) WITH (
  'connector' = 'kafka',
  'topic' = 'test_source',
  'properties.bootstrap.servers' = '<IP address of the Kafka broker instance:Kafka port>',
  'properties.group.id' = '<testGroup>',
  'scan.startup.mode' = 'latest-offset',
  'format' = 'drs-json',
  'properties.sasl.kerberos.service.name' = 'kafka',
  'properties.security.protocol' = 'SASL_PLAINTEXT',
  'properties.kerberos.domain.name' = 'hadoop.<System domain name>'
);
CREATE TABLE printSink(
  `user_id` VARCHAR,
  `user_name` VARCHAR,
  `age` INT
) WITH (
  'connector' = 'print'
);
Insert into
  printSink
select
  *
from
  KafkaSource;
```

5.12.11 Using ignoreDelete in JDBC Data Writes

Scenarios

Data in DELETE and UPDATE_BEFORE states can be filtered out when FlinkSQL writes JDBC data.

How to Use

Add **filter.record.enabled** and **filter.row-kinds** parameters to a created JDBC Connector Sink stream table.

NOTE

- The default value of **filter.record.enabled** is **false**.
- The default value of **filter.row-kinds** is **UPDATE_BEFORE, DELETE**.

The following is a SQL example:

```
CREATE TABLE user_score (
  idx varchar(20),
  user_id varchar(20),
  score bigint
) WITH (
  'connector' = 'kafka',
  'topic' = 'topic-qk',
  'properties.bootstrap.servers' = 'xxxx:21005',
  'properties.group.id' = 'test_qk',
  'scan.startup.mode' = 'latest-offset',
  'format' = 'csv'
);
CREATE TABLE dws_output (
  idx varchar(20),
  user_id varchar(20),
  all_score bigint,
  PRIMARY KEY(idx, user_id) NOT ENFORCED
) WITH(
  'connector' = 'jdbc',
  'driver' = 'com.xxx.gauss200.jdbc.Driver',
  'url' = 'jdbc:gaussdb://IP address of the GaussDB server:25308/postgres ',
  'table-name' = 'customer_t1',
  'username' = 'username',--Username for logging in to the GaussDB(DWS) database
  'password' = 'password',--Password for logging in to the GaussDB(DWS) database
  'filter.record.enabled' = 'true',
  'filter.row-kinds' = 'UPDATE_BEFORE'
);
insert into
  dws_output
select
  idx,
  user_id,
  sum(score) as all_score
from
  user_score
group by
  idx,
  user_id;
```

5.12.12 Join-To-Live

Flink dual-stream join needs to store data in the state backend. Currently, RocksDB is widely used as the state backend. In scenarios where the time to live (TTL) is too large, the TTL cannot be determined, or the data traffic increases, heavy traffic increases the state data and storage pressure. As a result, job stability decreases, or TTL expiration may cause inaccurate data association.

For services whose data associations are determined, the Join-To-Live (JTL) feature can be used to reduce the pressure on state backends. This feature determines whether data expires based on the number of associations. It can be configured in either of the following ways:

NOTE

- This function is available for the inner join statement of Flink regular joins only.
- This function cannot be used together with job-level TTLs, table-level TTLs, or small table broadcasting.

- Method 1: Using through SQL hints

  eliminate-state.left.threshold: indicates the threshold of the number of associations on the left. If the number of associations on the left exceeds the threshold, the piece of data expires.

eliminate-state.right.threshold: indicates the threshold of the number of associations on the right. If the number of associations on the right exceeds the threshold, the piece of data expires.

Example 1:

```
SELECT * FROM t1
  JOIN /*+ OPTIONS('eliminate-state.right.threshold'='1', 'eliminate-state.left.threshold'='2') */
  t2 ON a1 = a2
```

Example 2:

```
SELECT a1, a2, a3 from
 t1
 join /*+ OPTIONS('eliminate-state.left.threshold'='1', 'eliminate-state.right.threshold'='2') */
 t2
 on a1 = a2
 join /*+ OPTIONS('eliminate-state.left.threshold'='3', 'eliminate-state.right.threshold'='4') */
 t3
 on a2 = a3
```

- Method 2: Configuring the two parameters in *Client installation path*/**Flink/flink/conf/flink-conf.yaml** for globally effective

```
table.exec.join.eliminate-state.left.threshold
table.exec.join.eliminate-state.right.threshold
```

5.13 Flink on Hudi Development Specifications

5.13.1 Hudi Table Streaming Reads

Configurations

Table 5-56 Configuration parameters for Hudi table streaming reads

Parameter	Description	Recommended Value	Mandatory
Connector	Type of the table to be read	hudi	Yes
Path	Path for storing the table	Set this parameter as needed.	Yes
table.type	Hudi table type. Available values are as follows: • **MERGE_ON_READ** • **COPY_ON_WRITE** (default value)	**COPY_ON_WRITE**	Yes
hoodie.datasource.write.recordkey.field	Primary key of the table	Set this parameter as needed.	Yes

Parameter	Description	Recommended Value	Mandatory
write.precombine.field	Data combination field.	Set this parameter as needed.	Yes
read.tasks	Read task parallelism. The default value is 4.	4	No
read.streaming.enabled	Whether to enable incremental streaming read. The options are as follows: ● **true**: Incremental streaming read is enabled. ● **false**: Batch read is enabled.	true	Yes
read.streaming.start-commit	● **yyyyMMddHHmmss**: Start commit time in yyyyMMddHHmmss format for incremental stream consumption. By default, the latest commit is used. The start and end commit time form a close interval. ● **earliest** The consumption starts from the beginning.	-	No
hoodie.datasource.write.keygenerator.type	Primary key generator type of the upstream table. The options are as follows: ● **SIMPLE** (default value) ● **COMPLEX** (When a Spark table is created, use this value, or set the value same as the one specified when the Spark table is created.) ● TIMESTAMP ● CUSTOM ● NON_PARTITION ● GLOBAL_DELETE	COMPLEX	No
read.streaming.check-interval	Check interval (in minutes) for detecting new upstream commits. Use the default value **1** when the traffic is heavy.	5	No
read.end-commit	End commit time. The start and end commit time form a close interval. By default, the latest commit time is used.	-	No

Parameter	Description	Recommended Value	Mandatory
read.rate.limit	Traffic limit (records per second) for streaming read Default value **0** indicates that there is no limit. The value is the total limit. Limit for each operator = **read.rate.limit**/**read.tasks** (number of read operators).	-	No
changelog.enabled	Whether to write Changelog messages. The options are as follows: ● **false**: No Changelog message will be written (default value). ● **true**: Changelog messages will be written for CDC.	false	No
hoodie.datasource.write.hive_style_partitioning	Whether to use Hive style partitioning. The options are as follows: ● **false**: The Hive style is not used. Only the partition value (default value) is used as the partition directory name. ● **true**: The Hive style is used. The format of the partition directory name is <partition_column_name>=<partition_value>. If the Hudi partition table is created by Spark, this parameter is mandatory and must be set to **true**.	-	No

Development Suggestions

- Set proper consumption parameters to avoid the "File Not Found" error.

  When the downstream consumes Hudi files too slowly, the upstream archives the Hudi files. As a result, the "File Not Found" error occurs.

  Optimization suggestions:

  a. Improve the downstream read speed, for example, increase the number of **read.tasks**.

  b. Improve the data consumption speed, for example, increase the traffic limit.

  c. Increase the compaction period to prolong the retention period of log files.

- Set the traffic limit for streaming read when a Hudi table is used as the source table.

  If streaming read traffic exceeds the maximum traffic of the system, job exceptions may occur. Set a streaming read limit that equals the peak value verified by the service pressure test.

- Run compaction on Hudi tables to prevent the long checkpointing of the Hudi Source operator.

  If the Hudi Source operator takes long time for checkpointing, check whether the compaction of the Hudi table is normal. If compaction is not performed for a long time, the list performance deteriorates.

- When streaming read is enabled for Hudi MOR tables, enable log indexing to improve the Flink streaming read performance.

  The read and write performance of Hudi MOR tables can be improved through log indexing. Add **'hoodie.log.index.enabled'='true'** for Sink tables and Source tables.

- Impact of DDL changes on stream reading of Hudi tables

  Adding columns using DDL has no impact on Hudi table reads. Other DDL changes (such as changing a column type and name, and deleting a column) affect Hudi table reads. Therefore, you need to stop the read jobs before changes are performed.

5.13.2 Hudi Table Streaming Writes

Configurations

Table 5-57 Configuration parameters for Hudi table streaming writes

Parameter	Description	Recommended Value	Mandatory
Connector	Type of the table to be read	hudi	Yes
Path	Path for storing the table	Set this parameter as needed.	Yes
table.type	Hudi table type. The options are as follows: • **MERGE_ON_READ** • **COPY_ON_WRITE** (default value)	COPY_ON_WRITE	Yes
hoodie.datasource.write.recordkey.field	Primary key of the table	Set this parameter as needed.	Yes
write.precombine.field	Data combination field	Set this parameter as needed.	Yes
write.tasks	Write task parallelism. The default value is 4.	4	No

Parameter	Description	Recommended Value	Mandatory
index.bootstrap.enabled	Do not configure this parameter when the Bucket index is used. Flink uses in-memory indexes. The primary key of the data needs to be cached to the memory to ensure that the data in the target table is unique. Set this parameter to prevent data duplication. The default value is **true**.	true	No
write.index_bootstrap.tasks	This parameter is valid only when **index.bootstrap.enabled** is enabled. Increase the number of tasks to improve the startup speed. The default value is the default parallelism in the environment.	-	No
index.state.ttl	Duration for storing index data. The default value is **0** (unit: day), indicating that the index data is permanently valid.	-	No
hoodie.datasource.write.keygenerator.type	Primary key generator type of the upstream table. The options are as follows: ● **SIMPLE** (default value) ● **COMPLEX** (When a Spark table is created, use this value, or set the value same as the one specified when the Spark table is created.) ● **TIMESTAMP** ● **CUSTOM** ● **NON_PARTITION** ● **GLOBAL_DELETE**	COMPLEX	No
compaction.delta_commits	Condition for triggering the compaction plan for MOR tables. The default value is **5**.	200	No
compaction.async.enabled	Whether to enable async compaction. The compaction runs on SparkSQL to improve write performance. Set this parameter to **false** to run asynchronous compaction on SparkSQL.	false	No

Parameter	Description	Recommended Value	Mandatory
clean.async.enabled	Whether to clear old commits immediately upon new commits. This function is enabled by default. ● **true** (default value) ● **false**	false	No
clean.retain_commits	Number of commits to retain The default value is 30.	-	No
hoodie.archive.automatic	Whether the archive table service is invoked immediately after each commit. ● **true** (default value) ● **false**	false	No
archive.min_commits	Minimum number of commits to be retained before older commits are archived to the sequential log. The default value is **40**.	500	No
archive.max_commits	Maximum number of commits to be retained before older commits are archived to the sequential log. The default value is **50**.	600	No
hive_sync.enable	Whether to synchronize table information to Hive.	true	No
hive_sync.metastore.uris	Hivemeta URI	Set this parameter as needed.	No
hive_sync.jdbc_url	Hive JDBC link	Set this parameter as needed.	No
hive_sync.table	Hive table name	Set this parameter as needed.	No
hive_sync.db	Name of a Hive database	Set this parameter as needed.	No
hive_sync.support_timestamp	Whether to support timestamps	true	No

Parameter	Description	Recommended Value	Mandatory
changelog.enabled	Whether to write Changelog messages. The options are as follows: ● **false**: No Changelog message will be written (default value). ● **true**: Changelog messages will be written for CDC.	false	No
hoodie.datasource.write.hive_style_partitioning	Whether to use Hive style partitioning. The options are as follows: ● **false**: The Hive style is not used. Only the partition value (default value) is used as the partition directory name. ● **true**: The Hive style is used. The format of the partition directory name is <partition_column_name>=<partition_value>. If the Hudi partition table is created by Spark, this parameter is mandatory and must be set to **true**.	-	No
filter.delete.record.enabled	Whether to filter delete messages. ● **false**: Do not filter (default value). ● **true**: Filter delete messages. If **changelog** is disabled, upstream delete messages cannot be written to the Hudi table.	true	No
delete.empty.instant.ttl	If no data is written to an instant and the LLT of the instant exceeds the configured value (unit: ms), the instant is deleted and a new instant is created. The default value is 5 minutes. The value **-1** indicates that this function is disabled.	10000	No

Development Suggestions

- Table names must meet the Hive requirements, for example, my_table, customer_info, and sales_data.

  A table name:

  – Must start with a letter or underscore (_) and cannot start with a digit.
  – Can contain only letters, digits, underscores (_), and dots (.).
  – Can contain a maximum of 128 characters.
  – Cannot contain spaces or special characters, such as colons (:), semicolons (;), and slashes (/).

  - Is case insensitive. **Lowercase letters are recommended.**
  - Cannot be Hive reserved keywords, such as **select**, **from**, and **where**.

- Use Spark SQL to create Hudi tables in a unified manner. The following is an example:

```
create table hudi_mor_par_ddl (
  id int,
  comb int,
  col0 int,
  col1 bigint,
  col2 float,
  col3 double,
  col4 decimal(30, 10),
  col5 string,
  col6 date,
  col7 timestamp,
  col8 boolean,
  col9 binary,
  par date
) using hudi partitioned by(par) options(
  type = 'mor',
  primaryKey = 'id',
  preCombineField = 'comb',
  hoodie.index.type = 'BUCKET'
);
```

- Use Spark asynchronous tasks to compact Hudi tables. The following are examples for reference only:

  Add the following parameters in the Flink job:

```
  'compaction.async.enabled' = 'false',
  'compaction.delta_commits' = '5',
  'clean.async.enabled' = 'false',
  'hoodie.archive.automatic' = 'false',
```

  Example SparkSQL commands are as follows:

```
set hoodie.clean.automatic = true;
  set hoodie.clean.async = false;
  set hoodie.cleaner.commits.retained = 10;
  set hoodie.compact.inline = true;
  set hoodie.run.compact.only.inline = true;
  set hoodie.keep.min.commits = 500;
  set hoodie.keep.max.commits = 600;
  run compaction on tableName;
  run archivelog on tableName;
```

- Impact of DDL changes on stream writing of Hudi tables

  DDL changes (such as adding a column, changing a column type and name, and deleting a column) affect Hudi table writes. Therefore, you need to stop the write jobs before changes are performed.

5.13.3 Submitting Flink on Hudi Jobs

Parameters

Table 5-58 Parameters for submitting a job

Parameter	Description	Recommended Value	Description
-c	Main class name	Set this parameter as needed.	Mandatory
-ynm	Flink YARN job name	Set this parameter as needed.	Mandatory
execution.checkpointing.interval	Interval for triggering checkpointing, in milliseconds	60000	Mandatory. Use **-yD** to pass this parameter.
execution.checkpointing.timeout	Checkpoint timeout, in minutes. The default value is 30 minutes.	30min	Mandatory. Use **-yD** to pass this parameter.
parallelism.default	Parallelism of a job, for example, a join job. The default value is 1.	Set this parameter as needed.	Mandatory. Use **-yD** to pass this parameter.
table.exec.state.ttl	Flink status TTL (join TTL). The default value is **0**.	Set this parameter as needed.	Mandatory. Use **-yD** to pass this parameter.

Development Suggestions

- The checkpoint interval must be greater than the checkpoint execution duration.

  The checkpoint execution duration depends on the checkpoint data volume. The larger the data volume, the longer the execution duration.

  The checkpoint execution duration depends on the number of partitions. The more the partitions, the longer the execution duration.
- The checkpoint timeout must be greater than the checkpoint interval.

  The checkpoint interval indicates the interval for triggering a checkpoint operation. If a checkpoint operation takes longer time than the checkpoint timeout, the job fails.
- If CDC is used, Changelog needs to be enabled for Hudi table read and write.

To ensure Flink calculation accuracy when CDC is used, retain +I, +U, -U, and -D in Hudi tables. Changelog must be enabled when data is written to or read from the same Hudi table.

- Hudi tables of the COW type are used when data is ingested to the lake in batches.

  Copy-on-write tables use Parquet columnar storage only. Files to be updated are rewritten by merging versions synchronously during writing. Less storage space is required. However, synchronous data rewriting increases the data update cost and read latency. Therefore, COW tables are not suitable for real-time data ingestion.

6 Using Flume

6.1 Using Flume from Scratch

Scenario

You can use Flume to import collected log information to Kafka.

Prerequisites

- A streaming cluster that contains components such as Flume and Kafka and has Kerberos authentication enabled has been created.
- The streaming cluster can properly communicate with the node where logs are generated.
- A human-machine user, for example, **test1**, has been created. The user has been added to the **hadoop**, **yarnviewgroup**, **hadooppmanager**, and **kafkaadmin** user groups as needed, and the **System_administrator** and **default** roles have been added. (If the user is created for the first time, use this username to log in to Manager and change the password.)

Using the Flume Client

Step 1 Install the Flume client.

Install the Flume client in a directory, for example, **/opt/Flumeclient**, on the node where logs are generated by referring to **Installing the Flume Client**. The Flume client installation directories in the following steps are only examples. Change them to the actual installation directories.

Step 2 Perform the following operations if Kerberos authentication is enabled for the cluster. Otherwise, skip these operations.

1. Download the user authentication credential.

   Log in to FusionInsight Manager and choose **System** > **Permission** > **User**. In the user list, locate the row containing the created user **test1**, click **More**, and select **Download Authentication Credential** to download the authentication credential to the local host as prompted. Decompress the package to obtain the **krb5.conf** and **user.keytab** files.

2. Copy **krb5.conf** and **user.keytab** obtained in **Step 2.1** to the *Flume client installation directory*/**fusioninsight-flume-***Flume version number*/**conf** directory on the Flume client node.
3. Log in to the Flume client node, go to the *Flume client installation directory*/**fusioninsight-flume-***Flume version number*/**conf** directory, and run the following command to create the **jaas.conf** file. Then, save the file.

   cd /opt/FlumeClient/fusioninsight-flume-*Flume version number*/**conf/**

   vi jaas.conf

   ```
   KafkaClient {
   com.sun.security.auth.module.Krb5LoginModule required
   useKeyTab=true
   keyTab="/opt/FlumeClient/fusioninsight-flume-Flume version number/conf/user.keytab"
   principal="test1"
   useTicketCache=false
   storeKey=true
   debug=true;
   };
   ```

   NOTE

   - **keyTab**: full path of the user authentication file, which is the directory for storing the user authentication file in **Step 2.2**.
   - If the user or authentication file is changed after the first authentication configuration, you need to reconfigure user authentication and restart the Flume instance.

Step 3 Configure jobs based on actual service scenarios.

- Some parameters can be configured on Manager.
- Set the parameters in the **properties.properties** file. The following uses SpoolDir Source+File Channel+Kafka Sink as an example.

  Run the following command on the node where the Flume client is installed. Configure and save jobs in the Flume client configuration file **properties.properties** based on actual service requirements.

  vi *Flume client installation directory*/**fusioninsight-flume-***Flume component version number*/**conf/properties.properties**

  ```
  ################################################################################
  ###################
  client.sources = static_log_source
  client.channels = static_log_channel
  client.sinks = kafka_sink
  ################################################################################
  ###################
  #LOG_TO_HDFS_ONLINE_1

  client.sources.static_log_source.type = spooldir
  client.sources.static_log_source.spoolDir = Monitoring directory
  client.sources.static_log_source.fileSuffix = .COMPLETED
  client.sources.static_log_source.ignorePattern = ^$
  client.sources.static_log_source.trackerDir = Metadata storage path during transmission
  client.sources.static_log_source.maxBlobLength = 16384
  client.sources.static_log_source.batchSize = 51200
  client.sources.static_log_source.inputCharset = UTF-8
  client.sources.static_log_source.deserializer = LINE
  client.sources.static_log_source.selector.type = replicating
  client.sources.static_log_source.fileHeaderKey = file
  client.sources.static_log_source.fileHeader = false
  client.sources.static_log_source.basenameHeader = true
  client.sources.static_log_source.basenameHeaderKey = basename
  client.sources.static_log_source.deletePolicy = never
  ```

```
client.channels.static_log_channel.type = file
client.channels.static_log_channel.dataDirs = Data cache path. Multiple paths, separated by commas (,), can be configured to improve performance.
client.channels.static_log_channel.checkpointDir = Checkpoint storage path
client.channels.static_log_channel.maxFileSize = 2146435071
client.channels.static_log_channel.capacity = 1000000
client.channels.static_log_channel.transactionCapacity = 612000
client.channels.static_log_channel.minimumRequiredSpace = 524288000

client.sinks.kafka_sink.type = org.apache.flume.sink.kafka.KafkaSink
client.sinks.kafka_sink.kafka.topic = Topic to which data is written, for example, flume_test
client.sinks.kafka_sink.kafka.bootstrap.servers = XXX.XXX.XXX.XXX:Kafka port number,XXX.XXX.XXX.XXX:Kafka port number,XXX.XXX.XXX.XXX:Kafka port number
client.sinks.kafka_sink.flumeBatchSize = 1000
client.sinks.kafka_sink.kafka.producer.type = sync
client.sinks.kafka_sink.kafka.security.protocol = SASL_PLAINTEXT
client.sinks.kafka_sink.kafka.kerberos.domain.name = Kafka domain name. This parameter is mandatory for a security cluster, for example, hadoop.xxx.com.
client.sinks.kafka_sink.requiredAcks = 0

client.sources.static_log_source.channels = static_log_channel
client.sinks.kafka_sink.channel = static_log_channel
```

NOTE

- **client.sinks.kafka_sink.kafka.topic**: Topic to which data is written. If the topic does not exist in Kafka, it is automatically created by default.
- **client.sinks.kafka_sink.kafka.bootstrap.servers**: List of Kafka Brokers, which are separated by commas (,). By default, the port is **21007** for a security cluster and **9092** for a normal cluster.
- **client.sinks.kafka_sink.kafka.security.protocol**: The value is **SASL_PLAINTEXT** for a security cluster and **PLAINTEXT** for a normal cluster.
- **client.sinks.kafka_sink.kafka.kerberos.domain.name**:

  You do not need to set this parameter for a normal cluster. For a security cluster, the value of this parameter is the value of **kerberos.domain.name** in the Kafka cluster.

  Obtain the value by checking **${BIGDATA_HOME}/FusionInsight_Current/1_X_Broker/etc/server.properties** on the node where the broker instance is located.

Step 4 After the parameters are configured and saved, the Flume client automatically loads the content configured in **properties.properties**. When new log files are generated by spoolDir, the files are sent to Kafka producers and can be consumed by Kafka consumers.

----End

6.2 Overview

Flume is a distributed, reliable, and highly available system for aggregating massive logs, which can efficiently collect, aggregate, and move massive log data from different data sources and store the data in a centralized data storage system. Various data senders can be customized in the system to collect data. Additionally, Flume provides simple data processes capabilities and writes data to data receivers (which is customizable).

Flume consists of the client and server, both of which are FlumeAgents. The server corresponds to the FlumeServer instance and is directly deployed in a cluster. The client can be deployed inside or outside the cluster. he client-side and service-side FlumeAgents work independently and provide the same functions.

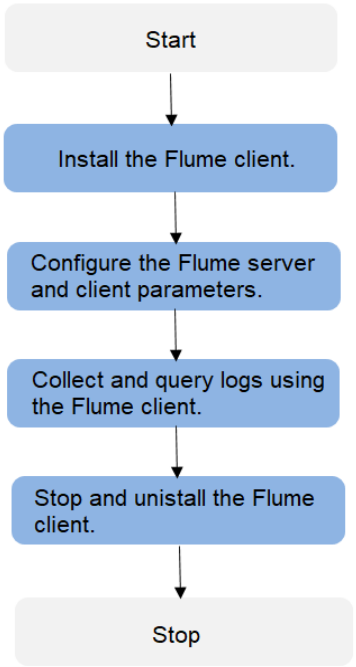
The client-side FlumeAgent needs to be independently installed. Data can be directly imported to components such as HDFS and Kafka. Additionally, the client-side and service-side FlumeAgents can also work together to provide services.

Process

The process for collecting logs using Flume is as follows:

1. Installing the flume client
2. Configuring the Flume server and client parameters
3. Collecting and querying logs using the Flume client
4. Stopping and uninstalling the Flume client

Figure 6-1 Log collection process



Flume Client

A Flume client consists of the source, channel, and sink. The source sends the data to the channel, and then the sink transmits the data from the channel to the external device. **Table 6-1** describes Flume modules.

Table 6-1 Module description

Name	Description
Source	A source receives or generates data and sends the data to one or multiple channels. The source can work in either data-driven or polling mode. Typical sources include: ● Sources that are integrated with the system and receives data, such as Syslog and Netcat ● Sources that automatically generate event data, such as Exec and SEQ ● IPC sources that are used for communication between agents, such as Avro A Source must associate with at least one channel.
Channel	A channel is used to buffer data between a source and a sink. After the sink transmits the data to the next channel or the destination, the cache is deleted automatically. The persistency of the channels varies with the channel types: ● Memory channel: non-persistency ● File channel: persistency implemented based on write-ahead logging (WAL) ● JDBC channel: persistency implemented based on the embedded database Channels support the transaction feature to ensure simple sequential operations. A channel can work with sources and sinks of any quantity.
Sink	Sink is responsible for sending data to the next hop or final destination and removing the data from the channel after successfully sending the data. Typical sinks include: ● Sinks that send storage data to the final destination, such as HDFS and Kafka ● Sinks that are consumed automatically, such as Null Sink ● IPC sinks that are used for communication between agents, such as Avro A sink must associate with at least one channel.

A Flume client can have multiple sources, channels, and sinks. A source can send data to multiple channels, and then multiple sinks send the data out of the client.

Multiple Flume clients can be cascaded. That is, a sink can send data to the source of another client.

Supplementary Information

1. Flume provides the following reliability measures:
   - The transaction mechanism is implemented between sources and channels, and between channels and sinks.
   - The sink processor supports the failover and load balancing (load_balance) mechanisms.

     The following is an example of the load balancing (load_balance) configuration:

     ```
     server.sinkgroups=g1
     server.sinkgroups.g1.sinks=k1 k2
     server.sinkgroups.g1.processor.type=load_balance
     server.sinkgroups.g1.processor.backoff=true
     server.sinkgroups.g1.processor.selector=random
     ```
2. The following are precautions for the aggregation and cascading of multiple Flume clients:
   - Avro or Thrift protocol can be used for cascading.
   - When the aggregation end contains multiple nodes, evenly distribute the clients to these nodes. Do not connect all the clients to a single node.
3. The Flume client can contain multiple independent data flows. That is, multiple sources, channels, and sinks can be configured in the **properties.properties** configuration file. These components can be linked to form multiple flows.

   For example, to configure two data flows in a configuration, run the following commands:

   ```
   server.sources = source1 source2
   server.sinks = sink1 sink2
   server.channels = channel1 channel2

   #dataflow1
   server.sources.source1.channels = channel1
   server.sinks.sink1.channel = channel1

   #dataflow2
   server.sources.source2.channels = channel2
   server.sinks.sink2.channel = channel2
   ```

6.3 Installing the Flume Client

Scenario

To use Flume to collect logs, you must install the Flume client on a log host. You can create an ECS and install the Flume client on it.

Prerequisites

- A cluster with the Flume component has been created.
- The log host is in the same VPC and subnet with the MRS cluster.
- You have obtained the username and password for logging in to the log host.
- The installation directory is automatically created if it does not exist. If it exists, the directory must be left blank. The directory path cannot contain any space.

Procedure

Step 1 Obtain the software package.

Log in to the FusionInsight Manager. Choose **Cluster** > *Name of the target cluster* > **Services** > **Flume**. On the Flume service page that is displayed, choose **More** > **Download Client** in the upper right corner and set **Select Client Type** to **Complete Client** to download the Flume service client file.

The file name of the client is **FusionInsight_Cluster**_<*Cluster ID*>_**Flume_Client.tar**. This section takes the client file **FusionInsight_Cluster_1_Flume_Client.tar** as an example.

Step 2 Upload the software package.

Upload the software package to a directory, for example, **/opt/client**, on the node where the Flume client is to be installed as user **user**.

NOTE

user is the user who installs and runs the Flume client.

Step 3 Decompress the software package.

Log in to the node where the Flume service client is to be installed as user **user**. Go to the directory where the installation package is installed, for example, **/opt/client**, and run the following command to decompress the installation package to the current directory:

cd /opt/client

tar -xvf FusionInsight_Cluster_1_Flume_Client.tar

Step 4 Verify the software package.

Run the **sha256sum -c** command to verify the decompressed file. If **OK** is returned, the verification is successful. Example:

sha256sum -c FusionInsight_Cluster_1_Flume_ClientConfig.tar.sha256

```
FusionInsight_Cluster_1_Flume_ClientConfig.tar: OK
```

Step 5 Decompress the package.

tar -xvf FusionInsight_Cluster_1_Flume_ClientConfig.tar

Step 6 To install the Flume client on a node outside the cluster, perform the following steps to configure the installation environment. Skip this step if you install Flume client on a node in the cluster.

1. Run the following command to install the client running environment to a new directory, for example, **/opt/Flumeenv**. A directory is automatically generated during the client installation.

   sh /opt/client/FusionInsight_Cluster_1_Flume_ClientConfig/install.sh /opt/Flumeenv

   If the following information is displayed, the client running environment is successfully installed:

   ```
   Components client installation is complete.
   ```

2. Run the following command to configure environment variables:

source /opt/Flumeenv/bigdata_env

Step 7 Check whether the number of clients is **1**.

- If yes, use the independent installation mode and go to **Step 8**. The installation is complete.
- If no, use the batch installation mode and go to **Step 9**.

Step 8 Run the following command in the Flume client installation directory to install the client to a specified directory (for example, **opt/FlumeClient**): After the client is installed successfully, the installation is complete.

cd /opt/client/FusionInsight_Cluster_1_Flume_ClientConfig/Flume/FlumeClient

./install.sh -d */opt/FlumeClient* **-f** *MonitorServer Service IP address or host name of the role* **-c** *User service configuration file Path for storing* ***properties.properties*** **-s** *CPU threshold* **-l /var/log/Bigdata -e** *FlumeServer service IP address or host name* **-n** *Flume*

NOTE

- **-d**: Flume client installation path
- (Optional) **-f**: IP addresses or host names of two MonitorServer roles. The IP addresses or host names are separated by commas (,). If this parameter is not configured, the Flume client does not send alarm information to MonitorServer and information about the client cannot be viewed on the FusionInsight Manager GUI.
- (Optional) **-c**: Service configuration file, which needs to be generated on the configuration tool page of the Flume server based on your service requirements. Upload the file to any directory on the node where the client is to be installed. If this parameter is not specified during the installation, you can upload the generated service configuration file **properties.properties** to the **/opt/FlumeClient/fusioninsight-flume-***Flume component version***/conf** directory after the installation.
- (Optional) **-s**: cgroup threshold. The value is an integer ranging from 1 to 100 x *N*. *N* indicates the number of CPU cores. The default threshold is **-1**, indicating that the processes added to the cgroup are not restricted by the CPU usage.
- (Optional) **-l**: Log path. The default value is **/var/log/Bigdata**. The user **user** must have the write permission on the directory. When the client is installed for the first time, a subdirectory named **flume-client** is generated. After the installation, subdirectories named **flume-client-***n* will be generated in sequence. The letter *n* indicates a sequence number, which starts from 1 in ascending order. In the **/conf/** directory of the Flume client installation directory, modify the **ENV_VARS** file and search for the **FLUME_LOG_DIR** attribute to view the client log path.
- (Optional) **-e**: Service IP address or host name of FlumeServer, which is used to receive statistics for the monitoring indicator reported by the client.
- (Optional) **-n**: Name of the Flume client. You can choose **Cluster** > *Name of the desired cluster* > **Service** > **Flume** > **Flume Management** on FusionInsight Manager to view the client name on the corresponding node.
- If the following error message is displayed, run the **export JAVA_HOME=*JDK path*** command. You can run the **echo $JAVA_HOME** command to query the JDK path.
  JAVA_HOME is null in current user,please install the JDK and set the JAVA_HOME
- IBM JDK does not support **-Xloggc**. You must change **-Xloggc** to **-Xverbosegclog** in **flume/conf/flume-env.sh**. For 32-bit JDK, the value of **-Xmx** must not exceed 3.25 GB.
- When installing a cross-platform client in a cluster, go to the **/opt/client/FusionInsight_Cluster_1_Flume_ClientConfig/Flume/FusionInsight-Flume-***Flume component version***.tar.gz** directory to install the Flume client.

Step 9 Go to the directory for installing clients in batches.

cd /opt/client/FusionInsight_Cluster_1_Flume_ClientConfig/Flume/FlumeClient/batch_install

NOTE

When installing a cross-platform client in a cluster, go to the **/opt/client/FusionInsight_Cluster_1_Flume_ClientConfig/Flume/FusionInsight-Flume-***Flume component version***.tar.gz** directory to install the Flume client.

Step 10 Configure the **host_info.cfg** file. The format of the configuration file is as follows:

host_ip="",user="",password="",install_path="",flume_config_file="",monitor_server_ip="",log_path="",flume_server_ip="",cgroup_threshold="",client_name=""

NOTE

- (Mandatory) *host_ip*: IP address of the node where the Flume client is to be installed.
- (Mandatory) *user*: User name for logging in to the node where the Flume client is to be installed remotely.
- (Mandatory) *password*: Password for logging in to the Flume client to be installed remotely. Configuration files containing authentication passwords pose security risks. Delete such files after configuration or store them securely.
- (Mandatory) **install_path**: Installation path of the Flume client.
- (Optional) **flume_config_file**: Configuration file for Flume running. You are advised to specify this configuration file during Flume installation. If you do not set this parameter, retain the value "" and do not delete the parameter.
- (Optional) **monitor_server_ip**: Service IP address of the Flume MonitorServer in the cluster. You can check the IP address on FusionInsight Manager. You can select either of the two IP addresses. If the IP address is not configured, the client does not send alarm information to the cluster in the scenario where a process is faulty.
- (Optional) **log_path**: Path for storing Flume run logs. If this parameter is not set, logs are recorded in **/var/log/Bigdata/flume-client**-*Index* by default. Index value: If there is only one client in this path, the value is 1. If there are multiple clients, the index value is incremented by 1.
- (Optional) **flume_server_ip**: Service IP address of the Flume server. The indicator information of the client is reported to the cluster from this node. The indicator information about the client can be displayed on the web client. If the indicator information is not configured, the client does not display the indicator information.
- (Optional) **cgroup_threshold**: cgroup threshold. The value is an integer ranging from 1 to 100 x *N*. *N* indicates the number of CPU cores. The default threshold is **-1**, indicating that the processes added to the cgroup are not restricted by the CPU usage.
- (Optional) **client_name**: Client name. The client name is displayed on the client monitoring page. If the client name is not configured, the client name is empty.
- If multiple nodes need to be added, the format is as follows:

  host_ip="ip1",user="user1",password="******",install_path="/tmp/flumeclient",flume_config_file="",monitor_server_ip="xxx.xxx.xxx.xxx",log_path="",flume_server_ip="xxx.xxx.xxx.xxx",cgroup_threshold="",client_name="ip1-client-1"

  host_ip="ip2",user="user1",password="******",install_path="/tmp/flumeclient",flume_config_file="",monitor_server_ip="xxx.xxx.xxx.xxx",log_path="",flume_server_ip="xxx.xxx.xxx.xxx",cgroup_threshold="",client_name="ip2-client-1"

  host_ip="ip3",user="user1",password="******",install_path="/tmp/flumeclient",flume_config_file="",monitor_server_ip="xxx.xxx.xxx.xxx",log_path="",flume_server_ip="xxx.xxx.xxx.xxx",cgroup_threshold="",client_name="ip3-client-1"

Step 11 Run the following command to install the Flume client in batches.

./batch_install.sh -p /opt/client/FusionInsight_Cluster_1_Flume_Client.tar

Step 12 Delete the password information from the **host_info.cfg** file.

After the batch installation is complete, delete the password information from the **host_info.cfg** file immediately. Otherwise, the password may be disclosed.

----End

6.4 Viewing Flume Client Logs

Scenario

You can view logs to locate faults.

Prerequisites

The Flume client has been installed.

Procedure

Step 1 Go to the Flume client log directory (**/var/log/Bigdata** by default).

Step 2 Run the following command to view the log file:

ls -lR flume-client-*

A log file is shown as follows:

```
flume-client-1/flume:
total 7672
-rw-------. 1 root root       0 Sep  8 19:43 Flume-audit.log
-rw-------. 1 root root 1562037 Sep 11 06:05 FlumeClient.2017-09-11_04-05-09.[1].log.zip
-rw-------. 1 root root 6127274 Sep 11 14:47 FlumeClient.log
-rw-------. 1 root root    2935 Sep  8 22:20 flume-root-20170908202009-pid72456-gc.log.0.current
-rw-------. 1 root root    2935 Sep  8 22:27 flume-root-20170908202634-pid78789-gc.log.0.current
-rw-------. 1 root root    4382 Sep  8 22:47 flume-root-20170908203137-pid84925-gc.log.0.current
-rw-------. 1 root root    4390 Sep  8 23:46 flume-root-20170908204918-pid103920-gc.log.0.current
-rw-------. 1 root root    3196 Sep  9 10:12 flume-root-20170908215351-pid44372-gc.log.0.current
-rw-------. 1 root root    2935 Sep  9 10:13 flume-root-20170909101233-pid55119-gc.log.0.current
-rw-------. 1 root root    6441 Sep  9 11:10 flume-root-20170909101631-pid59301-gc.log.0.current
-rw-------. 1 root root       0 Sep  9 11:10 flume-root-20170909111009-pid119477-gc.log.0.current
-rw-------. 1 root root   92896 Sep 11 13:24 flume-root-20170909111126-pid120689-gc.log.0.current
-rw-------. 1 root root    5588 Sep 11 14:46 flume-root-20170911132445-pid42259-gc.log.0.current
-rw-------. 1 root root    2576 Sep 11 13:24 prestartDetail.log
-rw-------. 1 root root    3303 Sep 11 13:24 startDetail.log
-rw-------. 1 root root    1253 Sep 11 13:24 stopDetail.log

flume-client-1/monitor:
total 8
-rw-------. 1 root root  141 Sep  8 19:43 flumeMonitorChecker.log
-rw-------. 1 root root 2946 Sep 11 13:24 flumeMonitor.log
```

In the log file, **FlumeClient.log** is the run log of the Flume client.

----End

6.5 Stopping or Uninstalling the Flume Client

Scenario

You can stop and start the Flume client or uninstall the Flume client when the Flume data ingestion channel is not required.

Procedure

- Stop the Flume client of the Flume role.

  Assume that the Flume client installation path is **/opt/FlumeClient**. Run the following command to stop the Flume client:

  cd /opt/FlumeClient/fusioninsight-flume-*Flume component version number***/bin**

  ./flume-manage.sh stop

  If the following information is displayed after the command execution, the Flume client is successfully stopped.

  ```
  Stop Flume PID=120689 successful..
  ```

  NOTE

  The Flume client will be automatically restarted after being stopped. If you do not need automatic restart, run the following command:

  ./flume-manage.sh stop force

  If you want to restart the Flume client, run the following command:

  ./flume-manage.sh start force

- Uninstall the Flume client of the Flume role.

  Assume that the Flume client installation path is **/opt/FlumeClient**. Run the following command to uninstall the Flume client:

  cd /opt/FlumeClient/fusioninsight-flume-*Flume component version number***/inst**

  ./uninstall.sh

6.6 Using the Encryption Tool of the Flume Client

Scenario

You can use the encryption tool provided by the Flume client to encrypt some parameter values in the configuration file.

Prerequisites

The Flume client has been installed.

Procedure

Step 1 Log in to the Flume client node and go to the client installation directory, for example, **/opt/FlumeClient**.

Step 2 Run the following command to switch the directory:

cd fusioninsight-flume-*Flume component version number***/bin**

Step 3 Run the following command to encrypt information:

./genPwFile.sh

Input the information that you want to encrypt twice.

Step 4 Run the following command to query the encrypted information:

cat password.property

NOTE

If the encryption parameter is used for the Flume server, you need to perform encryption on the corresponding Flume server node. You need to run the encryption script as user **omm** for encryption.

----End

6.7 Flume Service Configuration Guide

This configuration guide describes how to configure common Flume services.

NOTE

- Parameters in bold in the following tables are mandatory.
- The value of **BatchSize** of the Sink must be less than that of **transactionCapacity** of the Channel.
- Only some parameters of Source, Channel, and Sink are displayed on the Flume configuration tool page. For details, see the following configurations.
- The Customer Source, Customer Channel, and Customer Sink displayed on the Flume configuration tool page need to be configured based on self-developed code. The following common configurations are not displayed.

Common Source Configurations

- **Avro Source**

  Avro Source listens to the Avro port, receives data from the external Avro client, and puts the data into the configured channel. Common configurations are as follows:

  Table 6-2 Common configurations of an Avro source

Parameter	Default Value	Description
channels	-	Specifies the channel connected to the source. Multiple channels can be configured.

Parameter	Default Value	Description
type	avro	Specifies the type of the avro source, which must be **avro**.
bind	-	Specifies the listening host name/IP address.
port	-	Specifies the bound listening port. Ensure that this port is not occupied.
threads	-	Specifies the maximum number of source threads.
compression-type	none	Specifies the message compression format, which can be set to **none** or **deflate**. **none** indicates that data is not compressed, while **deflate** indicates that data is compressed.
compression-level	6	Specifies the data compression level, which ranges from **1** to **9**. The larger the value is, the higher the compression rate is.
ssl	false	Specifies whether to use SSL encryption. If this parameter is set to **true**, **keystore** and **keystore-password** must be specified.
truststore-type	JKS	Specifies the Java trust store type, which can be set to **JKS** or **PKCS12**. **NOTE** Different passwords are used to protect the key store and private key of **JKS**, while the same password is used to protect the key store and private key of **PKCS12**.
truststore	-	Specifies the Java trust store file.

Parameter	Default Value	Description
truststore-password	-	Specifies the Java trust store password.
keystore-type	JKS	Specifies the keystore type set after SSL is enabled, which can be set to **JKS** or **PKCS12**. **NOTE** Different passwords are used to protect the key store and private key of **JKS**, while the same password is used to protect the key store and private key of **PKCS12**.
keystore	-	Specifies the keystore file path set after SSL is enabled. This parameter is mandatory if SSL is enabled.
keystore-password	-	Specifies the keystore password set after SSL is enabled. This parameter is mandatory if SSL is enabled.
trust-all-certs	false	Specifies whether to disable the check for the SSL server certificate. If this parameter is set to **true**, the SSL server certificate of the remote source is not checked. You are not advised to perform this operation during the production.
exclude-protocols	SSLv3	Specifies the excluded protocols. The entered protocols must be separated by spaces. The default value is **SSLv3**.
ipFilter	false	Specifies whether to enable the IP address filtering.

Parameter	Default Value	Description
ipFilter.rules	-	Specifies the rules of *N* network **ipFilters**. Host names or IP addresses must be separated by commas (,). If this parameter is set to **true**, there are two configuration rules: allow and forbidden. The configuration format is as follows: ipFilterRules=allow:ip:127.*, allow:name:localhost, deny:ip:*

- **SpoolDir Source**

  SpoolDir Source monitors and transmits new files that have been added to directories in real-time mode. Common configurations are as follows:

  Table 6-3 Common configurations of a Spooling Directory source

Parameter	Default Value	Description
channels	-	Specifies the channel connected to the source. Multiple channels can be configured.
type	spooldir	Specifies the type of the spooling source, which must be set to **spooldir**.
spoolDir	-	Specifies the monitoring directory of the Spooldir source. A Flume running user must have the read, write, and execution permissions on the directory.
monTime	0 (Disabled)	Specifies the thread monitoring threshold. When the update time exceeds the threshold, the source is restarted. Unit: second
fileSuffix	.COMPLETED	Specifies the suffix added after file transmission is complete.

Parameter	Default Value	Description
deletePolicy	never	Specifies the source file deletion policy after file transmission is complete. The value can be either **never** or **immediate**. **never** indicates that the source file is not deleted after file transmission is complete, while **immediate** indicates that the source file is immediately deleted after file transmission is complete.
ignorePattern	^$	Specifies the regular expression of a file to be ignored. The default value is ^$, indicating that spaces are ignored.
includePattern	^.*$	Specifies the regular expression that contains a file. This parameter can be used together with **ignorePattern**. If a file meets both **ignorePattern** and **includePattern**, the file is ignored. In addition, when a file starts with a period (.), the file will not be filtered.
trackerDir	.flumespool	Specifies the metadata storage path during data transmission.
batchSize	1000	Specifies the number of events written to the channel in batches.
decodeErrorPolicy	FAIL	Specifies the code error policy. **NOTE** If a code error occurs in the file, set **decodeErrorPolicy** to **REPLACE** or **IGNORE**. Flume will skip the code error and continue to collect subsequent logs.
deserializer	LINE	Specifies the file parser. The value can be either **LINE** or **BufferedLine**. ● When the value is set to **LINE**, characters read from the file are transcoded one by one. ● When the value is set to **BufferedLine**, one line or multiple lines of characters read from the file are transcoded in batches, which delivers better performance.
deserializer.maxLineLength	2048	Specifies the maximum length for resolution by line.

Parameter	Default Value	Description
deserializer.maxBatchLine	1	Specifies the maximum number of lines for resolution by line. If multiple lines are set, **maxLineLength** must be set to a corresponding multiplier. **NOTE** When configuring the Interceptor, take the multi-line combination into consideration to avoid data loss. If the Interceptor cannot process combined lines, set this parameter to **1**.
selector.type	replicating	Specifies the selector type. The value can be either **replicating** or **multiplexing**. **replicating** indicates that data is replicated and then transferred to each channel so that each channel receives the same data, while **multiplexing** indicates that a channel is selected based on the value of the header in the event and each channel has different data.
interceptors	-	Specifies the interceptor. Multiple interceptors are separated by spaces.
inputCharset	UTF-8	Specifies the encoding format of a read file. The encoding format must be the same as that of the data source file that has been read. Otherwise, an error may occur during character parsing.
fileHeader	false	Specifies whether to add the file name (including the file path) to the event header.
fileHeaderKey	-	Specifies that the data storage structure in header is set in the <key,value> mode. Parameters **fileHeaderKey** and **fileHeader** must be used together. Following is an example if **fileHeader** is set to true: Define **fileHeaderKey** as **file**. When the **/root/a.txt** file is read, **fileHeaderKey** exists in the header in the **file=/root/a.txt** format.
basenameHeader	false	Specifies whether to add the file name (excluding the file path) to the event header.

Parameter	Default Value	Description
basenameHeaderKey	-	Specifies that the data storage structure in header is set in the <key,value> mode. Parameters **basenameHeaderKey** and **basenameHeader** must be used together. Following is an example if **basenameHeader** is set to **true**: Define **basenameHeaderKey** as **file**. When the **a.txt** file is read, **fileHeaderKey** exists in the header in the **file=a.txt** format.
pollDelay	500	Specifies the delay for polling new files in the monitoring directory. Unit: milliseconds
recursiveDirectorySearch	false	Specifies whether to monitor new files in the subdirectory of the configured directory.
consumeOrder	oldest	Specifies the consumption order of files in a directory. If this parameter is set to **oldest** or **youngest**, the sequence of files to be read is determined by the last modification time of files in the monitored directory. If there are a large number of files in the directory, it takes a long time to search for **oldest** or **youngest** files. If this parameter is set to **random**, an earlier created file may not be read for a long time. If this parameter is set to **oldest** or **youngest**, it takes a long time to find the latest and the earliest file. The options are as follows: **random**, **youngest**, and **oldest**.
maxBackoff	4000	Specifies the maximum time to wait between consecutive attempts to write to a channel if the channel is full. If the time exceeds the threshold, an exception is thrown. The corresponding source starts to write at a smaller time value. Each time the source attempts, the digital exponent increases until the current specified value is reached. If data cannot be written, the data write fails. Unit: second
emptyFileEvent	true	Specifies whether to collect empty file information and send it to the sink end. The default value is **true**, indicating that empty file information is sent to the sink end. This parameter is valid only for HDFS Sink. Taking HDFS Sink as an example, if this parameter is set to **true** and an empty file exists in the **spoolDir** directory, an empty file with the same name will be created in the **hdfs.path** directory of HDFS.

NOTE

SpoolDir Source ignores the last line feed character of each event when data is reading by row. Therefore, Flume does not calculate the data volume counters used by the last line feed character.

- **Kafka Source**

  A Kafka source consumes data from Kafka topics. Multiple sources can consume data of the same topic, and the sources consume different partitions of the topic. Common configurations are as follows:

  Table 6-4 Common configurations of a Kafka source

Parameter	Default Value	Description
channels	-	Specifies the channel connected to the source. Multiple channels can be configured.
type	org.apache.flume.source.kafka.KafkaSource	Specifies the type of the Kafka source, which must be set to **org.apache.flume.source.kafka.KafkaSource**.
kafka.bootstrap.servers	-	Specifies the bootstrap address port list of Kafka. If Kafka has been installed in the cluster and the configuration has been synchronized to the server, you do not need to set this parameter on the server. The default value is the list of all brokers in the Kafka cluster. This parameter must be configured on the client. Use commas (,) to separate multiple values of *IP address:Port number*. The rules for matching ports and security protocols must be as follows: port 21007 matches the security mode (SASL_PLAINTEXT), and port 9092 matches the common mode (PLAINTEXT).
kafka.topics	-	Specifies the list of subscribed Kafka topics, which are separated by commas (,).
kafka.topics.regex	-	Specifies the subscribed topics that comply with regular expressions. **kafka.topics.regex** has a higher priority than **kafka.topics** and will overwrite **kafka.topics**.

Parameter	Default Value	Description
monTime	0 (Disabled)	Specifies the thread monitoring threshold. When the update time exceeds the threshold, the source is restarted. Unit: second
nodatatime	0 (Disabled)	Specifies the alarm threshold. An alarm is triggered when the duration that Kafka does not release data to subscribers exceeds the threshold. Unit: second This parameter can be configured in the **properties.properties** file.
batchSize	1000	Specifies the number of events written to the channel in batches.
batchDurationMillis	1000	Specifies the maximum duration of topic data consumption at a time, expressed in milliseconds.
keepTopicInHeader	false	Specifies whether to save topics in the event header. If the parameter value is **true**, topics configured in Kafka Sink become invalid.
setTopicHeader	true	If this parameter is set to **true**, the topic name defined in **topicHeader** is stored in the header.
topicHeader	topic	When **setTopicHeader** is set to **true**, this parameter specifies the name of the topic received by the storage device. If the property is used with that of Kafka Sink **topicHeader**, be careful not to send messages to the same topic cyclically.
useFlumeEventFormat	false	By default, an event is transferred from a Kafka topic to the body of the event in the form of bytes. If this parameter is set to **true**, the Avro binary format of Flume is used to read events. When used together with the **parseAsFlumeEvent** parameter with the same name in KafkaSink or KakfaChannel, any set **header** generated from the data source is retained.

Parameter	Default Value	Description
keepPartitionInHeader	false	Specifies whether to save partition IDs in the event header. If the parameter value is **true**, Kafka Sink writes data to the corresponding partition.
kafka.consumer.group.id	flume	Specifies the Kafka consumer group ID. Sources or proxies having the same ID are in the same consumer group.
kafka.security.protocol	SASL_PLAINTEXT	Specifies the Kafka security protocol. The parameter value must be set to PLAINTEXT in a common cluster. The rules for matching ports and security protocols must be as follows: port 21007 matches the security mode (SASL_PLAINTEXT), and port 9092 matches the common mode (PLAINTEXT).
Other Kafka Consumer Properties	-	Specifies other Kafka configurations. This parameter can be set to any consumption configuration supported by Kafka, and the **.kafka** prefix must be added to the configuration.

- **Taildir Source**

  A Taildir source monitors file changes in a directory and automatically reads the file content. In addition, it can transmit data in real time. Common configurations are as follows:

  Table 6-5 Common configurations of a Taildir source

Parameter	Default Value	Description
channels	-	Specifies the channel connected to the source. Multiple channels can be configured.
type	TAILDIR	Specifies the type of the taildir source, which must be set to TAILDIR.
filegroups	-	Specifies the group name of a collection file directory. Group names are separated by spaces.

Parameter	Default Value	Description
filegroups.<filegroupName>	-	Specifies the file path. The value must be an absolute path.
filegroups.<filegroupName>.parentDir	-	Specifies the parent directory. The value must be an absolute path.
filegroups.<filegroupName>.filePattern	-	Specifies the relative file path of the file group's parent directory. Directories can be included and regular expressions are supported. It must be used together with **parentDir**.
positionFile	-	Specifies the metadata storage path during data transmission.
headers.<filegroupName>.<headerKey>	-	Specifies the key-value of an event when data of a group is being collected.
byteOffsetHeader	false	Specifies whether each event header contains the event location information in the source file. If the parameter value is true, the location information is saved in the byteoffset variable.
maxBatchCount	Long.MAX_VALUE	Specifies the maximum number of batches that can be consecutively read from a file. If the monitored directory reads multiple files consecutively and one of the files is written at a rapid rate, other files may fail to be processed. This is because the file that is written at a high speed will be in an infinite read loop. In this case, set this parameter to a smaller value.
skipToEnd	false	Specifies whether Flume can locate the latest location of a file and read the latest data after restart. If the parameter value is true, Flume locates and reads the latest file data after restart.
idleTimeout	120000	Specifies the idle duration during file reading, expressed in milliseconds. If file content is not changed in the preset time duration, close the file. If data is written to this file after the file is closed, open the file and read data.

Parameter	Default Value	Description
writePosInterval	3000	Specifies the interval for writing metadata to a file, expressed in milliseconds.
batchSize	1000	Specifies the number of events written to the channel in batches.
monTime	0 (Disabled)	Specifies the thread monitoring threshold. When the update time exceeds the threshold, the source is restarted. Unit: second
fileHeader	false	Specifies whether to add the file name (including the file path) to the event header.
fileHeaderKey	file	Specifies that the data storage structure in header is set in the <key,value> mode. Parameters **fileHeaderKey** and **fileHeader** must be used together. Following is an example if **fileHeader** is set to true: Define **fileHeaderKey** as **file**. When the **/root/a.txt** file is read, **fileHeaderKey** exists in the header in the **file=/root/a.txt** format.

- **Http Source**

  An HTTP source receives data from an external HTTP client and sends the data to the configured channels. Common configurations are as follows:

  Table 6-6 Common configurations of an HTTP source

Parameter	Default Value	Description
channels	-	Specifies the channel connected to the source. Multiple channels can be configured.
type	http	Specifies the type of the http source, which must be set to http.
bind	-	Specifies the listening host name/IP address.
port	-	Specifies the bound listening port. Ensure that this port is not occupied.

Parameter	Default Value	Description
handler	org.apache.flume.source.http.JSONHandler	Specifies the message parsing method of an HTTP request. Two formats are supported: JSON (org.apache.flume.source.http.JSONHandler) and BLOB (org.apache.flume.sink.solr.morphline.BlobHandler).
handler.*	-	Specifies handler parameters.
exclude-protocols	SSLv3	Specifies the excluded protocols. The entered protocols must be separated by spaces. The default value is **SSLv3**.
include-cipher-suites	-	Specifies the included protocols. The entered protocols must be separated by spaces. If this parameter is left empty, all protocols are supported by default.
enableSSL	false	Specifies whether SSL is enabled in HTTP. If this parameter is set to **true**, **keystore** and **keystore-password** must be specified.
keystore-type	JKS	Specifies the keystore type, which can be **JKS** or **PKCS12**.
keystore	-	Specifies the keystore path set after SSL is enabled in HTTP.
keystorePassword	-	Specifies the keystore password set after SSL is enabled in HTTP.

- **Thrift Source**

  Thrift Source listens to the thrift port, receives data from the external Thrift clients, and puts the data into the configured channel. Common configurations are as follows:

Parameter	Default Value	Description
channels	-	Specifies the channel connected to the source. Multiple channels can be configured.
type	thrift	Specifies the type of the thrift source, which must be set to **thrift**.
bind	-	Specifies the listening host name/IP address.

Parameter	Default Value	Description
port	-	Specifies the bound listening port. Ensure that this port is not occupied.
threads	-	Specifies the maximum number of worker threads that can be run.
kerberos	false	Specifies whether Kerberos authentication is enabled.
agent-keytab	-	Specifies the address of the keytab file used by the server. The machine-machine account must be used. You are advised to use **flume/conf/flume_server.keytab** in the Flume service installation directory.
agent-principal	-	Specifies the principal of the security user used by the server. The principal must be a machine-machine account. You are advised to use the default user of Flume: flume_server/hadoop.*<system domain name>*@*<system domain name>* **NOTE** **flume_server/hadoop.**<*system domain name*> is the username. All letters in the system domain name contained in the username are lowercase letters. For example, **Local Domain** is set to **9427068F-6EFA-4833-B43E-60CB641E5B6C.COM**, and the username is **flume_server/hadoop.9427068f-6efa-4833-b43e-60cb641e5b6c.com**.
compression-type	none	Specifies the message compression format, which can be set to **none** or **deflate**. **none** indicates that data is not compressed, while **deflate** indicates that data is compressed.
ssl	false	Specifies whether to use SSL encryption. If this parameter is set to **true**, **keystore** and **keystore-password** must be specified.
keystore-type	JKS	Specifies the keystore type set after SSL is enabled.
keystore	-	Specifies the keystore file path set after SSL is enabled. This parameter is mandatory if SSL is enabled.
keystore-password	-	Specifies the keystore password set after SSL is enabled. This parameter is mandatory if SSL is enabled.

Parameter	Default Value	Description
truststore-type	JKS	Specifies the Java trust store type, which can be set to **JKS** or **PKCS12**. **NOTE** Different passwords are used to protect the key store and private key of **JKS**, while the same password is used to protect the key store and private key of **PKCS12**.
truststore	-	Specifies the Java trust store file.
truststore-password	-	Specifies the Java trust store password.

Common Channel Configurations

- **Memory Channel**

  A memory channel uses memory as the cache. Events are stored in memory queues. Common configurations are as follows:

  Table 6-7 Common configurations of a memory channel

Parameter	Default Value	Description
type	-	Specifies the type of the memory channel, which must be set to **memory**.
capacity	10000	Specifies the maximum number of events cached in a channel.
transactionCapacity	1000	Specifies the maximum number of events accessed each time. **NOTE** • The parameter value must be greater than the batchSize of the source and sink. • The value of **transactionCapacity** must be less than or equal to that of **capacity**.
channelfullcount	10	Specifies the channel full count. When the count reaches the threshold, an alarm is reported.

Parameter	Default Value	Description
keep-alive	3	Specifies the waiting time of the Put and Take threads when the transaction or channel cache is full. Unit: second
byteCapacity	80% of the maximum JVM memory	Specifies the total bytes of all event bodies in a channel. The default value is the 80% of the maximum JVM memory (indicated by **-Xmx**). Unit: bytes
byteCapacityBufferPercentage	20	Specifies the percentage of bytes in a channel (%).

- **File Channel**

  A file channel uses local disks as the cache. Events are stored in the folder specified by **dataDirs**. Common configurations are as follows:

  Table 6-8 Common configurations of a file channel

Parameter	Default Value	Description
type	-	Specifies the type of the file channel, which must be set to **file**.
checkpointDir	${BIGDATA_DATA_HOME}/hadoop/data1~N/flume/checkpoint **NOTE** This path is changed with the custom data path.	Specifies the checkpoint storage directory.
dataDirs	${BIGDATA_DATA_HOME}/hadoop/data1~N/flume/data **NOTE** This path is changed with the custom data path.	Specifies the data cache directory. Multiple directories can be configured to improve performance. The directories are separated by commas (,).
maxFileSize	2146435071	Specifies the maximum size of a single cache file, expressed in bytes.

Parameter	Default Value	Description
minimumRequiredSpace	524288000	Specifies the minimum idle space in the cache, expressed in bytes.
capacity	1000000	Specifies the maximum number of events cached in a channel.
transactionCapacity	10000	Specifies the maximum number of events accessed each time. **NOTE** • The parameter value must be greater than the batchSize of the source and sink. • The value of **transactionCapacity** must be less than or equal to that of **capacity**.
channelfullcount	10	Specifies the channel full count. When the count reaches the threshold, an alarm is reported.
useDualCheckpoints	false	Specifies the backup checkpoint. If this parameter is set to **true**, the **backupCheckpointDir** parameter value must be set.
backupCheckpointDir	-	Specifies the path of the backup checkpoint.
checkpointInterval	30000	Specifies the check interval, expressed in seconds.
keep-alive	3	Specifies the waiting time of the Put and Take threads when the transaction or channel cache is full. Unit: second
use-log-replay-v1	false	Specifies whether to enable the old reply logic.

Parameter	Default Value	Description
use-fast-replay	false	Specifies whether to enable the queue reply.
checkpointOnClose	true	Specifies that whether a checkpoint is created when a channel is disabled.

- **Memory File Channel**

  A memory file channel uses both memory and local disks as its cache and supports message persistence. It provides similar performance as a memory channel and better performance than a file channel. This channel is currently experimental and not recommended for use in production. The following table describes common configuration items: Common configurations are as follows:

  Table 6-9 Common configurations of a memory file channel

Parameter	Default Value	Description
type	org.apache.flume.channel.MemoryFileChannel	Specifies the type of the memory file channel, which must be set to **org.apache.flume.channel.MemoryFileChannel**.
capacity	50000	Specifies the maximum number of events cached in a channel.
transactionCapacity	5000	Specifies the maximum number of events processed by a transaction. **NOTE** • The parameter value must be greater than the batchSize of the source and sink. • The value of **transactionCapacity** must be less than or equal to that of **capacity**.

Parameter	Default Value	Description
subqueueByteCapacity	20971520	Specifies the maximum size of events that can be stored in a subqueue, expressed in bytes. A memory file channel uses both queues and subqueues to cache data. Events are stored in a subqueue, and subqueues are stored in a queue. **subqueueCapacity** and **subqueueInterval** determine the size of events that can be stored in a subqueue. **subqueueCapacity** specifies the capacity of a subqueue, and **subqueueInterval** specifies the duration that a subqueue can store events. Events in a subqueue are sent to the destination only after the subqueue reaches the upper limit of **subqueueCapacity** or **subqueueInterval**. **NOTE** The value of **subqueueByteCapacity** must be greater than the number of events specified by **batchSize**.
subqueueInterval	2000	Specifies the maximum duration that a subqueue can store events, expressed in milliseconds.
keep-alive	3	Specifies the waiting time of the Put and Take threads when the transaction or channel cache is full. Unit: second
dataDir	-	Specifies the cache directory for local files.
byteCapacity	80% of the maximum JVM memory	Specifies the channel cache capacity. Unit: bytes
compression-type	None	Specifies the message compression format, which can be set to **none** or **deflate**. **none** indicates that data is not compressed, while **deflate** indicates that data is compressed.
channelfullcount	10	Specifies the channel full count. When the count reaches the threshold, an alarm is reported.

The following is a configuration example of a memory file channel:

```
server.channels.c1.type = org.apache.flume.channel.MemoryFileChannel
server.channels.c1.dataDir = /opt/flume/mfdata
server.channels.c1.subqueueByteCapacity = 20971520
server.channels.c1.subqueueInterval=2000
server.channels.c1.capacity = 500000
server.channels.c1.transactionCapacity = 40000
```

- **Kafka Channel**

  A Kafka channel uses a Kafka cluster as the cache. Kafka provides high availability and multiple copies to prevent data from being immediately consumed by sinks when Flume or Kafka Broker crashes.

  Table 6-10 Common configurations of a Kafka channel

Parameter	Default Value	Description
type	-	Specifies the type of the Kafka channel, which must be set to **org.apache.flume.channel.kafka.KafkaChannel**.
kafka.bootstrap.servers	-	Specifies the bootstrap address port list of Kafka. If Kafka has been installed in the cluster and the configuration has been synchronized to the server, you do not need to set this parameter on the server. The default value is the list of all brokers in the Kafka cluster. This parameter must be configured on the client. Use commas (,) to separate multiple values of *IP address:Port number*. The rules for matching ports and security protocols must be as follows: port 21007 matches the security mode (SASL_PLAINTEXT), and port 9092 matches the common mode (PLAINTEXT).

Parameter	Default Value	Description
kafka.topic	flume-channel	Specifies the Kafka topic used by the channel to cache data.
kafka.consumer.group.id	flume	Specifies the data group ID obtained from Kafka. This parameter cannot be left blank.
parseAsFlumeEvent	true	Specifies whether data is parsed into Flume events.
migrateZookeeperOffsets	true	Specifies whether to search for offsets in ZooKeeper and submit them to Kafka when there is no offset in Kafka.
kafka.consumer.auto.offset.reset	latest	Specifies where to consume if there is no offset record, which can be set to **earliest**, **latest**, or **none**. **earliest** indicates that the offset is reset to the initial point, **latest** indicates that the offset is set to the latest position, and **none** indicates that an exception is thrown if there is no offset.

Parameter	Default Value	Description
kafka.producer.security.protocol	SASL_PLAINTEXT	Specifies the Kafka producer security protocol. The rules for matching ports and security protocols must be as follows: port 21007 matches the security mode (SASL_PLAINTEXT), and port 9092 matches the common mode (PLAINTEXT). **NOTE** If the parameter is not displayed, click **+** in the lower left corner of the dialog box to display all parameters.
kafka.consumer.security.protocol	SASL_PLAINTEXT	Specifies the Kafka consumer security protocol. The rules for matching ports and security protocols must be as follows: port 21007 matches the security mode (SASL_PLAINTEXT), and port 9092 matches the common mode (PLAINTEXT).
pollTimeout	500	Specifies the maximum timeout interval for the consumer to invoke the poll function. Unit: milliseconds
ignoreLongMessage	false	Specifies whether to discard oversized messages.
messageMaxLength	1000012	Specifies the maximum length of a message written by Flume to Kafka.

Common Sink Configurations

- **HDFS Sink**

  An HDFS sink writes data into HDFS. Common configurations are as follows:

Table 6-11 Common configurations of an HDFS sink

Parameter	Default Value	Description
channel	-	Specifies the channel connected to the sink.
type	hdfs	Specifies the type of the hdfs sink, which must be set to **hdfs**.
hdfs.path	-	Specifies the data storage path in HDFS. The value must start with **hdfs://hacluster/**.
monTime	0 (Disabled)	Specifies the thread monitoring threshold. When the update time exceeds the threshold, the sink is restarted. Unit: second
hdfs.inUseSuffix	.tmp	Specifies the suffix of the HDFS file to which data is being written.
hdfs.rollInterval	30	Specifies file rolling by time, in seconds. Set **hdfs.fileCloseByEndEvent** to **false** if you set this parameter.
hdfs.rollSize	1024	Specifies file rolling by size, in bytes. Set **hdfs.fileCloseByEndEvent** to **false** if you set this parameter.
hdfs.rollCount	10	Specifies file rolling by the number of events, set **hdfs.fileCloseByEndEvent** to **false** if you set this parameter. **NOTE** Parameters **rollInterval**, **rollSize**, and **rollCount** can be configured at the same time. The parameter meeting the requirements takes precedence for compression.
hdfs.idleTimeout	0	Specifies the timeout interval for closing idle files automatically, expressed in seconds.
hdfs.batchSize	1000	Specifies the number of events written into HDFS in batches.
hdfs.kerberosPrincipal	-	Specifies the Kerberos principal of HDFS authentication. This parameter is mandatory in a secure mode, but not required in a common mode.

Parameter	Default Value	Description
hdfs.kerberosKeytab	-	Specifies the Kerberos keytab of HDFS authentication. This parameter is not required in a common mode, but in a secure mode, the Flume running user must have the permission to access **keyTab** path in the **jaas.cof** file.
hdfs.fileCloseByEndEvent	true	Specifies whether to close the HDFS file when the last event of the source file is received.
hdfs.batchCallTimeout	-	Specifies the timeout control duration when events are written into HDFS in batches. Unit: milliseconds If this parameter is not specified, the timeout duration is controlled when each event is written into HDFS. When the value of **hdfs.batchSize** is greater than 0, configure this parameter to improve the performance of writing data into HDFS. **NOTE** The value of **hdfs.batchCallTimeout** depends on **hdfs.batchSize**. A greater **hdfs.batchSize** requires a larger **hdfs.batchCallTimeout**. If the value of **hdfs.batchCallTimeout** is too small, writing events to HDFS may fail.
serializer.appendNewline	true	Specifies whether to add a line feed character (**\n**) after an event is written to HDFS. If a line feed character is added, the data volume counters used by the line feed character will not be calculated by HDFS sinks.
hdfs.filePrefix	over_%{basename}	Specifies the file name prefix after data is written to HDFS.
hdfs.fileSuffix	-	Specifies the file name suffix after data is written to HDFS.
hdfs.inUsePrefix	-	Specifies the prefix of the HDFS file to which data is being written.

Parameter	Default Value	Description
hdfs.fileType	DataStream	Specifies the HDFS file format, which can be set to **SequenceFile**, **DataStream**, or **CompressedStream**. **NOTE** If the parameter is set to **SequenceFile** or **DataStream**, output files are not compressed, and the **codeC** parameter cannot be configured. However, if the parameter is set to **CompressedStream**, the output files are compressed, and the **codeC** parameter must be configured together.
hdfs.codeC	-	Specifies the file compression format, which can be set to **gzip**, **bzip2**, **lzo**, **lzop**, or **snappy**.
hdfs.maxOpenFiles	5000	Specifies the maximum number of HDFS files that can be opened. If the number of opened files reaches this value, the earliest opened files are closed.
hdfs.writeFormat	Writable	Specifies the file write format, which can be set to **Writable** or **Text**.
hdfs.callTimeout	10000	Specifies the timeout control duration each time events are written into HDFS, expressed in milliseconds.
hdfs.threadsPoolSize	-	Specifies the number of threads used by each HDFS sink for HDFS I/O operations.
hdfs.rollTimerPoolSize	-	Specifies the number of threads used by each HDFS sink to schedule the scheduled file rolling.
hdfs.round	false	Specifies whether to round off the timestamp value. If this parameter is set to true, all time-based escape sequences (except %t) are affected.
hdfs.roundUnit	second	Specifies the unit of the timestamp value that has been rounded off, which can be set to **second**, **minute**, or **hour**.
hdfs.useLocalTimeStamp	true	Specifies whether to enable the local timestamp. The recommended parameter value is **true**.

Parameter	Default Value	Description
hdfs.closeTries	0	Specifies the maximum attempts for the **hdfs sink** to stop renaming a file. If the parameter is set to the default value **0**, the sink does not stop renaming the file until the file is successfully renamed.
hdfs.retryInterval	180	Specifies the interval of request for closing the HDFS file, expressed in seconds. **NOTE** For each closing request, there are multiple RPCs working on the NameNode back and forth, which may make the NameNode overloaded if the parameter value is too small. Also, when the parameter is set to **0**, the Sink will not attempt to close the file, but opens the file or uses **.tmp** as the file name extension, if the first closing attempt fails.
hdfs.failcount	10	Specifies the number of times that data fails to be written to HDFS. If the number of times that the sink fails to write data to HDFS exceeds the parameter value, an alarm indicating abnormal data transmission is reported.

- **Avro Sink**

  An Avro sink converts events into Avro events and sends them to the listening ports of the hosts. Common configurations are as follows:

  Table 6-12 Common configurations of an Avro sink

Parameter	Default Value	Description
channel	-	Specifies the channel connected to the sink.
type	-	Specifies the type of the avro sink, which must be set to **avro**.
hostname	-	Specifies the bound host name or IP address.
port	-	Specifies the bound listening port. Ensure that this port is not occupied.

Parameter	Default Value	Description
batch-size	1000	Specifies the number of events sent in a batch.
client.type	DEFAULT	Specifies the client instance type. Set this parameter based on the communication protocol used by the configured model. The options are as follows: • **DEFAULT**: The client instance of the AvroRPC type is returned. • **OTHER**: NULL is returned. • **THRIFT**: The client instance of the Thrift RPC type is returned. • **DEFAULT_LOADBALANCING**: The client instance of the LoadBalancing RPC type is returned. • **DEFAULT_FAILOVER**: The client instance of the Failover RPC type is returned.
ssl	false	Specifies whether to use SSL encryption. If this parameter is set to **true**, **keystore** and **keystore-password** must be specified.
truststore-type	JKS	Specifies the Java trust store type, which can be set to **JKS** or **PKCS12**. **NOTE** Different passwords are used to protect the key store and private key of **JKS**, while the same password is used to protect the key store and private key of **PKCS12**.

Parameter	Default Value	Description
truststore	-	Specifies the Java trust store file.
truststore-password	-	Specifies the Java trust store password.
keystore-type	JKS	Specifies the keystore type set after SSL is enabled.
keystore	-	Specifies the keystore file path set after SSL is enabled. This parameter is mandatory if SSL is enabled.
keystore-password	-	Specifies the keystore password after SSL is enabled. This parameter is mandatory if SSL is enabled.
connect-timeout	20000	Specifies the timeout for the first connection, expressed in milliseconds.
request-timeout	20000	Specifies the maximum timeout for a request after the first request, expressed in milliseconds.
reset-connection-interval	0	Specifies the interval between a connection failure and a second connection, expressed in seconds. If the parameter is set to **0**, the system continuously attempts to perform a connection.

Parameter	Default Value	Description
compression-type	none	Specifies the compression type of the batch data, which can be set to **none** or **deflate**. **none** indicates that data is not compressed, while **deflate** indicates that data is compressed. This parameter value must be the same as that of the AvroSource compression-type.
compression-level	6	Specifies the compression level of batch data, which can be set to **1** to **9**. A larger value indicates a higher compression rate.
exclude-protocols	SSLv3	Specifies the excluded protocols. The entered protocols must be separated by spaces. The default value is **SSLv3**.

- **HBase Sink**

  An HBase sink writes data into HBase. Common configurations are as follows:

  Table 6-13 Common configurations of an HBase sink

Parameter	Default Value	Description
channel	-	Specifies the channel connected to the sink.
type	-	Specifies the type of the HBase sink, which must be set to **hbase**.
table	-	Specifies the HBase table name.
columnFamily	-	Specifies the HBase column family.
monTime	0 (Disabled)	Specifies the thread monitoring threshold. When the update time exceeds the threshold, the sink is restarted. Unit: second

Parameter	Default Value	Description
batchSize	1000	Specifies the number of events written into HBase in batches.
kerberosPrincipal	-	Specifies the Kerberos principal of HBase authentication. This parameter is mandatory in a secure mode, but not required in a common mode.
kerberosKeytab	-	Specifies the Kerberos keytab of HBase authentication. This parameter is not required in a common mode, but in a secure mode, the Flume running user must have the permission to access **keyTab** path in the **jaas.cof** file.
coalesceIncrements	true	Specifies whether to perform multiple operations on the same hbase cell in a same processing batch. Setting this parameter to **true** improves performance.

- **Kafka Sink**

  A Kafka sink writes data into Kafka. Common configurations are as follows:

  Table 6-14 Common configurations of a Kafka sink

Parameter	Default Value	Description
channel	-	Specifies the channel connected to the sink.
type	-	Specifies the type of the kafka sink, which must be set to **org.apache.flume.sink.kafka.KafkaSink**.

Parameter	Default Value	Description
kafka.bootstrap.servers	-	Specifies the bootstrap address port list of Kafka. If Kafka has been installed in the cluster and the configuration has been synchronized to the server, you do not need to set this parameter on the server. The default value is the list of all brokers in the Kafka cluster. The client must be configured with this parameter. If there are multiple values, use commas (,) to separate the values. The rules for matching ports and security protocols must be as follows: port 21007 matches the security mode (SASL_PLAINTEXT), and port 9092 matches the common mode (PLAINTEXT).
monTime	0 (Disabled)	Specifies the thread monitoring threshold. When the update time exceeds the threshold, the sink is restarted. Unit: second
kafka.producer.acks	1	Successful write is determined by the number of received acknowledgement messages about replicas. The value **0** indicates that no confirm message needs to be received, the value **1** indicates that the system is only waiting for only the acknowledgement information from a leader, and the value **-1** indicates that the system is waiting for the acknowledgement messages of all replicas. If this parameter is set to **-1**, data loss can be avoided in some leader failure scenarios.
kafka.topic	-	Specifies the topic to which data is written. This parameter is mandatory.
allowTopicOverride	false	Specifies whether to replace the topic configured in **kafka.topic** with the topic saved in Event Header.
flumeBatchSize	1000	Specifies the number of events written into Kafka in batches.

Parameter	Default Value	Description
kafka.security.protocol	SASL_PLAINTEXT	Specifies the Kafka security protocol. The parameter value must be set to PLAINTEXT in a common cluster. The rules for matching ports and security protocols must be as follows: port 21007 matches the security mode (SASL_PLAINTEXT), and port 9092 matches the common mode (PLAINTEXT).
ignoreLongMessage	false	Specifies whether to discard oversized messages.
messageMaxLength	1000012	Specifies the maximum length of a message written by Flume to Kafka.
defaultPartitionId	-	Specifies the ID of the Kafka partition to which the events of a channel are transferred. The **partitionIdHeader** value overwrites this parameter value. By default, if this parameter is left blank, events will be distributed by the Kafka Producer's partitioner (by a specified key or a partitioner customized by **kafka.partitioner.class**).
partitionIdHeader	-	When you set this parameter, the sink will take the value of the field named using the value of this property from the event header and send the message to the specified partition of the topic. If the value does not have a valid partition, **EventDeliveryException** is thrown. If the header value already exists, this setting overwrites the **defaultPartitionId** parameter.
Other Kafka Producer Properties	-	Specifies other Kafka configurations. This parameter can be set to any production configuration supported by Kafka, and the **.kafka** prefix must be added to the configuration.

- **Solr Sink**

  Solr Sink writes data to Apache Solr servers. Common configurations are as follows:

Table 6-15 Common configurations of a Solr sink

Parameter	Default Value	Description
channel	-	Specifies the channel connected to the sink.
type	-	Specifies the type of the solr sink, which must be set to **org.apache.flume.sink.solr.morphline.MorphlineSolrSink**.
morphlineFile	-	Specifies the morphline configuration file.
batchSize	1000	Specifies the number of events written to Solr in batches.
handlerClass	org.apache.flume.sink.solr.morphline.MorphlineHandlerImpl	Specifies the operation class. **org.apache.flume.sink.solr.morphline.MorphlineHandler** needs to be implemented.
kerberosPrincipal	-	Specifies the Kerberos principal of Solr authentication. This parameter is mandatory in a secure mode, but not required in a common mode.
kerberosKeytab	-	Specifies the Kerberos keytab of Solr authentication. This parameter is not required in a common mode, but in a secure mode, the Flume running user must have the permission to access **keyTab** path in the **jaas.cof** file.
batchDurationMillis	1000	Specifies the duration for storing data in a channel before the data is transmitted, expressed in milliseconds. **NOTE** The parameter (**batchSize** or **batchDurationMillis**) meeting the requirements takes precedence for transmission standards.

NOTE

Solr Sink can write data to Solr. When using Solr in the cluster, pay attention to the following:

Some Solr-related JAR packages need to be imported. In addition, use the related JAR packages of the Solr component in the cluster. Do not use the original JAR package with the same name on the Maven official website. After the **lib** packages of the Flume instance to be tested are replaced, restart the Flume instance for the JAR packages to take effect. The JAR files to be imported are as follows (the **lucene-*** and **solr-*** JAR files need to be copied from the lib directory with **solr-8.11.2** contained in the directory name of the Solr service in the cluster):

lucene-analyzers-common-8.11.2.jar

lucene-analyzers-kuromoji-8.11.2.jar

lucene-analyzers-phonetic-8.11.2.jar

lucene-backward-codecs-8.11.2.jar

lucene-classification-8.11.2.jar

lucene-codecs-8.11.2.jar

lucene-core-8.11.2.jar

lucene-expressions-8.11.2.jar

lucene-grouping-8.11.2.jar

lucene-highlighter-8.11.2.jar

lucene-join-8.11.2.jar

lucene-memory-8.11.2.jar

lucene-misc-8.11.2.jar

lucene-queries-8.11.2.jar

lucene-queryparser-8.11.2.jar

lucene-sandbox-8.11.2.jar

lucene-spatial-extras-8.11.2.jar

lucene-suggest-8.11.2.jar

httpmime-4.3.1.jar

noggit-0.5.jar

solr-cell-8.11.2.jar

solr-core-8.11.2.jar

solr-morphlines-core-8.11.2.jar

solr-solrj-8.11.2.jar

- **Thrift Sink**

  A Thrift sink converts events to Thrift events and sends them to the listening port of the configured host. Common configurations are as follows:

  Table 6-16 Common configurations of a Thrift sink

Parameter	Default Value	Description
channel	-	Specifies the channel connected to the sink.
type	thrift	Specifies the type of the thrift sink, which must be set to **thrift**.

Parameter	Default Value	Description
hostname	-	Specifies the bound host name or IP address.
port	-	Specifies the bound listening port. Ensure that this port is not occupied.
batch-size	1000	Specifies the number of events sent in a batch.
connect-timeout	20000	Specifies the timeout for the first connection, expressed in milliseconds.
request-timeout	20000	Specifies the maximum timeout for a request after the first request, expressed in milliseconds.
kerberos	false	Specifies whether Kerberos authentication is enabled.
client-keytab	-	Specifies the path of the client **keytab** file. The Flume running user must have the access permission on the authentication file.
client-principal	-	Specifies the principal of the security user used by the client.
server-principal	-	Specifies the principal of the security user used by the server.
compression-type	none	Specifies the compression type of data sent by Flume, which can be set to **none** or **deflate**. **none** indicates that data is not compressed, while **deflate** indicates that data is compressed.

Parameter	Default Value	Description
maxConnections	5	Specifies the maximum size of the connection pool for Flume to send data.
ssl	false	Specifies whether to use SSL encryption.
truststore-type	JKS	Specifies the Java trust store type.
truststore	-	Specifies the Java trust store file.
truststore-password	-	Specifies the Java trust store password.
reset-connection-interval	0	Specifies the interval between a connection failure and a second connection, expressed in seconds. If the parameter is set to **0**, the system continuously attempts to perform a connection.

Precautions

- What are the reliability measures of Flume?
  - Use the transaction mechanisms between Source and Channel as well as between Channel and Sink.
  - Sink Processor supports failover and load balancing. The following is an example of load balancing:

    ```
    server.sinkgroups=g1
    server.sinkgroups.g1.sinks=k1 k2
    server.sinkgroups.g1.processor.type=load_balance
    server.sinkgroups.g1.processor.backoff=true
    server.sinkgroups.g1.processor.selector=random
    ```
- What are the precautions for the aggregation and cascading of multiple Flume agents?
  - Avro or Thrift protocol can be used for cascading.
  - When the aggregation end contains multiple nodes, evenly distribute the agents and do not aggregate all agents on a single node.

6.8 Flume Configuration Parameter Description

Overview

This section describes how to configure the sources, channels, and sinks of Flume, and modify the configuration items of each module.

Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Flume**. On the displayed page, click the **Configuration Tool** tab, select and drag the source, channel, and sink to be used to the GUI on the right, and double-click them to configure corresponding parameters. Parameters such as **channels** and **type** are configured only in the client configuration file **properties.properties**, the path of which is *Flume client installation directory*/**fusioninsight-flume-***Flume version*/**conf/properties.properties**.

NOTE

You must input encrypted information for some configurations. For details on how to encrypt information, see **Using the Encryption Tool of the Flume Client**.

Common Source Configurations

- **Avro Source**

  Avro Source listens to the Avro port, receives data from the external Avro client, and puts the data into the configured channel. **Table 6-17** lists common configurations.

Table 6-17 Common configurations of an Avro source

Parameter	Default Value	Description
channels	-	Specifies the channel connected to the source. Multiple channels can be configured. Use spaces to separate them. In a single proxy process, sources and sinks are connected through channels. A source instance corresponds to multiple channels, but a sink instance corresponds only to one channel. The format is as follows: **<Agent >.sources.<Source>.channels = <channel1> <channel2> <channel3>...** **<Agent >.sinks.<Sink>.channels = <channel1>** This parameter can be configured only in the **properties.properties** file.
type	avro	Specifies the type, which is set to **avro**. The type of each source is a fixed value. This parameter can be configured only in the **properties.properties** file.
bind	-	Specifies the host name or IP address associated with the source.
port	-	Specifies the bound port number.
ssl	false	Specifies whether to use SSL encryption. • true • false
truststore-type	JKS	Specifies the Java trust store type. Set this parameter to **JKS** or other truststore types supported by Java.
truststore	-	Specifies the Java trust store file.
truststore-password	-	Specifies the Java trust store password.

Parameter	Default Value	Description
keystore-type	JKS	Specifies the key storage type. Set this parameter to **JKS** or other truststore types supported by Java.
keystore	-	Specifies the key storage file.
keystore-password	-	Specifies the key storage password.

- **SpoolDir Source**

  A SpoolDir source monitors and transmits new files that have been added to directories in quasi-real-time mode. Common configurations are as follows:

  Table 6-18 Common configurations of a SpoolDir source

Parameter	Default Value	Description
channels	-	Specifies the channel connected to the source. Multiple channels can be configured. This parameter can be configured only in the **properties.properties** file.
type	spooldir	Type, which is set to **spooldir**. This parameter can be configured only in the **properties.properties** file.
monTime	0 (Disabled)	Specifies the thread monitoring threshold. When the update time exceeds the threshold, the source is restarted. Unit: second
spoolDir	-	Specifies the monitoring directory.
fileSuffix	.COMPLETED	Specifies the suffix added after file transmission is complete.
deletePolicy	never	Specifies the source file deletion policy after file transmission is complete. The value can be either **never** or **immediate**.
ignorePattern	^$	Specifies the regular expression of a file to be ignored.
trackerDir	.flumespool	Specifies the metadata storage path during data transmission.

Parameter	Default Value	Description
batchSize	1000	Specifies the source transmission granularity.
decodeErrorPolicy	FAIL	Specifies the code error policy. This parameter can be configured only in the **properties.properties** file. The value can be **FAIL**, **REPLACE**, or **IGNORE**. **FAIL**: Generate an exception and fail the parsing. **REPLACE**: Replace the characters that cannot be identified with other characters, such as U+FFFD. **IGNORE**: Discard character strings that cannot be parsed. **NOTE** If a code error occurs in the file, set **decodeErrorPolicy** to **REPLACE** or **IGNORE**. Flume will skip the code error and continue to collect subsequent logs.
deserializer	LINE	Specifies the file parser. The value can be either **LINE** or **BufferedLine**. ● When the value is set to **LINE**, characters read from the file are transcoded one by one. ● When the value is set to **BufferedLine**, one line or multiple lines of characters read from the file are transcoded in batches, which delivers better performance.
deserializer.maxLineLength	2048	Specifies the maximum length for resolution by line, ranging from 0 to 2,147,483,647.
deserializer.maxBatchLine	1	Specifies the maximum number of lines for resolution by line. If multiple lines are set, **maxLineLength** must be set to a corresponding multiplier. For example, if **maxBatchLine** is set to **2**, **maxLineLength** is set to **4096** (2048 x 2).

Parameter	Default Value	Description
selector.type	replicating	Specifies the selector type. The value can be either **replicating** or **multiplexing**. • **replicating** indicates that the same content is sent to each channel. • **multiplexing** indicates that the content is sent only to certain channels according to the distribution rule.
interceptors	-	Specifies the interceptor. This parameter can be configured only in the **properties.properties** file.

NOTE

The Spooling source ignores the last line feed character of each event when data is read by line. Therefore, Flume does not calculate the data volume counters used by the last line feed character.

- **Kafka Source**

  A Kafka source consumes data from Kafka topics. Multiple sources can consume data of the same topic, and the sources consume different partitions of the topic. Common configurations are as follows:

  Table 6-19 Common configurations of a Kafka source

Parameter	Default Value	Description
channels	-	Specifies the channel connected to the source. Multiple channels can be configured. This parameter can be configured only in the **properties.properties** file.
type	org.apache.flume.source.kafka.KafkaSource	Specifies the type, which is set to **org.apache.flume.source.kafka.KafkaSource**. This parameter can be configured only in the **properties.properties** file.

Parameter	Default Value	Description
monTime	0 (Disabled)	Specifies the thread monitoring threshold. When the update time exceeds the threshold, the source is restarted. Unit: second
nodatatime	0 (Disabled)	Specifies the alarm threshold. An alarm is triggered when the duration that Kafka does not release data to subscribers exceeds the threshold. Unit: second
batchSize	1000	Specifies the number of events written into a channel at a time.
batchDurationMillis	1000	Specifies the maximum duration of topic data consumption at a time, expressed in milliseconds.
keepTopicInHeader	false	Specifies whether to save topics in the event header. If topics are saved, topics configured in Kafka sinks become invalid. ● true ● false This parameter can be configured only in the **properties.properties** file.
keepPartitionIn-Header	false	Specifies whether to save partition IDs in the event header. If partition IDs are saved, Kafka sinks write data to the corresponding partitions. ● true ● false This parameter can be set only in the properties.properties file.
kafka.bootstrap.servers	-	Specifies the list of Broker addresses, which are separated by commas.
kafka.consumer.group.id	-	Specifies the Kafka consumer group ID.
kafka.topics	-	Specifies the list of subscribed Kafka topics, which are separated by commas (,).

Parameter	Default Value	Description
kafka.topics.regex	-	Specifies the subscribed topics that comply with regular expressions. **kafka.topics.regex** has a higher priority than **kafka.topics** and will overwrite **kafka.topics**.
kafka.security.protocol	SASL_PLAINTEXT	Specifies the security protocol of Kafka. The value must be set to **PLAINTEXT** for clusters in which Kerberos authentication is disabled.
kafka.kerberos.domain.name	-	Specifies the value of **default_realm** of Kerberos in the Kafka cluster, which should be configured only for security clusters. This parameter can be set only in the properties.properties file.
Other Kafka Consumer Properties	-	Specifies other Kafka configurations. This parameter can be set to any consumption configuration supported by Kafka, and the **.kafka** prefix must be added to the configuration. This parameter can be set only in the properties.properties file.

- **Taildir Source**

  A Taildir source monitors file changes in a directory and automatically reads the file content. In addition, it can transmit data in real time. **Table 6-20** lists common configurations.

  Table 6-20 Common configurations of a Taildir source

Parameter	Default Value	Description
channels	-	Specifies the channel connected to the source. Multiple channels can be configured. This parameter can be set only in the properties.properties file.
type	taildir	Specifies the type, which is set to **taildir**. This parameter can be set only in the properties.properties file.

Parameter	Default Value	Description
filegroups	-	Specifies the group name of a collection file directory. Group names are separated by spaces.
filegroups.<filegroupName>	-	Specifies the file path. The value must be an absolute path.
filegroups.<filegroupName>.parentDir	-	Specifies the parent directory. The value must be an absolute path. This parameter can be set only in the properties.properties file.
filegroups.<filegroupName>.filePattern	-	Specifies the relative file path of the file group's parent directory. Directories can be included and regular expressions are supported. It must be used together with **parentDir**. This parameter can be set only in the properties.properties file.
positionFile	-	Specifies the metadata storage path during data transmission.
headers.<filegroupName>.<headerKey>	-	Specifies the key-value of an event when data of a group is being collected. This parameter can be set only in the properties.properties file.
byteOffsetHeader	false	Specifies whether each event header should contain the location information about the event in the source file. The location information is saved in the **byteoffset** variable.
skipToEnd	false	Specifies whether Flume can locate the latest location of a file and read the latest data after restart.
idleTimeout	120000	Specifies the idle duration during file reading, expressed in milliseconds. If the file data is not changed in this idle period, the source closes the file. If data is written into this file after it is closed, the source opens the file and reads data.
writePosInterval	3000	Specifies the interval for writing metadata to a file, expressed in milliseconds.

Parameter	Default Value	Description
batchSize	1000	Specifies the number of events written to the channel in batches.
monTime	0 (Disabled)	Specifies the thread monitoring threshold. When the update time exceeds the threshold, the source is restarted. Unit: second

- **Http Source**

  An HTTP source receives data from an external HTTP client and sends the data to the configured channels. **Table 6-21** lists common configurations.

  Table 6-21 Common configurations of an HTTP source

Parameter	Default Value	Description
channels	-	Specifies the channel connected to the source. Multiple channels can be configured. This parameter can be set only in the properties.properties file.
type	http	Specifies the type, which is set to **http**. This parameter can be set only in the properties.properties file.
bind	-	Specifies the name or IP address of the bound host.
port	-	Specifies the bound port.
handler	org.apache.flume.source.http.JSONHandler	Specifies the message parsing method of an HTTP request. The following methods are supported: • **org.apache.flume.source.http.JSONHandler**: JSON • **org.apache.flume.sink.solr.morphline.BlobHandler**: BLOB
handler.*	-	Specifies handler parameters.
enableSSL	false	Specifies whether SSL is enabled in HTTP.
keystore	-	Specifies the keystore path set after SSL is enabled in HTTP.
keystorePassword	-	Specifies the keystore password set after SSL is enabled in HTTP.

Common Channel Configurations

- **Memory Channel**

  A memory channel uses memory as the cache. Events are stored in memory queues. Table 6-22 lists common configurations.

  Table 6-22 Common configurations of a memory channel

Parameter	Default Value	Description
type	-	Specifies the type, which is set to **memory**. This parameter can be set only in the properties.properties file.
capacity	10000	Specifies the maximum number of events cached in a channel.
transactionCapacity	1000	Specifies the maximum number of events accessed each time.
channelfullcount	10	Specifies the channel full count. When the count reaches the threshold, an alarm is reported.

- **File Channel**

  A file channel uses local disks as the cache. Events are stored in the folder specified by **dataDirs**. Table 6-23 lists common configurations.

  Table 6-23 Common configurations of a file channel

Parameter	Default Value	Description
type	-	Specifies the type, which is set to **file**. This parameter can be set only in the properties.properties file.
checkpointDir	${BIGDATA_DATA_HOME}/flume/checkpoint	Specifies the checkpoint storage directory.
dataDirs	${BIGDATA_DATA_HOME}/flume/data	Specifies the data cache directory. Multiple directories can be configured to improve performance. The directories are separated by commas (,).
maxFileSize	2146435071	Specifies the maximum size of a single cache file, expressed in bytes.

Parameter	Default Value	Description
minimumRequired-Space	524288000	Specifies the minimum idle space in the cache, expressed in bytes.
capacity	1000000	Specifies the maximum number of events cached in a channel.
transactionCapacity	10000	Specifies the maximum number of events accessed each time.
channelfullcount	10	Specifies the channel full count. When the count reaches the threshold, an alarm is reported.

- **Kafka Channel**

  A Kafka channel uses a Kafka cluster as the cache. Kafka provides high availability and multiple copies to prevent data from being immediately consumed by sinks when Flume or Kafka Broker crashes. **Table 10 Common configurations of a Kafka channel** lists common configurations.

  Table 6-24 Common configurations of a Kafka channel

Parameter	Default Value	Description
type	-	Specifies the type, which is set to **org.apache.flume.channel.kafka.KafkaChannel**. This parameter can be set only in the properties.properties file.
kafka.bootstrap.servers	-	Specifies the list of Brokers in the Kafka cluster.
kafka.topic	flume-channel	Specifies the Kafka topic used by the channel to cache data.
kafka.consumer.group.id	flume	Specifies the Kafka consumer group ID.
parseAsFlumeEvent	true	Specifies whether data is parsed into Flume events.
migrateZookeeper-Offsets	true	Specifies whether to search for offsets in ZooKeeper and submit them to Kafka when there is no offset in Kafka.
kafka.consumer.auto.offset.reset	latest	Consumes data from the specified location when there is no offset.

Parameter	Default Value	Description
kafka.producer.security.protocol	SASL_PLAINTEXT	Specifies the Kafka producer security protocol.
kafka.consumer.security.protocol	SASL_PLAINTEXT	Specifies the Kafka consumer security protocol.

Common Sink Configurations

- **HDFS Sink**

  An HDFS sink writes data into HDFS. **Table 6-25** lists common configurations.

  Table 6-25 Common configurations of an HDFS sink

Parameter	Default Value	Description
channel	-	Specifies the channel connected to the sink. This parameter can be set only in the properties.properties file.
type	hdfs	Specifies the type, which is set to **hdfs**. This parameter can be set only in the properties.properties file.
monTime	0 (Disabled)	Specifies the thread monitoring threshold. When the update time exceeds the threshold, the sink is restarted. Unit: second
hdfs.path	-	Specifies the HDFS path.
hdfs.inUseSuffix	.tmp	Specifies the suffix of the HDFS file to which data is being written.
hdfs.rollInterval	30	Specifies file rolling by time, in seconds. Set **hdfs.fileCloseByEndEvent** to **false** if you set this parameter.
hdfs.rollSize	1024	Specifies file rolling by size, in bytes. Set **hdfs.fileCloseByEndEvent** to **false** if you set this parameter.
hdfs.rollCount	10	Specifies file rolling by the number of events, set **hdfs.fileCloseByEndEvent** to **false** if you set this parameter.
hdfs.idleTimeout	0	Specifies the timeout interval for closing idle files automatically, expressed in seconds.

Parameter	Default Value	Description
hdfs.batchSize	1000	Specifies the number of events written into HDFS at a time.
hdfs.kerberosPrincipal	-	Specifies the Kerberos username for HDFS authentication. This parameter is not required for a cluster in which Kerberos authentication is disabled.
hdfs.kerberosKeytab	-	Specifies the Kerberos keytab of HDFS authentication. This parameter is not required for a cluster in which Kerberos authentication is disabled.
hdfs.fileCloseByEndEvent	true	Specifies whether to close the file when the last event is received.
hdfs.batchCallTimeout	-	Specifies the timeout control duration each time events are written into HDFS, expressed in milliseconds. If this parameter is not specified, the timeout duration is controlled when each event is written into HDFS. When the value of **hdfs.batchSize** is greater than 0, configure this parameter to improve the performance of writing data into HDFS. **NOTE** The value of **hdfs.batchCallTimeout** depends on **hdfs.batchSize**. A greater **hdfs.batchSize** requires a larger **hdfs.batchCallTimeout**. If the value of **hdfs.batchCallTimeout** is too small, writing events to HDFS may fail.
serializer.appendNewline	true	Specifies whether to add a line feed character (**\n**) after an event is written to HDFS. If a line feed character is added, the data volume counters used by the line feed character will not be calculated by HDFS sinks.

- **Avro Sink**

  An Avro sink converts events into Avro events and sends them to the listening ports of the hosts. **Table 6-26** lists common configurations.

Table 6-26 Common configurations of an Avro sink

Parameter	Default Value	Description
channel	-	Specifies the channel connected to the sink. This parameter can be set only in the properties.properties file.
type	-	Specifies the type, which is set to **avro**. This parameter can be set only in the properties.properties file.
hostname	-	Specifies the name or IP address of the bound host.
port	-	Specifies the listening port.
batch-size	1000	Specifies the number of events sent in a batch.
ssl	false	Specifies whether to use SSL encryption.
truststore-type	JKS	Specifies the Java trust store type.
truststore	-	Specifies the Java trust store file.
truststore-password	-	Specifies the Java trust store password.
keystore-type	JKS	Specifies the key storage type.
keystore	-	Specifies the key storage file.
keystore-password	-	Specifies the key storage password.

- **HBase Sink**

  An HBase sink writes data into HBase. **Table 6-27** lists common configurations.

  Table 6-27 Common configurations of an HBase sink

Parameter	Default Value	Description
channel	-	Specifies the channel connected to the sink. This parameter can be set only in the properties.properties file.
type	-	Specifies the type, which is set to **hbase**. This parameter can be set only in the properties.properties file.
table	-	Specifies the HBase table name.

Parameter	Default Value	Description
monTime	0 (Disabled)	Specifies the thread monitoring threshold. When the update time exceeds the threshold, the sink is restarted. Unit: second
columnFamily	-	Specifies the HBase column family.
batchSize	1000	Specifies the number of events written into HBase at a time.
kerberosPrincipal	-	Specifies the Kerberos username for HBase authentication. This parameter is not required for a cluster in which Kerberos authentication is disabled.
kerberosKeytab	-	Specifies the Kerberos keytab of HBase authentication. This parameter is not required for a cluster in which Kerberos authentication is disabled.

- **Kafka Sink**

  A Kafka sink writes data into Kafka. **Table 6-28** lists common configurations.

  Table 6-28 Common configurations of a Kafka sink

Parameter	Default Value	Description
channel	-	Specifies the channel connected to the sink. This parameter can be set only in the properties.properties file.
type	-	Specifies the type, which is set to **org.apache.flume.sink.kafka.KafkaSink**. This parameter can be set only in the properties.properties file.
kafka.bootstrap.servers	-	Specifies the list of Kafka Brokers, which are separated by commas.
monTime	0 (Disabled)	Specifies the thread monitoring threshold. When the update time exceeds the threshold, the sink is restarted. Unit: second
kafka.topic	default-flume-topic	Specifies the topic where data is written.

Parameter	Default Value	Description
allowTopicOverride	false	Specifies whether to replace the topic configured in **kafka.topic** with the topic saved in Event Header.
flumeBatchSize	1000	Specifies the number of events written into Kafka at a time.
kafka.security.protocol	SASL_PLAINTEXT	Specifies the security protocol of Kafka. The value must be set to **PLAINTEXT** for clusters in which Kerberos authentication is disabled.
kafka.kerberos.domain.name	-	Specifies the Kafka domain name. This parameter is mandatory for a security cluster. This parameter can be set only in the properties.properties file.
Other Kafka Producer Properties	-	Specifies other Kafka configurations. This parameter can be set to any production configuration supported by Kafka, and the **.kafka** prefix must be added to the configuration. This parameter can be set only in the properties.properties file.

6.9 Using Environment Variables in the properties.properties File

Scenario

This section describes how to use environment variables in the **properties.properties** configuration file.

Prerequisites

The Flume service is running properly and the Flume client has been installed.

Procedure

Step 1 Log in to the node where the Flume client is installed as user **root**.

Step 2 Switch to the following directory:

cd *Flume client installation directory*/**fusioninsight-flume**-*Flume component version*/**conf**

Step 3 Add environment variables to the **flume-env.sh** file in the directory.

- Format:
  export *Variable name*=*Variable value*
- Example:
  JAVA_OPTS="-Xms2G -Xmx4G -XX:CMSFullGCsBeforeCompaction=1 -XX:+UseConcMarkSweepGC -XX:+CMSParallelRemarkEnabled -XX:+UseCMSCompactAtFullCollection -DpropertiesImplementation=org.apache.flume.node.EnvVarResolverProperties"
  export *TAILDIR_PATH=/tmp/flumetest/201907/20190703/1/.*log.**

Step 4 Restart the Flume instance process.

1. Log in to FusionInsight Manager.
2. Choose **Cluster** > **Services** > **Flume**. On the page that is displayed, click the **Instance** tab, select all Flume instances, and choose **More** > **Restart Instance**. In the displayed **Verify Identity** dialog box, enter the password, and click **OK**.

NOTICE

Do not restart the Flume service on FusionInsight Manager after **flume-env.sh** takes effect on the server. Otherwise, the user-defined environment variables will lost. You only need to restart the corresponding instances on FusionInsight Manager.

Step 5 In the *Flume client installation directory*/**fusioninsight-flume-***Flume component version number*/**conf/properties.properties** configuration file, reference variables in the **${***Variable name***}** format. The following is an example:

```
client.sources.s1.type = TAILDIR
client.sources.s1.filegroups = f1
client.sources.s1.filegroups.f1 = ${TAILDIR_PATH}
client.sources.s1.positionFile = /tmp/flumetest/201907/20190703/1/taildir_position.json
client.sources.s1.channels = c1
```

NOTICE

- Ensure that **flume-env.sh** takes effect before you go to **Step 5** to configure the **properties.properties** file.
- If you configure file on the local host, upload the file on FusionInsight Manager by performing the following steps. The user-defined environment variables may be lost if the operations are not performed in the correct sequence.
  1. Log in to FusionInsight Manager.
  2. Choose **Cluster** > **Services** > **Flume**. On the page that is displayed, click the **Configurations** tab, select the Flume instance, and click **Upload File** next to **flume.config.file** to upload the **properties.properties** file.

----End

6.10 Non-Encrypted Transmission

6.10.1 Configuring Non-encrypted Transmission

Scenario

This section describes how to configure Flume server and client parameters after the cluster and the Flume service are installed to ensure proper running of the service.

NOTE

By default, the cluster network environment is secure and the SSL authentication is not enabled during the data transmission process. For details about how to use the encryption mode, see **Configuring the Encrypted Transmission**.

Prerequisites

- The Flume client has been installed. For details about how to install the Flume client, see "Using Flume" > "Installing the Flume Client" in *MapReduce Service Component Operation Guide*.
- The cluster and Flume service have been installed.
- The network environment of the cluster is secure.

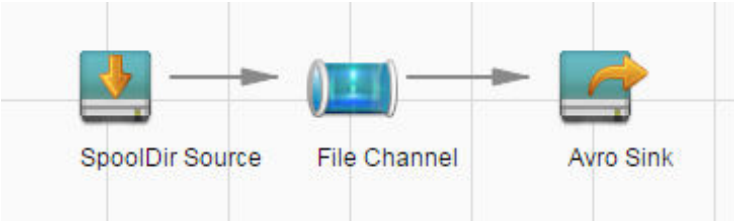
Procedure

Step 1 Configure the client parameters of the Flume role.

1. Use the Flume configuration tool on FusionInsight Manager to configure the Flume role client parameters and generate a configuration file.
   a. Log in to FusionInsight Manager. Choose **Cluster** > **Services** > **Flume** > **Configuration Tool**.
   b. Set **Agent Name** to **client**. Select and drag the source, channel, and sink to be used to the GUI on the right, and connect them.

      For example, use SpoolDir Source, File Channel, and Avro Sink, as shown in **Figure 6-2**.

      Figure 6-2 Example for the Flume configuration tool

   c. Double-click the source, channel, and sink. Set corresponding configuration parameters by referring to **Table 6-29** based on the actual environment.

NOTE

- If the client parameters of the Flume role have been configured, you can obtain the existing client parameter configuration file from *client installation directory*/**fusioninsight-flume-***Flume component version*/**conf/** properties.properties to ensure that the configuration is in concordance with the previous. Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Flume**. Click **Configurations**, click **Import**, import the file, and modify the configuration items related to non-encrypted transmission.
- It is recommended that the numbers of Sources, Channels, and Sinks do not exceed 40 during configuration file import. Otherwise, the response time may be very long.

Table 6-29 Parameters to be modified for the Flume role client

Parameter	Description	Example Value
ssl	Specifies whether to enable the SSL authentication. (You are advised to enable this function to ensure security.) Only Sources of the Avro type have this configuration item. ■ **true** indicates that the function is enabled. ■ **false** indicates that the function is not enabled.	false

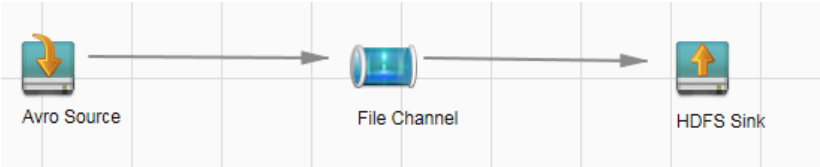
d. Click **Export** to save the **properties.properties** configuration file to the local server.

2. Upload the **properties.properties** file to **flume/conf/** under the installation directory of the Flume client.

Step 2 Configure the server parameters of the Flume role and upload the configuration file to the cluster.

1. Use the Flume configuration tool on the FusionInsight Manager portal to configure the server parameters and generate the configuration file.
   a. Log in to FusionInsight Manager. Choose **Cluster** > **Services** > **Flume** > **Configuration Tool**.
   b. Set **Agent Name** to **server**. Select and drag the source, channel, and sink to be used to the GUI on the right, and connect them.
      For example, use Avro Source, File Channel, and HDFS Sink, as shown in **Figure 6-3**.

Figure 6-3 Example for the Flume configuration tool



c. Double-click the source, channel, and sink. Set corresponding configuration parameters by referring to **Table 6-30** based on the actual environment.

NOTE

- If the server parameters of the Flume role have been configured, you can choose **Cluster** > **Services** > **Flume** > **Instance** on FusionInsight Manager. Then select the corresponding Flume role instance and click the **Download** button behind the **flume.config.file** parameter on the **Instance Configurations** page to obtain the existing server parameter configuration file. Choose **Cluster** > **Service** > **Flume** > **Configurations** > **Import**, import the file, and modify the configuration items related to non-encrypted transmission.
- It is recommended that the numbers of Sources, Channels, and Sinks do not exceed 40 during configuration file import. Otherwise, the response time may be very long.
- A unique checkpoint directory needs to be configured for each File Channel.

Table 6-30 Parameters to be modified for the Flume role server

Parameter	Description	Example Value
ssl	Specifies whether to enable the SSL authentication. (You are advised to enable this function to ensure security.) Only Sources of the Avro type have this configuration item. ■ **true** indicates that the function is enabled. ■ **false** indicates that the function is not enabled.	false

d. Click **Export** to save the **properties.properties** configuration file to the local server.

2. Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Flume**. On the **Instances** tab page, click **Flume**.
3. Select the Flume role of the node where the configuration file is to be uploaded, choose **Instance Configurations** > **Import** beside the **flume.config.file**, and select the **properties.properties** file.

NOTE

- An independent server configuration file can be uploaded to each Flume instance.
- This step is required for updating the configuration file. Modifying the configuration file on the background is an improper operation because the modification will be overwritten after configuration synchronization.

4. Click **Save**, and then click **OK**.
5. Click **Finish**.

----End

6.10.2 Typical Scenario: Collecting Local Static Logs and Uploading Them to Kafka

Scenario

This section describes how to use the Flume server to collect static logs from a local host and save them to the topic list (test1) of Kafka.

NOTE

By default, the cluster network environment is secure and the SSL authentication is not enabled during the data transmission process. For details about how to use the encryption mode, see **Configuring the Encrypted Transmission**. The configuration applies to scenarios where only the Flume is configured, for example, Spooldir Source+Memory Channel+Kafka Sink.

Prerequisites

- The cluster has been installed, including the Kafka and Flume services.
- The network environment of the cluster is secure.
- The MRS cluster administrator has understood service requirements and prepared Kafka administrator **flume_kafka**.

Procedure

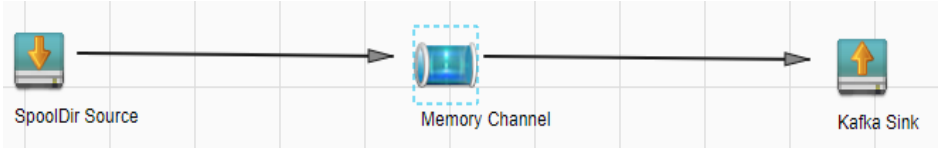
Step 1 Set Flume parameters.

Use the Flume configuration tool on Manager to configure the Flume role server parameters and generate a configuration file.

1. Log in to FusionInsight Manager. Choose **Cluster** > **Services** > **Flume** > **Configuration Tool**.
2. Set **Agent Name** to **server**. Select the source, channel, and sink to be used, drag them to the GUI on the right, and connect them.

   Use SpoolDir Source, Memory Channel, and Kafka Sink.

   Figure 6-4 Example for the Flume configuration tool



3. Double-click the source, channel, and sink. Set corresponding configuration parameters by referring to **Table 6-31** based on the actual environment.

   NOTE

   - If you want to continue using the **properties.propretites** file by modifying it, log in to FusionInsight Manager, choose **Cluster** > **Services**. On the page that is displayed, choose **Flume**. On the displayed page, click the **Configuration Tool** tab, click **Import**, import the file, and modify the configuration items related to non-encrypted transmission.
   - It is recommended that the numbers of Sources, Channels, and Sinks do not exceed 40 during configuration file import. Otherwise, the response time may be very long.

   Table 6-31 Parameters to be modified for the Flume role server

Parameter	Description	Example Value
Name	The value must be unique and cannot be left blank.	test
spoolDir	Specifies the directory where the file to be collected resides. This parameter cannot be left blank. The directory needs to exist and have the write, read, and execute permissions on the flume running user.	/srv/BigData/hadoop/data1/zb
trackerDir	Specifies the path for storing the metadata of files collected by Flume.	/srv/BigData/hadoop/data1/tracker
batchSize	Specifies the number of events that Flume sends in a batch (number of data pieces). A larger value indicates higher performance and lower timeliness.	61200
kafka.topics	Specifies the list of subscribed Kafka topics, which are separated by commas (,). This parameter cannot be left blank.	test1
kafka.bootstrap.servers	Specifies the bootstrap IP address and port list of Kafka. The default value is all Kafkabrokers in the Kafka cluster.	192.168.101.10:21007

4. Click **Export** to save the **properties.properties** configuration file to the local server.

Step 2 Upload the configuration file.

Upload the file exported in **Step 1.4** to the **flume/conf** directory of the cluster. For details, see **Step 2.2**.

Step 3 Verify log transmission.

1. Log in to the Kafka client.

   cd *Kafka client installation directory*/**Kafka/kafka**

   kinit flume_kafka (Enter the password.)

2. Read data from Kafka topics.

   bin/kafka-console-consumer.sh --topic *topic name* **--bootstrap-server** *Kafka service IP address of the node where the role instance is located*: **21007 --consumer.config config/consumer.properties --from-beginning**

   The system displays the contents of the file to be collected.

   ```
   [root@host1 kafka]# bin/kafka-console-consumer.sh --topic test1 --bootstrap-server 192.168.101.10:21007 --consumer.config config/consumer.properties --from-beginning
   Welcome to flume
   ```

----End

6.10.3 Typical Scenario: Collecting Local Static Logs and Uploading Them to HDFS

Scenario

This section describes how to use the Flume server to collect static logs from a local host and save them to the **/flume/test** directory on HDFS.

NOTE

By default, the cluster network environment is secure and the SSL authentication is not enabled during the data transmission process. For details about how to use the encryption mode, see **Configuring the Encrypted Transmission**. The configuration applies to scenarios where only the Flume is configured, for example, Spooldir Source+Memory Channel+HDFS Sink.

Prerequisites

- The cluster has been installed, including the HDFS and Flume services.
- The network environment of the cluster is secure.
- User **flume_hdfs** has been created, and the HDFS directory and data used for log verification have been authorized to the user.

Procedure

Step 1 On FusionInsight Manager, choose **System** > **Permission** > **User**, select user **flume_hdfs**, and choose **More** > **Download Authentication Credential** to download the Kerberos certificate file of user **flume_hdfs** and save it to the local host.

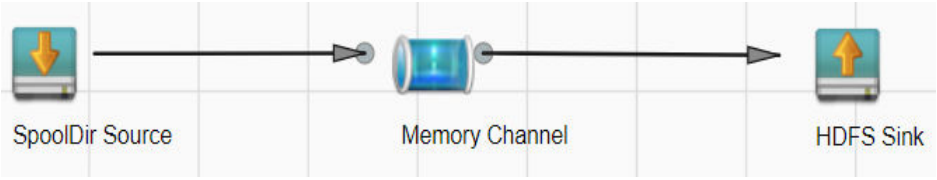
Step 2 Set Flume parameters.

Use Flume on FusionInsight Manager to configure the Flume role server parameters and generate a configuration file.

1. Log in to FusionInsight Manager. Choose **Cluster** > **Services** > **Flume** > **Configuration Tool**.
2. Set **Agent Name** to **server**. Select the source, channel, and sink to be used, drag them to the GUI on the right, and connect them.

   Use SpoolDir Source, Memory Channel, and HDFS Sink.

   Figure 6-5 Example for the Flume configuration tool

3. Double-click the source, channel, and sink. Set corresponding configuration parameters by referring to **Table 6-32** based on the actual environment.

   NOTE

   - If you want to continue using the **properties.propretites** file by modifying it, log in to FusionInsight Manager, choose **Cluster** > *Name of the desired cluster* > **Services**. On the page that is displayed, choose **Flume**. On the displayed page, click the **Configuration Tool** tab, click **Import**, import the file, and modify the configuration items related to non-encrypted transmission.
   - It is recommended that the numbers of Sources, Channels, and Sinks do not exceed 40 during configuration file import. Otherwise, the response time may be very long.

Table 6-32 Parameters to be modified for the Flume role server

Parameter	Description	Example Value
Name	The value must be unique and cannot be left blank.	test
spoolDir	Specifies the directory where the file to be collected resides. This parameter cannot be left blank. The directory needs to exist and have the write, read, and execute permissions on the flume running user.	/srv/BigData/hadoop/data1/zb
trackerDir	Specifies the path for storing the metadata of files collected by Flume.	/srv/BigData/hadoop/data1/tracker
batchSize	Specifies the number of events that Flume sends in a batch.	61200

Parameter	Description	Example Value
hdfs.path	Specifies the HDFS data write directory. This parameter cannot be left blank.	hdfs://hacluster/flume/test
hdfs.filePrefix	Specifies the file name prefix after data is written to HDFS.	TMP_
hdfs.batchSize	Specifies the maximum number of events that can be written to HDFS once.	61200
hdfs.kerberosPrincipal	Specifies the Kerberos authentication user, which is mandatory in security versions. This configuration is required only in security clusters.	flume_hdfs
hdfs.kerberosKeytab	Specifies the keytab file path for Kerberos authentication, which is mandatory in security versions. This configuration is required only in security clusters.	/opt/test/conf/user.keytab **NOTE** Obtain the **user.keytab** file from the Kerberos certificate file of the user **flume_hdfs**. In addition, ensure that the user who installs and runs the Flume client has the read and write permissions on the **user.keytab** file.
hdfs.useLocalTimeStamp	Specifies whether to use the local time. Possible values are **true** and **false**.	true

4. Click **Export** to save the **properties.properties** configuration file to the local.

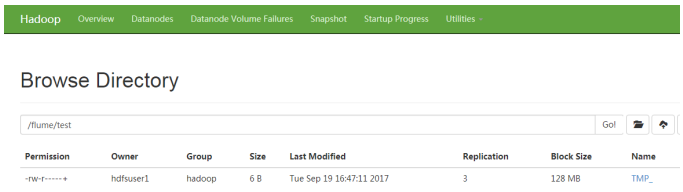
Step 3 Upload the configuration file.

Upload the file exported in **Step 2.4** to the **flume/conf** directory of the cluster. For details, see **Step 2.2**.

Step 4 Verify log transmission.

1. Log in to FusionInsight Manager as a user who has the management permission on HDFS. Choose **Cluster** > **Services** > **HDFS**. On the page that is displayed, click the **NameNode(***Node name***,Active)** link next to **NameNode WebUI** to go to the HDFS web UI. On the displayed page, choose **Utilities** > **Browse the file system**.
2. Check whether the data is generated in the **/flume/test** directory on the HDFS.

Figure 6-6 Checking HDFS directories and files



----End

6.10.4 Typical Scenario: Collecting Local Dynamic Logs and Uploading Them to HDFS

Scenario

This section describes how to use the Flume server to collect dynamic logs from a local host and save them to the **/flume/test** directory on HDFS.

NOTE

By default, the cluster network environment is secure and the SSL authentication is not enabled during the data transmission process. For details about how to use the encryption mode, see **Configuring the Encrypted Transmission**. The configuration applies to scenarios where only the Flume is configured, for example, Taildir Source+Memory Channel+HDFS Sink.

Prerequisites

- The cluster has been installed, including the HDFS and Flume services.
- The network environment of the cluster is secure.
- You have created user **flume_hdfs** and authorized the HDFS directory and data to be operated during log verification.

Procedure

Step 1 On FusionInsight Manager, choose **System > User** and choose **More > Download Authentication Credential** to download the Kerberos certificate file of user **flume_hdfs** and save it to the local host.

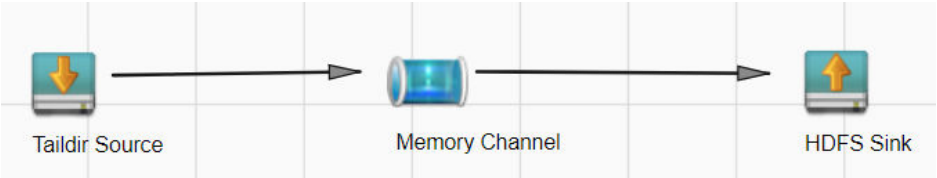
Step 2 Set Flume parameters.

Use the Flume configuration tool on FusionInsight Manager to configure the Flume role server parameters and generate a configuration file.

1. Log in to FusionInsight Manager and choose **Cluster** > **Services**. On the page that is displayed, choose **Flume**. On the displayed page, click the **Configuration Tool** tab.
2. Set **Agent Name** to **server**. Select the source, channel, and sink to be used, drag them to the GUI on the right, and connect them.

   Use Taildir Source, Memory Channel, and HDFS Sink.

Figure 6-7 Example for the Flume configuration tool



3. Double-click the source, channel, and sink. Set corresponding configuration parameters by referring to **Table 6-33** based on the actual environment.

   NOTE

   - If you want to continue using the **properties.propretites** file by modifying it, log in to FusionInsight Manager, choose **Cluster** > *Name of the desired cluster* > **Services**. On the page that is displayed, choose **Flume**. On the displayed page, click the **Configuration Tool** tab, click **Import**, import the file, and modify the configuration items related to non-encrypted transmission.
   - It is recommended that the numbers of Sources, Channels, and Sinks do not exceed 40 during configuration file import. Otherwise, the response time may be very long.

Table 6-33 Parameters to be modified for the Flume role server

Parameter	Description	Example Value
Name	The value must be unique and cannot be left blank.	test
filegroups	Specifies the file group list name. This parameter cannot be left blank. The value contains the following two parts: – **Name**: name of the file group list. – **filegroups**: absolute path of dynamic log files.	-
positionFile	Specifies the location where the collected file information (file name and location from which the file collected) is saved. This parameter cannot be left blank. The file does not need to be created manually, but the Flume running user needs to have the write permission on its upper-level directory.	/home/omm/flume/positionfile
batchSize	Specifies the number of events that Flume sends in a batch.	61200

Parameter	Description	Example Value
hdfs.path	Specifies the HDFS data write directory. This parameter cannot be left blank.	hdfs://hacluster/flume/test
hdfs.filePrefix	Specifies the file name prefix after data is written to HDFS.	TMP_
hdfs.batchSize	Specifies the maximum number of events that can be written to HDFS once.	61200
hdfs.kerberosPrincipal	Specifies the Kerberos authentication user, which is mandatory in security versions. This configuration is required only in security clusters.	flume_hdfs
hdfs.kerberosKeytab	Specifies the keytab file path for Kerberos authentication, which is mandatory in security versions. This configuration is required only in security clusters.	/opt/test/conf/user.keytab **NOTE** Obtain the **user.keytab** file from the Kerberos certificate file of the user **flume_hdfs**. In addition, ensure that the user who installs and runs the Flume client has the read and write permissions on the **user.keytab** file.
hdfs.useLocalTimeStamp	Specifies whether to use the local time. Possible values are **true** and **false**.	true

4. Click **Export** to save the **properties.properties** configuration file to the local.

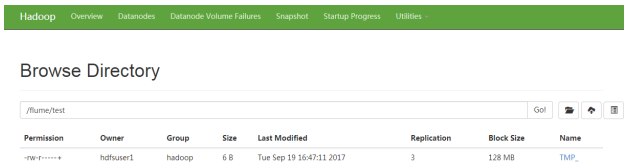
Step 3 Upload the configuration file.

Upload the file exported in **Step 2.4** to the **flume/conf** directory of the cluster. For details, see **Step 2.2**.

Step 4 Verify log transmission.

1. Log in to FusionInsight Manager as a user who has the management permission on HDFS. Choose **Cluster** > **Services** > **HDFS**. On the page that is displayed, click the **NameNode(***Node name***,Active)** link next to **NameNode WebUI** to go to the HDFS web UI. On the displayed page, choose **Utilities** > **Browse the file system**.
2. Check whether the data is generated in the **/flume/test** directory on the HDFS.

Figure 6-8 Checking HDFS directories and files



----End

6.10.5 Typical Scenario: Collecting Logs from Kafka and Uploading Them to HDFS

Scenario

This section describes how to use the Flume server to collect logs from the topic list (test1) of Kafka and save them to the **/flume/test** directory on HDFS.

NOTE

By default, the cluster network environment is secure and the SSL authentication is not enabled during the data transmission process. For details about how to use the encryption mode, see **Configuring the Encrypted Transmission**. The configuration applies to scenarios where only the Flume is configured, for example, Kafka Source+Memory Channel+HDFS Sink.

Prerequisites

- The cluster has been installed, including the HDFS, Kafka, and Flume services.
- The network environment of the cluster is secure.
- You have created user **flume_hdfs** and authorized the HDFS directory and data to be operated during log verification.

Procedure

Step 1 On FusionInsight Manager, choose **System > User** and choose **More > Download Authentication Credential** to download the Kerberos certificate file of user **flume_hdfs** and save it to the local host.

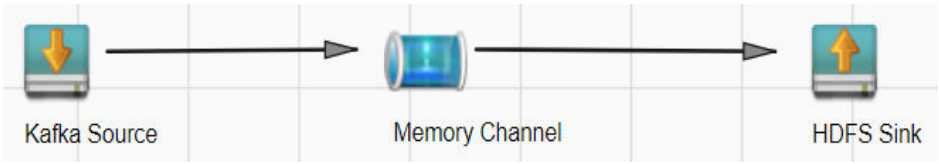
Step 2 Configure the server parameters of the Flume role.

Use the Flume configuration tool on FusionInsight Manager to configure the Flume role server parameters and generate a configuration file.

1. Log in to FusionInsight Manager and choose **Cluster** > **Services**. On the page that is displayed, choose **Flume**. On the displayed page, click the **Configuration Tool** tab.
2. Set **Agent Name** to **server**. Select the source, channel, and sink to be used, drag them to the GUI on the right, and connect them.

   For example, use Kafka Source, Memory Channel, and HDFS Sink.

Figure 6-9 Example for the Flume configuration tool



3. Double-click the source, channel, and sink. Set corresponding configuration parameters by referring to **Table 6-34** based on the actual environment.

   NOTE

   - If you want to continue using the **properties.propretites** file by modifying it, log in to FusionInsight Manager, choose **Cluster** > *Name of the desired cluster* > **Services**. On the page that is displayed, choose **Flume**. On the displayed page, click the **Configuration Tool** tab, click **Import**, import the file, and modify the configuration items related to non-encrypted transmission.
   - It is recommended that the numbers of Sources, Channels, and Sinks do not exceed 40 during configuration file import. Otherwise, the response time may be very long.

Table 6-34 Parameters to be modified for the Flume role server

Parameter	Description	Example Value
Name	The value must be unique and cannot be left blank.	test
kafka.topics	Specifies the subscribed Kafka topic list, in which topics are separated by commas (,). This parameter cannot be left blank.	test1
kafka.consumer.group.id	Specifies the data group ID obtained from Kafka. This parameter cannot be left blank.	flume
kafka.bootstrap.servers	Specifies the bootstrap IP address and port list of Kafka. The default value is all Kafka lists in a Kafka cluster. If Kafka has been installed in the cluster and its configurations have been synchronized, this parameter can be left blank.	192.168.101.10:9092
batchSize	Specifies the number of events that Flume sends in a batch (number of data pieces).	61200

Parameter	Description	Example Value
hdfs.path	Specifies the HDFS data write directory. This parameter cannot be left blank.	hdfs://hacluster/flume/test
hdfs.filePrefix	Specifies the file name prefix after data is written to HDFS.	TMP_
hdfs.batchSize	Specifies the maximum number of events that can be written to HDFS once.	61200
hdfs.kerberosPrincipal	Specifies the Kerberos authentication user, which is mandatory in security versions. This configuration is required only in security clusters.	flume_hdfs
hdfs.kerberosKeytab	Specifies the keytab file path for Kerberos authentication, which is mandatory in security versions. This configuration is required only in security clusters.	/opt/test/conf/user.keytab **NOTE** Obtain the **user.keytab** file from the Kerberos certificate file of the user **flume_hdfs**. In addition, ensure that the user who installs and runs the Flume client has the read and write permissions on the **user.keytab** file.
hdfs.useLocalTimeStamp	Specifies whether to use the local time. Possible values are **true** and **false**.	true

4. Click **Export** to save the **properties.properties** configuration file to the local.

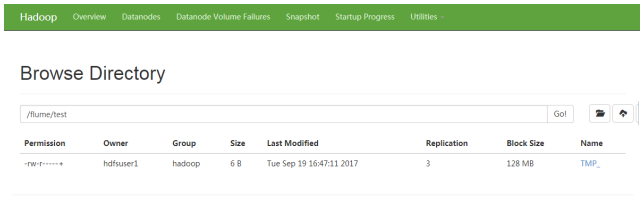
Step 3 Upload the configuration file.

Upload the file exported in **Step 2.4** to the **flume/conf** directory of the cluster. For details, see **Step 2.2**.

Step 4 Verify log transmission.

1. Log in to FusionInsight Manager as a user who has the management permission on HDFS. Choose **Cluster** > **Services** > **HDFS**. On the page that is displayed, click the **NameNode(***Node name***,Active)** link next to **NameNode WebUI** to go to the HDFS web UI. On the displayed page, choose **Utilities** > **Browse the file system**.
2. Check whether the data is generated in the **/flume/test** directory on the HDFS.

Figure 6-10 Checking HDFS directories and files



----End

6.10.6 Typical Scenario: Collecting Logs from Kafka and Uploading Them to HDFS Through the Flume Client

Scenario

This section describes how to use the Flume client to collect logs from the topic list (test1) of the Kafka client and save them to the **/flume/test** directory on HDFS.

NOTE

By default, the cluster network environment is secure and the SSL authentication is not enabled during the data transmission process. For details about how to use the encryption mode, see **Configuring the Encrypted Transmission**.

Prerequisites

- The Flume client has been installed. For details about how to install the Flume client, see "Using Flume" > "Installing the Flume Client" in *MapReduce Service Component Operation Guide*.
- The cluster has been installed, including the HDFS, Kafka, and Flume services.
- You have created user **flume_hdfs** and authorized the HDFS directory and data to be operated during log verification.
- The network environment of the cluster is secure.

Procedure

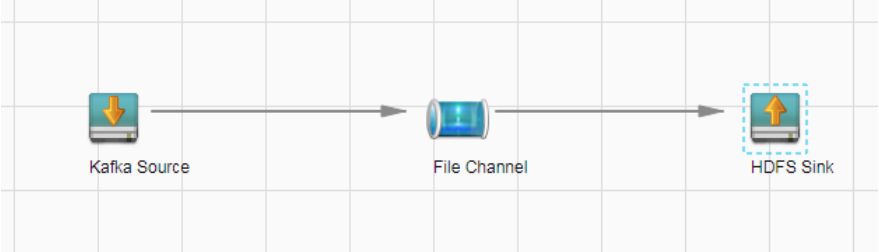
Step 1 On FusionInsight Manager, choose **System > User** and choose **More > Download Authentication Credential** to download the Kerberos certificate file of user **flume_hdfs** and save it to the local host.

Step 2 Configure the client parameters of the Flume role.

1. Use the Flume configuration tool on FusionInsight Manager to configure the Flume role server parameters and generate a configuration file.
   a. Log in to FusionInsight Manager and choose **Cluster** > **Services**. On the page that is displayed, choose **Flume**. On the displayed page, click the **Configuration Tool** tab.
   b. Set **Agent Name** to **client**. Select the source, channel, and sink to be used, drag them to the GUI on the right, and connect them.

      For example, use Kafka Source, File Channel, and HDFS Sink, as shown in **Figure 6-11**.

Figure 6-11 Example for the Flume configuration tool



c. Double-click the source, channel, and sink. Set corresponding configuration parameters by referring to **Table 6-35** based on the actual environment.

NOTE

- If you want to continue using the **properties.propretites** file by modifying it, log in to FusionInsight Manager, choose **Cluster** > *Name of the desired cluster* > **Services**. On the page that is displayed, choose **Flume**. On the displayed page, click the **Configuration Tool** tab, click **Import**, import the file, and modify the configuration items related to non-encrypted transmission.
- It is recommended that the numbers of Sources, Channels, and Sinks do not exceed 40 during configuration file import. Otherwise, the response time may be very long.

Table 6-35 Parameters to be modified for the Flume role client

Parameter	Description	Example Value
Name	The value must be unique and cannot be left blank.	test
kafka.topics	Specifies the subscribed Kafka topic list, in which topics are separated by commas (,). This parameter cannot be left blank.	test1
kafka.consumer.group.id	Specifies the data group ID obtained from Kafka. This parameter cannot be left blank.	flume

Parameter	Description	Example Value
kafka.bootstrap.servers	Specifies the bootstrap IP address and port list of Kafka. The default value is all Kafka lists in a Kafka cluster. If Kafka has been installed in the cluster and its configurations have been synchronized, this parameter can be left blank. This parameter is mandatory when the Flume client is used.	192.168.101.10:21007
batchSize	Specifies the number of events that Flume sends in a batch (number of data pieces).	61200
dataDirs	Specifies the directory for storing buffer data. The run directory is used by default. Configuring multiple directories on disks can improve transmission efficiency. Use commas (,) to separate multiple directories. If the directory is inside the cluster, the **/srv/BigData/hadoop/dataX/flume/data** directory can be used. **dataX** ranges from data1 to dataN. If the directory is outside the cluster, it needs to be independently planned.	/srv/BigData/hadoop/data1/flume/data

Parameter	Description	Example Value
checkpointDir	Specifies the directory for storing the checkpoint information, which is under the run directory by default. If the directory is inside the cluster, the **/srv/BigData/hadoop/dataX/flume/checkpoint** directory can be used. **dataX** ranges from data1 to dataN. If the directory is outside the cluster, it needs to be independently planned.	/srv/BigData/hadoop/data1/flume/checkpoint
transactionCapacity	Specifies the transaction size, that is, the number of events in a transaction that can be processed by the current Channel. The size cannot be smaller than the batchSize of Source. Setting the same size as batchSize is recommended.	61200
hdfs.path	Specifies the HDFS data write directory. This parameter cannot be left blank.	hdfs://hacluster/flume/test
hdfs.filePrefix	Specifies the file name prefix after data is written to HDFS.	TMP_
hdfs.batchSize	Specifies the maximum number of events that can be written to HDFS once.	61200

Parameter	Description	Example Value
hdfs.kerberosPrincipal	Specifies the Kerberos authentication user, which is mandatory in security versions. This configuration is required only in security clusters.	flume_hdfs
hdfs.kerberosKeytab	Specifies the keytab file path for Kerberos authentication, which is mandatory in security versions. This configuration is required only in security clusters.	/opt/test/conf/user.keytab **NOTE** Obtain the **user.keytab** file from the Kerberos certificate file of the user **flume_hdfs**. In addition, ensure that the user who installs and runs the Flume client has the read and write permissions on the **user.keytab** file.
hdfs.useLocalTimeStamp	Specifies whether to use the local time. Possible values are **true** and **false**.	true

d. Click **Export** to save the **properties.properties** configuration file to the local.

2. Upload the **properties.properties** file to **flume/conf/** in the Flume client installation directory.
3. To connect the Flume client to the HDFS, you need to add the following configuration:

   a. Download the Kerberos certificate of account **flume_hdfs** and obtain the **krb5.conf** configuration file. Upload the configuration file to the **fusioninsight-flume-***Flume component version***/conf/** directory on the node where the client is installed.

   b. Create the **jaas.conf** configuration file and save it to the **fusioninsight-flume-***Flume component version***/conf/** directory in the installation directory of the node where the client is deployed.

      vi jaas.conf

      ```
      KafkaClient {
      com.sun.security.auth.module.Krb5LoginModule required
      useKeyTab=true
      keyTab="/opt/test/conf/user.keytab"
      principal="flume_hdfs@<System domain name>"
      useTicketCache=false
      storeKey=true
      debug=true;
      };
      ```

      Values of **keyTab** and **principal** vary depending on the actual situation.

c. Obtain configuration files **core-site.xml** and **hdfs-site.xml** from **/opt/FusionInsight_Cluster_*<Cluster ID>*_Flume_ClientConfig/Flume/config** and upload them to **fusioninsight-flume-***Flume component version***/conf/**.

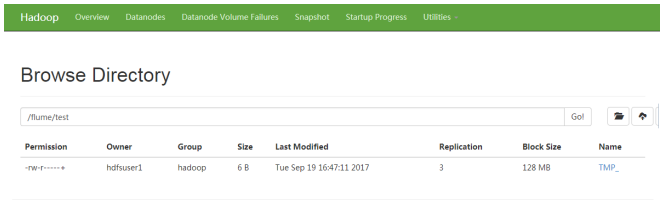
4. Go to **fusioninsight-flume-***Flume component version***/bin** in the installation directory of the client node and run the following command to restart the Flume process:

   ./flume-manage.sh restart

Step 3 Verify log transmission.

1. Log in to FusionInsight Manager as a user who has the management permission on HDFS. Choose **Cluster** > **Services** > **HDFS**. On the page that is displayed, click the **NameNode(***Node name***,Active)** link next to **NameNode WebUI** to go to the HDFS web UI. On the displayed page, choose **Utilities** > **Browse the file system**.
2. Check whether the data is generated in the **/flume/test** directory on the HDFS.

Figure 6-12 Checking HDFS directories and files



----End

6.10.7 Typical Scenario: Collecting Local Static Logs and Uploading Them to HBase

Scenario

This section describes how to use the Flume client to collect static logs from a local host and save them to the **flume_test** HBase table. In this scenario, multi-level agents are cascaded.

NOTE

By default, the cluster network environment is secure and the SSL authentication is not enabled during the data transmission process. For details about how to use the encryption mode, see **Configuring the Encrypted Transmission**. The configuration applies to scenarios where only the server is configured, for example, Spooldir Source+File Channel+HBase Sink.

Prerequisites

- The cluster has been installed, including the HBase and Flume services.
- The Flume client has been installed. For details about how to install the Flume client, see "Using Flume" > "Installing the Flume Client" in *MapReduce Service Component Operation Guide*.
- The network environment of the cluster is secure.

- An HBase table has been created by running the **create 'flume_test', 'cf'** command.
- The MRS cluster administrator has understood service requirements and prepared HBase administrator **flume_hbase**.

Procedure

Step 1 On FusionInsight Manager, choose **System > User** and choose **More > Download Authentication Credential** to download the Kerberos certificate file of user **flume_hbase** and save it to the local host.

Step 2 Configure the client parameters of the Flume role.

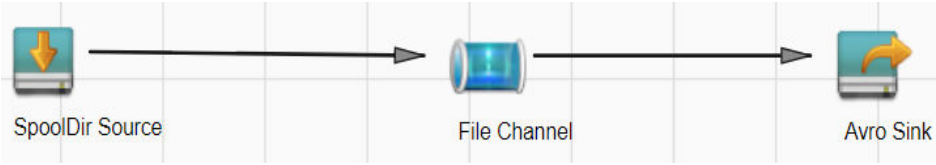
1. Use the Flume configuration tool on FusionInsight Manager to configure the Flume role client parameters and generate a configuration file.

   a. Log in to FusionInsight Manager and choose **Cluster** > **Services**. On the page that is displayed, choose **Flume**. On the displayed page, click the **Configuration Tool** tab.

   b. Set **Agent Name** to **client**. Select the source, channel, and sink to be used, drag them to the GUI on the right, and connect them.

   Use SpoolDir Source, File Channel, and Avro Sink.

   Figure 6-13 Example for the Flume configuration tool

   c. Double-click the source, channel, and sink. Set corresponding configuration parameters by referring to **Table 6-36** based on the actual environment.

   NOTE

   - If you want to continue using the **properties.propretites** file by modifying it, log in to FusionInsight Manager, choose **Cluster** > *Name of the desired cluster* > **Services**. On the page that is displayed, choose **Flume**. On the displayed page, click the **Configuration Tool** tab, click **Import**, import the file, and modify the configuration items related to non-encrypted transmission.
   - It is recommended that the numbers of Sources, Channels, and Sinks do not exceed 40 during configuration file import. Otherwise, the response time may be very long.

   Table 6-36 Parameters to be modified for the Flume role client

Parameter	Description	Example Value
Name	The value must be unique and cannot be left blank.	test

Parameter	Description	Example Value
spoolDir	Specifies the directory where the file to be collected resides. This parameter cannot be left blank. The directory needs to exist and have the write, read, and execute permissions on the flume running user.	/srv/BigData/hadoop/data1/zb
trackerDir	Specifies the path for storing the metadata of files collected by Flume.	/srv/BigData/hadoop/data1/tracker
batchSize	Specifies the number of events that Flume sends in a batch (number of data pieces). A larger value indicates higher performance and lower timeliness.	61200
dataDirs	Specifies the directory for storing buffer data. The run directory is used by default. Configuring multiple directories on disks can improve transmission efficiency. Use commas (,) to separate multiple directories. If the directory is inside the cluster, the **/srv/BigData/hadoop/dataX/flume/data** directory can be used. **dataX** ranges from data1 to dataN. If the directory is outside the cluster, it needs to be independently planned.	/srv/BigData/hadoop/data1/flume/data

Parameter	Description	Example Value
checkpointDir	Specifies the directory for storing the checkpoint information, which is under the run directory by default. If the directory is inside the cluster, the **/srv/BigData/hadoop/dataX/flume/checkpoint** directory can be used. **dataX** ranges from data1 to dataN. If the directory is outside the cluster, it needs to be independently planned.	/srv/BigData/hadoop/data1/flume/checkpoint
transactionCapacity	Specifies the transaction size, that is, the number of events in a transaction that can be processed by the current Channel. The size cannot be smaller than the batchSize of Source. Setting the same size as batchSize is recommended.	61200
hostname	Specifies the name or IP address of the host whose data is to be sent. This parameter cannot be left blank. Name or IP address must be configured to be the name or IP address that the Avro source associated with it.	192.168.108.11

Parameter	Description	Example Value
port	Specifies the port that sends the data. This parameter cannot be left blank. It must be consistent with the port that is monitored by the connected Avro Source.	21154
ssl	Specifies whether to enable the SSL authentication. (You are advised to enable this function to ensure security.) Only Sources of the Avro type have this configuration item. ■ **true** indicates that the function is enabled. ■ **false** indicates that the client authentication function is not enabled.	false

d. Click **Export** to save the **properties.properties** configuration file to the local.

2. Upload the **properties.properties** file to **flume/conf/** under the installation directory of the Flume client.

Step 3 Configure the server parameters of the Flume role and upload the configuration file to the cluster.

1. Use the Flume configuration tool on the FusionInsight Manager portal to configure the server parameters and generate the configuration file.
   a. Log in to FusionInsight Manager and choose **Cluster** > **Services**. On the page that is displayed, choose **Flume**. On the displayed page, click the **Configuration Tool** tab.
   b. Set **Agent Name** to **server**. Select the source, channel, and sink to be used, drag them to the GUI on the right, and connect them.
      For example, use Avro Source, File Channel, and HBase Sink.

Figure 6-14 Example for the Flume configuration tool

c. Double-click the source, channel, and sink. Set corresponding configuration parameters by referring to **Table 6-37** based on the actual environment.

NOTE

- If the server parameters of the Flume role have been configured, you can choose **Cluster** > *Name of the desired cluster* > **Services** > **Flume** > **Instance** on FusionInsight Manager. Then select the corresponding Flume role instance and click the **Download** button behind the **flume.config.file** parameter on the **Instance Configurations** page to obtain the existing server parameter configuration file. Choose **Cluster** > *Name of the desired cluster* > **Services** > **Flume** > **Configuration Tool** > **Import**, import the file, and modify the configuration items related to non-encrypted transmission.
- It is recommended that the numbers of Sources, Channels, and Sinks do not exceed 40 during configuration file import. Otherwise, the response time may be very long.
- A unique checkpoint directory needs to be configured for each File Channel.

Table 6-37 Parameters to be modified for the Flume role server

Parameter	Description	Example Value
Name	The value must be unique and cannot be left blank.	test
bind	Specifies the IP address to which Avro Source is bound. This parameter cannot be left blank. It must be configured as the IP address that the server configuration file will upload.	192.168.108.11
port	Specifies the ID of the port that the Avro Source monitors. This parameter cannot be left blank. It must be configured as an unused port.	21154

Parameter	Description	Example Value
ssl	Specifies whether to enable the SSL authentication. (You are advised to enable this function to ensure security.) Only Sources of the Avro type have this configuration item. ▪ **true** indicates that the function is enabled. ▪ **false** indicates that the client authentication function is not enabled.	false
dataDirs	Specifies the directory for storing buffer data. The run directory is used by default. Configuring multiple directories on disks can improve transmission efficiency. Use commas (,) to separate multiple directories. If the directory is inside the cluster, the **/srv/BigData/hadoop/dataX/flume/data** directory can be used. **dataX** ranges from data1 to dataN. If the directory is outside the cluster, it needs to be independently planned.	/srv/BigData/hadoop/data1/flumeserver/data
checkpointDir	Specifies the directory for storing the checkpoint information, which is under the run directory by default. If the directory is inside the cluster, the **/srv/BigData/hadoop/dataX/flume/checkpoint** directory can be used. **dataX** ranges from data1 to dataN. If the directory is outside the cluster, it needs to be independently planned.	/srv/BigData/hadoop/data1/flumeserver/checkpoint
transactionCapacity	Specifies the transaction size, that is, the number of events in a transaction that can be processed by the current Channel. The size cannot be smaller than the batchSize of Source. Setting the same size as batchSize is recommended.	61200

Parameter	Description	Example Value
table	Specifies the HBase table name. This parameter cannot be left blank.	flume_test
columnFamily	Specifies the HBase column family name. This parameter cannot be left blank.	cf
batchSize	Specifies the maximum number of events written to HBase by Flume in a batch.	61200
kerberosPrincipal	Specifies the Kerberos authentication user, which is mandatory in security versions. This configuration is required only in security clusters.	flume_hbase
kerberosKeytab	Specifies the file path for Kerberos authentication, which is mandatory in security versions. This configuration is required only in security clusters.	/opt/test/conf/user.keytab **NOTE** Obtain the **user.keytab** file from the Kerberos certificate file of the user **flume_hbase**. In addition, ensure that the user who installs and runs the Flume client has the read and write permissions on the **user.keytab** file.

d. Click **Export** to save the **properties.properties** configuration file to the local.

2. Log in to FusionInsight Manager and choose **Cluster** > *Name of the desired cluster* > **Services** > **Flume**. On the displayed page, click the **Flume** role on the **Instance** tab page.
3. Select the Flume role of the node where the configuration file is to be uploaded, choose **Instance Configurations** > **Import** beside the **flume.config.file**, and select the **properties.properties** file.

   NOTE

   - An independent server configuration file can be uploaded to each Flume instance.
   - This step is required for updating the configuration file. Modifying the configuration file on the background is an improper operation because the modification will be overwritten after configuration synchronization.

4. Click **Save**, and then click **OK**.
5. Click **Finish**.

Step 4 Verify log transmission.

1. Go to the directory where the HBase client is installed.

   cd /*Client installation directory***/ HBase/hbase**

   kinit flume_hbase (Enter the password.)

2. Run the **hbase shell** command to access the HBase client.
3. Run the **scan 'flume_test'** statement. Logs are written in the HBase column family by line.

```
hbase(main):001:0> scan 'flume_test'
ROW                                             COLUMN
+CELL

2017-09-18 16:05:36,394 INFO  [hconnection-0x415a3f6a-shared--pool2-t1] ipc.AbstractRpcClient:
RPC Server Kerberos principal name for service=ClientService is hbase/hadoop.<system domain
name>@<system domain name>
 default4021ff4a-9339-4151-a4d0-00f20807e76d                column=cf:pCol,
timestamp=1505721909388, value=Welcome to
flume
 incRow                                         column=cf:iCol, timestamp=1505721909461, value=
\x00\x00\x00\x00\x00\x00\x00\x01
2 row(s) in 0.3660 seconds
```

----End

6.11 Encrypted Transmission

6.11.1 Configuring the Encrypted Transmission

Scenario

This section describes how to configure the server and client parameters of the Flume service (including the Flume and MonitorServer roles) after the cluster is installed to ensure proper running of the service.

Prerequisites

The cluster and Flume service have been installed.

Procedure

Step 1 Generate the certificate trust lists of the server and client of the Flume role respectively.

1. Remotely log in to the node using ECM where the Flume server is to be installed as user **omm**. Go to the **${BIGDATA_HOME}/FusionInsight_Porter_8.1.0.1/install/FusionInsight-Flume-**Flume component version**/flume/bin** directory.

   cd ${BIGDATA_HOME}/FusionInsight_Porter_8.1.0.1/install/FusionInsight-Flume-Flume component version**/flume/bin**

   NOTE

   The version number **8.1.0.1** is used as an example. Replace it with the actual version number.

2. Run the following command to generate and export the server and client certificates of the Flume role:

   sh geneJKS.sh -f *xxx* **-g** *xxx*

   The generated certificate is stored in the **${BIGDATA_HOME}/FusionInsight_Porter_8.1.0.1/install/FusionInsight-Flume-**Flume component version**/flume/conf** directory. .

   - **flume_sChat.jks** is the certificate library of the Flume role server. **flume_sChat.crt** is the exported file of the **flume_sChat.jks** certificate. **-f** indicates the password of the certificate and certificate library.
   - **flume_cChat.jks** is the certificate library of the Flume role client. **flume_cChat.crt** is the exported file of the **flume_cChat.jks** certificate. **-g** indicates the password of the certificate and certificate library.
   - **flume_sChatt.jks** and **flume_cChatt.jks** are the SSL certificate trust lists of the Flume server and client, respectively.

   NOTE

   All user-defined passwords involved in this section must meet the following strength requirements:

   - The password must contain at least four types of uppercase letters, lowercase letters, digits, and special characters.
   - The password must contain 8 to 64 characters.
   - It is recommended that the user-defined passwords be changed periodically (for example, every three months), and certificates and trust lists be generated again to ensure security.

Step 2 Configure the server parameters of the Flume role and upload the configuration file to the cluster.

1. Remotely log in to any node where the Flume role is located as user **omm** using ECM. Run the following command to go to **${BIGDATA_HOME}/FusionInsight_Porter_8.1.0.1/install/FusionInsight-Flume-**Flume component version**/flume/bin**:

   cd ${BIGDATA_HOME}/FusionInsight_Porter_8.1.0.1/install/FusionInsight-Flume-Flume component version**/flume/bin**

2. Run the following command to generate and obtain Flume server keystore password, trust list password, and keystore-password encrypted private key information. Enter the password twice and confirm the password. It is the password of the **flume_sChat.jks** certificate library.

   ./genPwFile.sh

   cat password.property

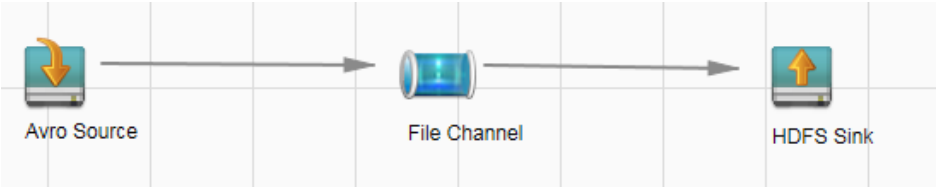
3. Use the Flume configuration tool on the FusionInsight Manager portal to configure the server parameters and generate the configuration file.

   a. Log in to FusionInsight Manager. Choose **Services** > **Flume** > **Configuration Tool**.

   b. Set **Agent Name** to **server**. Select the source, channel, and sink to be used, drag them to the GUI on the right, and connect them.

      For example, use Avro Source, File Channel, and HDFS Sink, as shown in **Figure 6-15**.

Figure 6-15 Example for the Flume configuration tool



c. Double-click the source, channel, and sink. Set corresponding configuration parameters by seeing **Table 6-38** based on the actual environment.

NOTE

- If the server parameters of the Flume role have been configured, you can choose **Services** > **Flume** > **Instance** on FusionInsight Manager. Then select the corresponding Flume role instance and click the **Download** button behind the **flume.config.file** parameter on the **Instance Configurations** page to obtain the existing server parameter configuration file. Choose **Services** > **Flume** > **Import** to change the relevant configuration items of encrypted transmission after the file is imported.
- It is recommended that the numbers of Sources, Channels, and Sinks do not exceed 40 during configuration file import. Otherwise, the response time may be very long.

d. Click **Export** to save the **properties.properties** configuration file to the local.

Table 6-38 Parameters to be modified of the Flume role server

Parameter	Description	Example Value
ssl	Specifies whether to enable the SSL authentication. (You are advised to enable this function to ensure security.) ■ **true** indicates that the function is enabled. ■ **false** indicates that the client authentication function is not enabled.	true
keystore	Indicates the server certificate.	**${BIGDATA_HOME}/FusionInsight_Porter_8.1.0.1/install/FusionInsight-Flume-**Flume component version**/flume/conf/flume_sChat.jks**

Parameter	Description	Example Value
keystore-password	Specifies the password of the key library, which is the password required to obtain the keystore information. Enter the value of password obtained in **Step 2.2**.	-
truststore	Indicates the SSL certificate trust list of the server.	**${BIGDATA_HOME}/FusionInsight_Porter_8.1.0.1/install/FusionInsight-Flume-**Flume component version**/flume/conf/flume_sChatt.jks**
truststore-password	Specifies the trust list password, which is the password required to obtain the truststore information. Enter the value of password obtained in **Step 2.2**.	-

4. Log in to FusionInsight Manager and choose **Cluster** > *Name of the desired cluster* > **Services** > **Flume**. On the displayed page, click the **Flume** role under **Role**.
5. Select the Flume role of the node where the configuration file is to be uploaded, choose **Instance Configurations** > **Import** beside the **flume.config.file**, and select the **properties.properties** file.

   NOTE

   - An independent server configuration file can be uploaded to each Flume instance.
   - This step is required for updating the configuration file. Modifying the configuration file on the background is an improper operation because the modification will be overwritten after configuration synchronization.
6. Click **Save**, and then click **OK**. Click **Finish**.

Step 3 Set the client parameters of the Flume role.

1. Run the following commands to copy the generated client certificate (**flume_cChat.jks**) and client trust list (**flume_cChatt.jks**) to the client directory, for example, **/opt/flume-client/fusionInsight-flume-***Flume component version***/conf/**. (The Flume client must have been installed.) **10.196.26.1** is the service plane IP address of the node where the client resides.

   scp ${BIGDATA_HOME}/FusionInsight_Porter_8.1.0.1/install/FusionInsight-Flume-Flume component version**/flume/conf/flume_cChat.jks user@10.196.26.1:/opt/flume-client/fusionInsight-flume-**Flume component version**/conf/**

scp ${BIGDATA_HOME}/FusionInsight_Porter_8.1.0.1/install/FusionInsight-Flume-Flume component version**/flume/conf/flume_cChatt.jks user@10.196.26.1:/opt/flume-client/fusionInsight-flume-**Flume component version**/conf/**

NOTE

When copying the client certificate, you need to enter the password of user **user** of the host (for example, **10.196.26.1**) where the client resides.

2. Log in to the node where the Flume client is decompressed as user **user**. Run the following command to go to the client directory **opt/flume-client/fusionInsight-flume-***Flume component version***/bin**:

   cd opt/flume-client/fusionInsight-flume-Flume component version**/bin**

3. Run the following command to generate and obtain Flume client keystore password, trust list password, and keystore-password encrypted private key information. Enter the password twice and confirm the password. The password is the same as the password of the certificate whose alias is *flumechatclient* and the password of the *flume_cChat.jks* certificate library.

   ./genPwFile.sh

   cat password.property

   NOTE

   If the following error message is displayed, run the export **JAVA_HOME=*JDK path*** command.

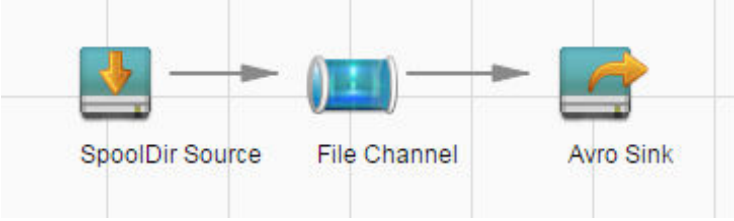
   ```
   JAVA_HOME is null in current user,please install the JDK and set the JAVA_HOME
   ```

4. Run the **echo $SCC_PROFILE_DIR** command to check whether the **SCC_PROFILE_DIR** environment variable is empty.
   - If yes, run the **source .sccfile** command.
   - If no, go to **Step 3.5**.

5. Use the Flume configuration tool on FusionInsight Manager to configure the Flume role client parameters and generate a configuration file.
   a. Log in to FusionInsight Manager and choose **Cluster** > *Name of the desired cluster* > **Services** > **Flume** > **Configuration Tool**.
   b. Set **Agent Name** to **client**. Select the source, channel, and sink to be used, drag them to the GUI on the right, and connect them.

      For example, use SpoolDir Source, File Channel, and Avro Sink, as shown in **Figure 6-16**.

      Figure 6-16 Example for the Flume configuration tool

   c. Double-click the source, channel, and sink. Set corresponding configuration parameters by seeing **Table 6-39** based on the actual environment.

NOTE

- If the client parameters of the Flume role have been configured, you can obtain the existing client parameter configuration file from *Client installation directory*/**fusioninsight-flume-***Flume component version*/**conf/** properties.properties to ensure that the configuration is in concordance with the previous. Log in to FusionInsight Manager, choose **Cluster** > *Name of the desired cluster* > **Services** > **Flume** > **Configuration Tool** > **Import**, import the file, and modify the configuration items related to encrypted transmission.
- It is recommended that the numbers of Sources, Channels, and Sinks do not exceed 40 during configuration file import. Otherwise, the response time may be very long.
- A unique checkpoint directory needs to be configured for each File Channel.

d. Click **Export** to save the **properties.properties** configuration file to the local.

Table 6-39 Parameters to be modified of the Flume role client

Parameter	Description	Example Value
ssl	Indicates whether to enable the SSL authentication. (You are advised to enable this function to ensure security.) ■ **true** indicates that the function is enabled. ■ **false** indicates that the client authentication function is not enabled.	true
keystore	Specified the client certificate.	**/opt/flume-client/fusionInsight-flume-***Flume component version*/**conf/flume_cChat.jks**
keystore-password	Specifies the password of the key library, which is the password required to obtain the keystore information. Enter the value of password obtained in **Step 3.3**.	-

Parameter	Description	Example Value
truststore	Indicates the SSL certificate trust list of the client.	**/opt/flume-client/fusionInsight-flume-***Flume component version***/conf/flume_cChatt.jks**
truststore-password	Specifies the trust list password, which is the password required to obtain the truststore information. Enter the value of password obtained in **Step 3.3**.	-

6. Upload the **properties.properties** file to **flume/conf/** under the installation directory of the Flume client.

Step 4 Generate the certificate and trust list of the server and client of the MonitorServer role respectively.

1. Log in to the host using ECM with the MonitorServer role assigned as user **omm**.

   Go to the **${BIGDATA_HOME}/FusionInsight_Porter_8.1.0.1/install/FusionInsight-Flume-**Flume component version**/flume/bin** directory.

   cd ${BIGDATA_HOME}/FusionInsight_Porter_8.1.0.1/install/FusionInsight-Flume-Flume component version**/flume/bin**

2. Run the following command to generate and export the server and client certificates of the MonitorServer role:

   sh geneJKS.sh -m *xxx* **-n** ***xxx***

   The generated certificate is stored in the **${BIGDATA_HOME}/FusionInsight_Porter_8.1.0.1/install/FusionInsight-Flume-**Flume component version**/flume/conf** directory.

   - **ms_sChat.jks** is the certificate library of the MonitorServer role server. **ms_sChat.crt** is the exported file of the **ms_sChat.jks** certificate. **-m** indicates the password of the certificate and certificate library.
   - **ms_cChat.jks** is the certificate library of the MonitorServer role client. **ms_cChat.crt** is the exported file of the **ms_cChat.jks** certificate. **-n** indicates the password of the certificate and certificate library.
   - **ms_sChatt.jks** and **ms_cChatt.jks** are the SSL certificate trust lists of the MonitorServer server and client, respectively.

Step 5 Set the server parameters of the MonitorServer role.

1. Run the following command to generate and obtain MonitorServer server keystore password, trust list password, and keystore-password encrypted private key information. Enter the password twice and confirm the password. The password is the same as the password of the certificate whose alias is *mschatserver* and the password of the *ms_sChat.jks* certificate library.

./genPwFile.sh

cat password.property

2. Run the following command to open **${BIGDATA_HOME}/FusionInsight_Porter_8.1.0.1/install/FusionInsight-Flume-**Flume component version**/flume/conf/service/application.properties**: Modify related parameters based on the description in **Table 6-40**, save the modification, and exit.

   vi ${BIGDATA_HOME}/FusionInsight_Porter_8.1.0.1/install/FusionInsight-Flume-Flume component version**/flume/conf/service/application.properties**

   Table 6-40 Parameters to be modified of the MonitorServer role server

Parameter	Description	Example Value
ssl_need_kspasswd_decrypt_key	Specifies whether to enable the user-defined key encryption and decryption function. (You are advised to enable this function to ensure security.) – **true** indicates that the function is enabled. – **false** indicates that the client authentication function is not enabled.	true
ssl_server_enable	Indicates whether to enable the SSL authentication. (You are advised to enable this function to ensure security.) – **true** indicates that the function is enabled. – **false** indicates that the client authentication function is not enabled.	true
ssl_server_key_store	Set this parameter based on the specific storage location.	**${BIGDATA_HOME}/FusionInsight_Porter_8.1.0.1/install/FusionInsight-Flume-**Flume component version**/flume/conf/ms_sChat.jks**
ssl_server_trust_key_store	Set this parameter based on the specific storage location.	**${BIGDATA_HOME}/FusionInsight_Porter_8.1.0.1/install/FusionInsight-Flume-**Flume component version**/flume/conf/ms_sChatt.jks**

Parameter	Description	Example Value
ssl_server_key_store_password	Indicates the keystore password. Set this parameter based on the actual situation of certificate creation (the plaintext key used to generate the certificate). Enter the value of password obtained in **Step 5.1**.	-
ssl_server_trust_key_store_password	Specifies the trustkeystore password. Set this parameter based on the actual situation of certificate creation (the plaintext key used to generate the trust list). Enter the value of password obtained in **Step 5.1**.	-
ssl_need_client_auth	Indicates whether to enable the client authentication. (You are advised to enable this function to ensure security.) – **true** indicates that the function is enabled. – **false** indicates that the client authentication function is not enabled.	true

3. Restart the MonitorServer instance. Choose **Services** > **Flume** > **Instance** > **MonitorServer**, select the MonitorServer instance, and choose **More** > **Restart Instance**. Enter the cluster administrator password and click **OK**. After the restart is complete, click **Finish**.

Step 6 Set the client parameters of the MonitorServer role.

1. Run the following commands to copy the generated client certificate (**ms_cChat.jks**) and client trust list (**ms_cChatt.jks**) to the **/opt/flume-client/fusionInsight-flume-***Flume component version***/conf/ client** directory. **10.196.26.1** is the service plane IP address of the node where the client resides.

   scp ${BIGDATA_HOME}/FusionInsight_Porter_8.1.0.1/install/FusionInsight-Flume-Flume component version**/flume/conf/ms_cChat.jks user@10.196.26.1:/opt/flume-client/fusionInsight-flume-**Flume component version**/conf/**

   scp ${BIGDATA_HOME}/FusionInsight_Porter_8.1.0.1/install/FusionInsight-Flume-Flume component version**/flume/conf/ms_cChatt.jks**

user@10.196.26.1:/opt/flume-client/fusionInsight-flume-Flume component version**/conf/**

2. Log in to the node where the Flume client is located as **user**. Run the following command to go to the client directory **opt/flume-client/fusionInsight-flume-***Flume component version***/bin**:

   cd opt/flume-client/fusionInsight-flume-Flume component version**/bin**

3. Run the following command to generate and obtain MonitorServer client keystore password, trust list password, and keystore-password encrypted private key information. Enter the password twice and confirm the password. The password is the same as the password of the certificate whose alias is *mschatclient* and the password of the *ms_cChat.jks* certificate library.

   ./genPwFile.sh

   cat password.property

4. Run the following command to open the **/opt/flume-client/fusionInsight-flume-**Flume component version**/conf/service/application.properties** file (**/opt/flume-client/fusionInsight-flume-***Flume component version* is the directory where the client software is installed): Modify related parameters based on the description in **Table 6-41**, save the modification, and exit.

   vi /opt/flume-client/fusionInsight-flume-Flume component version**/flume/conf/service/application.properties**

Table 6-41 Parameters to be modified of the MonitorServer role client

Parameter	Description	Example Value
ssl_need_kspaswd_decrypt_key	Indicates whether to enable the user-defined key encryption and decryption function. (You are advised to enable this function to ensure security.) – **true** indicates that the function is enabled. – **false** indicates that the client authentication function is not enabled.	true
ssl_client_enable	Indicates whether to enable the SSL authentication. (You are advised to enable this function to ensure security.) – **true** indicates that the function is enabled. – **false** indicates that the client authentication function is not enabled.	true

Parameter	Description	Example Value
ssl_client_key_store	Set this parameter based on the specific storage location.	**${BIGDATA_HOME}/FusionInsight_Porter_8.1.0.1/install/FusionInsight-Flume-**Flume component version**/flume/conf/ms_cChat.jks**
ssl_client_trust_key_store	Set this parameter based on the specific storage location.	**${BIGDATA_HOME}/FusionInsight_Porter_8.1.0.1/install/FusionInsight-Flume-**Flume component version**/flume/conf/ms_cChatt.jks**
ssl_client_key_store_password	Specifies the keystore password. Set this parameter based on the actual situation of certificate creation (the plaintext key used to generate the certificate). Enter the value of **password** obtained in **Step 6.3**.	-
ssl_client_trust_key_store_password	Specifies the trustkeystore password. Set this parameter based on the actual situation of certificate creation (the plaintext key used to generate the trust list). Enter the value of **password** obtained in **Step 6.3**.	-
ssl_need_client_auth	Indicates whether to enable the client authentication. (You are advised to enable this function to ensure security.) – **true** indicates that the function is enabled. – **false** indicates that the client authentication function is not enabled.	true

----End

6.11.2 Typical Scenario: Collecting Local Static Logs and Uploading Them to HDFS

Scenario

This section describes how to use Flume to collect static logs from a local host and save them to the **/flume/test** directory on HDFS.

Prerequisites

- The cluster, HDFS and Flume services, and Flume client have been installed.
- User **flume_hdfs** has been created, and the HDFS directory and data used for log verification have been authorized to the user.

Procedure

Step 1 Generate the certificate trust lists of the server and client of the Flume role respectively.

1. Log in to the node where the Flume server is located as user **omm**. Go to the **${BIGDATA_HOME}/FusionInsight_Porter_8.1.0.1/install/FusionInsight-Flume-**Flume component version**/flume/bin** directory.

   cd ${BIGDATA_HOME}/FusionInsight_Porter_8.1.0.1/install/FusionInsight-Flume-Flume component version**/flume/bin**

2. Run the following command to generate and export the server and client certificates of the Flume role:

   sh geneJKS.sh -f *Password* **-g** *Password*

   The generated certificate is stored in the **${BIGDATA_HOME}/FusionInsight_Porter_8.1.0.1/install/FusionInsight-Flume-**Flume component version**/flume/conf** directory. The command parameters are as follows:

   - **flume_sChat.jks** is the certificate library of the Flume role server. **flume_sChat.crt** is the exported file of the **flume_sChat.jks** certificate. **-f** indicates the password of the certificate and certificate library.
   - **flume_cChat.jks** is the certificate library of the Flume role client. **flume_cChat.crt** is the exported file of the **flume_cChat.jks** certificate. **-g** indicates the password of the certificate and certificate library.
   - **flume_sChatt.jks** and **flume_cChatt.jks** are the SSL certificate trust lists of the Flume server and client, respectively.

   NOTE

   All user-defined passwords involved in this section must meet the following requirements:

   - Contain at least four types of the following: uppercase letters, lowercase letters, digits, and special characters.
   - Contain at least eight characters and a maximum of 64 characters.
   - It is recommended that the user-defined passwords be changed periodically (for example, every three months), and certificates and trust lists be generated again to ensure security.

Step 2 On FusionInsight Manager, choose **System > User** and choose **More > Download Authentication Credential** to download the Kerberos certificate file of user **flume_hdfs** and save it to the local host.

Step 3 Configure the server parameters of the Flume role and upload the configuration file to the cluster.

1. Log in to any node where the Flume role is located as user **omm**. Run the following command to go to **${BIGDATA_HOME}/FusionInsight_Porter_8.1.0.1/install/FusionInsight-Flume-**Flume component version**/flume/bin**:

   cd ${BIGDATA_HOME}/FusionInsight_Porter_8.1.0.1/install/FusionInsight-Flume-Flume component version**/flume/bin**

2. Run the following command to generate and obtain Flume server keystore password, trust list password, and keystore-password encrypted private key information. Enter the password twice and confirm the password. It is the password of the **flume_sChat.jks** certificate library.

   ./genPwFile.sh

   cat password.property

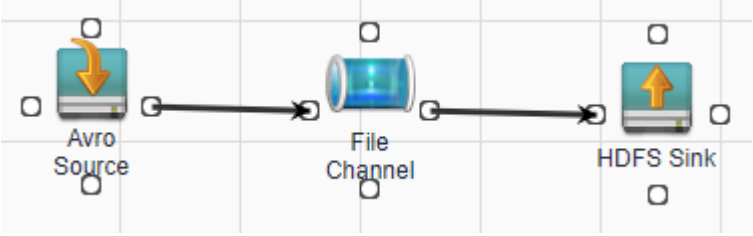
3. Use the Flume configuration tool on the FusionInsight Manager portal to configure the server parameters and generate the configuration file.

   a. Log in to FusionInsight Manager and choose **Cluster** > *Name of the desired cluster* > **Services** > **Flume** > **Configuration Tool**.

   b. Set **Agent Name** to **server**. Select the source, channel, and sink to be used, drag them to the GUI on the right, and connect them.

      For example, use Avro Source, File Channel, and HDFS Sink.

      Figure 6-17 Example for the Flume configuration tool

   c. Double-click the source, channel, and sink. Set corresponding configuration parameters by seeing **Table 6-42** based on the actual environment.

NOTE

- If the server parameters of the Flume role have been configured, you can choose **Cluster** > *Name of the desired cluster* > **Services** > **Flume** > **Instance** on FusionInsight Manager. Then select the corresponding Flume role instance and click the **Download** button behind the **flume.config.file** parameter on the **Instance Configurations** page to obtain the existing server parameter configuration file. Choose **Cluster** > *Name of the desired cluster* > **Services** > **Flume** > **Configuration Tool** > **Import**, import the file, and modify the configuration items related to encrypted transmission.
- It is recommended that the numbers of Sources, Channels, and Sinks do not exceed 40 during configuration file import. Otherwise, the response time may be very long.
- A unique checkpoint directory needs to be configured for each File Channel.

d. Click **Export** to save the **properties.properties** configuration file to the local.

Table 6-42 Parameters to be modified of the Flume role server

Parameter	Description	Example Value
Name	The value must be unique and cannot be left blank.	test
bind	Specifies the IP address to which Avro Source is bound. This parameter cannot be left blank. It must be configured as the IP address that the server configuration file will upload.	192.168.108.11
port	Specifies the IP address to which Avro Source is bound. This parameter cannot be left blank. Set this parameter to a port that is not in use.	21154
ssl	Indicates whether to enable the SSL authentication. (You are advised to enable this function to ensure security.) Only Sources of the Avro type have this configuration item. ■ **true** indicates that the function is enabled. ■ **false** indicates that the client authentication function is not enabled.	true

Parameter	Description	Example Value
keystore	Indicates the server certificate.	**${BIGDATA_HOME}/FusionInsight_Porter_8.1.0.1/install/FusionInsight-Flume-**Flume component version**/flume/conf/flume_sChat.jks**
keystore-password	Specifies the password of the key library, which is the password required to obtain the keystore information. Enter the value of **password** obtained in **Step 3.2**.	-
truststore	Indicates the SSL certificate trust list of the server.	**${BIGDATA_HOME}/FusionInsight_Porter_8.1.0.1/install/FusionInsight-Flume-**Flume component version**/flume/conf/flume_sChatt.jks**
truststore-password	Specifies the trust list password, which is the password required to obtain the truststore information. Enter the value of **password** obtained in **Step 3.2**.	-
dataDirs	Specifies the directory for storing buffer data. The run directory is used by default. Configuring multiple directories on disks can improve transmission efficiency. Use commas (,) to separate multiple directories. If the directory is inside the cluster, the **/srv/BigData/hadoop/dataX/flume/data** directory can be used. **dataX** ranges from data1 to dataN. If the directory is outside the cluster, it needs to be independently planned.	/srv/BigData/hadoop/data1/flumeserver/data

Parameter	Description	Example Value
checkpointDir	Specifies the directory for storing the checkpoint information, which is under the run directory by default. If the directory is inside the cluster, the **/srv/BigData/hadoop/dataX/flume/checkpoint** directory can be used. **dataX** ranges from data1 to dataN. If the directory is outside the cluster, it needs to be independently planned.	/srv/BigData/hadoop/data1/flumeserver/checkpoint
transactionCapacity	Specifies the transaction size, that is, the number of events in a transaction that can be processed by the current Channel. The size cannot be smaller than the batchSize of Source. Setting the same size as batchSize is recommended.	61200
hdfs.path	Specifies the HDFS data write directory. This parameter cannot be left blank.	hdfs://hacluster/flume/test
hdfs.inUsePrefix	Specifies the prefix of the file that is being written to HDFS.	TMP_
hdfs.batchSize	Specifies the maximum number of events that can be written to HDFS once.	61200
hdfs.kerberosPrincipal	Specifies the Kerberos authentication user, which is mandatory in security versions. This configuration is required only in security clusters.	flume_hdfs
hdfs.kerberosKeytab	Specifies the keytab file path for Kerberos authentication, which is mandatory in security versions. This configuration is required only in security clusters.	/opt/test/conf/user.keytab **NOTE** Obtain the **user.keytab** file from the Kerberos certificate file of the user **flume_hdfs**. In addition, ensure that the user who installs and runs the Flume client has the read and write permissions on the **user.keytab** file.

Parameter	Description	Example Value
hdfs.useLocalTimeStamp	Specifies whether to use the local time. Possible values are **true** and **false**.	true

4. Log in to FusionInsight Manager and choose **Cluster** > *Name of the desired cluster* > **Services** > **Flume**. On the displayed page, click the **Flume** role under **Role**.
5. Select the Flume role of the node where the configuration file is to be uploaded, choose **Instance Configurations** > **Import** beside the **flume.config.file**, and select the **properties.properties** file.

   NOTE

   - An independent server configuration file can be uploaded to each Flume instance.
   - This step is required for updating the configuration file. Modifying the configuration file on the background is an improper operation because the modification will be overwritten after configuration synchronization.
6. Click **Save**, and then click **OK**.
7. Click **Finish**.

Step 4 Configure the client parameters of the Flume role.

1. Run the following commands to copy the generated client certificate (**flume_cChat.jks**) and client trust list (**flume_cChatt.jks**) to the client directory, for example, **/opt/flume-client/fusionInsight-flume-***Flume component version***/conf/**. (The Flume client must have been installed.) **10.196.26.1** is the service plane IP address of the node where the client resides.

   scp ${BIGDATA_HOME}/FusionInsight_Porter_8.1.0.1/install/FusionInsight-Flume-Flume component version**/flume/conf/flume_cChat.jks user@10.196.26.1:/opt/flume-client/fusionInsight-flume-**Flume component version**/conf/**

   scp ${BIGDATA_HOME}/FusionInsight_Porter_8.1.0.1/install/FusionInsight-Flume-Flume component version**/flume/conf/flume_cChatt.jks user@10.196.26.1:/opt/flume-client/fusionInsight-flume-**Flume component version**/conf/**

   NOTE

   When copying the client certificate, you need to enter the password of user **user** of the host (for example, **10.196.26.1**) where the client resides.
2. Log in to the node where the Flume client is decompressed as user **user**. Run the following command to go to the client directory **opt/flume-client/fusionInsight-flume-***Flume component version***/bin**:

   cd opt/flume-client/fusionInsight-flume-Flume component version**/bin**
3. Run the following command to generate and obtain Flume client keystore password, trust list password, and keystore-password encrypted private key information. Enter the password twice and confirm the password. The password is the same as the password of the certificate whose alias is *flumechatclient* and the password of the *flume_cChat.jks* certificate library.

./genPwFile.sh

cat password.property

NOTE

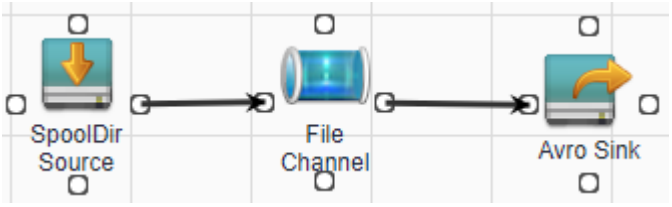
If the following error message is displayed, run the export **JAVA_HOME=*JDKpath*** command.

```
JAVA_HOME is null in current user,please install the JDK and set the JAVA_HOME
```

4. Run the **echo $SCC_PROFILE_DIR** command to check whether the **SCC_PROFILE_DIR** environment variable is empty.
   - If yes, run the **source .sccfile** command.
   - If no, go to **Step 4.5**.
5. Use the Flume configuration tool on FusionInsight Manager to configure the Flume role client parameters and generate a configuration file.
   a. Log in to FusionInsight Manager and choose **Cluster** > *Name of the desired cluster* > **Services** > **Flume** > **Configuration Tool**.
   b. Set **Agent Name** to **client**. Select the source, channel, and sink to be used, drag them to the GUI on the right, and connect them.

      Use SpoolDir Source, File Channel, and Avro Sink.

      Figure 6-18 Example for the Flume configuration tool

   c. Double-click the source, channel, and sink. Set corresponding configuration parameters by seeing **Table 6-43** based on the actual environment.

      NOTE

      - If the client parameters of the Flume role have been configured, you can obtain the existing client parameter configuration file from *client installation directory*/**fusioninsight-flume-***Flume component version*/**conf/** properties.properties to ensure that the configuration is in concordance with the previous. Log in to FusionInsight Manager, choose **Cluster** > *Name of the desired cluster* > **Services** > **Flume** > **Configuration Tool** > **Import**, import the file, and modify the configuration items related to encrypted transmission.
      - It is recommended that the numbers of Sources, Channels, and Sinks do not exceed 40 during configuration file import. Otherwise, the response time may be very long.

   d. Click **Export** to save the **properties.properties** configuration file to the local.

Table 6-43 Parameters to be modified of the Flume role client

Parameter	Description	Example Value
Name	The value must be unique and cannot be left blank.	test
spoolDir	Specifies the directory where the file to be collected resides. This parameter cannot be left blank. The directory needs to exist and have the write, read, and execute permissions on the flume running user.	/srv/BigData/hadoop/data1/zb
trackerDir	Specifies the path for storing the metadata of files collected by Flume.	/srv/BigData/hadoop/data1/tracker
batch-size	Specifies the number of events that Flume sends in a batch.	61200
dataDirs	Specifies the directory for storing buffer data. The run directory is used by default. Configuring multiple directories on disks can improve transmission efficiency. Use commas (,) to separate multiple directories. If the directory is inside the cluster, the **/srv/BigData/hadoop/dataX/flume/data** directory can be used. **dataX** ranges from data1 to dataN. If the directory is outside the cluster, it needs to be independently planned.	/srv/BigData/hadoop/data1/flume/data

Parameter	Description	Example Value
checkpointDir	Specifies the directory for storing the checkpoint information, which is under the run directory by default. If the directory is inside the cluster, the **/srv/BigData/hadoop/dataX/flume/checkpoint** directory can be used. **dataX** ranges from data1 to dataN. If the directory is outside the cluster, it needs to be independently planned.	/srv/BigData/hadoop/data1/flume/checkpoint
transactionCapacity	Specifies the transaction size, that is, the number of events in a transaction that can be processed by the current Channel. The size cannot be smaller than the batchSize of Source. Setting the same size as batchSize is recommended.	61200
hostname	Specifies the name or IP address of the host whose data is to be sent. This parameter cannot be left blank. Name or IP address must be configured to be the name or IP address that the Avro source associated with it.	192.168.108.11

Parameter	Description	Example Value
port	Specifies the IP address to which Avro Sink is bound. This parameter cannot be left blank. It must be consistent with the port that is monitored by the connected Avro Source.	21154
ssl	Specifies whether to enable the SSL authentication. (You are advised to enable this function to ensure security.) Only Sources of the Avro type have this configuration item. ■ **true** indicates that the function is enabled. ■ **false** indicates that the client authentication function is not enabled.	true
keystore	Specifies the **flume_cChat.jks** certificate generated on the server.	**/opt/flume-client/fusionInsight-flume-***Flume component version*/**conf/flume_cChat.jks**
keystore-password	Specifies the password of the key library, which is the password required to obtain the keystore information. Enter the value of **password** obtained in **Step 4.3**.	-
truststore	Indicates the SSL certificate trust list of the server.	**/opt/flume-client/fusionInsight-flume-***Flume component version*/**conf/flume_cChatt.jks**

Parameter	Description	Example Value
truststore-password	Specifies the trust list password, which is the password required to obtain the truststore information. Enter the value of **password** obtained in **Step 4.3**.	-

6. Upload the **properties.properties** file to **flume/conf/** under the installation directory of the Flume client.

Step 5 Generate the certificate and trust list of the server and client of the MonitorServer role respectively.

1. Log in to the host with the MonitorServer role assigned as user **omm**.

   Go to the **${BIGDATA_HOME}/FusionInsight_Porter_8.1.0.1/install/FusionInsight-Flume-**Flume component version**/flume/bin** directory.

   cd ${BIGDATA_HOME}/FusionInsight_Porter_8.1.0.1/install/FusionInsight-Flume-Flume component version**/flume/bin**

2. Run the following command to generate and export the server and client certificates of the MonitorServer role:

   sh geneJKS.sh -m *Password* **-n** *Password*

   The generated certificate is stored in the **${BIGDATA_HOME}/FusionInsight_Porter_8.1.0.1/install/FusionInsight-Flume-**Flume component version**/flume/conf** directory.

   - **ms_sChat.jks** is the certificate library of the MonitorServer role server. **ms_sChat.crt** is the exported file of the **ms_sChat.jks** certificate. **-m** indicates the password of the certificate and certificate library.
   - **ms_cChat.jks** is the certificate library of the MonitorServer role client. **ms_cChat.crt** is the exported file of the **ms_cChat.jks** certificate. **-n** indicates the password of the certificate and certificate library.
   - **ms_sChatt.jks** and **ms_cChatt.jks** are the SSL certificate trust lists of the MonitorServer server and client, respectively.

Step 6 Set the server parameters of the MonitorServer role.

1. Run the following command to generate and obtain MonitorServer server keystore password, trust list password, and keystore-password encrypted private key information. Enter the password twice and confirm the password. The password is the same as the password of the certificate whose alias is *mschatserver* and the password of the *ms_sChat.jks* certificate library.

   ./genPwFile.sh

   cat password.property

2. Run the following command to open **${BIGDATA_HOME}/FusionInsight_Porter_8.1.0.1/install/FusionInsight-Flume-**Flume component version**/flume/conf/service/application.properties**: Modify related

parameters based on the description in **Table 6-44**, save the modification, and exit.

vi ${BIGDATA_HOME}/FusionInsight_Porter_8.1.0.1/install/FusionInsight-Flume-Flume component version**/flume/conf/service/application.properties**

Table 6-44 Parameters to be modified of the MonitorServer role server

Parameter	Description	Example Value
ssl_need_kspasswd_decrypt_key	Indicates whether to enable the user-defined key encryption and decryption function. (You are advised to enable this function to ensure security.) – **true** indicates that the function is enabled. – **false** indicates that the client authentication function is not enabled.	true
ssl_server_enable	Indicates whether to enable the SSL authentication. (You are advised to enable this function to ensure security.) – **true** indicates that the function is enabled. – **false** indicates that the client authentication function is not enabled.	true
ssl_server_key_store	Set this parameter based on the specific storage location.	**${BIGDATA_HOME}/FusionInsight_Porter_8.1.0.1/install/FusionInsight-Flume-**Flume component version**/flume/conf/ms_sChat.jks**
ssl_server_trust_key_store	Set this parameter based on the specific storage location.	**${BIGDATA_HOME}/FusionInsight_Porter_8.1.0.1/install/FusionInsight-Flume-**Flume component version**/flume/conf/ms_sChatt.jks**

Parameter	Description	Example Value
ssl_server_key_store_password	Indicates the keystore password. Set this parameter based on the actual situation of certificate creation (the plaintext key used to generate the certificate). Enter the value of **password** obtained in **Step 6.1**.	-
ssl_server_trust_key_store_password	Indicates the client trust list password. Set this parameter based on the actual situation of certificate creation (the plaintext key used to generate the trust list). Enter the value of **password** obtained in **Step 6.1**.	-
ssl_need_client_auth	Indicates whether to enable the client authentication. (You are advised to enable this function to ensure security.) – **true** indicates that the function is enabled. – **false** indicates that the client authentication function is not enabled.	true

3. Restart the MonitorServer instance. Choose **Cluster** > *Name of the desired cluster* > **Services** > **Flume** > **Instance** > **MonitorServer**, select the configured MonitorServer instance, and choose **More** > **Restart Instance**. Enter the cluster administrator password and click **OK**. After the restart is complete, click **Finish**.

Step 7 Set the client parameters of the MonitorServer role.

1. Run the following commands to copy the generated client certificate (**ms_cChat.jks**) and client trust list (**ms_cChatt.jks**) to the **/opt/flume-client/fusionInsight-flume-***Flume component version***/conf/ client** directory. **10.196.26.1** is the service plane IP address of the node where the client resides.

   scp ${BIGDATA_HOME}/FusionInsight_Porter_8.1.0.1/install/FusionInsight-Flume-Flume component version**/flume/conf/ms_cChat.jks user@10.196.26.1:/opt/flume-client/fusionInsight-flume-**Flume component version**/conf/**

scp ${BIGDATA_HOME}/FusionInsight_Porter_8.1.0.1/install/FusionInsight-Flume-Flume component version**/flume/conf/ms_cChatt.jks user@10.196.26.1:/opt/flume-client/fusionInsight-flume-**Flume component version**/conf/**

2. Log in to the node where the Flume client is located as user **user**. Run the following command to go to the client directory **opt/flume-client/fusionInsight-flume-***Flume component version***/bin**:

   cd opt/flume-client/fusionInsight-flume-Flume component version**/bin**

3. Run the following command to generate and obtain MonitorServer client keystore password, trust list password, and keystore-password encrypted private key information. Enter the password twice and confirm the password. The password is the same as the password of the certificate whose alias is *mschatclient* and the password of the *ms_cChat.jks* certificate library.

   ./genPwFile.sh

   cat password.property

4. Run the following command to open the **/opt/flume-client/fusionInsight-flume-**Flume component version**/conf/service/application.properties** file (**/opt/flume-client/fusionInsight-flume-***Flume component version* is the directory where the client is installed): Modify related parameters based on the description in **Table 6-45**, save the modification, and exit.

   vi /opt/flume-client/fusionInsight-flume-Flume component version**/conf/service/application.properties**

   Table 6-45 Parameters to be modified of the MonitorServer role client

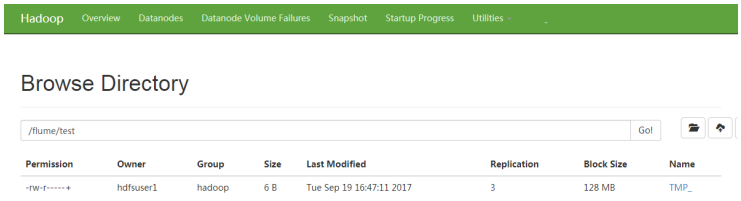
Parameter	Description	Example Value
ssl_need_kspaswd_decrypt_key	Indicates whether to enable the user-defined key encryption and decryption function. (You are advised to enable this function to ensure security.) – **true** indicates that the function is enabled. – **false** indicates that the client authentication function is not enabled.	true
ssl_client_enable	Indicates whether to enable the SSL authentication. (You are advised to enable this function to ensure security.) – **true** indicates that the function is enabled. – **false** indicates that the client authentication function is not enabled.	true

Parameter	Description	Example Value
ssl_client_key_store	Set this parameter based on the specific storage location.	**${BIGDATA_HOME}/FusionInsight_Porter_8.1.0.1/install/FusionInsight-Flume-**Flume component version**/flume/conf/ms_cChat.jks**
ssl_client_trust_key_store	Set this parameter based on the specific storage location.	**${BIGDATA_HOME}/FusionInsight_Porter_8.1.0.1/install/FusionInsight-Flume-**Flume component version**/flume/conf/ms_cChatt.jks**
ssl_client_key_store_password	Specifies the keystore password. Set this parameter based on the actual situation of certificate creation (the plaintext key used to generate the certificate). Enter the value of **password** obtained in **Step 7.3**.	-
ssl_client_trust_key_store_password	Specifies the trustkeystore password. Set this parameter based on the actual situation of certificate creation (the plaintext key used to generate the trust list). Enter the value of **password** obtained in **Step 7.3**.	-
ssl_need_client_auth	Indicates whether to enable the client authentication. (You are advised to enable this function to ensure security.) – **true** indicates that the function is enabled. – **false** indicates that the client authentication function is not enabled.	true

Step 8 Verify log transmission.

1. Log in to FusionInsight Manager as a user who has the management permission on HDFS. Choose **Cluster >** *Name of the desired cluster* > **Services** > **HDFS**, click the HDFS WebUI link to go to the HDFS WebUI, and choose **Utilities** > **Browse the file system**.
2. Check whether the data is generated in the **/flume/test** directory on the HDFS.

Figure 6-19 Checking HDFS directories and files



----End

6.12 Viewing Flume Client Monitoring Information

Scenario

The Flume client outside the FusionInsight cluster is a part of the end-to-end data collection. Both the Flume client outside the cluster and the Flume server in the cluster need to be monitored. Users can use FusionInsight Manager to monitor the Flume client and view the monitoring indicators of the Source, Sink, and Channel of the client as well as the client process status.

Procedure

Step 1 Log in to FusionInsight Manager.

Step 2 Choose **Cluster** > *Name of the desired cluster* > **Services** > **Flume** > **Flume Management** to view the current Flume client list and process status.

Step 3 Click the **Instance ID**, and view client monitoring metrics in the **Current** area.

Step 4 Click **History**. The page for querying historical monitoring data is displayed. Select a time range and click **View** to view the monitoring data within the time range.

----End

6.13 Connecting Flume to Kafka in Security Mode

Scenario

This section describes how to connect to Kafka using the Flume client in security mode.

Procedure

Step 1 Create a **jaas.conf** file and save it to **${***Flume client installation directory***} /conf**. The content of the **jaas.conf** file is as follows:

```
KafkaClient {
com.sun.security.auth.module.Krb5LoginModule required
useKeyTab=true
keyTab="/opt/test/conf/user.keytab"
principal="Flume_HDFS@<System domain name>"
useTicketCache=false
storeKey=true
debug=true;
 };
```

Set **keyTab** and **principal** based on site requirements. The configured **principal** must have certain kafka permissions.

Step 2 Configure services. Set the port number of **kafka.bootstrap.servers** to **21007**, and set **kafka.security.protocol** to **SASL_PLAINTEXT**.

Step 3 If the domain name of the cluster where Kafka is located is changed, change the value of *-Dkerberos.domain.name* in the **flume-env.sh** file in **$**{*Flume client installation directory*} **/conf/** based on the site requirements.

Step 4 Upload the configured **properties.properties** file to **$**{*Flume client installation directory*} **/conf**.

----End

6.14 Connecting Flume with Hive in Security Mode

Scenario

This section describes how to use Flume to connect to Hive (version 3.1.0) in the cluster.

Prerequisites

Flume and Hive have been correctly installed in the cluster. The services are running properly, and no alarm is reported.

Procedure

Step 1 Import the following JAR packages to the lib directory (client/server) of the Flume instance to be tested as user **omm**:

- antlr-*Version number*.jar
- antlr-runtime-*Version number*.jar
- calcite-core-*Version number*.jar
- hadoop-mapreduce-client-core-*Version number*.jar
- hive-beeline-*Version number*.jar
- hive-cli-*Version number*.jar
- hive-common-*Version number*.jar

- hive-exec-*Version number*.jar
- hive-hcatalog-core-*Version number*.jar
- hive-hcatalog-pig-adapter-*Version number*.jar
- hive-hcatalog-server-extensions-*Version number*.jar
- hive-hcatalog-streaming-*Version number*.jar
- hive-metastore-*Version number*.jar
- hive-service-*Version number*.jar
- libfb303-*Version number*.jar
- hadoop-plugins-*Version number*.jar

You can obtain the JAR package from the Hive installation directory and restart the Flume process to ensure that the JAR package is loaded to the running environment.

Step 2 Set Hive configuration items.

On FusionInsight Manager, choose **Cluster** > *Name of the desired cluster* > **Services** > **Hive**. On the page that is displayed, click the **Configurations** tab then the **All Configurations** sub-tab. On this sub-tab page, choose **HiveServer(Role)** > **Customization** > **hive.server.customized.configs**.

Table 6-46 hive.server.customized.configs parameters

Name	Value
hive.support.concurrency	true
hive.exec.dynamic.partition.mode	nonstrict
hive.txn.manager	org.apache.hadoop.hive.ql.lockmgr.DbTxnManager
hive.compactor.initiator.on	true
hive.compactor.worker.threads	1

Step 3 Prepare the system user **flume_hive** who has the supergroup and Hive permissions, install the client, and create the required Hive table.

Example:

1. Install the cluster client in **/opt/client**.
2. Run the following command to authenticate the user:

   cd /opt/client

   source bigdata_env

   kinit flume_hive
3. Run the **beeline** command and run the following table creation statement:

   ```
   create table flume_multi_type_part(id string, msg string)
   partitioned by (country string, year_month string, day string)
   clustered by (id) into 5 buckets
   stored as orc TBLPROPERTIES('transactional'='true');
   ```
4. Run the **select * from** *Table name*; command to query data in the table.

In this case, the number of data records in the table is **0**.

Step 4 Prepare related configuration files. Assume that the client installation package is stored in **/opt/FusionInsight_Cluster_1_Services_ClientConfig**.

1. Obtain the following files from the $*Client decompression directory*/**Hive/config** directory:
   - hivemetastore-site.xml
   - hive-site.xml
2. Obtain the following files from the **$***Client decompression directory*/**HDFS/config** directory:

   core-site.xml
3. Create a directory on the host where the Flume instance is started and save the prepared files to the created directory.

   Example: **/opt/hivesink-conf/hive-site.xml**.
4. Copy all property configurations in the **hivemetastore-site.xml** file to the **hive-site.xml** file and ensure that the configurations are placed before the original configurations.

   Data is loaded in sequence in Hive.

   NOTE

   Ensure that the Flume running user **omm** has the read and write permissions on the directory where the configuration file is stored.

Step 5 Observe the result.

On the Hive client, run the **select * from** *Table name***;** command. Check whether the corresponding data has been written to the Hive table.

----End

Examples

Flume configuration example (SpoolDir--Mem--Hive):

```
server.sources = spool_source
server.channels = mem_channel
server.sinks = Hive_Sink

#config the source
server.sources.spool_source.type = spooldir
server.sources.spool_source.spoolDir = /tmp/testflume
server.sources.spool_source.montime =
server.sources.spool_source.fileSuffix =.COMPLETED
server.sources.spool_source.deletePolicy = never
server.sources.spool_source.trackerDir =.flumespool
server.sources.spool_source.ignorePattern = ^$
server.sources.spool_source.batchSize = 20
server.sources.spool_source.inputCharset =UTF-8
server.sources.spool_source.selector.type = replicating
server.sources.spool_source.fileHeader = false
server.sources.spool_source.fileHeaderKey = file
server.sources.spool_source.basenameHeaderKey= basename
server.sources.spool_source.deserializer = LINE
server.sources.spool_source.deserializer.maxBatchLine= 1
server.sources.spool_source.deserializer.maxLineLength= 2048
server.sources.spool_source.channels = mem_channel

#config the channel
```

```
server.channels.mem_channel.type = memory
server.channels.mem_channel.capacity =10000
server.channels.mem_channel.transactionCapacity= 2000
server.channels.mem_channel.channelfullcount= 10
server.channels.mem_channel.keep-alive = 3
server.channels.mem_channel.byteCapacity =
server.channels.mem_channel.byteCapacityBufferPercentage= 20

#config the sink
server.sinks.Hive_Sink.type = hive
server.sinks.Hive_Sink.channel = mem_channel
server.sinks.Hive_Sink.hive.metastore = thrift://${any MetaStore service IP address}:21088
server.sinks.Hive_Sink.hive.hiveSite = /opt/hivesink-conf/hive-site.xml
server.sinks.Hive_Sink.hive.coreSite = /opt/hivesink-conf/core-site.xml
server.sinks.Hive_Sink.hive.metastoreSite = /opt/hivesink-conf/hivemeatastore-site.xml
server.sinks.Hive_Sink.hive.database = default
server.sinks.Hive_Sink.hive.table = flume_multi_type_part
server.sinks.Hive_Sink.hive.partition = Tag,%Y-%m,%d
server.sinks.Hive_Sink.hive.txnsPerBatchAsk= 100
server.sinks.Hive_Sink.hive.autoCreatePartitions= true
server.sinks.Hive_Sink.useLocalTimeStamp = true
server.sinks.Hive_Sink.batchSize = 1000
server.sinks.Hive_Sink.hive.kerberosPrincipal= super1
server.sinks.Hive_Sink.hive.kerberosKeytab= /opt/mykeytab/user.keytab
server.sinks.Hive_Sink.round = true
server.sinks.Hive_Sink.roundValue = 10
server.sinks.Hive_Sink.roundUnit = minute
server.sinks.Hive_Sink.serializer = DELIMITED
server.sinks.Hive_Sink.serializer.delimiter= ";"
server.sinks.Hive_Sink.serializer.serdeSeparator= ';'
server.sinks.Hive_Sink.serializer.fieldnames= id,msg
```

6.15 Configuring the Flume Service Model

6.15.1 Overview

Guide a reasonable Flume service configuration by providing performance differences between Flume common modules, to avoid a nonstandard overall service performance caused when a frontend Source and a backend Sink do not match in performance.

Only single channels are compared for description.

6.15.2 Service Model Configuration Guide

During Flume service configuration and module selection, the ultimate throughput of a sink must be greater than the maximum throughput of a source. Otherwise, in extreme load scenarios, the write speed of the source to a channel is greater than the read speed of sink from channel. Therefore, the channel is fully occupied due to frequent usage, and the performance is affected.

Avro Source and Avro Sink are usually used in pairs to transfer data between multiple Flume Agents. Therefore, Avro Source and Avro Sink do not become a performance bottleneck in general scenarios.

Inter-Module Performance

Based on comparison between the limit performances of modules, Kafka Sink and HDFS Sink can meet the throughput requirements when the front-end is SpoolDir Source. However, HBase Sink could become performance bottlenecks due to the

low write performances thereof. As a result, data is stacked in Channel. If you have to use HBase Sink or other sinks that are prone to become performance bottlenecks, you can use **Channel Selector** or **Sink Group** to meet performance requirements.

Channel Selector

A channel selector allows a source to connect to multiple channels. Data of the source can be distributed or copied by selecting different types of selectors. Currently, a channel selector provided by Flume can be a replicating channel selector or a multiplexing channel selector.

Replicating: indicates that the data of the source is synchronized to all channels.

Multiplexing: indicates that based on the value of a specific field of the header of an event, a channel is selected to send the data. In this way, the data is distributed based on a service type.

- Replicating configuration example:

```
client.sources = kafkasource
client.channels = channel1 channel2
client.sources.kafkasource.type = org.apache.flume.source.kafka.KafkaSource
client.sources.kafkasource.kafka.topics = topic1,topic2
client.sources.kafkasource.kafka.consumer.group.id = flume
client.sources.kafkasource.kafka.bootstrap.servers = 10.69.112.108:21007
client.sources.kafkasource.kafka.security.protocol = SASL_PLAINTEXT
client.sources.kafkasource.batchDurationMillis = 1000
client.sources.kafkasource.batchSize = 800
client.sources.kafkasource.channels = channel1 c el2

client.sources.kafkasource.selector.type = replicating
client.sources.kafkasource.selector.optional = channel2
```

Table 6-47 Parameters in the Replicating configuration example

Parameter	Default Value	Description
Selector.type	replicating	Selector type. Set this parameter to **replicating**.
Selector.optional	-	Optional channel. Configure this parameter as a list.

- Multiplexing configuration example:

```
client.sources = kafkasource
client.channels = channel1 channel2
client.sources.kafkasource.type = org.apache.flume.source.kafka.KafkaSource
client.sources.kafkasource.kafka.topics = topic1,topic2
client.sources.kafkasource.kafka.consumer.group.id = flume
client.sources.kafkasource.kafka.bootstrap.servers = 10.69.112.108:21007
client.sources.kafkasource.kafka.security.protocol = SASL_PLAINTEXT
client.sources.kafkasource.batchDurationMillis = 1000
client.sources.kafkasource.batchSize = 800
client.sources.kafkasource.channels = channel1 channel2

client.sources.kafkasource.selector.type = multiplexing
client.sources.kafkasource.selector.header = myheader
client.sources.kafkasource.selector.mapping.topic1 = channel1
```

```
client.sources.kafkasource.selector.mapping.topic2 = channel2
client.sources.kafkasource.selector.default = channel1
```

Table 6-48 Parameters in the Multiplexing configuration example

Parameter	Default Value	Description
Selector.type	replicating	Selector type. Set this parameter to **multiplexing**.
Selector.header	Flume.selector.header	-
Selector.default	-	-
Selector.mapping.*	-	-

In a multiplexing selector example, select a field whose name is topic from the header of the event. When the value of the topic field in the header is topic1, send the event to a channel 1; or when the value of the topic field in the header is topic2, send the event to a channel 2.

Selectors need to use a specific header of an event in a source to select a channel, and need to select a proper header based on a service scenario to distribute data.

SinkGroup

When the performance of a backend single sink is insufficient, and high reliability or heterogeneous output is required, you can use a sink group to connect a specified channel to multiple sinks, thereby meeting use requirements. Currently, Flume provides two types of sink processors to manage sinks in a sink group. The types are load balancing and failover.

Failover: Indicates that there is only one active sink in the sink group each time, and the other sinks are on standby and inactive. When the active sink becomes faulty, one of the inactive sinks is selected based on priorities to take over services, so as to ensure that data is not lost. This is used in high-reliability scenarios.

Load balancing: Indicates that all sinks in the sink group are active. Each sink obtains data from the channel and processes the data. In addition, during running, loads of all sinks in the sink group are balanced. This is used in performance improvement scenarios.

- Load balancing configuration examples:

```
client.sources = source1
client.sinks = sink1 sink2
client.channels = channel1

client.sinkgroups = g1
client.sinkgroups.g1.sinks = sink1 sink2
client.sinkgroups.g1.processor.type = load_balance
client.sinkgroups.g1.processor.backoff = true
client.sinkgroups.g1.processor.selector = random

client.sinks.sink1.type = logger
client.sinks.sink1.channel = channel1
```

```
client.sinks.sink2.type = logger
client.sinks.sink2.channel = channel1
```

Table 6-49 Parameters of Load Balancing configuration examples

Parameter	Default Value	Description
sinks	-	Specifies the sink list of the sink group. Multiple sinks are separated by spaces.
processor.type	default	Specifies the type of a processor. Set this parameter to **load_balance**.
processor.backoff	false	Indicates whether to back off failed sinks exponentially.
processor.selector	round_robin	Specifies the selection mechanism. It must be round_robin, random, or a customized class that inherits AbstractSinkSelector.
processor.selector.maxTimeOut	30000	Specifies the time for masking a faulty sink. The default value is 30,000 ms.

- Failover configuration examples:

```
client.sources = source1
client.sinks = sink1 sink2
client.channels = channel1

client.sinkgroups = g1
client.sinkgroups.g1.sinks = sink1 sink2
client.sinkgroups.g1.processor.type = failover
client.sinkgroups.g1.processor.priority.sink1 = 10
client.sinkgroups.g1.processor.priority.sink2 = 5
client.sinkgroups.g1.processor.maxpenalty = 10000

client.sinks.sink1.type = logger
client.sinks.sink1.channel = channel1

client.sinks.sink2.type = logger
client.sinks.sink2.channel = channel1
```

Table 6-50 Parameters in the **failover** configuration example

Parameter	Default Value	Description
sinks	-	Specifies the sink list of the sink group. Multiple sinks are separated by spaces.
processor.type	default	Specifies the type of a processor. Set this parameter to **failover**.
processor.priority.<sinkName>	-	Priority. **<sinkName>** must be defined in description of sinks. A sink having a higher priority is activated earlier. A larger value indicates a higher priority. **Note**: If there are multiple sinks, their priorities must be different. Otherwise, only one of them takes effect.
processor.maxpenalty	30000	Specifies the maximum backoff time of failed sinks (unit: ms).

Interceptors

The Flume interceptor supports modification or discarding of basic unit events during data transmission. You can specify the class name list of built-in interceptors in Flume or develop customized interceptors to modify or discard events. The following table lists the built-in interceptors in Flume. A complex example is used in this section. Other users can configure and use interceptions as required.

NOTE

1. The interceptor is used between the sources and channels of Flume. Most sources provide parameters for configuring interceptors. You can set the parameters as required.
2. Flume allows multiple interceptors to be configured for a source. The interceptor names are separated by spaces.
3. The specified interceptor sequence is the order in which they are called.
4. The contents inserted by the interceptor in the header can be read and used in sink.

Table 6-51 Types of built-in interceptors in Flume

Interceptor Type	Description
Timestamp Interceptor	The interceptor inserts a timestamp into the header of an event.
Host Interceptor	The interceptor inserts the IP address or host name of the node where the agent is located into the Header of an event.
Remove Header Interceptor	The interceptor discards the corresponding event based on the strings that matches the regular expression contained in the event header.
UUID Interceptor	The interceptor generates a UUID string for the header of each event.
Search and Replace Interceptor	The interceptor provides a simple string-based search and replacement function based on Java regular expressions. The rule is the same as that of Java Matcher.replaceAll().
Regex Filtering Interceptor	The interceptor uses the body of an event as a text file and matches the configured regular expression to filter events. The provided regular expression can be used to exclude or include events.
Regex Extractor Interceptor	The interceptor extracts content from the original events using a regular expression and adds the content to the header of events.

Regex Filtering Interceptor is used as an example to describe how to use the interceptor. (For other types of interceptions, see the configuration provided on the official website.)

Table 6-52 Parameter configuration for **Regex Filtering Interceptor**

Parameter	Default Value	Description
type	-	Specifies the component type name. The value must be **regex_filter**.
regex	-	Specifies the regular expression used to match events.
excludeEvents	false	By default, the matched events are collected. If this parameter is set to **true**, the matched events are deleted and the unmatched events are retained.

Configuration example (**netcat tcp** is used as the source, and **logger** is used as the sink). After configuring the preceding parameters, run the **telnet** *Host name or IP address* **44444** command on the host where the Linux operating system is run, and enter a string that complies with the regular expression and another does not comply with the regular expression. The log shows that only the matched string is transmitted.

```
#define the source, channel, sink
server.sources = r1

server.channels = c1
server.sinks = k1

#config the source
server.sources.r1.type = netcat
server.sources.r1.bind = ${Host IP address}
server.sources.r1.port = 44444
server.sources.r1.interceptors= i1
server.sources.r1.interceptors.i1.type= regex_filter
server.sources.r1.interceptors.i1.regex= (flume)|(myflume)
server.sources.r1.interceptors.i1.excludeEvents= false
server.sources.r1.channels = c1

#config the channel
server.channels.c1.type = memory
server.channels.c1.capacity = 1000
server.channels.c1.transactionCapacity = 100
#config the sink
server.sinks.k1.type = logger
server.sinks.k1.channel = c1
```

6.16 Introduction to Flume Logs

Log Description

Log path: The default path of Flume log files is **/var/log/Bigdata/***Role name*.

- FlumeServer: **/var/log/Bigdata/flume/flume**
- FlumeClient: **/var/log/Bigdata/flume-client-n/flume**
- MonitorServer: **/var/log/Bigdata/flume/monitor**

Log archive rule: The automatic Flume log compression function is enabled. By default, when the size of logs exceeds 50 MB , logs are automatically compressed into a log file named in the following format: *<Original log file name>-<yyyy-mm-dd_hh-mm-ss>.[ID]***.log.zip**. A maximum of 20 latest compressed files are reserved. The number of compressed files can be configured on the Manager portal.

Table 6-53 Flume log list

Type	Name	Description
Run logs	/flume/flumeServer.log	Log file that records FlumeServer running environment information.

Type	Name	Description
	/flume/install.log	FlumeServer installation log file
	/flume/flumeServer-gc.log.*<No.>*	GC archive log file of the FlumeServer process
	/flume/prestartDvietail.log	Work log file before the FlumeServer startup
	/flume/startDetail.log	Startup log file of the Flume process
	/flume/stopDetail.log	Shutdown log file of the Flume process
	/monitor/monitorServer.log	Log file that records MonitorServer running environment information
	/monitor/startDetail.log	Startup log file of the MonitorServer process
	/monitor/stopDetail.log	Shutdown log file of the MonitorServer process
	function.log	External function invoking log file
	/flume/flume-*Username-Date-pid*-gc.log	GC log file of the Flume process
	/flume/Flume-audit.log	Audit log file of the Flume client
	/flume/startAgent.out	Process parameter log file generated before Flume startup
Stack information log	threadDump-<DATE>.log	The jstack log file to be printed when the NodeAgent delivers a service stop command

Log Level

Table 6-54 describes the log levels supported by Flume.

Levels of run logs are FATAL, ERROR, WARN, INFO, and DEBUG from the highest to the lowest priority. Run logs of equal or higher levels are recorded. The higher the specified log level, the fewer the logs recorded.

Table 6-54 Log level

Type	Level	Description
Run log	FATAL	Logs of this level record critical error information about system running.
	ERROR	Logs of this level record error information about system running.
	WARN	Logs of this level record exception information about the current event processing.
	INFO	Logs of this level record normal running status information about the system and events.
	DEBUG	Logs of this level record the system information and system debugging information.

To modify log levels, perform the following operations:

Step 1 Go to the **All Configurations** page of Flume by referring to **Modifying Cluster Service Configuration Parameters**.

Step 2 On the menu bar on the left, select the log menu of the target role.

Step 3 Select a desired log level.

Step 4 Save the configuration. In the displayed dialog box, click **OK** to make the configurations take effect.

----End

NOTE

The configurations take effect immediately without the need to restart the service.

Log Format

The following table lists the Flume log formats.

Table 6-55 Log format

Type	Format	Example
Run logs	<*yyyy-MM-dd HH:mm:ss,SSS*>|<*Log level*>|<*Name of the thread that generates the log*>|<*Message in the log*>|<*Location where the log event occurs*>	2014-12-12 11:54:57,316 | INFO | [main] | log4j dynamic load is start. | org.apache.flume.tools.LogDynamicLoad.start(LogDynamicLoad.java:59)
	<*yyyy-MM-dd HH:mm:ss,SSS*><*Username*><*User IP*><*Time*><*Operation*><*Resource*><*Result*><*Detail*>	2014-12-12 23:04:16,572 | INFO | [SinkRunner-PollingRunner-DefaultSinkProcessor] | SRCIP=null OPERATION=close

6.17 Flume Client Cgroup Usage Guide

Scenario

This section describes how to join and log out of a cgroup, query the cgroup status, and change the cgroup CPU threshold.

Procedure

- **Join Cgroup**

  Assume that the Flume client installation path is **/opt/FlumeClient**, and the cgroup CPU threshold is 50%. Run the following command to join a cgroup:

  cd /opt/FlumeClient/fusioninsight-flume-*Flume component version***/bin**

  ./flume-manage.sh cgroup join 50

  NOTE

  - This command can be used to join a cgroup and change the cgroup CPU threshold.
  - The value of the CPU threshold of a cgroup ranges from 1 to 100 x *N*. *N* indicates the number of CPU cores.

- **Check Cgroup status**

  Assume that the Flume client installation path is **/opt/FlumeClient**. Run the following commands to query the cgroup status:

  cd /opt/FlumeClient/fusioninsight-flume-*Flume component version***/bin**

  ./flume-manage.sh cgroup status

- **Exit Cgroup**

  Assume that the Flume client installation path is **/opt/FlumeClient**. Run the following commands to exit cgroup:

  cd /opt/FlumeClient/fusioninsight-flume-*Flume component version***/bin**

  ./flume-manage.sh cgroup exit

NOTE

- After the client is installed, the default cgroup is automatically created. If the **-s** parameter is not configured during client installation, the default value **-1** is used. The default value indicates that the agent process is not restricted by the CPU usage.
- Joining or exiting a cgroup does not affect the agent process. Even if the agent process is not started, the joining or exiting operation can be performed successfully, and the operation will take effect after the next startup of the agent process.
- After the client is uninstalled, the cgroups created during the client installation are automatically deleted.

6.18 Secondary Development Guide for Flume Third-Party Plug-ins

Scenario

This section describes how to perform secondary development for third-party plug-ins.

Prerequisites

- You have obtained the third-party JAR package.
- The Flume server or client has been installed, for example, in the **/opt/flumeclient** directory.

Procedure

Step 1 Compress the self-developed code into a JAR package.

Step 2 Create a directory for the plug-in.

1. Go to *Flume client installation directory*/**fusionInsight-flume-*/plugins.d** and run the following command to create a directory. The directory name can be changed based on the site requirements.

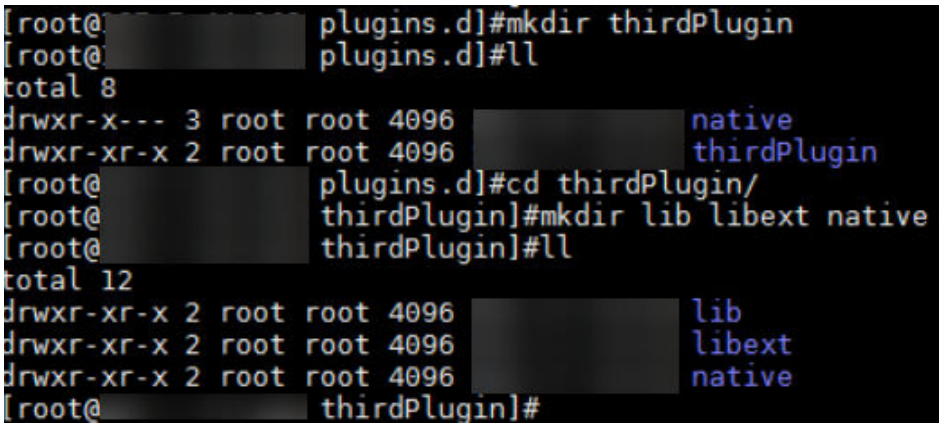
   cd /opt/flumeclient/fusioninsight-flume-*Flume component version***/plugins.d**

   mkdir thirdPlugin

   cd thirdPlugin

   mkdir lib libext native

   The command output is displayed as follows:



2. Place the third-party JAR package in *Flume client installation directory*/**fusionInsight-flume-*/plugins.d/thirdPlugin/lib**. If the JAR package depends on other JAR packages, place the dependent JAR packages in *Flume client installation directory*/**fusionInsight-flume-*/plugins.d/thirdPlugin/libext**. Stores local library files in *Flume client installation directory*/**fusionInsight-flume-*/plugins.d/thirdPlugin/native**.

Step 3 Configure the *Flume client installation directory*/**fusionInsight-flume-*/conf/properties.properties** file.

For details about how to set parameters in the **properties.properties** file, see the parameter list in the **properties.properties** file in the corresponding typical scenario **Non-Encrypted Transmission** and **Encrypted Transmission**.

----End

6.19 Common Issues About Flume

Flume logs are stored in **/var/log/Bigdata/flume/flume/flumeServer.log**. Most data transmission exceptions and data transmission failures are recorded in logs. You can run the following command:

tailf /var/log/Bigdata/flume/flume/flumeServer.log

- Problem: After the configuration file is uploaded, an exception occurs. After the configuration file is uploaded again, the scenario requirements are still not met, but no exception is recorded in the log.

  Solution: Restart the Flume process, run the **kill -9** *Process code* to kill the process code, and view the logs.

- Issue: **"java.lang.IllegalArgumentException: Keytab is not a readable file: /opt/test/conf/user.keytab"** is displayed when HDFS is connected.

  Solution: Grant the read and write permissions to the Flume running user.

- Problem: The following error is reported when the Flume client is connected to Kafka:

  ```
  Caused by: java.io.IOException: /opt/FlumeClient/fusioninsight-flume-Flume component version: /conf//jaas.conf (No such file or directory)
  ```

  Solution: Add the **jaas.conf** configuration file and save it to the **conf** directory of the Flume client.

  vi jaas.conf

```
KafkaClient {
com.sun.security.auth.module.Krb5LoginModule required
useKeyTab=true
keyTab="/opt/test/conf/user.keytab"
principal="flume_hdfs@<System domain name>"
useTicketCache=false
storeKey=true
debug=true;
};
```

Values of **keyTab** and **principal** vary depending on the actual situation.

- Problem: The following error is reported when the Flume client is connected to HBase:

  ```
  Caused by: java.io.IOException: /opt/FlumeClient/fusioninsight-flume-Flume component version: /cof//
  jaas.conf (No such file or directory)
  ```

  Solution: Add the **jaas.conf** configuration file and save it to the **conf** directory of the Flume client.

  vi jaas.conf

  ```
  Client {
  com.sun.security.auth.module.Krb5LoginModule required
  useKeyTab=true
  keyTab="/opt/test/conf/user.keytab"
  principal="flume_hbase@<System domain name>"
  useTicketCache=false
  storeKey=true
  debug=true;
  };
  ```

  Values of **keyTab** and **principal** vary depending on the actual situation.

- Question: After the configuration file is submitted, the Flume Agent occupies resources. How do I restore the Flume Agent to the state when the configuration file is not uploaded?

  Solution: Submit an empty **properties.properties** file.

7 Using HBase

7.1 Using HBase from Scratch

HBase is a column-based distributed storage system that features high reliability, performance, and scalability. This section describes how to use HBase from scratch, including how to update the client on the Master node in the cluster, create a table using the client, insert data in the table, modify the table, read data from the table, delete table data, and delete the table.

Background

Suppose a user develops an application to manage users who use service A in an enterprise. The procedure of operating service A on the HBase client is as follows:

- Create the **user_info** table.
- Add users' educational backgrounds and titles to the table.
- Query user names and addresses by user ID.
- Query information by user name.
- Deregister users and delete user data from the user information table.
- Delete the user information table after service A ends.

Table 7-1 User information

ID	Name	Gender	Age	Address
12005000201	A	Male	19	City A
12005000202	B	Female	23	City B
12005000203	C	Male	26	City C
12005000204	D	Male	18	City D
12005000205	E	Female	21	City E
12005000206	F	Male	32	City F

ID	Name	Gender	Age	Address
12005000207	G	Female	29	City G
12005000208	H	Female	30	City H
12005000209	I	Male	26	City I
12005000210	J	Male	25	City J

Prerequisites

The client has been installed in a directory, for example, **/opt/client**. The client directory in the following operations is only an example. Change it to the actual installation directory. Before using the client, download and update the client configuration file, and ensure that the active management node of Manager is available.

Procedure

Step 1 Use the client on the active management node.

1. Log in to the node where the client is installed as the client installation user and run the following command to switch to the client directory:

   cd /opt/client

2. Run the following command to configure environment variables:

   source bigdata_env

3. If Kerberos authentication has been enabled for the current cluster, run the following command to authenticate the current user. The current user must have the permission to create HBase tables. If Kerberos authentication is disabled for the current cluster, skip this step.

   kinit *MRS cluster user*

   For example, **kinit hbaseuser**.

4. Run the following HBase client command:

   hbase shell

Step 2 Run the following commands on the HBase client to implement service A.

1. Create the **user_info** user information table according to **Table 7-1** and add data to it.

   create '*user_info*',{**NAME** => 'i'}

   For example, to add information about the user whose ID is **12005000201**, run the following commands:

   put '*user_info*','*12005000201*','***i:name***','*A*'

   put '*user_info*','*12005000201*','***i:gender***','*Male*'

   put '*user_info*','*12005000201*','***i:age***','*19*'

   put '*user_info*','*12005000201*','***i:address***','*City A*'

2. Add users' educational backgrounds and titles to the **user_info** table.

For example, to add educational background and title information about user 12005000201, run the following commands:

put '*user_info*','*12005000201*','**i:degree**','*master*'

put '*user_info*','*12005000201*','**i:pose**','*manager*'

3. Query user names and addresses by user ID.

   For example, to query the name and address of user 12005000201, run the following command:

   scan'*user_info*', {**STARTROW**=>'*12005000201*',**STOPROW**=>'*12005000201*',**COLUMNS**=>['**i:name**','**i:address**']}

4. Query information by user name.

   For example, to query information about user A, run the following command:

   scan'*user_info*',{**FILTER**=>"SingleColumnValueFilter('i','name',=,'binary:*A*')"}

5. Delete user data from the user information table.

   All user data needs to be deleted. For example, to delete data of user 12005000201, run the following commands:

   - Delete all data fields of the user whose ID is 12005000201 in sequence. The following uses the **age** field as an example:

     delete '*user_info*','*12005000201*','i:age'

   - Remove all the data of the user whose ID is 12005000201.

     delete all '*user_info*','*12005000201*'

6. Delete the user information table.

   disable'*user_info*'

   drop '*user_info*'

----End

7.2 Using an HBase Client

Scenario

This section describes how to use the HBase client in an O&M scenario or a service scenario.

Prerequisites

- The client has been installed. For example, the installation directory is **/opt/hadoopclient**. The client directory in the following operations is only an example. Change it to the actual installation directory.
- Service component users have been created by the MRS cluster administrator.

  A machine-machine user needs to download the **keytab** file and a human-machine user needs to change the password upon the first login.
- If a non-**root** user uses the HBase client, ensure that the owner of the HBase client directory is this user. Otherwise, run the following command to change the owner.

  chown user:group -R *Client installation directory*/**HBase**

Using the HBase Client

Step 1 Log in to the node where the client is installed as the client installation user.

Step 2 Run the following command to go to the client directory:

cd /opt/hadoopclient

Step 3 Run the following command to configure environment variables:

source bigdata_env

Step 4 If Kerberos authentication has been enabled for the current cluster, run the following command to authenticate the current user. The current user must have the permission to create HBase tables. If Kerberos authentication is disabled for the current cluster, skip this step.

kinit *Component service user*

For example, **kinit hbaseuser**.

Step 5 Run the following HBase client command:

hbase shell

----End

Common HBase client commands

The following table lists common HBase client commands.

Table 7-2 HBase client commands

Command	Description
create	Used to create a table, for example, **create 'test', 'f1', 'f2', 'f3'**.
disable	Used to disable a specified table, for example, **disable 'test'**.
enable	Used to enable a specified table, for example, **enable 'test'**.
alter	Used to alter the table structure. You can run the **alter** command to add, modify, or delete column family information and table-related parameter values, for example, **alter 'test', {NAME => 'f3', METHOD => 'delete'}**.
describe	Used to obtain the table description, for example, **describe 'test'**.
drop	Used to delete a specified table, for example, **drop 'test'**. Before deleting a table, you must stop it.
put	Used to write the value of a specified cell, for example, **put 'test','r1','f1:c1','myvalue1'**. The cell location is unique and determined by the table, row, and column.
get	Used to get the value of a row or the value of a specified cell in a row, for example, **get 'test','r1'**.

Command	Description
scan	Used to query table data, for example, **scan 'test'**. The table name and scanner must be specified in the command.

7.3 Creating HBase Roles

Scenario

Create and configure an HBase role on Manager as an MRS cluster administrator. The HBase role can set HBase administrator permissions and read (R), write (W), create (C), execute (X), or manage (A) permissions for HBase tables and column families.

Users can create a table, query/delete/insert/update data, and authorize others to access HBase tables after they set the corresponding permissions for the specified databases or tables on HDFS.

NOTE

- HBase roles can be created in security mode, but cannot be created in normal mode.
- If the current component uses Ranger for permission control, you need to configure related policies based on Ranger for permission management. For details, see **Adding a Ranger Access Permission Policy for HBase**.

Prerequisites

- The MRS cluster administrator has understood service requirements.
- You have logged in to Manager.

Procedure

Step 1 On Manager, choose **System** > **Permission** > **Role**.

Step 2 On the displayed page, click **Create Role** and enter a **Role Name** and **Description**.

Step 3 Set **Permission**. For details, see **Table 7-3**.

HBase permissions:

- HBase Scope: Authorizes HBase tables. The minimum permission is read (R) and write (W) for columns.
- SUPER_USER_GROUP: HBase administrator permissions.

NOTE

Users have the read (R), write (W), create (C), execute (X), and administrate (A) permissions for the tables created by themselves.

Table 7-3 Setting a role

Task	Role Authorization
Setting the HBase administrator permission	In **Configure Resource Permission**, choose *Name of the desired cluster* > **HBase** and select **HBase Administrator Permission**.
Setting the permission for users to create tables	1. In **Configure Resource Permission**, choose *Name of the desired cluster* > **HBase** > **HBase Scope**. 2. Click **global**. 3. In the **Permission** column of the specified namespace, select **Create** and **Execute**. For example, select **Create** and **Execute** for the default namespace **default**.
Setting the permission for users to write data to tables	1. In **Configure Resource Permission**, choose *Name of the desired cluster* > **HBase** > **HBase Scope** > **global**. 2. In the **Permission** column of the specified namespace, select **Write**. For example, select **Write** for the default namespace **default**. By default, HBase sub-objects inherit the permission from the parent object.
Setting the permission for users to read data from tables	1. In **Configure Resource Permission**, choose *Name of the desired cluster* > **HBase** > **HBase Scope** > **global**. 2. In the **Permission** column of the specified namespace, select **Read**. For example, select **Read** for the default namespace **default**. By default, HBase sub-objects inherit the permission from the parent object.
Setting the permission for users to manage namespaces or tables	1. In **Configure Resource Permission**, choose *Name of the desired cluster* > **HBase** > **HBase Scope** > **global**. 2. In the **Permission** column of the specified namespace, select **admin**. For example, select **admin** for the default namespace **default**.

Task	Role Authorization
Setting the permission for reading data from or writing data to columns	1. In **Configure Resource Permission**, select *Name of the desired cluster* > **HBase** > **HBase Scope** > **global** and click the specified namespace to display the tables in the namespace. 2. Click a table. 3. Click a column family. 4. Confirm whether you want to create a role? – If yes, enter the column name in the **Resource Name** text box. Use commas (,) to separate multiple columns. Select **Read** or **Write**. If there are no columns with the same name in the HBase table, a newly created column with the same name as the existing column has the same permission as the existing one. The column permission is set successfully. – If no, modify the column permission of the existing HBase role. The columns for which the permission has been separately set are displayed in the table. Go to **Step 3.5**. 5. To add column permissions for a role, enter the column name in the **Resource Name** text box and set the column permissions. To modify column permissions for a role, enter the column name in the **Resource Name** text box and set the column permissions. Alternatively, you can directly modify the column permissions in the table. If the column permissions are modified in the table and column permissions with the same name are added, the settings cannot be saved. You are advised to modify the column permission of a role directly in the table. The search function is supported.

Step 4 Click **OK**, and return to the **Role** page.

----End

7.4 Configuring HBase Replication

Scenario

As a key feature to ensure high availability of the HBase cluster system, HBase cluster replication provides HBase with remote data replication in real time. It provides basic O&M tools, including tools for maintaining and re-establishing active/standby relationships, verifying data, and querying data synchronization progress. To achieve real-time data replication, you can replicate data from the HBase cluster to another one.

Prerequisites

- The active and standby clusters have been successfully installed and started (the cluster status is **Running** on the **Active Clusters** page), and you have the administrator rights of the clusters.
- The network between the active and standby clusters is normal and ports can be used properly.
- Cross-cluster mutual trust must have been configured for the active and standby clusters.
- If historical data exists in the active cluster and needs to be synchronized to the standby cluster, cross-cluster replication must be configured for the active and standby clusters. For details, see **Enabling Cross-Cluster Copy**.
- Time is consistent between the active and standby clusters and the Network Time Protocol (NTP) service on the active and standby clusters uses the same time source.
- Mapping relationships between the names of all hosts in the active and standby clusters and service IP addresses have been configured in the **/etc/hosts** file by appending **192.***.***.*** **host1** to the **hosts** file.
- The network bandwidth between the active and standby clusters is determined based on service volume, which cannot be less than the possible maximum service volume.

Constraints

- Despite that HBase cluster replication provides the real-time data replication function, the data synchronization progress is determined by several factors, such as the service loads in the active cluster and the health status of processes in the standby cluster. In normal cases, the standby cluster should not take over services. In extreme cases, system maintenance personnel and other decision makers determine whether the standby cluster takes over services according to the current data synchronization indicators.
- Currently, the replication function supports only one active cluster and one standby cluster in HBase.
- Typically, do not perform operations on data synchronization tables in the standby cluster, such as modifying table properties or deleting tables. If any misoperation on the standby cluster occurs, data synchronization between the active and standby clusters will fail and data of the corresponding table in the standby cluster will be lost.
- If the replication function of HBase tables in the active cluster is enabled for data synchronization, after modifying the structure of a table in the active cluster, you need to manually modify the structure of the corresponding table in the standby cluster to ensure table structure consistency.

Procedure

Enable the replication function for the active cluster to synchronize data written by Put.

Step 1 Log in to the MRS console, click a cluster name and choose **Components**.

Step 2 Go to the **All Configurations** page of the HBase service. For details, see **Modifying Cluster Service Configuration Parameters**.

NOTE

If the **Components** tab is unavailable, complete IAM user synchronization first. (On the **Dashboard** page, click **Synchronize** on the right side of **IAM User Sync** to synchronize IAM users.)

Step 3 (Optional) Set configuration items listed in **Table 7-4**. You can set the parameters based on the description or use the default values.

Table 7-4 Optional configuration items

Navigation Path	Parameter	Default Value	Description
HMaster > Performance	hbase.master.logcleaner.ttl	600000	Time to live (TTL) of HLog files. If the value is set to **604800000** (unit: millisecond), the retention period of HLog is 7 days.
	hbase.master.cleaner.interval	60000	Interval for the HMaster to delete historical HLog files. The HLog that exceeds the configured period will be automatically deleted. You are advised to set it to the maximum value to save more HLogs.
RegionServer > Replication	replication.source.size.capacity	16777216	Maximum size of edits, in bytes. If the edit size exceeds the value, HLog edits will be sent to the standby cluster.
	replication.source.nb.capacity	25000	Maximum number of edits, which is another condition for triggering HLog edits to be sent to the standby cluster. After data in the active cluster is synchronized to the standby cluster, the active cluster reads and sends data in HLog according to this parameter value. This parameter is used together with **replication.source.size.capacity**.
	replication.source.maxretriesmultiplier	10	Maximum number of retries when an exception occurs during replication.
	replication.source.sleepforretries	1000	Retry interval (unit: ms)

Navigation Path	Parameter	Default Value	Description
	hbase.regionserver.replication.handler.count	6	Number of replication RPC server instances on RegionServer

Enable the replication function for the active cluster to synchronize data written by bulkload.

Step 4 Determine whether to enable bulkload replication.

NOTE

If bulkload import is used and data needs to be synchronized, you need to enable Bulkload replication.

If yes, go to **Step 5**.

If no, go to **Step 9**.

Step 5 Go to the **All Configurations** page of the HBase service parameters by referring to **Modifying Cluster Service Configuration Parameters**.

Step 6 On the HBase configuration interface of the active and standby clusters, search for **hbase.replication.cluster.id** and modify it. It specifies the HBase ID of the active and standby clusters. For example, the HBase ID of the active cluster is set to **replication1** and the HBase ID of the standby cluster is set to **replication2** for connecting the active cluster to the standby cluster. To save data overhead, the parameter value length is not recommended to exceed 30.

Step 7 On the HBase configuration interface of the standby cluster, search for **hbase.replication.conf.dir** and modify it. It specifies the HBase configurations of the active cluster client used by the standby cluster and is used for data replication when the bulkload data replication function is enabled. The parameter value is a path name, for example, **/home**.

NOTE

- When bulkload replication is enabled, you need to manually place the HBase client configuration files (**core-site.xml**, **hdfs-site.xml**, and **hbase-site.xml**) in the active cluster on all RegionServer nodes in the standby cluster. The actual path for placing the configuration file is **${hbase.replication.conf.dir}/${hbase.replication.cluster.id}**. For example, if **hbase.replication.conf.dir** of the standby cluster is set to **/home** and **hbase.replication.cluster.id** of the active cluster is set to **replication1**, the actual path for placing the configuration files in the standby cluster is **/home/replication1**. You also need to change the corresponding directory and file permissions by running the **chown -R omm:wheel /home/replication1** command.
- You can obtain the client configuration file from a directory on the client in the active cluster, for example, **/opt/client/HBase/hbase/conf**.

Step 8 On the HBase configuration page of the active cluster, search for and change the value of **hbase.replication.bulkload.enabled** to **true** to enable bulkload replication.

Restarting the HBase service and install the client

Step 9 Save the configurations and restart HBase.

Step 10 In the active and standby clusters, update the client configuration file.

Synchronize table data of the active cluster. (Skip this step if the active cluster has no data.)

Step 11 Access the HBase shell of the active cluster as user **hbase**.

1. On the active management node where the client has been updated, run the following command to go to the client directory:

   cd /opt/client

2. Run the following command to configure environment variables:

   source bigdata_env

3. If Kerberos authentication is enabled for the current cluster, run the following command to authenticate the current user. If Kerberos authentication is disabled for the current cluster, skip this step.

   kinit hbase

   NOTE

   The system prompts you to enter the password after you run **kinit hbase**. To obtain the default password of user **hbase**, contact the system administrator.

4. Run the following HBase client command:

   hbase shell

Step 12 Check whether historical data exists in the standby cluster. If historical data exists and data in the active and standby clusters must be consistent, delete data from the standby cluster first.

1. On the HBase shell of the standby cluster, run the **list** command to view the existing tables in the standby cluster.
2. Delete data tables from the standby cluster based on the output list.

   disable '*tableName*'

   drop '*tableName*'

Step 13 After HBase replication is configured and data synchronization is enabled, check whether tables and data exist in the active cluster and whether the historical data needs to be synchronized to the standby cluster.

Run the **list** command to check the existing tables in the active cluster and run the **scan** '*tableName*' command to check whether the tables contain historical data.

- If tables exist and data needs to be synchronized, go to **Step 14**.
- If no, no further action is required.

Step 14 The HBase replication configuration does not support automatic synchronization of historical data in tables. You need to back up the historical data of the active cluster and then manually synchronize the historical data to the standby cluster.

Manual synchronization refers to the synchronization of a single table that is implemented by Export, distcp, and Import.

The process for manually synchronizing data of a single table is as follows:

1. Export table data from the active cluster.

   hbase org.apache.hadoop.hbase.mapreduce.Export -Dhbase.mapreduce.include.deleted.rows=true *Table name Directory where the source data is stored*

   Example: **hbase org.apache.hadoop.hbase.mapreduce.Export -Dhbase.mapreduce.include.deleted.rows=true t1 /user/hbase/t1**

2. Copy the data that has been exported to the standby cluster.

   hadoop distcp *Directory for storing source data in the active cluster* **hdfs://***ActiveNameNodeIP*:**9820/** *Directory for storing source data in the standby cluster*

   ActiveNameNodeIP indicates the IP address of the active NameNode in the standby cluster.

   Example: **hadoop distcp /user/hbase/t1 hdfs://192.168.40.2:9820/user/hbase/t1**

3. Import data to the standby cluster as the HBase table user of the standby cluster.

   hbase org.apache.hadoop.hbase.mapreduce.Import -*Dimport.bulk.output=Directory where the output data is stored in the standby cluster Table name Directory where the source data is stored in the standby cluster*

   hbase org.apache.hadoop.hbase.mapreduce.LoadIncrementalHFiles *Directory where the output data is stored in the standby cluster Table name*

   For example, **hbase org.apache.hadoop.hbase.mapreduce.Import -Dimport.bulk.output=/user/hbase/output_t1 t1 /user/hbase/t1** and

   hbase org.apache.hadoop.hbase.mapreduce.LoadIncrementalHFiles /user/hbase/output_t1 t1

Add the replication relationship between the active and standby clusters.

Step 15 Run the following command on the HBase Shell to create the replication synchronization relationship between the active cluster and the standby cluster:

add_peer '*Standby cluster ID', CLUSTER_KEY => 'ZooKeeper address of the standby cluster*',**{HDFS_CONFS => true}**

- *Standby cluster ID* indicates an ID for the active cluster to recognize the standby cluster. It is recommended that the ID contain letters and digits.
- The ZooKeeper address of the standby cluster includes the service IP address of ZooKeeper, the port for listening to client connections, and the HBase root directory of the standby cluster on ZooKeeper.
- **{HDFS_CONFS => true}** indicates that the default HDFS configuration of the active cluster will be synchronized to the standby cluster. This parameter is used for HBase of the standby cluster to access HDFS of the active cluster. If bulkload replication is disabled, you do not need to use this parameter.

  Suppose the standby cluster ID is replication2 and the ZooKeeper address of the standby cluster is **192.168.40.2,192.168.40.3,192.168.40.4:2181:/hbase**.

  – Run the **add_peer 'replication2',CLUSTER_KEY => '192.168.40.2,192.168.40.3,192.168.40.4:2181:/hbase',CONFIG => { "hbase.regionserver.kerberos.principal" => "<val>", "hbase.master.kerberos.principal" => "<val2>" }** command for a

security cluster and the **add_peer 'replication2',CLUSTER_KEY => '192.168.40.2,192.168.40.3,192.168.40.4:2181:/hbase'** command for a common cluster.

The **hbase.master.kerberos.principal** and **hbase.regionserver.kerberos.principal** parameters are the Kerberos users of HBase in the security cluster. You can search the **hbase-site.xml** file on the client for the parameter values. For example, if the client is installed in the **/opt/client** directory of the master node, you can run the **grep "kerberos.principal" /opt/client/HBase/hbase/conf/hbase-site.xml -A1** command to obtain the parameter value.

Figure 7-1 Obtaining the principal of HBase

```
[root@xxxxxx opt]# grep "kerberos.principal" /opt/client/HBase/hbase/conf/hbase-site.xml -A1
<name>hbase.regionserver.kerberos.principal</name>
<value>hbase/hadoop.hadoop.com@HADOOP.COM</value>
--
<name>hbase.master.kerberos.principal</name>
<value>hbase/hadoop.hadoop.com@HADOOP.COM</value>
--
```

NOTE

1. Obtain the ZooKeeper service IP address.

   Log in to the MRS console, click the cluster name, and choose **Components** > **ZooKeeper** > **Instances** to obtain the ZooKeeper service IP address.
2. On the ZooKeeper service parameter configuration page, search for clientPort, which is the port for the client to connect to the server.
3. Run the **list_peers** command to check whether the replication relationship between the active and standby clusters is added. If the following information is displayed, the relationship is successfully added.

   ```
   hbase(main):003:0> list_peers
   PEER_ID CLUSTER_KEY ENDPOINT_CLASSNAME STATE REPLICATE_ALL NAMESPACES
   TABLE_CFS BANDWIDTH SERIAL
   replication2 192.168.0.13,192.168.0.177,192.168.0.25:2181:/hbase ENABLED  true   0 false
   ```

Specify the data writing status for the active and standby clusters.

Step 16 On the HBase shell of the active cluster, run the following command to retain the data writing status:

set_clusterState_active

The command is run successfully if the following information is displayed:

```
hbase(main):001:0> set_clusterState_active
=> true
```

Step 17 On the HBase shell of the standby cluster, run the following command to retain the data read-only status:

set_clusterState_standby

The command is run successfully if the following information is displayed:

```
hbase(main):001:0> set_clusterState_standby
=> true
```

Enable the HBase replication function to synchronize data.

Step 18 Check whether a namespace exists in the HBase service instance of the standby cluster and the namespace has the same name as the namespace of the HBase table for which the replication function is to be enabled.

On the HBase shell of the standby cluster, run the **list_namespace** command to query the namespace.

- If the same namespace exists, go to **Step 19**.
- If the same namespace does not exist, on the HBase shell of the standby cluster, run the following command to create a namespace with the same name and go to **Step 19**:

  create_namespace'ns1

Step 19 On the HBase shell of the active cluster, run the following command to enable real-time replication for tables in the active cluster. This ensures that modified data in the active cluster can be synchronized to the standby cluster in real time.

You can only synchronize data of one HTable at one time.

enable_table_replication '*Table name***'**

NOTE

- If the standby cluster does not contain a table with the same name as the table for which real-time synchronization is to be enabled, the table is automatically created.
- If a table with the same name as the table for which real-time synchronization is to be enabled exists in the standby cluster, the structures of the two tables must be the same.
- If the encryption algorithm SMS4 or AES is configured for '*Table name*', the function for synchronizing data from the active cluster to the standby cluster cannot be enabled for the HBase table.
- If the standby cluster is offline or has tables with the same name but different structures, the replication function cannot be enabled.

  If the standby cluster is offline, start it.

  If the standby cluster has a table with the same name but different structure, modify the table structure to make it as the same as the table structure of the active cluster. On the HBase shell of the standby cluster, run the ***alter*** command to change the password by referring to the example.

Step 20 On the HBase shell of the active cluster, run the following command to enable the real-time replication function for the active cluster to synchronize the HBase permission table:

enable_table_replication 'hbase:acl'

NOTE

After the permission of the active HBase source data table is modified, to ensure that the standby cluster can properly read data, modify the role permission for the standby cluster.

Check the data synchronization status for the active and standby clusters.

Step 21 Run the following command on the HBase client to check the synchronized data of the active and standby clusters. After the replication function is enabled, you can run this command to check whether the newly synchronized data is consistent.

hbase org.apache.hadoop.hbase.mapreduce.replication.VerifyReplication --starttime=*Start time* **--endtime**=*End time Column family name ID of the standby cluster Table name*

NOTE

- The start time must be earlier than the end time.
- The value of **starttime** and **endtime** must be in the timestamp format. You need to run **date -d "2015-09-30 00:00:00" +%s to** change a common time format to a timestamp format. The command output is a 10-digit number (accurate to second), but HBase identifies a 13-digit number (accurate to millisecond). Therefore, you need to add three zeros (000) to the end of the command output.

Switch over active and standby clusters.

NOTE

1. If the standby cluster needs to be switched over to the active one, reconfigure the active/standby relationship by referring to **Step 2** to **Step 10** and **Step 15** to **Step 20**.
2. Do not perform **Step 11** to **Step 14**.

----End

Related Commands

Table 7-5 HBase replication

Operation	Command	Description
Set up the active/standby relationship.	**add_peer** *'Standby cluster ID', 'Standby cluster address'* Examples: **add_peer '1', 'zk1,zk2,zk3:2181:/hbase'** **add_peer '1', 'zk1,zk2,zk3:2181:/hbase1'**	Set up the relationship between the active cluster and the standby cluster. To enable bulkload replication, run the **add_peer** *'Standby cluster ID'*,***CLUSTER_KEY =>*** *'Standby cluster address'* command, configure **hbase.replication.conf.dir**, and manually copy the HBase client configuration file in the active cluster to all RegionServer nodes in the standby cluster. For details, see **Step 4** to **11**.
Remove the active/standby relationship.	**remove_peer** *'Standby cluster ID'* Example: **remove_peer '1'**	Remove standby cluster information from the active cluster.
Query the active/standby relationship.	**list_peers**	Query standby cluster information (mainly Zookeeper information) in the active cluster.

Operation	Command	Description
Enable the real-time user table synchronization function.	**enable_table_replication** *'Table name'* Example: **enable_table_replication 't1'**	Synchronize user tables from the active cluster to the standby cluster.
Disable the real-time user table synchronization function.	**disable_table_replication** *'Table name'* Example: **disable_table_replication 't1'**	Do not synchronize user tables from the active cluster to the standby cluster.
Verify data of the active and standby clusters.	**bin/hbase org.apache.hadoop.hbase.mapreduce.replication.VerifyReplication** *--starttime --endtime Column family name Standby cluster ID Table name*	Verify whether data of the specified table is the same between the active cluster and the standby cluster. The description of the parameters in this command is as follows: ● Start time: If start time is not specified, the default value **0** will be used. ● End time: If end time is not specified, the time when the current operation is submitted will be used by default. ● Table name: If a table name is not entered, all user tables for which the real-time synchronization function is enabled will be verified by default.
Switch the data writing status.	**set_clusterState_active** **set_clusterState_standby**	Specifies whether data can be written to the cluster HBase tables.

Operation	Command	Description
Add or update the active cluster HDFS configurations saved in the peer cluster.	**set_replication_hdfs_confs 'PeerId', {'key1' => 'value1', 'key2' => 'value2'}**	Enable replication for data including bulkload data. When HDFS parameters are modified in the active cluster, the modification cannot be automatically synchronized to the standby cluster. You need to manually run the command to synchronize the changes. The affected parameters are as follows: • fs.defaultFS • dfs.client.failover.proxy.provider.hacluster • dfs.client.failover.connection.retries.on.timeouts • dfs.client.failover.connection.retries For example, if the value of **fs.defaultFS** is changed to **hdfs://hacluster_sale**, run the **set_replication_hdfs_confs '1', {'fs.defaultFS' => 'hdfs://hacluster_sale'}** command to synchronization the HDFS configuration to the standby cluster whose ID is 1.

7.5 Configuring HBase Parameters

NOTE

The operations described in this section apply only to clusters of versions earlier than MRS 3.x.

If the default parameter settings of the MRS service cannot meet your requirements, you can modify the parameter settings as required.

Step 1 Go to the cluster details page and choose **Components**.

NOTE

If the **Components** tab is unavailable, complete IAM user synchronization first. (On the **Dashboard** page, click **Synchronize** on the right side of **IAM User Sync** to synchronize IAM users.)

Step 2 Choose **HBase** > **Service Configuration** and switch **Basic** to **All**. On the displayed HBase configuration page, modify parameter settings.

Table 7-6 HBase parameters

Parameter	Description	Value
hbase.regionserver.hfile.durable.sync	Whether to enable the HFile durability to make data persistence on disks. If this parameter is set to **true**, HBase performance is affected because each HFile is synchronized to disks by **hadoop fsync** when being written to HBase. This parameter exists only in MRS 1.9.2 or earlier.	Possible values are as follows: • **true** • **false** The default value is **true**.
hbase.regionserver.wal.durable.sync	Specifies whether to enable WAL file durability to make the WAL data persistence on disks. If this parameter is set to **true**, HBase performance is affected because each edited WAL file is synchronized to disks by **hadoop fsync** when being written to HBase. This parameter exists only in MRS 1.9.2 or earlier.	Possible values are as follows: • **true** • **false** The default value is **true**.

----End

7.6 Enabling Cross-Cluster Copy

Scenario

DistCp is used to copy the data stored on HDFS from a cluster to another cluster. DistCp depends on the cross-cluster copy function, which is disabled by default. This function needs to be enabled in both clusters.

Modify parameters on MRS to enable cross-cluster copy.

Impact on the System

Yarn needs to be restarted to enable the cross-cluster copy function and cannot be accessed during the restart.

Prerequisites

The **hadoop.rpc.protection** parameter of the two HDFS clusters must be set to the same data transmission mode, which can be **privacy** (encryption enabled) or **authentication** (encryption disabled).

NOTE

Go to the **All Configurations** page by referring to **Modifying Cluster Service Configuration Parameters** and search for **hadoop.rpc.protection**.

Procedure

Step 1 Go to the **All Configurations** page of the Yarn service. For details, see **Modifying Cluster Service Configuration Parameters**.

NOTE

If the **Components** tab is unavailable, complete IAM user synchronization first. (On the **Dashboard** page, click **Synchronize** on the right side of **IAM User Sync** to synchronize IAM users.)

Step 2 In the navigation pane, choose **Yarn** > **Distcp**.

Step 3 Set **haclusterX.remotenn1** of **dfs.namenode.rpc-address** to the service IP address and RPC port number of one NameNode instance of the peer cluster, and set **haclusterX.remotenn2** to the service IP address and RPC port number of the other NameNode instance of the peer cluster. Enter a value in the *IP address:port* format.

NOTE

You can log in to FusionInsight Manager, choose **Cluster** > **Services** > **HDFS**, and click **Instance** to obtain the service IP address of the NameNode instance.

dfs.namenode.rpc-address.haclusterX.remotenn1 and **dfs.namenode.rpc-address.haclusterX.remotenn2** do not distinguish active and standby NameNode instances. The default NameNode RPC port is 9820 and cannot be modified on MRS Manager.

For example, **10.1.1.1:9820** and **10.1.1.2:9820**.

Step 4 Save the configuration. On the **Dashboard** tab page, and choose **More** > **Restart Service** to restart the Yarn service.

Operation succeeded is displayed. Click **Finish**. The Yarn service is started successfully.

Step 5 Log in to the other cluster and repeat the preceding operations.

----End

7.7 Using the ReplicationSyncUp Tool

Prerequisites

1. Active and standby clusters have been installed and started.
2. Time is consistent between the active and standby clusters and the NTP service on the active and standby clusters uses the same time source.
3. When the HBase service of the active cluster is stopped, the ZooKeeper and HDFS services must be started and run.
4. ReplicationSyncUp must be run by the system user who starts the HBase process.

5. In security mode, ensure that the HBase system user of the standby cluster has the read permission on HDFS of the active cluster. This is because that it will update the ZooKeeper nodes and HDFS files of the HBase system.
6. When HBase of the active cluster is faulty, the ZooKeeper, file system, and network of the active cluster are still available.

Scenarios

The replication mechanism can use WAL to synchronize the state of a cluster with the state of another cluster. After HBase replication is enabled, if the active cluster is faulty, ReplicationSyncUp synchronizes incremental data from the active cluster to the standby cluster using the information from the ZooKeeper node. After data synchronization is complete, the standby cluster can be used as an active cluster.

Parameter Configuration

Parameter	Description	Default Value
hbase.replication.bulkload.enabled	Whether to enable the bulkload data replication function. The parameter value type is Boolean. To enable the bulkload data replication function, set this parameter to **true** for the active cluster.	**false**
hbase.replication.cluster.id	ID of the source HBase cluster. After the bulkload data replication is enabled, this parameter is mandatory and must be defined in the source cluster. The parameter value type is String.	-

Tool Usage

Run the following command on the client of the active cluster:

hbase org.apache.hadoop.hbase.replication.regionserver.ReplicationSyncUp -Dreplication.sleep.before.failover=1

NOTE

replication.sleep.before.failover indicates sleep time required for replication of the remaining data when RegionServer fails to start. You are advised to set this parameter to 1 second to quickly trigger replication.

Precautions

1. When the active cluster is stopped, this tool obtains the WAL processing progress and WAL processing queue from the ZooKeeper Node (RS znode) and copies the queues that are not copied to the standby cluster.

2. RegionServer of each active cluster has its own znode under the replication node of ZooKeeper in the standby cluster. It contains one znode of each peer cluster.
3. If RegionServer is faulty, each RegionServer in the active cluster receives a notification through the watcher and attempts to lock the znode of the faulty RegionServer, including its queues. The successfully created RegionServer transfers all queues to the znode of its own queue. After queues are transferred, they are deleted from the old location.
4. When the active cluster is stopped, ReplicationSyncUp synchronizes data between active and standby clusters using the information from the ZooKeeper node. In addition, WALs of the RegionServer znode will be moved to the standby cluster.

Restrictions and Limitations

If the standby cluster is stopped or the peer relationship is closed, the tool runs normally but the peer relationship cannot be replicated.

7.8 GeoMesa Command Line

NOTE

This section applies only to MRS 3.1.0 or later.

This section describes common GeoMesa commands.

After installing the HBase client and loading environment variables, you can use the geomesa-hbase command line.

- Viewing **classpath**

  After you run the **classpath** command, all **classpath** information of the current command line tool will be returned.

  bin/geomesa-hbase classpath

- Creating a table

  Run the **create-schema** command to create a table. When creating a table, you need to specify the directory name, table name, and table specifications at least.

  bin/geomesa-hbase create-schema -c geomesa -f test -s Who:String,What:java.lang.Long,When:Date,*Where:Point:srid=4326,Why:String

- Describing a table

  Run the **describe-schema** command to obtain table descriptions. When describing a table, you need to specify the directory name and table name.

  bin/geomesa-hbase describe-schema -c geomesa -f test

- Importing data in batches

  Run the **ingest** command to import data in batches. When importing data, you need to specify the directory name, table name, table specifications, and the related data converter.

  The data in the **data.csv** file contains license plate number, vehicle color, longitude, latitude, and time. Save the data table to the folder.

```
AAA,red,113.918417,22.505892,2017-04-09 18:03:46
BBB,white,113.960719,22.556511,2017-04-24 07:38:47
CCC,blue,114.088333,22.637222,2017-04-23 15:07:54
DDD,yellow,114.195456,22.596103,2017-04-21 21:27:06
EEE,black,113.897614,22.551331,2017-04-09 09:34:48
```

Table structure definition: **myschema.sft**. Save **myschema.sft** to the **conf** folder of the GeoMesa command line tool.

```
geomesa.sfts.cars = {
  attributes = [
      { name = "carid", type = "String", index = true }
      { name = "color", type = "String", index = false }
      { name = "time", type = "Date",   index = false }
      { name = "geom", type = "Point",  index = true,srid = 4326,default = true }
  ]
}
```

Converter definition: **myconvertor.convert** Save **myconvertor.convert** to the **conf** folder of the GeoMesa command line tool.

```
geomesa.converters.cars= {
    type   = "delimited-text",
    format = "CSV",
    id-field = "$fid",
    fields = [
      { name = "fid",     transform = "concat($1,$5)" }
      { name = "carid",   transform = "$1::string" }
      { name = "color",   transform = "$2::string" }
      { name = "lon",     transform = "$3::double" }
      { name = "lat",     transform = "$4::double" }
      { name = "geom",    transform = "point($lon,$lat)" }
      { name = "time",    transform = "date('YYYY-MM-dd HH:mm:ss',$5)" }
    ]
}
```

Run the following command to import data:

bin/geomesa-hbase ingest -c geomesa -C conf/myconvertor.convert -s conf/myschema.sft data/data.csv

For details about other parameters for importing data, visit **https://www.geomesa.org/documentation/user/accumulo/examples.html#ingesting-data**.

- Querying explanations

  Run the **explain** command to obtain execution plan explanations of the specified query statement. You need to specify the directory name, table name, and query statement.

  bin/geomesa-hbase explain -c geomesa -f cars -q "carid = 'BBB'"

- Analyzing statistics

  Run the **stats-analyze** command to conduct statistical analysis on the data table. In addition, you can run the **stats-bounds**, **stats-count**, **stats-histogram**, and **stats-top-k** commands to collect more detailed statistics on the data table.

  bin/geomesa-hbase stats-analyze -c geomesa -f cars

  bin/geomesa-hbase stats-bounds -c geomesa -f cars

  bin/geomesa-hbase stats-count -c geomesa -f cars

  bin/geomesa-hbase stats-histogram -c geomesa -f cars

  bin/geomesa-hbase stats-top-k -c geomesa -f cars

- Exporting a feature

Run the **export** command to export a feature. When exporting the feature, you must specify the directory name and table name. In addition, you can specify a query statement to export the feature.

bin/geomesa-hbase export -c geomesa -f cars -q "carid = 'BBB'"

- Deleting a feature

  Run the **delete-features** command to delete a feature. When deleting the feature, you must specify the directory name and table name. In addition, you can specify a query statement to delete the feature.

  bin/geomesa-hbase delete-features -c geomesa -f cars -q "carid = 'BBB'"

- Obtain the names of all tables in the directory.

  Run the **get-type-names** command to obtain the names of tables in the specified directory.

  bin/geomesa-hbase get-type-names -c geomesa

- Deleting a table

  Run the **remove-schema** command to delete a table. You need to specify the directory name and table name at least.

  bin/geomesa-hbase remove-schema -c geomesa -f test

  bin/geomesa-hbase remove-schema -c geomesa -f cars

- Deleting a catalog

  Run the **delete-catalog** command to delete the specified catalog.

  bin/geomesa-hbase delete-catalog -c geomesa

7.9 Using HIndex

7.9.1 Introduction to HIndex

Scenarios

HBase is a distributed storage database of the Key-Value type. Data in tables is sorted by dictionary based on row keys. If you query data by specifying a row key or scan data in a specific row key range, HBase can help you quickly locate the data to be read. In most cases, you need to query data whose column value is *XXX*. HBase provides the filter function to enable you to query data with a specific column value. All data is scanned in the sequence of row keys and is matched with the specific column value until the required data is found. To obtain the required data, the filter will scan some unnecessary data. As a result, the filter function cannot meet the requirements for high-performance, frequent queries.

HBase HIndex is designed to address these issues. HBase HIndex provides HBase with the capability of indexing based on specific column values, making queries faster.

Figure 7-2 HBase HIndex

NOTE

- Rolling upgrade is not supported for index data.
- Composite index: You must add or delete all columns that participate in composite indexes. Otherwise, the data may be inconsistent.
- You should not explicitly configure any split policy to a data table where an index has been created.
- The mutation operations are not supported, such as increment and append.
- Index of the column with **maxVersions** greater than 1 is not supported.
- The value size of a column for which an index is added cannot exceed 32 KB.
- When the user data is deleted because TTL of the column family is invalid, the corresponding index data will not be deleted immediately. The index data will be deleted during major compaction.
- After an index is created, the TTL of the user column family must not be changed.
  - If the TTL of the column family is changed to a larger value after an index is created, delete the index and create one again. Otherwise, some generated index data may be deleted before the deletion of user data.
  - If the TTL of the column family is changed to a smaller value after an index is created, the index may be deleted after the deletion of user data.
- After disaster recovery is enabled for HBase tables, a secondary index is created in the active cluster and index table changes are not automatically synchronized to the standby cluster. To implement disaster recovery in this case, perform the following operations:
  1. After the secondary index is created in the active table, create a secondary index with the same schema and name using the same method in the standby cluster.
  2. In the active cluster, manually set **REPLICATION_SCOPE** of the index column family (default value: **d**) to **1**.

Parameter Configuration

1. Log in to the MRS console, click a cluster name and choose **Components**.
2. Go to the **All Configurations** page of the HBase service. For details, see **Modifying Cluster Service Configuration Parameters**.
3. View parameters on the HBase configurations page.

Navigation Path	Parameter	Default Value	Description
HMaster > System	hbase.coprocessor.master.classes	org.apache.hadoop.hbase.hindex.server.master.HIndexMasterCoprocessor,com.xxx.hadoop.hbase.backup.services.RecoveryCoprocessor,org.apache.ranger.authorization.hbase.RangerAuthorizationCoprocessor,org.apache.hadoop.hbase.security.access.ReadOnlyClusterEnabler,org.apache.hadoop.hbase.rsgroup.RSGroupAdminEndpoint	This coprocessor is used to handle Master-level operations after the HIndex function is enabled, for example, creating an index meta table, adding an index, and deleting an index, a table, and index metadata.
RegionServer > RegionServer	hbase.coprocessor.regionserver.classes	org.apache.hadoop.hbase.hindex.server.regionserver.HIndexRegionServerCoprocessor,org.apache.hadoop.hbase.JMXListener,org.apache.ranger.authorization.hbase.RangerAuthorizationCoprocessor	This coprocessor is used to handle the operations that the Master delivers to RegionServer after the HIndex function is enabled.

Navigation Path	Parameter	Default Value	Description
	hbase.coprocessor.region.classes	org.apache.hadoop.hbase.hindex.server.regionserver.HIndexRegionCoprocessor,org.apache.hadoop.hbase.security.token.TokenProvider,com.xxx.hadoop.hbase.backup.services.RecoveryCoprocessor,org.apache.ranger.authorization.hbase.RangerAuthorizationCoprocessor,org.apache.hadoop.hbase.security.access.SecureBulkLoadEndpoint,org.apache.hadoop.hbase.security.access.ReadOnlyClusterEnabler,org.apache.hadoop.hbase.coprocessor.MetaTableMetrics	This coprocessor is used to operate data in the Region after the HIndex function is enabled.

NOTE

1. The preceding default values need to be configured after the HBase HIndex function is enabled. In MRS clusters that support the HBase HIndex function, the values have been configured by default.

2. Ensure that the **master** parameter is configured on HMaster and the **region** and **regionserver** parameters are configured on RegionServer.

Related Interfaces

The APIs that use HIndex are in the **org.apache.hadoop.hbase.hindex.client.HIndexAdmin** class. The following table describes the related APIs.

Operation	API	Description	Precautions
Add an index.	addIndices()	Add an index to a table without data. Calling this API will add the specified index to a table but skips index data generation. Therefore, after this operation, the index cannot be used for the scanning and filtering operations. This API applies to scenarios where users want to add indexes in batches to tables that have a large amount of pre-existing user data. The specific operation is to use external tools such as the TableIndexer tool to build index data.	• An index cannot be modified once it is added. To modify the index, you need to delete the old index and then create a new one. • Do not create two indexes on the same column with different index names. Otherwise, storage and processing resources will be wasted. • Indexes cannot be added to a system table. • The append and increment operations are not supported when data is put into the index column. • If any fault occurs on the client except **DoNotRetryIOException**, you need to try again. • An index column family is selected from the following conditions in sequence based on availability: – Typically, the default index column family is **d**. However, if the value of **hindex.default.family.name** is set, the value will be used. – Symbol #, @, $, or %
	addIndicesWithData()	Add an index to a table with data. This API is used to add the specified index to the table and create index data for the existing user data. Alternatively, the API can be called to generate an index and then generate index data when the user data is being stored. Therefore, after this operation, the index can be used for the scanning and filtering operations immediately.	

Operation	API	Description	Precautions
			– #0, @ 0, $ 0, %0, #1, @ 1 ...to #255, @ 255, $ 255, %255 – Throw exceptions. ● You can use the HIndex TableIndexer tool to add indexes without building index data.
Delete an index.	dropIndices()	This API is used to delete an index only. It deletes the specified index from a table but skips the corresponding index data. After this operation, the index cannot be used for the scanning and filtering operations. The cluster automatically deletes old index data during major compaction. This API applies to scenarios where a table contains a large amount of index data and **dropIndicesWithData()** is unavailable. In addition, you can use the TableIndexer tool to delete indexes and index data.	● An index can be disabled when it is in the **ACTIVE**, **INACTIVE**, or **DROPPING** state. ● If you use **dropIndices()** to delete an index, ensure that the index data has been deleted before the index is added to the table with the same index name (that is, major compaction has been completed). ● If you delete an index, the following information will also be deleted: – A column family with an index – Any one of column families in a combination index ● Indexes and index data can be deleted together using the HIndex TableIndexer tool.
	dropIndicesWithData()	Delete index data. This API deletes the specified index and all index data corresponding to the index in a user table. After this operation, the index is completely deleted from the table and is no longer used for the scanning and filtering operations.	

Operation	API	Description	Precautions
Enable/ Disable an index.	disableIndices()	This API disables all indexes specified by a user so that they are no longer used for the scanning and filtering operations.	• An index can be enabled when the index is in the **ACTIVE**, **INACTIVE**, or **BUILDING** state. • An index can be disabled when the index is in the **ACTIVE** or **INACTIVE** state. • Before disabling an index, ensure that the index data is consistent with the user data. If no new data is added to the table when the index is disabled, the index data is consistent with the user data. • When enabling an index, you can use the TableIndexer tool to build index data to ensure data consistency.
	enableIndices()	This API enables all indexes specified by a user so that they can be used for the scanning and filtering operations.	
View the created index.	listIndices()	This API is used to list all indexes of a specified table.	N/A

Querying Data Based on Indexes

You can use a filter to query data in a user table with an index. The query result of a user table with a single or combination index is the same as that of a table without an index, but the table with an index provides higher data query performance than the table without an index.

The index usage rules are as follows:

- Scenario 1: A single index is created for one or more columns.
  - When this column is used for AND or OR query filtering, an index can improve query performance.

    Example: Filter_Condition(IndexCol1)AND / OR Filter_Condition(IndexCol2)
  - When you use **Index Column AND Non-Index Column** for filtering in the query, the index can improve query performance.

Example: Filter_Condition(IndexCol1)AND Filter_Condition(IndexCol2)AND Filter_Condition(NonIndexCol1)

- When you use **Index Column OR Non-Index Column** for filtering in the query but do not use an index, query performance will not be improved.

  Example: Filter_Condition(IndexCol1)AND / OR Filter_Condition(IndexCol2) OR Filter_Condition(NonIndexCol1)

- Scenario 2: A combination index is created for multiple columns.
  - When the columns to be queried are all or part of the combination index and have the same order as the combination index, using the index improves query performance.

    For example, create a combination index for C1, C2, and C3.

    - The index takes effect in the following situations:

      Filter_Condition(IndexCol1)AND Filter_Condition(IndexCol2)AND Filter_Condition(IndexCol3)

      Filter_Condition(IndexCol1)AND Filter_Condition(IndexCol2)

      FILTER_CONDITION(IndexCol1)

    - The index does not take effect in the following situations:

      Filter_Condition(IndexCol2)AND Filter_Condition(IndexCol3)

      Filter_Condition(IndexCol1)AND Filter_Condition(IndexCol3)

      FILTER_CONDITION(IndexCol2)

      FILTER_CONDITION(IndexCol3)

  - When you use **Index Column AND Non-Index Column** for filtering in the query, the index can improve query performance.

    Examples:

    Filter_Condition(IndexCol1)AND Filter_Condition(NonIndexCol1)

    Filter_Condition(IndexCol1)AND Filter_Condition(IndexCol2)AND Filter_Condition(NonIndexCol1)

  - When you use **Index Column OR Non-Index Column** for filtering in the query but do not use an index, query performance will not be improved.

    Examples:

    Filter_Condition(IndexCol1)OR Filter_Condition(NonIndexCol1)

    (Filter_Condition(IndexCol1)AND Filter_Condition(IndexCol2))OR(Filter_Condition(NonIndexCol1))

  - When multiple columns are used for query, you can specify a value range for only the last column in the combination index and set other columns to specified values

    For example, create a combination index for C1, C2, and C3. In a range query, only the value range of C3 can be set. The filter criteria are "C1 = *XXX*, C2 = *XXX*, and C3 = Value range."

Query Policy Selection

Use **SingleColumnValueFilter** or **SingleColumnRangeFilter**. It will provide the definite value **column_family:qualifierpair** (called **col1**) in filter criteria.

If **col1** is the first index column in the table, any index in the table can be a candidate index used during the query. The following provides an example:

If there is an index on **col1**, the index can be used as a candidate index because **col1** is the first and the only column of the index. If there is another index on **col1** and **col2**, you can consider this index as a candidate index because **col1** is the first column in the index list. However, if there is an index on **col2** and **col1**, this index cannot be used as a candidate index because the first column in the index list is not **col1**.

The most suitable method to use the index now is that when there are multiple candidate indexes, select the most suitable index for scanning data.

You can use the following solutions to learn how to select the best index policy.

- Use the fully matched index.

  Scenario: There are two indexes available, one for **col1&col2** and the other for **col1**.

  In this case, the second index is better than the first one, because it scans less index data.

- If there are multiple candidate multi-column indexes, select an index with fewer index columns.

  Scenario: There are two indexes available, one for **col1&col2** and the other for **col1&col2&col3**.

  In this case, you are advised to use the index on **col1&col2**, because it scans less index data.

NOTE

- During a query based on an index, the index state must be **ACTIVE**. You can call the **listIndices()** API to view the index state.
- To query the correct data based on the index, ensure the consistency between index data and user data.
- Run the following command to perform a complex query on the HBase shell client (assuming that an index has been created for the specified column):

  scan 'tablename', {FILTER => "SingleColumnValueFilter(family, qualifier, compareOp, comparator, filterIfMissing, latestVersionOnly)"}

  Example: **scan 'test', {FILTER => "SingleColumnValueFilter('info', 'age', =, 'binary:26', true, true)"}**

  In the preceding scenario, if you want to save the row where no column is found in the result, you should not create any index in any such column, because if the column to be queried does not exist, the row will be filtered out when SCVF is used to scan the index columns. When the SCVF whose **filterIfMissingset** is **false** (default value) scans non-index columns, rows where no column is queried will also be returned in the result. Therefore, to avoid inconsistent query results, you are advised to set **filterIfMissing** to **true** after creating SCVF for the index column.
- Run the following command on the HBase shell client to view the index data created for user data:

  scan 'tablename', {ATTRIBUTES => {'FETCH_INDEX_DATA' => 'true'}}

7.9.2 Loading Index Data in Batches

Scenarios

HBase provides the ImportTsv&LoadIncremental tool to load user data in batches. HBase also provides the HIndexImportTsv tool to load both the user data and index data in batches. HIndexImportTsv inherits all functions of the HBase batch data loading tool ImportTsv. If a table is not created before the HIndexImportTsv tool is executed, an index will be created when the table is created, and index data is generated when user data is generated.

Procedure

1. Run the following commands to import data to HDFS:

   hdfs dfs -mkdir <*inputdir*>

   hdfs dfs -put <local_data_file> <*inputdir*>

   For example, define the data file **data.txt** as follows:

   ```
   12005000201,Zhang San,Male,19,City a, Province a
   12005000202,Li Wanting,Female,23,City b, Province b
   12005000203,Wang Ming,Male,26,City c, Province c
   12005000204,Li Gang,Male,18,City d, Province d
   12005000205,Zhao Enru,Female,21,City e, Province e
   12005000206,Chen Long,Male,32,City f, Province f
   12005000207,Zhou Wei,Female,29,City g, Province g
   12005000208,Yang Yiwen,Female,30,City h, Province h
   12005000209,Xu Bing,Male,26,City i, Province i
   12005000210,Xiao Kai,Male,25,City j, Province j
   ```

   Run the following commands:

   hdfs dfs -mkdir /datadirImport

   hdfs dfs -put data.txt /datadirImport

2. Go to HBase shell and run the following command to create the **bulkTable** table:

   create 'bulkTable', {NAME => 'info',COMPRESSION => 'SNAPPY', DATA_BLOCK_ENCODING => 'FAST_DIFF'},{NAME=>'address'}

   After the execution is complete, exit the HBase shell.

3. Run the following commands to generate an HFile file (StoreFiles):

   hbase org.apache.hadoop.hbase.hindex.mapreduce.HIndexImportTsv -Dimporttsv.separator=*<separator>*

   -Dimporttsv.bulk.output=*</path/for/output>* **-Dindexspecs.to.add=**<indexspecs> **-Dimporttsv.columns=**<columns> tableName *<inputdir>*

   - **-Dimport.separator**: indicates a separator, for example, **-Dimport.separator=','**.
   - **-Dimport.bulk.output=</path/for/output>**: indicates the output path of the execution result. You need to specify a path that does not exist.
   - **<columns>**: Indicates the mapping of the imported data in a table, for example, **-Dimporttsv.columns=HBASE_ROW_KEY,info:name,info:gender,info:age,address:city,address:province**.

- **<tablename>**: Indicates the name of a table to be operated.
- **<inputdir>**: Indicates the directory where data is loaded in batches.
- **-Dindexspecs.to.add=<indexspecs>**: Indicates the mapping between an index name and a column, for example, **-Dindexspecs.to.add='index_bulk=>info:[age->String]'**. The index composition can be represented as follows:

  indexNameN=>familyN :[columnQualifierN-> columnQualifierDataType], [columnQualifierM-> columnQualifierDataType];familyM: [columnQualifierO-> columnQualifierDataType]# indexNameN=> familyM: [columnQualifierO-> columnQualifierDataType]

  Column qualifiers are separated by commas (,).

  Example: "index1 => f1:[c1-> String],[c2-> String]"

  Column families are separated by semicolons (;).

  Example: "index1 => f1:[c1-> String],[c2-> String]; f2:[c3-> Long]"

  Multiple indexes are separated by pound keys (#).

  Example: "index1 => f1:[c1-> String],[c2-> String]; f2:[c3-> Long]#index2 => f2:[c3-> Long]"

  The following data types are supported by columns.

  Available data types are as follows: STRING, INTEGER, FLOAT, LONG, DOUBLE, SHORT, BYTE, CHAR

  NOTE

  Data types can also be transferred in lowercase.

For example, run the following command:

hbase org.apache.hadoop.hbase.hindex.mapreduce.HIndexImportTsv -Dimporttsv.separator=',' -Dimporttsv.bulk.output=/dataOutput -Dindexspecs.to.add='index_bulk=>info:[age->String]' -Dimporttsv.columns=HBASE_ROW_KEY,info:name,info:gender,info:age,address:city,address:province bulkTable /datadirImport/data.txt

Command output:

```
[root@shap000000406 opt]# hbase org.apache.hadoop.hbase.hindex.mapreduce.HIndexImportTsv -Dimporttsv.separator=',' -Dimporttsv.bulk.output=/dataOutput -Dindexspecs.to.add='index_bulk=>info:[age->String]' -Dimporttsv.columns=HBASE_ROW_KEY,info:name,info:gender,info:age,address:city,address:province bulkTable /datadirImport/data.txt
2018-05-08 21:29:16,059 INFO  [main] mapreduce.HFileOutputFormat2: Incremental table bulkTable output configured.
2018-05-08 21:29:16,069 INFO  [main] client.ConnectionManager$HConnectionImplementation: Closing master protocol: MasterService
2018-05-08 21:29:16,069 INFO  [main] client.ConnectionManager$HConnectionImplementation: Closing zookeeper sessionid=0x80007c2cb4fd5b4d
2018-05-08 21:29:16,072 INFO  [main] zookeeper.ZooKeeper: Session: 0x80007c2cb4fd5b4d closed
2018-05-08 21:29:16,072 INFO  [main-EventThread] zookeeper.ClientCnxn: EventThread shut down for session: 0x80007c2cb4fd5b4d
2018-05-08 21:29:16,379 INFO  [main] client.ConfiguredRMFailoverProxyProvider: Failing over to 147
2018-05-08 21:29:17,328 INFO  [main] input.FileInputFormat: Total input files to process : 1
2018-05-08 21:29:17,413 INFO  [main] mapreduce.JobSubmitter: number of splits:1
2018-05-08 21:29:17,430 INFO  [main] Configuration.deprecation: io.bytes.per.checksum is deprecated. Instead, use dfs.bytes-per-checksum
2018-05-08 21:29:17,687 INFO  [main] mapreduce.JobSubmitter: Submitting tokens for job: job_1525338489458_0002
2018-05-08 21:29:18,100 INFO  [main] impl.YarnClientImpl: Submitted application application_1525338489458_0002
2018-05-08 21:29:18,136 INFO  [main] mapreduce.Job: The url to track the job: http://
```

```
shap000000407:8088/proxy/application_1525338489458_0002/
2018-05-08 21:29:18,136 INFO  [main] mapreduce.Job: Running job: job_1525338489458_0002
2018-05-08 21:29:28,248 INFO  [main] mapreduce.Job: Job job_1525338489458_0002 running in uber mode : false
2018-05-08 21:29:28,249 INFO  [main] mapreduce.Job:  map 0% reduce 0%
2018-05-08 21:29:38,344 INFO  [main] mapreduce.Job:  map 100% reduce 0%
2018-05-08 21:29:51,421 INFO  [main] mapreduce.Job:  map 100% reduce 100%
2018-05-08 21:29:51,428 INFO  [main] mapreduce.Job: Job job_1525338489458_0002 completed successfully
2018-05-08 21:29:51,523 INFO  [main] mapreduce.Job: Counters: 50
```

4. Run the following command to import the generated HFile to HBase:

   hbase org.apache.hadoop.hbase.mapreduce.LoadIncrementalHFiles *</path/for/output> <tablename>*

   For example, run the following command:

   hbase org.apache.hadoop.hbase.mapreduce.LoadIncrementalHFiles / dataOutput bulkTable

   Command output:

```
[root@shap000000406 opt]# hbase org.apache.hadoop.hbase.mapreduce.LoadIncrementalHFiles / dataOutput bulkTable
2018-05-08 21:30:01,398 WARN  [main] mapreduce.LoadIncrementalHFiles: Skipping non-directory hdfs://hacluster/dataOutput/_SUCCESS
2018-05-08 21:30:02,006 INFO  [LoadIncrementalHFiles-0] hfile.CacheConfig: Created cacheConfig: CacheConfig:disabled
2018-05-08 21:30:02,006 INFO  [LoadIncrementalHFiles-2] hfile.CacheConfig: Created cacheConfig: CacheConfig:disabled
2018-05-08 21:30:02,006 INFO  [LoadIncrementalHFiles-1] hfile.CacheConfig: Created cacheConfig: CacheConfig:disabled
2018-05-08 21:30:02,085 INFO  [LoadIncrementalHFiles-2] compress.CodecPool: Got brand-new decompressor [.snappy]
2018-05-08 21:30:02,120 INFO  [LoadIncrementalHFiles-0] mapreduce.LoadIncrementalHFiles: Trying to load hfile=hdfs://hacluster/dataOutput/address/042426c252f74e859858c7877b95e510 first=12005000201 last=12005000210
2018-05-08 21:30:02,120 INFO  [LoadIncrementalHFiles-2] mapreduce.LoadIncrementalHFiles: Trying to load hfile=hdfs://hacluster/dataOutput/info/f3995920ae0247a88182f637aa031c49 first=12005000201 last=12005000210
2018-05-08 21:30:02,128 INFO  [LoadIncrementalHFiles-1] mapreduce.LoadIncrementalHFiles: Trying to load hfile=hdfs://hacluster/dataOutput/d/c53b252248af42779f29442ab84f86b8 first=\x00index_bulk\x00\x00\x00\x00\x00\x00\x00\x0018\x00\x0012005000204 last=\x00index_bulk\x00\x00\x00\x00\x00\x00\x00\x0032\x00\x0012005000206
2018-05-08 21:30:02,231 INFO  [main] client.ConnectionManager$HConnectionImplementation: Closing master protocol: MasterService
2018-05-08 21:30:02,231 INFO  [main] client.ConnectionManager$HConnectionImplementation: Closing zookeeper sessionid=0x81007c2cf0f55cc5
2018-05-08 21:30:02,235 INFO  [main] zookeeper.ZooKeeper: Session: 0x81007c2cf0f55cc5 closed
2018-05-08 21:30:02,235 INFO  [main-EventThread] zookeeper.ClientCnxn: EventThread shut down for session: 0x81007c2cf0f55cc5
```

7.9.3 Using an Index Generation Tool

Scenarios

To quickly create indexes for user data, HBase provides the TableIndexer tool for you to create, add, and delete indexes using MapReduce functions. The application scenarios are as follows:

- You want to add an index for a specified column in a table where a large amount of data exists. However, if you use the **addIndicesWithData()** API to add an index, index data corresponding to the related user data will be generated, which is time-consuming. If you use **addIndices()** to create an index, index data corresponding to user data will not be generated. Therefore,

to create index data for user data, you can use the TableIndexer tool to create an index.

- If the index data is inconsistent with the user data, the tool can be used to rebuild index data.

  If you temporarily disable the index, put new data to the disabled index column, and then directly enable the index from the disabled state, index data and user data may be inconsistent. Therefore, you must rebuild all index data before using it again.
- You can use the TableIndexer tool to completely delete a large amount of existing index data from a user table.
- For user tables that do not have indexes, this tool allows you to add and build indexes at the same time.

How to Use

- **Adding a new index to a user table**

  The command is as follows:

  hbase org.apache.hadoop.hbase.hindex.mapreduce.TableIndexer -Dtablename.to.index=tablename -Dindexspecs.to.add='idx_0=>cf_0:[q_0->string],[q_1];cf_1:[q_2],[q_3]#*idx_1*=>cf_1:[q_4]'

  The following parameters are required.

  - **tablename.to.index**: Indicates the name of a table for which an index is created.
  - **indexspecs.to.add**: Indicates the mapping between the index name and the column in the corresponding user table.
  - **scan.caching** (optional): Contains an integer value, indicating the number of cached rows to be transmitted to the scanner during data table scanning.

  The parameters in the preceding command are described as follows:

  - **idx_1**: Indicates an index name.
  - **cf_0**: Indicates the name of a column family.
  - **q_0**: Indicates the name of a column.
  - **string**: Indicates a data type. The parameter value can be STRING, INTEGER, FLOAT, LONG, DOUBLE, SHORT, BYTE, or CHAR.

  NOTE

  - The pound key (#) is used to separate indexes. The semicolon (;) is used to separate column families. The comma (,) is used to separate column qualifiers.
  - The column name and its data type must be included in '[]'.
  - Column names and their data types are separated by '->'.
  - If the data type of a specific column is not specified, the default data type (string) is used.
  - If **scan.caching** is not configured, the default value **1000** is used.
  - The user table must exist.
  - The index specified in the table must not exist.
  - If a column family named **d** exists in the user table, you must use the TableIndexer tool to build index data.

After the preceding command is executed, the specified index is added to the table and is in INACTIVE state. This behavior is similar to the **addIndices()** API.

- **Creating index data for existing indexes in a user table**

  The command is as follows:

  hbase org.apache.hadoop.hbase.hindex.mapreduce.TableIndexer -Dtablename.to.index=tablename -Dindexnames.to.build='idx_0#idx_1'

  The following parameters are required.

  – **tablename.to.index**: Indicates the name of a table for which an index is created.

  – **indexspecs.to.build**: Indicates an index name.

  – **scan.caching** (optional): Contains an integer value, indicating the number of cached rows to be transmitted to the scanner during data table scanning.

  The parameters in the preceding command are described as follows:

  – **idx_1**: Indicates an index name.

  NOTE

  - The pound key (#) is used to separate index names.
  - If **scan.caching** is not configured, the default value **1000** is used.
  - The user table must exist.

  After the preceding command is executed, the specified index is set to the ACTIVE state. Users can use them when scanning data.

- **Deleting the existing indexes and their data from a user table**

  The command is as follows:

  hbase org.apache.hadoop.hbase.hindex.mapreduce.TableIndexer -Dtablename.to.index=tablename -Dindexnames.to.drop='idx_0#idx_1'

  The following parameters are required.

  – **tablename.to.index**: Indicates the name of a table for which an index is created.

  – **indexnames.to.drop**: Indicates the name of the index that should be deleted with its data (must exist in the table).

  – **scan.caching** (optional): Contains an integer value, indicating the number of cached rows to be transmitted to the scanner during data table scanning.

  The parameters in the preceding command are described as follows:

  – **idx_1**: Indicates an index name.

  NOTE

  - The pound key (#) is used to separate index names.
  - If **scan.caching** is not configured, the default value **1000** is used.
  - The user table must exist.

  After the preceding command is executed, the specified index is deleted from the table.

- **Adding new indexes to user tables and building data based on existing data**

The command is as follows:

hbase org.apache.hadoop.hbase.hindex.mapreduce.TableIndexer -Dtablename.to.index=tablename -Dindexspecs.to.add='idx_0 => cf_0:[q_0-> string],[q_1];cf_1:[q_2],[q_3]#idx_1 => cf_1:[q_4]' -Dindexnames.to.build='idx_0'

NOTE

- The parameters are the same as the previous ones.
- The user table must exist.
- The indexes specified in **indexspecs.to.add** must not exist in the table.
- The index names specified in **indexnames.to.build** must exist in the table or be part of the value of **indexspecs.to.add**.

After the preceding command is executed, all indexes specified in **indexspecs.to.add** will be added to this table, and index data will be built for all specified indexes using **indexnames.to.build**.

7.9.4 Migrating Index Data

Scenario

The indexes used in MRS 1.7 or later are incompatible with secondary indexes used by HBase in earlier MRS versions. Therefore, you need to perform the following operations to migrate index data from an earlier version (MRS 1.5 or earlier) to MRS 1.7 or later.

Prerequisites

1. During data migration, the cluster of the old version must be MRS 1.5 or earlier, and the cluster of the new version must be MRS 1.7 or later.
2. Before data migration, you must have old index data.
3. A cross-cluster mutual trust relationship must be configured and the inter-cluster replication function must be enabled for a security cluster. For a common cluster, only the inter-cluster replication function needs to be enabled.

Procedure

Migrate user data from an old cluster to a new cluster. To migrate data, you need to manually synchronize data of the old and new clusters in a single table by export, distcp, and import.

For example, the current old cluster has a user table (**t1**, index name: **idx_t1**) and its corresponding index table (**t1_idx**). Perform the following operations to migrate data.

1. Export table data from the old cluster.
   ```
   hbase org.apache.hadoop.hbase.mapreduce.Export -Dhbase.mapreduce.include.deleted.rows=true <tableName> <path/for/data>
   ```
   - *<tableName>*: Indicates a table name, for example, **t1**.
   - *<path/for/data>*: Indicates the path for storing source data, for example, **/user/hbase/t1**.

Example: **hbase org.apache.hadoop.hbase.mapreduce.Export -Dhbase.mapreduce.include.deleted.rows=true t1 /user/hbase/t1**

2. Copy the exported data to the new cluster as follows:
   hadoop distcp *<path/for/data> hdfs://ActiveNameNodeIP:9820/*<path/for/newData>
   - *<path/for/data>*: Indicates the path for storing source data in the old cluster, for example, **/user/hbase/t1**.
   - *<path/for/newData>*: Indicates the path for storing source data in the new cluster, for example, **/user/hbase/t1**.

   ActiveNameNodeIP indicates the IP address of the active NameNode in the new cluster.

   Example: **hadoop distcp /user/hbase/t1 hdfs://192.168.40.2:9820/user/hbase/t1**

   NOTE

   - Manually copy the exported data to HDFS of the new cluster, for example, **/user/hbase/t1**.

3. Use the HBase table user of the new cluster to generate HFiles in the new cluster.
   hbase org.apache.hadoop.hbase.mapreduce.Import -Dimport.bulk.output=<path/for/hfiles> <tableName><path/for/newData>
   - *<path/for/hfiles>*: Indicates the path of the HFiles generated in the new cluster, for example, **/user/hbase/output_t1**.
   - *<tableName>*: Indicates a table name, for example, **t1**.
   - *<path/for/newData>*: Indicates the path for storing source data in the new cluster, for example, **/user/hbase/t1**.

   Example:

   hbase org.apache.hadoop.hbase.mapreduce.Import -Dimport.bulk.output=/user/hbase/output_t1 t1 /user/hbase/t1

4. Import the generated HFiles to the table in the new cluster.

   The command is as follows:

   hbase org.apache.hadoop.hbase.mapreduce.LoadIncrementalHFiles <path/for/hfiles> <tableName>
   - *<path/for/hfiles>*: Indicates the path of the HFiles generated in the new cluster, for example, **/user/hbase/output_t1**.
   - *<tableName>*: Indicates a table name, for example, **t1**.

   Example:

   hbase org.apache.hadoop.hbase.mapreduce.LoadIncrementalHFiles /user/hbase/output_t1 t1

   NOTE

   1. The preceding shows the process of migrating user data. You only need to perform the first three steps to migrate the index data of the old cluster and change the corresponding table name to an index table name (for example, **t1_idx**).
   2. Skip **4** when migrating index data.

5. Import index data to a table in the new cluster.

   a. Add an index the same as that of the user table of the previous version to the user table of the new cluster (the user table cannot contain a column family named **d**).

The command is as follows:

```
hbase org.apache.hadoop.hbase.hindex.mapreduce.TableIndexer -
Dtablename.to.index=<tableName> -Dindexspecs.to.add=<indexspecs>
```

- *-Dtablename.to.index=<tableName>*: Indicates a table name, for example, **-Dtablename.to.index=t1**.
- **-Dindexspecs.to.add=<indexspecs>**: Indicates the mapping between an index name and a column, for example, **-Dindexspecs.to.add='idx_t1=>info:[name->String]'**.

Example:

hbase org.apache.hadoop.hbase.hindex.mapreduce.TableIndexer -Dtablename.to.index=t1 -Dindexspecs.to.add='idx_t1=>info:[name->String]'

NOTE

If a column family named **d** exists in the user table, you must use the TableIndexer tool to build index data.

b. Run the LoadIncrementalHFiles tool to load the index data of the old cluster to a table in the new cluster.

The command is as follows:

```
hbase org.apache.hadoop.hbase.mapreduce.LoadIncrementalHFiles </path/for/hfiles>
<tableName>
```

- *</path/for/hfiles>*: Indicates the path of index data on HDFS. The path is the index generation path specified in **-Dimport.bulk.output**, for example, **/user/hbase/output_t1_idx**.
- *<tableName>*: Indicates a table name of the new cluster, for example, **t1**.

Example:

hbase org.apache.hadoop.hbase.mapreduce.LoadIncrementalHFiles /user/hbase/output_t1_idx t1

7.10 Using Global Secondary Indexes

7.10.1 Introduction

Scenarios

HBase secondary indexes can accelerate conditional queries with filters. There are local secondary indexes (LSIs, also called HIndexes) and global secondary indexes (GSIs). Compared with LSIs, GSIs have better query performance and are suitable for scenarios that require low read latency.

HBase GSIs use independent index tables to store index data. When a given query condition hits an index, a full table query is converted into an exact range query on an index table. This way, query speed is greatly improved. You do not need to modify your application code to enable HBase GSIs.

NOTE

HBase GSIs are enabled by default. To modify the related parameters, log in to FusionInsight Manager, choose **Cluster** > **Services** > **HBase** > **Confiurations** > **All Configurations**, and select **HMaster(Role)** > **Secondary Indexes**.

Key features of HBase GSIs are as follows:

- **Composite index**

  Multiple columns of different column families can be specified as index columns.

- **Covering index**

  Multiple columns or column families can be stored in the index table in redundancy to cover all data needed for a query. With covering indexes, you can quickly query non-index columns in index query.

- **Index TTL**

  Index table TTL takes effect if data table TTL is enabled. To ensure consistency with the data table, the index table TTL is automatically inherited from the index column and the column to overwrite an index of the data table and cannot be specified.

- **Online index change**

  Indexes can be created, deleted, and their status can be modified without affecting data table read and write.

- **Online index repair**

  If the index data hit by a query is invalid, index data rebuilding is triggered to ensure that the final query result is correct.

- **Index tool**

  The index tool helps you to check consistency, repair, create, and delete indexes, modify index status, and rebuild index data.

7.10.2 Restrictions

Application Scenarios

- GSIs cannot be used together with HIndexes. That is, they cannot be created in the same data table.
- DR cannot be enabled directly for index tables. When DR is enabled for data tables, index data can be recovered from a disaster too.
- Rolling upgrade is not supported for index data.
- DISABLE, DROP, MODIFY, and TRUNCATE cannot be directly performed on index tables.
- Index definition cannot be modified. You need to delete definitions and create indexes again. Other DDL operations on indexes are allowed, for example, modify index status, and delete and create indexes.

Creating Indexes

- An index name must contain only the characters allowed for a regular expression, that is, [a-zA-Z_0-9-.]

- The data table specified for index creation must exist. An index cannot be created repeatedly.
- The index table cannot have multiple versions.

  Indexes cannot be created on data tables with multiple versions (**VERSION>1**). The **VERSION=1** setting is a must.
- The number of indexes in a single data table cannot exceed five.

  Do not create too many indexes for a data table. Otherwise, bigger storage is required and write operations become slow. If more than five indexes need to be created, add the **hbase.gsi.max.index.count.per.table** parameter to the custom configuration **hbase.hmaster.config.expandor** of HMaster and set the parameter to a value greater than **5**. Restart HMaster to make the configuration take effect.
- The index name can contain a maximum of 18 characters.

  Do not use long index names. If you have to, add the **hbase.gsi.max.index.name.length** parameter to the custom configuration **hbase.hmaster.config.expandor** of HMaster, set the parameter to a value greater than **18**, and restart HMaster to make the configuration take effect.
- Indexes cannot be created for index tables.

  Indexes cannot be nested. Index tables are used only to accelerate queries and do not provide data table functions.
- Indexes that can be covered by existing indexes cannot be created.

  If indexes you want to create are a subset of the existing indexes, they cannot be created. Duplicate indexes cause storage waste. In the following example, index 2 cannot be created:

  Create a data table: **create't1','cf1'**

  Create index 1: **hbase org.apache.hadoop.hbase.hindex.global.mapreduce.GlobalTableIndexer -Dtablename.to.index='t1' -Dindexspecs.to.add='idx1=>cf1:[q1],[q2]'**

  Create index 2: **hbase org.apache.hadoop.hbase.hindex.global.mapreduce.GlobalTableIndexer -Dtablename.to.index='t1' -Dindexspecs.to.add='idx2=>cf1:[q1]'**
- Indexes with the same name cannot be created in the same data table, but can be created in different data tables.
- The TTL of a column family in an index table is inherited from the original table, and must be the same as that of the original table.

  The TTLs of all column families in an index table are the same and are inherited from a data table. The TTLs of associated column families in the data table must be the same. Otherwise, associated indexes cannot be created.
- When creating an index for a table, you cannot customize other attributes of the index, such as the compression mode, BLOCKSIZE, and column encoding format.

Writing Indexes

- Only the Put/Delete interface can be used to generate index data. If data is written to a data table with other methods (such as Increment, Append, and Bulkload), the corresponding index will not be generated.

- When the index column data is defined as the string type, do not write special characters **\x00** and **\x01** (special invisible characters).
- Do not write data to index columns by specifying timestamps.

Index Query

- The index status must be **ACTIVE** during an index query.
- Index queries do not support **specified timestamp ranges**. If you need to query data within a time range by index, add a time column to store data timestamps. Otherwise, the data table will be used for query.
- Index query supports only **SingleColumnValueFilter**. Index acceleration cannot be triggered when other filters are used or no filter condition is used.

7.10.3 Using the GSI Tool

7.10.3.1 Creating Indexes

Scenarios

- If a large amount of data exists in a table, you can add an index on a column to accelerate data queries.
- For a table that does not have indexes, this tool allows you to add and create indexes.

How to Use

Run the following command on the HBase client to add or create indexes to a table:

hbase org.apache.hadoop.hbase.hindex.global.mapreduce.GlobalTableIndexer -Dtablename.to.index='*table*' **-Dindexspecs.to.add**='*idx1=>cf1:[c1->string],[c2]#idx2=>cf2:[c1->string],[c2]#idx3=>cf1:[c1];cf2:[c1]*' **-Dindexspecs.covered.family.to.add**='*idx2=>cf1*' **-Dindexspecs.covered.to.add**='*idx1=>cf1:[c3],[c4]*' **-Dindexspecs.coveredallcolumn.to.add**='*idx3=>true*' **-Dindexspecs.splitkeys.to.set**='*idx1=>[\x010,\x011,\x012]#idx2=>[\x01a,\x01b,\x01c]#idx3=>[\x01d,\x01e,\x01f]*'

The parameters are described as follows:

- **tablename.to.index**: name of the data table for which an index is created

  NOTE

  If the data table is empty when you use this parameter, the created index will be in **ACTIVE** state. Otherwise, the index will be in **INACTIVE** state.

- **indexspecs.to.addandbuild** (optional): Index data will be generated during data table creation. **If the data table is large, do not enable this parameter.** Use an index data generation tool instead.

NOTE

Do not use this parameter together with **indexspecs.to.add**. When this parameter is used, the index will be in **BUILDING** state. After the index data is generated, it will be in **ACTIVE** state.

- **tablename.to.index**: name of the data table for which an index is created
- **indexspecs.to.add**: mapping between the index name and the index column in the data table (definition of index column)
- (Optional) **indexspecs.covered.to.add**: column of the data table that is redundantly stored in an index table (definition of covering index column)
- (Optional) **indexspecs.covered.family.to.add**: column family of the data table that is redundantly stored in an index table (definition of covering index column family)
- (Optional) **indexspecs.coveredallcolumn.to.add**: all data in a data table that is redundantly stored in an index table (definition of all covering index columns)
- (Optional) **indexspecs.splitkeys.to.set**: pre-partition split keys of an index table. **Specify this parameter** in case hotspotting occurs in the region of the index table. You can configure pre-partitioning using the following characters:
  - **'#'**: separates indexes.
  - **'[]'** contains **splitkeys**.
  - **','** separates **splitkeys**.

    NOTE

    Each **splitkey** set for per-partitioning must start with **\x01**.

The parameters in the preceding command are described as follows:

- **idx1**, **idx2**, and **idx3** are index names.
- **cf1** and **cf2** are column family names.
- **c1**, **c2**, **c3**, and **c4** are column names.
- **string** indicates a data type. The value can be **STRING**, **INTEGER**, **FLOAT**, **LONG**, **DOUBLE**, **SHORT**, **BYTE**, or **CHAR**.

NOTE

- **'#'** is used to separate indexes, **';'** is used to separate column families, and **','** is used to separate column qualifiers.
- The column name and its data type must be included in **'[]'**.
- Column names and their data types are separated by **'->'**.
- If the data type of a column is not specified, the default data type (**string**) will be used.

7.10.3.2 Querying Index Information

Scenarios

You can use the GSI tool to view the definition and status of indexes of a data table in batches.

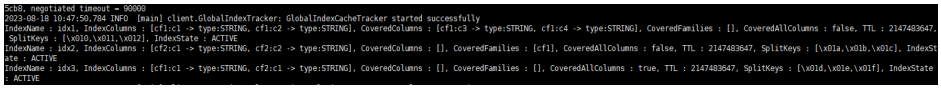
How to Use

Run the following command on the HBase client to view the definition and status of an index:

hbase org.apache.hadoop.hbase.hindex.global.mapreduce.GlobalTableIndexer -Dtablename.to.show = 'Data table name'

Figure 7-3 shows the query result. The index column definition, covering column definition, TTL, pre-partition information, and index status are displayed.

Figure 7-3 Index query result



7.10.3.3 Deleting an Index

Scenarios

You can use the GSI tool to delete an index.

How to Use

Run the following command on the HBase client to delete an index:

hbase org.apache.hadoop.hbase.hindex.global.mapreduce.GlobalTableIndexer -Dtablename.to.index='*table*' **-Dindexnames.to.drop**='*idx1#idx2*'

The parameters are described as follows:

- **tablename.to.index**: indicates the name of the table where the index to be deleted is.
- **indexnames.to.drop**: indicates the name of the index to be deleted. You can specify multiple indexes and separate them with number signs (#).

7.10.3.4 Changing Index Status

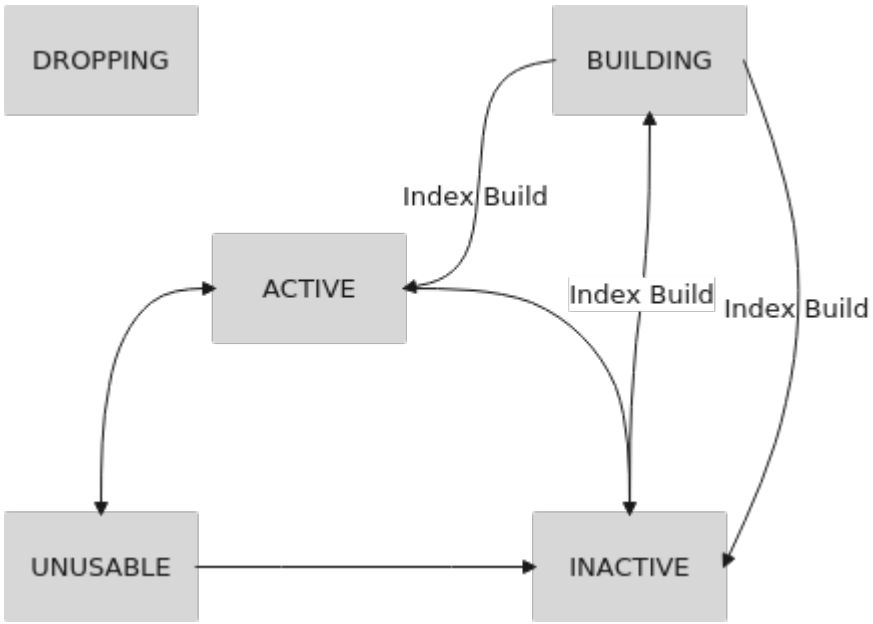
Index Status

A GSI has the following states:

- **ACTIVE**: The index can be read and written normally.
- **UNUSABLE**: The index is disabled. Index data can be written normally but cannot be used for query.
- **INACTIVE**: The index is abnormal. The index data is inconsistent with that in the data table. The indexed data is skipped and the index cannot be used during data query.
- **BUILDING**: Index data is being generated in batches. After the generation is complete, the index is automatically switched to the **ACTIVE** state. In this state, data can be read and written properly.
- **DROPPING**: The index is being deleted. The indexed data is skipped, and the index cannot be used during data query.

You can change index status with the GSI tool. **Figure 7-4** describes the states and transitions between them.

Figure 7-4 State transitions



Scenarios

You can use the GSI tool to disable or enable an index.

How to Use

Run the following command on the HBase client to disable or enable an index:

hbase org.apache.hadoop.hbase.hindex.global.mapreduce.GlobalTableIndexer -Dtablename.to.index='*table*' **-D**[idx_state_opt]='*idx1*'

The parameters are described as follows:

- **tablename.to.index**: indicates the name of the data table whose index status needs to be changed.
- **idx_state_opt**: indicates the target status of the index to be modified. The options are as follows:
  - **indexnames.to.inactive**: disables a specified index (**INACTIVE**).
  - **indexnames.to.active**: enables a specified index (**ACTIVE**).
  - **indexnames.to.unusable**: switches the specified index to **UNUSABLE**.

The following example changes the **idx1** index of **table** from **ACTIVE** to **UNUSABLE**:

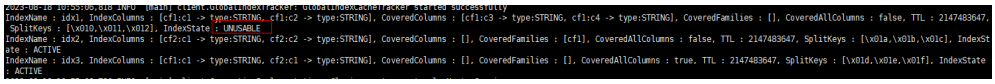
hbase org.apache.hadoop.hbase.hindex.global.mapreduce.GlobalTableIndexer -Dtablename.to.index='table' -Dindexnames.to.unusable='idx1'

After the command is executed successfully, check the index information.

hbase org.apache.hadoop.hbase.hindex.global.mapreduce.GlobalTableIndexer -Dtablename.to.show='table'

As shown in **Figure 7-5**, the status of index **idx1** is changed.

Figure 7-5 idx1 status



7.10.3.5 Creating Indexes in Batches

Scenarios

If a large amount of data exists in a data table, you can create indexes for the data in batches based on MapReduce tasks.

How to Use

NOTICE

- Only indexes in **INACTIVE** state can be created in batches. To re-create index data, change the index status first.
- If a data table contains a large amount of data, the creation takes a long time. You are advised to run the **nohup** command in the background to prevent the operation from being interrupted unexpectedly.

Run the following command on the HBase client to create indexes in batches:

hbase org.apache.hadoop.hbase.hindex.global.mapreduce.GlobalTableIndexer -Dtablename.to.index='*table*' **-Dindexnames.to.build**='*idx1*'

The parameters are described as follows:

- **tablename.to.index**: indicates the name of the data table whose index status needs to be changed.
- **indexnames.to.build**: indicates the names of the indexes you want to create in batches. You can specify multiple names and separate them with number signs (#).
- (Optional)**hbase.gsi.cleandata.enabled**: indicates whether to clear the index table before creating indexes. The default value is false.
- (Optional) **hbase.gsi.cleandata.timeout**: indicates timeout interval for clearing the index table before creating indexes. The default value is **1800**, in seconds.

7.10.3.6 Checking Consistency and Rebuilding Index Data

Scenarios

You can use the GSI tool to check the consistency between table data and index data. If they are inconsistent, use this tool to rebuild index data.

How to Use

Run the following command on the HBase client to check data consistency. If data is inconsistent, index data will be rebuilt. The consistency check result is saved to the {*NameSpace where the data table is*}:**GSI_INCONSISTENCY_TABLE** table.

hbase org.apache.hadoop.hbase.hindex.global.tools.GlobalHIndexConsistencyTool -dt *table1* **-n** *idx3* **-src** *BOTH* **-r**

The parameters are described as follows:

- **-dt,--data-table**: indicates the name of the data table where you want to check the consistency.
- **-n,--index-name**: indicates the name of the index where you want to check the consistency.
- **-src,--source**: indicates source tables used in the check. The default value is **BOTH**. The following modes are supported:
  - **INDEX_TABLE_SOURCE**: The index table is used as the source table.
  - **DATA_TABLE_SOURCE**: The data table is used as the source table.
  - **BOTH**: Both index tables and data tables are used as the source tables.
- **-r,--repair**: indicates the index data rebuilding option. The index data will be repaired after the check.
- (Optional) **-sc,--scan-caching**: indicates the size of scan caching in a MapReduce job for consistency check or index data rebuilding.

7.10.4 Loading Index Data in Batches

Scenarios

HBase allows you to use the ImportTsv and LoadIncremental tools to load user data in batches. You can also use the GlobalIndexImportTsv and GlobalIndexBulkLoadHFilesTool tools to load both user data and global index data in batches. GlobalIndexImportTsv inherits all functions of the HBase batch data loading tool ImportTsv.

If a table is not created before the GlobalIndexImportTsv tool is executed, a global index will be created when the table is created, and index data is generated when user data is generated. Pre-splitting is not supported for automatic table creation, which may cause performance problems. You need to create tables before you run the GlobalIndexImportTsv tool to load data.

Procedure

Step 1 Log in to the node where the HDFS clients are installed as the client installation user and run the following commands:

cd *Client installation directory*

source bigdata_env

kinit *Component service user* (skip this step if Kerberos authentication is disabled for the cluster (the cluster is in normal mode))

Step 2 Run the following commands to import data to HDFS:

hdfs dfs -mkdir <inputdir>

hdfs dfs -put <local_data_file> <inputdir>

For example, define data file **data.txt** as follows:

```
12005000201,Zhang San,Male,19,City a,Province a
12005000202,Li Wanting,Female,23,City b,Province b
12005000203,Wang Ming,Male,26,City c,Province c
12005000204,Li Gang,Male,18,City d,Province d
12005000205,Zhao Enru,Female,21,City e,Province e
12005000206,Chen Long,Male,32,City f,Province f
12005000207,Zhou Wei,Female,29,City g,Province g
12005000208,Yang Yiwen,Female,30,City h,Province h
12005000209,Xu Bing,Male,26,City i,Province i
12005000210,Xiao Kai,Male,25,City j,Province j
```

Run the following commands to import data to HDFS:

hdfs dfs -mkdir /datadirImport

hdfs dfs -put data.txt /datadirImport

Step 3 Run the following command to create the **bulkTable** table:

hbase shell

create 'bulkTable', {NAME => 'info',COMPRESSION => 'SNAPPY', DATA_BLOCK_ENCODING => 'FAST_DIFF'},{NAME=>'address'}

After the table is created, exit the HBase shell command line.

Step 4 Run the following command to create the global index:

hbase org.apache.hadoop.hbase.hindex.global.mapreduce.GlobalTableIndexer -Dtablename.to.index='bulkTable' -Dindexspecs.to.add='index_bulk=>info:[age->String]' -Dindexspecs.coveredallcolumn.to.add='index_bulk=>true' -Dindexspecs.splitkeys.to.set='index_bulk=>[\x010,\x011,\x012]'

For details about how to use the command, see **Creating Indexes**.

Step 5 Run the following commands to generate an HFile file (StoreFiles):

hbase org.apache.hadoop.hbase.hindex.global.mapreduce.GlobalIndexImportTsv -Dimporttsv.separator=<separator>

-Dimporttsv.bulk.output=</path/for/output> <columns> *tableName* <inputdir>

- **-Dimport.separator**: indicates a separator, for example, **-Dimport.separator=','**.
- **-Dimport.bulk.output=</path/for/output>**: indicates the output path of the execution result. You need to specify a path that does not exist.
- **<columns>**: indicates the mapping of the imported data in a table, for example, **-Dimporttsv.columns=HBASE_ROW_KEY,info:name,info:gender,info:age,address:city,address:province**.
- **<tablename>**: indicates the name of the table to be operated.
- **<inputdir>**: indicates the directory where data is loaded in batches.

- (Optional) **-Dindexspecs.covered.to.add**: indicates the column of the data table that is redundantly stored, that is, the covered column. Example: **-Dindexspecs.covered.to.add='IDX1=>cf1:[q1];cf2:[q1]#IDX2=>cf0:[q5]'**.
- (Optional) **-Dindexspecs.covered.family.to.add**: indicates the column family of the data table where the index table is redundantly stored, that is, the covered column family. Example: **-Dindexspecs.covered.family.to.add='IDX1=>cf_0#IDX2=>cf_1;cf_2'**.
- (Optional) **-Dindexspecs.coveredallcolumn.to.add**: indicates all data that the index table redundantly stores, that is, all covered columns in the data table. Example: **-Dindexspecs.coveredallcolumn.to.add='IDX1=>true#IDX2=>true'**.
- (Optional) **-Dindexspecs.splitkeys.to.set**: indicates the pre-splitting key of the index table. **Specify this parameter to prevent region hotspotting**. For example, the format of specifying the pre-splitting is as follows:
  - **'#'**: separates indexes.
  - **'[]'** contains **splitkeys**.
  - **','** separates **splitkeys**.

  For example: **-Dindexspecs.splitkeys.to.set='IDX1=>[1,2,3]#IDX2=>[a,b,c]'**
- (Optional) **-Dindexspecs.to.add=<indexspecs>**: indicates the mapping between an index name and a column, for example, **-Dindexspecs.to.add='index_bulk=>info:[age->String]'**. A value can be represented in the following format:

  indexNameN=>*familyN* **:**[columnQualifierN-> columnQualifierDataType]**,** [columnQualifierM-> columnQualifierDataType]**;***familyM***:** [columnQualifierO-> columnQualifierDataType]**#** *indexNameN*=> *familyM***:** [columnQualifierO-> columnQualifierDataType]

  The parameters are as follows:
  - Column qualifiers are separated by commas (,). Example: **index1 => f1:[c1-> String],[c2-> String]**
  - Column families are separated by semicolons (;). Example: **index1 => f1:[c1-> String],[c2-> String]; f2:[c3-> Long]**
  - Multiple indexes are separated by pound keys (#). Example: **index1 => f1 :[c1-> String], [c2-> String]; f2 :[c3-> Long]#index2 => f2 :[c3-> Long]**
  - The following data types are supported by columns:

    STRING, INTEGER, FLOAT\LONG, DOUBLE, SHORT, BYTE, and CHAR

NOTE

- Data types are not case-sensitive.
- The **indexspecs.covered.to.add**, **indexspecs.covered.family.to.add**, **indexspecs.coveredallcolumn.to.add**, **indexspecs.splitkeys.to.set**, and **indexspecs.to.add** parameters take effect only when the table to be operated does not exist and the table needs to be automatically created.

The following is an example:

hbase org.apache.hadoop.hbase.hindex.global.mapreduce.GlobalIndexImportTsv -Dimporttsv.separator=',' -Dimporttsv.bulk.output=/dataOutput -Dimporttsv.columns=HBASE_ROW_KEY,info:name,info:gender,info:age,address:city,address:province bulkTable /datadirImport/data.txt

Step 6 Run the following command to import the generated HFile to HBase:

hbase org.apache.hadoop.hbase.tool.GlobalIndexBulkLoadHFilesTool </path/for/output> <tablename>

The following is an example:

hbase org.apache.hadoop.hbase.tool.GlobalIndexBulkLoadHFilesTool /dataOutput bulkTable

Command output is as follows:

```
2024-01-13 18:29:03,043 INFO  [GlobalIndexBulkLoadHFiles-0] hdfs.DFSClient: Created token for admintest: HDFS_DELEGATION_TOKEN owner=admintest@HADOOP.COM, renewer=renewer, realUser=, issueDate=1705141743030, maxDate=1705746543030, sequenceNumber=4261, masterKeyId=5 on ha-hdfs:hacluster
2024-01-13 18:29:03,123 INFO  [LoadIncrementalHFiles-0] compress.CodecPool: Got brand-new decompressor [.snappy]
2024-01-13 18:29:03,127 INFO  [LoadIncrementalHFiles-0] compress.CodecPool: Got brand-new decompressor [.snappy]
2024-01-13 18:29:03,127 INFO  [LoadIncrementalHFiles-1] compress.CodecPool: Got brand-new decompressor [.snappy]
2024-01-13 18:29:03,127 INFO  [LoadIncrementalHFiles-4] compress.CodecPool: Got brand-new decompressor [.snappy]
2024-01-13 18:29:03,128 INFO  [LoadIncrementalHFiles-0] tool.LoadIncrementalHFiles: Trying to load hfile=hdfs://hacluster/dataOutput/bulkTable.index_bulk/0/861021782425445584957640 9ebf8f53 first=Optional[\x0118\x00\x0112005000204\x00] last=Optional[\x0119\x00\x0112005000201\x00]
2024-01-13 18:29:03,128 INFO  [LoadIncrementalHFiles-1] tool.LoadIncrementalHFiles: Trying to load hfile=hdfs://hacluster/dataOutput/bulkTable.index_bulk/0/fa17bc8e753341ffa0ba9e702200c04a first=Optional[\x0121\x00\x0112005000205\x00] last=Optional[\x0132\x00\x0112005000206\x00]
2024-01-13 18:29:03,129 INFO  [LoadIncrementalHFiles-2] tool.LoadIncrementalHFiles: Trying to load hfile=hdfs://hacluster/dataOutput/bulkTable.index_bulk/address/7a0308810d264d61bda32c385f50260c first=Optional[\x0121\x00\x0112005000205\x00] last=Optional[\x0132\x00\x0112005000206\x00]
2024-01-13 18:29:03,129 INFO  [LoadIncrementalHFiles-4] tool.LoadIncrementalHFiles: Trying to load hfile=hdfs://hacluster/dataOutput/bulkTable.index_bulk/info/27cb42f48cb14597badb6cf8b302d4e8 first=Optional[\x0118\x00\x0112005000204\x00] last=Optional[\x0119\x00\x0112005000201\x00]
2024-01-13 18:29:03,130 INFO  [LoadIncrementalHFiles-3] tool.LoadIncrementalHFiles: Trying to load hfile=hdfs://hacluster/dataOutput/bulkTable.index_bulk/address/fe8487c5e2cf4bbaaeb9e638b8acc2c1 first=Optional[\x0118\x00\x0112005000204\x00] last=Optional[\x0119\x00\x0112005000201\x00]
2024-01-13 18:29:03,131 INFO  [LoadIncrementalHFiles-5] tool.LoadIncrementalHFiles: Trying to load hfile=hdfs://hacluster/dataOutput/bulkTable.index_bulk/info/657937b1edd6401b8f5575e42e7ec92b first=Optional[\x0121\x00\x0112005000205\x00] last=Optional[\x0132\x00\x0112005000206\x00]
2024-01-13 18:29:03,539 INFO  [GlobalIndexBulkLoadHFiles-0] hdfs.DFSClient: Cancelling token for admintest: HDFS_DELEGATION_TOKEN owner=admintest@HADOOP.COM, renewer=renewer, realUser=, issueDate=1705141743030, maxDate=1705746543030, sequenceNumber=4261, masterKeyId=5 on ha-hdfs:hacluster
2024-01-13 18:29:03,571 INFO  [GlobalIndexBulkLoadHFiles-0] client.ConnectionImplementation: Closing master protocol: MasterService
2024-01-13 18:29:03,678 INFO  [GlobalIndexBulkLoadHFiles-0-EventThread] zookeeper.ClientCnxn: EventThread shut down for session: 0x3201ef383210e59e
2024-01-13 18:29:03,678 INFO  [GlobalIndexBulkLoadHFiles-0] zookeeper.ZooKeeper: Connection: 0x3201ef383210e59e closed
2024-01-13 18:29:03,679 INFO  [GlobalIndexBulkLoadHFiles-0] client.ConnectionImplementation: Connection has been closed by GlobalIndexBulkLoadHFiles-0.
```

NOTE

During index data generation and loading, do not modify indexes, including but not limited to adding and deleting indexes and changing index status. Otherwise, running tasks may fail due to data consistency. In this case, you need to execute the tasks again after the indexes becomes stable.

----End

7.10.5 GSI APIs

APIs that use global indexes are packed in the **org.apache.hadoop.hbase.hindex.global.GlobalIndexAdmin** class. Related APIs are listed in the following table.

Operation	API	Description
Adding an index	addIndices()	Adds a specified index to a table but skips index data generation. You can use this API to add indexes in batches to a table that contains a large amount of data and use the GlobalTableIndexer tool to build index data.
	addIndicesWithData()	Adds a specified index to a table and generates index data for existing table data. You can call this API to generate an index and then generate index data when table data is being stored. This API is not recommended when a data table contains a large amount of data.
Deleting an index	dropIndices()	Deletes both index metadata and index data. After deletion, the index cannot be used for scan or filter operations.
Changing index status	alterGlobalIndicesUnusable()	Disables a specified index so that it cannot be used for the scan or filter operation.
	alterGlobalIndicesActive()	Enables an index specified by the user so that it can be used for the scan or filter operation.
	alterGlobalIndicesInactive()	Disables a specified index and skips index data generation so that it cannot be used for the scan or filter operation. This API is usually used for index data re-building.
Viewing created indexes	listIndices()	Lists all indexes in a given table.

7.10.6 Querying Data with Indexes

Index-based Query

You can use **SingleColumnValueFilter** to query data in a table with indexes. When the query condition hits an index, the query speed is much faster than that of an ordinary table query.

Typical index query conditions are as follows:

- Query by multiple AND conditions
  - When the columns used for a query contain at least the first indexed column, the query performance is optimized.

    For example, create a composite index for C1, C2, and C3.

    The index takes effect in the following queries:

    Filter_Condition (IndexCol1) AND Filter_Condition (IndexCol2) AND Filter_Condition (IndexCol3)

    Filter_Condition (IndexCol1) AND Filter_Condition (IndexCol2)

    Filter_Condition (IndexCol1) AND Filter_Condition (IndexCol3)

    Filter_Condition (IndexCol1)

    The index does not take effect in the following queries:

    Filter_Condition (IndexCol2) AND Filter_Condition (IndexCol3)

    Filter_Condition (IndexCol2)

    Filter_Condition (IndexCol3)
  - When you use "Index Column AND Non-Index Column" as a query condition, the index can improve query performance. If a non-index column hits a covering column, the query performance is optimal. If a non-index column needs to be frequently queried, you are advised to define it as a covering column. The following are examples:

    Filter_Condition (IndexCol1) AND Filter_Condition (NonIndexCol1)

    Filter_Condition (IndexCol1) AND Filter_Condition (IndexCol2) AND Filter_Condition (NonIndexCol1)
  - When multiple columns are used for query, you can specify a value range for only the last column in the composite index and set other columns to specified values

    For example, create a composite index for C1, C2, and C3. In a range query, only the value range of C3 can be set. The search criteria are "C1 = *XXX*, C2 = *XXX*, and C3 = Value range."
- Query by multiple OR conditions

  For example, create a composite index for C1, C2, and C3.
  - If only the first field in the index column is searched (range filtering is supported), indexing improves the query performance.

    Filter_Condition (IndexCol1) OR Filter_Condition (IndexCol1) OR Filter_Condition (IndexCol1)
  - When non-index and non-index columns are searched, indexes cannot be hit, and query performance is not improved.

    Filter_Condition (IndexCol1) OR Filter_Condition (NonIndexCol1)
  - During a combined query, if the outermost layer contains the OR condition, the index cannot be hit, and the query performance is not improved.

    Filter_Condition (IndexCol1) OR Filter_Condition (NonIndexCol1)

    (Filter_Condition(IndexCol1)AND Filter_Condition (IndexCol2))OR(Filter_Condition(NonIndexCol1))

NOTE

Reduce the use of OR conditions, especially an OR condition used together with a range condition. Otherwise, large-scale data is queried in slow speed when indexes are hit.

7.11 Configuring HBase DR

Scenario

HBase disaster recovery (DR), a key feature that is used to ensure high availability (HA) of the HBase cluster system, provides the real-time remote DR function for HBase. HBase DR provides basic O&M tools, including tools for maintaining and re-establishing DR relationships, verifying data, and querying data synchronization progress. To implement real-time DR, back up data of an HBase cluster to another HBase cluster. For HBase tables, both regular data replication and replication of bulk loaded data are supported for DR.

Prerequisites

- The active and standby clusters are successfully installed and started, and you have the administrator permissions on the clusters.
- The network connection between the active and standby clusters is normal and ports are available.
- If the active cluster is deployed in security mode and is not managed by one FusionInsight Manager, cross-cluster trust relationship has been configured for the active and standby clusters.. If the active cluster is deployed in normal mode, no cross-cluster mutual trust is required.
- Cross-cluster replication has been configured for the active and standby clusters.
- Time is consistent between the active and standby clusters and the NTP service on the active and standby clusters uses the same time source.
- The mapping between host names and service IP addresses of all nodes in the active and standby clusters have been configured in the **hosts** file of these nodes.

  NOTE

  If the client of the active cluster is installed on a node outside the cluster, the mapping between host names and service IP addresses of all nodes in the active and standby clusters must have been configured in the **hosts** file of these nodes.
- The network bandwidth between the active and standby clusters is determined based on service volume, which cannot be less than the possible maximum service volume.
- The MRS versions of the active and standby clusters must be the same.
- The scale of the standby cluster must be greater than or equal to that of the active cluster.

Constraints

- Although DR provides the real-time data replication function, the data synchronization progress is affected by many factors, such as the service

volume in the active cluster and the health status of the standby cluster. In normal cases, the standby cluster should not take over services. In extreme cases, system maintenance personnel and other decision makers determine whether the standby cluster takes over services according to the current data synchronization indicators.

- HBase clusters must be deployed in active/standby mode.
- Table-level operations on the DR table of the standby cluster are forbidden, such as modifying the table attributes and deleting the table. Misoperations on the standby cluster will cause data synchronization failure of the active cluster. As a result, table data in the standby cluster is lost.
- If the DR data synchronization function is enabled for HBase tables of the active cluster, the DR table structure of the standby cluster needs to be modified to ensure table structure consistency between the active and standby clusters during table structure modification.
- Data synchronization for DR cannot be enabled by users for global index tables. After data synchronization is enabled for the primary table, index data is automatically generated for new data in the standby DR cluster. If there already is data before data synchronization is enabled for the primary table, you need to manually create indexes in the standby DR cluster after inventory data of the primary table is synchronized.

Procedure

Configuring the parameters of regular data replication for the active cluster

Step 1 Log in to Manager of the active cluster.

Step 2 Choose **Cluster** > **Services** > **HBase** and click **Configurations** then **All Configurations**. The HBase configuration page is displayed.

Step 3 (Optional) **Table 7-7** describes the optional configuration items during HBase DR. You can set the parameters based on the description or use the default values.

Table 7-7 Optional configuration items

Navigation Path	Parameter	Default Value	Description
HMaster > Performance	hbase.master.logcleaner.ttl	600000	Specifies the retention period of HLog. If the value is set to **604800000** (unit: millisecond), the retention period of HLog is 7 days.
	hbase.master.cleaner.interval	60000	Interval for the HMaster to delete historical HLog files. The HLog that exceeds the configured period will be automatically deleted. You are advised to set it to the maximum value to save more HLogs.

Navigation Path	Parameter	Default Value	Description
RegionServer > Replication	replication.source.size.capacity	16777216	Maximum size of edits, in bytes. If the edit size exceeds the value, HLog edits will be sent to the standby cluster.
	replication.source.nb.capacity	25000	Maximum number of edits, which is another condition for triggering HLog edits to be sent to the standby cluster. After data in the active cluster is synchronized to the standby cluster, the active cluster reads and sends data in HLog according to this parameter value. This parameter is used together with **replication.source.size.capacity**.
	replication.source.maxretriesmultiplier	10	Maximum number of retries when an exception occurs during replication.
	replication.source.sleepforretries	1000	Retry interval (Unit: ms)
	hbase.regionserver.replication.handler.count	6	Number of replication RPC server instances on RegionServer

Configuring parameters of bulk loaded data replication for the active cluster

Step 4 Determine whether to enable replication of bulk loaded data.

If you want to enable the function, go to **Step 5**.

If you do not, go to **Step 8**.

Step 5 Choose **Cluster** > **Services** > **HBase** and click **Configurations** then **All Configurations**. The HBase configuration page is displayed.

Step 6 Search for **hbase.replication.bulkload.enabled** and change its value to **true** to enable the replication of bulk loaded data.

Step 7 Search for **hbase.replication.cluster.id** and change the HBase ID of the active cluster. The ID is used by the standby cluster to connect to the active cluster. The value can contain uppercase letters, lowercase letters, digits, and underscores (_), and cannot exceed 30 characters.

Restarting the HBase service and installing the client

Step 8 Click **Save**. In the displayed dialog box, click **OK**. Restart the HBase service.

Step 9 In the active and standby clusters, choose **Cluster** > **Services** > **HBase**. Click **More** and select **Download Client** to download the client and install it.

Adding the DR relationship between the active and standby clusters

Step 10 Log in as user **hbase** to the HBase shell page of the active cluster.

Step 11 Run the following command on HBase Shell to create the DR synchronization relationship between the active cluster HBase and the standby cluster HBase.

add_peer '*Standby cluster ID***', CLUSTER_KEY => "***ZooKeeper service IP address in the standby cluster***", CONFIG => {"hbase.regionserver.kerberos.principal" => "***Standby cluster RegionServer principal***", "hbase.master.kerberos.principal" => "***Standby cluster HMaster principal***"}**

- The standby cluster ID indicates the ID for the active cluster to recognize the standby cluster. Enter an ID. The value can be specified randomly. Digits are recommended.
- The ZooKeeper address of the standby cluster includes the service IP address of ZooKeeper, the port for listening to client connections, and the HBase root directory of the standby cluster on ZooKeeper.
- Search for **hbase.master.kerberos.principal** and **hbase.regionserver.kerberos.principal** in the HBase **hbase-site.xml** configuration file of the standby cluster.

For example, to add the DR relationship between the active and standby clusters, run the **add_peer '***Standby cluster ID***', CLUSTER_KEY => "*192.168.40.2,192.168.40.3,192.168.40.4:24002:/hbase*", CONFIG => {"hbase.regionserver.kerberos.principal" => "*hbase/hadoop.hadoop.com@HADOOP.COM*", "hbase.master.kerberos.principal" => "*hbase/hadoop.hadoop.com@HADOOP.COM*"}**

Step 12 (Optional) If replication of bulk loaded data is enabled, the HBase client configuration of the active cluster must be copied to the standby cluster.

- Create the **/hbase/replicationConf/*hbase.replication.cluster.id of the active cluster*** directory in the HDFS of the standby cluster.
- HBase client configuration file, which is copied to the **/hbase/replicationConf/*hbase.replication.cluster.id of the active cluster*** directory of the HDFS of the standby cluster.

  Example: **hdfs dfs -put HBase/hbase/conf/core-site.xml HBase/hbase/conf/hdfs-site.xml HBase/hbase/conf/yarn-site.xml hdfs://*NameNode IP*:25000/hbase/replicationConf/*source_cluster***

Enabling HBase DR to synchronize data

Step 13 Check whether a naming space exists in the HBase service instance of the standby cluster and the naming space has the same name as the naming space of the HBase table for which the DR function is to be enabled.

- If the same namespace exists, go to **Step 14**.
- If no, create a naming space with the same name in the HBase shell of the standby cluster and go to **Step 14**.

Step 14 In the HBase shell of the active cluster, run the following command as user **hbase** to enable the real-time DR function for the table data of the active cluster to

ensure that the data modified in the active cluster can be synchronized to the standby cluster in real time.

You can only synchronize the data of one HTable at a time.

enable_table_replication '*table name***'**

NOTE

- If the standby cluster does not contain a table with the same name as the table for which real-time synchronization is to be enabled, the table is automatically created.
- If a table with the same name as the table for which real-time synchronization is to be enabled exists in the standby cluster, the structures of the two tables must be the same.
- If the encryption algorithm SMS4 or AES is configured for '*Table name*', the function for synchronizing data from the active cluster to the standby cluster cannot be enabled for the HBase table.
- If the standby cluster is offline or has tables with the same name but different structures, the DR function cannot be enabled.
- If the DR data synchronization function is enabled for some Phoenix tables in the active cluster, the standby cluster cannot have common HBase tables with the same names as the Phoenix tables in the active cluster. Otherwise, the DR function fails to be enabled or the tables with the names in the standby cluster cannot be used properly.
- If the DR data synchronization function is enabled for Phoenix tables in the active cluster, you need to enable the DR data synchronization function for the metadata tables of the Phoenix tables. The metadata tables include SYSTEM.CATALOG, SYSTEM.FUNCTION, SYSTEM.SEQUENCE, and SYSTEM.STATS.
- If the DR data synchronization function is enabled for HBase tables of the active cluster, after adding new indexes to HBase tables, you need to manually add secondary indexes to DR tables in the standby cluster to ensure secondary index consistency between the active and standby clusters.

Step 15 (Optional) If HBase does not use Ranger, run the following command as user **hbase** in the HBase shell of the active cluster to enable the real-time permission to control data DR function for the HBase tables in the active cluster.

enable_table_replication 'hbase:acl'

Creating Users

Step 16 Log in to FusionInsight Manager of the standby cluster, choose **System** > **Permission** > **Role** > **Create Role** to create a role, and add the same permission for the standby data table to the role based on the permission of the HBase source data table of the active cluster.

Step 17 Choose **System** > **Permission** > **User** > **Create** to create a user. Set the **User Type** to **Human-Machine** or **Machine-Machine** based on service requirements and add the user to the created role. Access the HBase DR data of the standby cluster as the newly created user.

NOTE

- After the permission of the active HBase source data table is modified, to ensure that the standby cluster can properly read data, modify the role permission for the standby cluster.
- If the current component uses Ranger for permission control, you need to configure permission management policies based on Ranger. For details, see **Adding a Ranger Access Permission Policy for HBase**.

Synchronizing the table data of the active cluster

Step 18 After HBase DR is configured and data synchronization is enabled, check whether tables and data exist in the active cluster and whether the historical data needs to be synchronized to the standby cluster.

- If yes, a table exists and data needs to be synchronized. Log in as the HBase table user to the node where the HBase client of the active cluster is installed and run the kinit username to authenticate the identity. The user must have the read and write permissions on tables and the execute permission on the **hbase:meta** table. Then go to **Step 19**.
- If no, no further action is required.

Step 19 The HBase DR configuration does not support automatic synchronization of historical data in tables. You need to back up the historical data of the active cluster and then manually restore the historical data in the standby cluster.

Manual recovery refers to the recovery of a single table, which can be performed through Export, DistCp, or Import.

To manually recover a single table, perform the following steps:

1. Export table data from the active cluster.

   hbase org.apache.hadoop.hbase.mapreduce.Export -Dhbase.mapreduce.include.deleted.rows=true *Table name Directory where the source data is stored*

   Example: **hbase org.apache.hadoop.hbase.mapreduce.Export -Dhbase.mapreduce.include.deleted.rows=true t1 /user/hbase/t1**

2. Copy the data that has been exported to the standby cluster.

   hadoop distcp *directory where the source data is stored on the active cluster* **hdfs://***ActiveNameNodeIP:8020/directory where the source data is stored on the standby cluster*

   ActiveNameNodeIP indicates the IP address of the active NameNode in the standby cluster.

   Example: **hadoop distcp /user/hbase/t1 hdfs://192.168.40.2:8020/user/hbase/t1**

3. Import data to the standby cluster as the HBase table user of the standby cluster.

   On the HBase shell screen of the standby cluster, run the following command as user **hbase** to retain the data writing status:

   set_clusterState_active

   The command is run successfully if the following information is displayed:

   ```
   hbase(main):001:0> set_clusterState_active
   => true
   ```

   hbase org.apache.hadoop.hbase.mapreduce.Import -*Dimport.bulk.output=Directory where the output data is stored in the standby cluster Table name Directory where the source data is stored in the standby cluster*

   hbase org.apache.hadoop.hbase.mapreduce.LoadIncrementalHFiles *Directory where the output data is stored in the standby cluster Table name*

   Example:

   ```
   hbase(main):001:0> set_clusterState_active
   => true
   ```

hbase org.apache.hadoop.hbase.mapreduce.Import -Dimport.bulk.output=/user/hbase/output_t1 t1 /user/hbase/t1

hbase org.apache.hadoop.hbase.mapreduce.LoadIncrementalHFiles /user/hbase/output_t1 t1

Step 20 Run the following command on the HBase client to check the synchronized data of the active and standby clusters. After the DR data synchronization function is enabled, you can run this command to check whether the newly synchronized data is consistent.

hbase org.apache.hadoop.hbase.mapreduce.replication.VerifyReplication --starttime=*Start time* **--endtime**=*End time Column family name ID of the standby cluster Table name*

NOTE

- The start time must be earlier than the end time.
- The values of **starttime** and **endtime** must be in the timestamp format. You need to run **date -d "2015-09-30 00:00:00" +%s to** change a common time format to a timestamp format.

Specify the data writing status for the active and standby clusters.

Step 21 On the HBase shell screen of the active cluster, run the following command as user **hbase** to retain the data writing status:

set_clusterState_active

The command is run successfully if the following information is displayed:

```
hbase(main):001:0> set_clusterState_active
=> true
```

Step 22 On the HBase shell screen of the standby cluster, run the following command as user **hbase** to retain the data read-only status:

set_clusterState_standby

The command is run successfully if the following information is displayed:

```
hbase(main):001:0> set_clusterState_standby
=> true
```

----End

Related Commands

Table 7-8 HBase DR

Operation	Command	Description
Set up a DR relationship.	add_peer'*Standby cluster ID*', CLUSTER_KEY => "*Standby cluster ZooKeeper service IP address*", CONFIG => {"hbase.regionserver.kerberos.principal" => "*Standby cluster RegionServer principal*", "hbase.master.kerberos.principal" => "*Standby cluster HMaster principal*"} **add_peer '1','zk1,zk2,zk3:2181:/hbase1'** **2181**: port number of ZooKeeper in the cluster	Set up the relationship between the active cluster and the standby cluster. If replication of bulk loaded data is enabled: • Create the **/hbase/replicationConf/*hbase.replication.cluster.id of the active cluster*** directory in the HDFS of the standby cluster. • HBase client configuration file, which is copied to the **/hbase/replicationConf/*hbase.replication.cluster.id of the active cluster*** directory of the HDFS of the standby cluster.
Remove the DR relationship.	**remove_peer** *'Standby cluster ID'* Example: **remove_peer '1'**	Remove standby cluster information from the active cluster.
Querying the DR Relationship	**list_peers**	Query standby cluster information (mainly Zookeeper information) in the active cluster.
Enable the real-time user table synchronization function.	**enable_table_replication** *'Table name'* Example: **enable_table_replication 't1'**	Synchronize user tables from the active cluster to the standby cluster.
Disable the real-time user table synchronization function.	**disable_table_replication** *'Table name'* Example: **disable_table_replication 't1'**	Do not synchronize user tables from the active cluster to the standby cluster.

Operation	Command	Description
Verify data of the active and standby clusters.	**bin/hbase org.apache.hadoop.hbase.mapreduce.replication.VerifyReplication --starttime=***Start time* **--endtime=***End time Column family name Standby cluster ID Table name*	Verify whether data of the specified table is the same between the active cluster and the standby cluster. The description of the parameters in this command is as follows: ● Start time: If start time is not specified, the default value **0** will be used. ● End time: If end time is not specified, the time when the current operation is submitted will be used by default. ● Table name: If a table name is not entered, all user tables for which the real-time synchronization function is enabled will be verified by default.
Switch the data writing status.	**set_clusterState_active** **set_clusterState_standby**	Specifies whether data can be written to the cluster HBase tables.

Operation	Command	Description
Add or update the active cluster HDFS configurations saved in the peer cluster.	**hdfs dfs -put -f HBase/hbase/conf/core-site.xml HBase/hbase/conf/hdfs-site.xml HBase/hbase/conf/yarn-site.xml hdfs://***Standby cluster* ***NameNode IP:PORT*****/hbase/replicationConf/***Active cluster* ***hbase.replication.cluster.id***	Enable DR for data including bulk loaded data. When HDFS parameters are modified in the active cluster, the modification cannot be automatically synchronized from the active cluster to the standby cluster. You need to manually run the command to synchronize configuration. The affected parameters are as follows: • fs.defaultFS • dfs.client.failover.proxy.provider.hacluster • dfs.client.failover.connection.retries.on.timeouts • dfs.client.failover.connection.retries For example, change **fs.defaultFS** to **hdfs://hacluster_sale**, HBase client configuration file, which is copied to the **/hbase/replicationConf/*hbase.replication.cluster.id of the active cluster*** directory of the HDFS of the standby cluster.
Disable replication for bulk loaded data of a single table, when **hbase.replication.bulkload.enabled** is set to **true**.	**disable_bulkload_replication** *'peerId', 'Table name'* Example: **disable_bulkload_replication '1','t1'**	If replication for bulk loaded data is enabled for the active cluster and real-time synchronization is enabled for a table, you can run this command to pause replication for bulk loaded data of the table. Run the **list_peers** command to view *peerId* in the standby cluster information.

Operation	Command	Description
Enable replication for bulk loaded data of a single table, when **hbase.replication.bulkload.enabled** is set to **true**.	**enable_bulkload_replication 'peerId', 'Table name'** Example: **enable_bulkload_replication '1','t1'**	Replication for bulk loaded data is enabled for the active cluster, and real-time synchronization is enabled for a table. You can run this command to resume replication for bulk loaded data of the table after the function is paused. Run the **get_peer_config** *'peerId'* command to check the DR configuration of the standby cluster. If the value of a table name field that starts with **BULREP_** is **false**, replication for bulk loaded data is disabled for the table. **NOTE** • Data generated when replication for bulk loaded data is paused will not be synchronized after the function is resumed. • It takes several minutes for this operation to take effect on the server. To prevent bulk loaded data loss caused by synchronization latency, ensure that "Update peer configs succeed." is printed in run logs on each RegionServer after this command is executed. Then, perform subsequent operations on the active cluster.

7.12 Configuring HBase Data Compression and Encoding

Scenario

HBase encodes data blocks in HFiles to reduce duplicate keys in KeyValues, reducing used space. Currently, the following data block encoding modes are supported: NONE, PREFIX, DIFF, FAST_DIFF, and ROW_INDEX_V1. NONE indicates that data blocks are not encoded. HBase also supports compression algorithms for HFile compression. The following algorithms are supported by default: NONE, GZ, SNAPPY, and ZSTD. NONE indicates that HFiles are not compressed.

The two methods are used on the HBase column family. They can be used together or separately.

Prerequisites

- The HBase client has been installed in a directory, for example, **/opt/client**.
- If authentication has been enabled for HBase, you must have the corresponding operation permissions. For example, you must have the creation (C) or administration (A) permission on the corresponding namespace or higher-level items to create a table, and the creation (C) or administration (A) permission on the created table or higher-level items to modify a table. For details about how to grant permissions, see **Creating HBase Roles**.

Procedure

Setting data block encoding and compression algorithms during creation

1. Log in to the node where the client is installed as the client installation user.
2. Run the following command to go to the client directory:

   cd /opt/client
3. Run the following command to configure environment variables:

   source bigdata_env
4. If the Kerberos authentication is enabled for the current cluster, run the following command to authenticate the user. If Kerberos authentication is disabled for the current cluster, skip this step:

   kinit *Component service user*

   For example, **kinit hbaseuser**.
5. Run the following HBase client command:

   hbase shell
6. Create a table.

   create '*t1***', {NAME => '***f1***', COMPRESSION => '***SNAPPY***', DATA_BLOCK_ENCODING => '***FAST_DIFF***}**

   NOTE

   - *t1*: indicates the table name.
   - *f1*: indicates the column family name.
   - *SNAPPY*: indicates the column family uses the SNAPPY compression algorithm.
   - *FAST_DIFF*: indicates FAST_DIFF is used for encoding.
   - The parameter in the braces specifies the column family. You can specify multiple column families using multiple braces and separate them by commas (,). For details about table creation statements, run the **help 'create'** statement in the HBase shell.

Setting or modifying the data block encoding mode and compression algorithm for an existing table

1. Log in to the node where the client is installed as the client installation user.
2. Run the following command to go to the client directory:

   cd /opt/client
3. Run the following command to configure environment variables:

   source bigdata_env

4. If the Kerberos authentication is enabled for the current cluster, run the following command to authenticate the user. If Kerberos authentication is disabled for the current cluster, skip this step:

   kinit *Component service user*

   For example, **kinit hbaseuser**.

5. Run the following HBase client command:

   hbase shell

6. Run the following command to modify the table:

   alter '*t1***', {NAME => '***f1***', COMPRESSION => '***SNAPPY***', DATA_BLOCK_ENCODING => '***FAST_DIFF***}**

7.13 Performing an HBase DR Service Switchover

Scenario

MRS cluster administrators can configure HBase cluster DR to improve system availability. If the active cluster in the DR environment is faulty and the connection to the HBase upper-layer application is affected, you need to configure the standby cluster information for the HBase upper-layer application so that the application can run in the standby cluster.

Impact on the System

After a service switchover, data written to the standby cluster is not synchronized to the active cluster by default. Add the active cluster is recovered, the data newly generated in the standby cluster needs to be synchronized to the active cluster by backup and recovery. If automatic data synchronization is required, you need to switch over the active and standby HBase DR clusters.

Procedure

Step 1 Log in to FusionInsight Manager of the standby cluster.

Step 2 Download and install the HBase client.

Step 3 On the HBase client of the standby cluster, run the following command as user **hbase** to enable the data writing status in the standby cluster.

kinit hbase

hbase shell

set_clusterState_active

The command is run successfully if the following information is displayed:

```
hbase(main):001:0> set_clusterState_active
=> true
```

Step 4 Check whether the original configuration files **hbase-site.xml**, **core-site.xml**, and **hdfs-site.xml** of the HBase upper-layer application are modified to adapt to the application running.

- If yes, update the related content to the new configuration file and replace the old configuration file.
- If no, use the new configuration file to replace the original configuration file of the HBase upper-layer application.

Step 5 Configure the network connection between the host where the HBase upper-layer application is located and the standby cluster.

NOTE

If the host where the client is installed is not a node in the cluster, configure network connections for the client to prevent errors when you run commands on the client.

1. Ensure that the host where the client is installed can communicate with the hosts listed in the **hosts** file in the directory where the client installation package is decompressed.
2. If the host where the client is located is not a node in the cluster, you need to set the mapping between the host name and the IP address (service plan) in the /etc/hosts file on the host. The host names and IP addresses must be mapped one by one.

Step 6 Set the time of the host where the HBase upper-layer application is located to be the same as that of the standby cluster. The time difference must be less than 5 minutes.

Step 7 Check the authentication mode of the active cluster.

- If the security mode is used, go to **Step 8**.
- If the normal mode is used, no further action is required.

Step 8 Obtain the **keytab** and **krb5.conf** configuration files of the HBase upper-layer application user.

1. On FusionInsight Manager of the standby cluster, choose **System** > **Permission** > **User**.
2. Locate the row that contains the target user, click **More** > **Download Authentication Credential** in the **Operation** column, and download the **keytab** file to the local PC.
3. Decompress the package to obtain **user.keytab** and **krb5.conf**.

Step 9 Use the **user.keytab** and **krb5.conf** files to replace the original files in the HBase upper-layer application.

Step 10 Stop upper-layer applications.

Step 11 Determine whether to switch over the active and standby HBase clusters. If the switchover is not performed, data will not be synchronized.

- If yes, switch over the active and standby HBase DR clusters. For details, see **Performing an HBase DR Active/Standby Cluster Switchover**. Then, go to **Step 12**.
- If no, go to **Step 12**.

Step 12 Start the upper-layer services.

----End

7.14 Performing an HBase DR Active/Standby Cluster Switchover

Scenario

The HBase cluster in the current environment is a DR cluster. Due to some reasons, the active and standby clusters need to be switched over. That is, the standby cluster becomes the active cluster, and the active cluster becomes the standby cluster.

Impact on the System

After the active and standby clusters are switched over, data cannot be written to the original active cluster, and the original standby cluster becomes the active cluster to take over upper-layer services.

Procedure

Ensuring that upper-layer services are stopped

Step 1 Ensure that the upper-layer services have been stopped. If not, perform operations by referring to **Performing an HBase DR Service Switchover**.

Disabling the write function of the active cluster

Step 2 Download and install the HBase client.

Step 3 On the HBase client of the standby cluster, run the following command as user **hbase** to disable the data write function of the standby cluster:

kinit hbase

hbase shell

set_clusterState_standby

The command is run successfully if the following information is displayed:

```
hbase(main):001:0> set_clusterState_standby
=> true
```

Checking whether the active/standby synchronization is complete

Step 4 Run the following command to ensure that the current data has been synchronized (SizeOfLogQueue=0 and SizeOfLogToReplicate=0 are required). If the values are not 0, wait and run the following command repeatedly until the values are 0.

status 'replication'

Disabling synchronization between the active and standby clusters

Step 5 Query all synchronization clusters and obtain the value of **PEER_ID**.

list_peers

Step 6 Delete all synchronization clusters.

remove_peer *'Standby cluster ID'*

Example:

remove_peer *'1'*

Step 7 Query all synchronized tables.

list_replicated_tables

Step 8 Disable all synchronized tables queried in the preceding step.

disable_table_replication *'Table name'*

Example:

disable_table_replication *'t1'*

Performing an active/standby switchover

Step 9 Reconfigure HBase DR. For details, see **Configuring HBase DR**.

----End

7.15 Community BulkLoad Tool

The Apache HBase official website provides the function of importing data in batches. For details, see the description of the **Import** and **ImportTsv** tools at **http://hbase.apache.org/2.4/book.html#tools**.

7.16 Configuring Secure HBase Replication

Scenario

This topic provides the procedure to configure the secure HBase replication during cross-realm Kerberos setup in security mode.

Prerequisites

- Mapping for all the FQDNs to their realms should be defined in the Kerberos configuration file.
- The passwords and keytab files of **ONE.COM** and **TWO.COM** must be the same.

Procedure

Step 1 Create krbtgt principals for the two realms.

For example, if you have two realms called **ONE.COM** and **TWO.COM**, you need to add the following principals: **krbtgt/ONE.COM@TWO.COM** and **krbtgt/TWO.COM@ONE.COM**.

Add these two principals at both realms.

```
kadmin: addprinc -e "<enc_type_list>" krbtgt/ONE.COM@TWO.COM
kadmin: addprinc -e "<enc_type_list>" krbtgt/TWO.COM@ONE.COM
```

NOTE

There must be at least one common keytab mode between these two realms.

Step 2 Add rules for creating short names in Zookeeper.

Dzookeeper.security.auth_to_local is a parameter of the ZooKeeper server process. Following is an example rule that illustrates how to add support for the realm called **ONE.COM**. The principal has two members (such as **service/instance@ONE.COM**).

```
Dzookeeper.security.auth_to_local=RULE:[2:\$1@\$0](.*@\\QONE.COM\\E$)s/@\\QONE.COM\\E$//DEFAULT
```

The above code example adds support for the **ONE.COM** realm in a different realm. Therefore, in the case of replication, you must add a rule for the master cluster realm in the slave cluster realm. **DEFAULT** is for defining the default rule.

Step 3 Add rules for creating short names in the Hadoop processes.

The following is the **hadoop.security.auth_to_local** property in the **core-site.xml** file in the slave cluster HBase processes. For example, to add support for the **ONE.COM** realm:

```
<property>
<name>hadoop.security.auth_to_local</name>
<value>RULE:[2:$1@$0](.*@\QONE.COM\E$)s/@\QONE.COM\E$//DEFAULT</value>
</property>
```

NOTE

If replication for bulkload data is enabled, then the same property for supporting the slave realm needs to be added in the **core-site.xml** file in the master cluster HBase processes.

Example:

```
<property>
<name>hadoop.security.auth_to_local</name>
<value>RULE:[2:$1@$0](.*@\QTWO.COM\E$)s/@\QTWO.COM\E$//DEFAULT</value>
</property>
```

----End

7.17 Configuring Region In Transition Recovery Chore Service

Scenario

In a faulty environment, there are possibilities that a region may be stuck in transition for longer duration due to various reasons like slow region server response, unstable network, ZooKeeper node version mismatch. During region transition, client operation may not work properly as some regions will not be available.

Configuration

A chore service should be scheduled at HMaster to identify and recover regions that stay in the transition state for a long time.

The following table describes the parameters for enabling this function.

Table 7-9 Parameters

Parameter	Description	Default Value
hbase.region.assignment.auto.recovery.enabled	Configuration parameter used to enable/disable the region assignment recovery thread feature.	true

7.18 Enabling the HBase Compaction

Scenario

HBase allows you to set compaction throughput during off-peak hours. A large throughput can speed up compaction execution and reduce impacts on services during peak hours.

Configuring HBase Compaction Throughput Parameters

Log in to FusionInsight Manager, choose **Cluster** > **Service** > **HBase**, and click **Configuration**. In the search box, search for the parameters listed in **Table 7-10** and change the parameter values as you need. The parameter settings take effect dynamically. After the modification is saved, log in to the **hbase shell** CLI and run the **update_all_config** command to update the configuration. You do not need to restart the instance.

NOTE

To enable the HBase compaction throughput settings, neither **hbase.offpeak.start.hour** nor **hbase.offpeak.end.hour** must be **-1**.

Table 7-10 HBase compaction throughput parameters

Parameter	Description	Default Value
hbase.offpeak.start.hour	Start time of off-peak hours of the HBase cluster. The value must be an integer from **-1** to **23**. If the value is **-1**, HBase compaction throughput will not be used.	-1
hbase.offpeak.end.hour	End time of off-peak hours of the HBase cluster. The value must be an integer from **-1** to **23**. If the value is **-1**, HBase compaction throughput will not be used.	-1
hbase.hstore.compaction.throughput.offpeak	Compaction throughput during off-peak hours. The unit is byte/s.	104857600

Configuration Example

Step 1 Log in to FusionInsight Manager, choose **Cluster** > **Service** > **HBase**, and click **Configuration**. Set off-peak hours as needed. The following are examples:

- If **hbase.offpeak.start.hour** is **18** and **hbase.offpeak.end.hour** is **23**, off-peak hours are 18:00 to 23:00 every day.
- If **hbase.offpeak.start.hour** is **23** and **hbase.offpeak.end.hour** is **8**, off-peak hours are 23:00 to 8:00 the next day.

Step 2 During off-peak hours, log in to FusionInsight Manager, choose **Cluster** > **Service** > **HBase**, and click **Chart**. Check whether the value of **Compaction Queue Size-All Instances** keeps increasing and whether the values of some RegionServers in **Traffic of the RegionServer Compaction Operations-All Instances** have reached or exceeded the value of **hbase.hstore.compaction.throughput.offpeak**.

- If they are, set **hbase.hstore.compaction.throughput.offpeak** to a larger value based on the cluster disk usage and go to **Step 3**.
- If they are not, no further action is required.

Step 3 Check whether the value of **P99 Percentile RegionServer RPC Request Response Time-All Instances** keeps increasing in the HBase chart.

- If it does, go to **Step 4**.
- If it does not, no further action is required.

Step 4 Check whether the value of **Disk IO Utilization** of the host where the RegionServer is located exceeds 90%.

- If it does, reduce the write speed or expand the disk capacity.
- If it does not, no further action is required.

----End

7.19 Using a Secondary Index

Scenario

HIndex enables HBase indexing based on specific column values, making the retrieval of data highly efficient and fast.

Constraints

- Column families are separated by semicolons (;).
- Columns and data types must be contained in square brackets ([]).
- The column data type is specified by using -> after the column name.
- If the column data type is not specified, the default data type (string) is used.
- The number sign (#) is used to separate two index details.
- The following is an optional parameter:

  -Dscan.caching: number of cached rows when the data table is scanned.

  The default value is set to 1000.

- Indexes are created for a single region to repair damaged indexes.
  This function is not used to generate new indexes.

Procedure

Step 1 Install the HBase client. For details, see **Using an HBase Client**.

Step 2 Go to the client installation directory, for example, **/opt/client**.

cd /opt/client

Step 3 Run the following command to configure environment variables:

source bigdata_env

Step 4 If the cluster is in security mode, run the following command to authenticate the user. In normal mode, user authentication is not required.

kinit *Component service user*

Step 5 Run the following command to access HIndex:

hbase org.apache.hadoop.hbase.hindex.mapreduce.TableIndexer

Table 7-11 Common HIndex commands

Description	Command
Add Index	TableIndexer-Dtablename.to.index=table1-Dindexspecs.to.add='IDX1=>cf1:[q1->datatype],[q2],[q3];cf2:[q1->datatype],[q2->datatype]#IDX2=>cf1:[q5]'
Create Index	TableIndexer -Dtablename.to.index=table1 -Dindexnames.to.build='IDX1#IDX2'
Delete Index	TableIndexer -Dtablename.to.index=table1 -Dindexnames.to.drop='IDX1#IDX2'
Disable Index	TableIndexer -Dtablename.to.index=table1 -Dindexnames.to.disable='IDX1#IDX2'
Add and Create Index	TableIndexer -Dtablename.to.index=table1 -Dindexspecs.to.add='IDX1=>cf1:[q1->datatype],[q2],[q3];cf2:[q1->datatype],[q2->datatype]#IDX2=>cf1:[q5]' -Dindexnames.to.build='IDX1'
Create Index for a Single Region	TableIndexer -Dtablename.to.index=table1 -Dregion.to.index=regionEncodedName -Dindexnames.to.build='IDX1#IDX2'

NOTE

- **IDX1**: indicates the index name.
- **cf1**: indicates the column family name.
- **q1**: indicates the column name.
- **datatype**: indicates the data type, including String, Integer, Double, Float, Long, Short, Byte and Char.

----End

7.20 Hot-Cold Data Separation

7.20.1 Overview

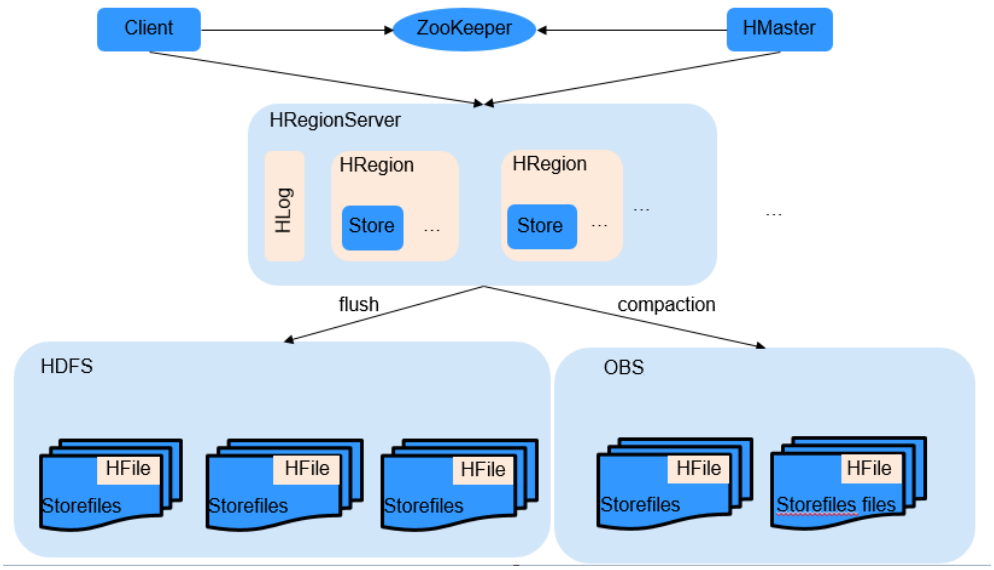
In a big data storage scenario, HBase table data such as order data or monitoring data grows over time. As your business develops, such data can be of a large volume and rarely used. Companies may want to use cost-effective storage to store this type of data to reduce costs.

HBase separates cold data from hot data and stores them on different media. Cold data is stored in OBS and hot data is stored in HDFS, reducing storage costs.

Principles

HBase supports separate cold and hot storage of data in the same table. After a user configures the time boundary between hot and cold data, HBase determines whether data is hot or cold based on the timestamp (ms) and the time boundary configured by the user. New data is stored in the hot storage and is gradually moved to the cold storage over time. You can change the time boundary for separating cold and hot data as you need. Data can be moved from the cold storage to the hot storage or vice versa.

Figure 7-6 HBase cold and hot separation principle



Precautions

- IOPS of data reading in OBS decreases. As a result, OBS is suitable for infrequent queries only.
- It is not a good choice to use OBS for a large number of concurrent read requests. Otherwise, exceptions may occur.

7.20.2 Enabling Hot-Cold Data Separation

You can modify the HBase configuration on FusionInsight Manager to enable hot-cold data separation. Cold data will be stored in OBS and hot data will be stored in HDFS.

Procedure

Step 1 Interconnecting the Guardian Service with OBS

Step 2 Log in to FusionInsight Manager, choose **Cluster** > **Services** > **HBase**, and click **Configuration**. Search for and modify the following parameters:

- **fs.coldFS**: OBS file system name, for example, **obs://***OBS parallel file system name*
- **hbase.fs.hot.cold.enabled**: The default value is **false**. Set this parameter to **true**.
- **fs.obs.buffer.dir**: Set this parameter to the directory of the locally mounted data disk, for example, **/srv/BigData/data1/tmp/HBase/obs**.

Step 3 Click **Save**.

Step 4 Click **Dashboard** and click **More** > **Restart Service** to restart the HBase service. After the service is restarted, hot-cold data separation is enabled.

Step 5 Set the cold and hot boundary for the table data. For details, see **Cold-Hot Separation Commands**.

----End

7.20.3 Cold-Hot Separation Commands

The following content describes how to use the commands related to cold-hot separation, including shell commands and Java API commands.

Shell commands are executed on the HBase client.

Setting the Hot and Cold Data Boundary of an HBase Table

- Shell
  - Create a table where data will be separately stored.

    create '*hot_cold_table*', {NAME=>'*f*', COLD_BOUNDARY=>'*86400*'}

    Required parameters are as follows:

    - **NAME** indicates the column family that requires cold-hot separation.
    - **COLD_BOUNDARY** indicates the time boundary (in seconds) for separating cold and hot data. For example, if **COLD_BOUNDARY** is

set to **86400**, data that was written 86,400 seconds (one day) ago will be archived as cold data.

NOTE

The boundary time must be greater than the Major Compaction execution period. The default Major Compaction execution period is 7 days.

- Disable cold-hot separation.

  alter '*hot_cold_table*', {NAME=>'*f*', COLD_BOUNDARY=>""}

- Enable cold-hot separation for an existing table or change the time boundary. The time boundary is measured in seconds.

  alter '*hot_cold_table*', {NAME=>'*f*', COLD_BOUNDARY=>'*86400*'}

- Check whether cold-hot separation is enabled or whether the time boundary is successfully modified.

  desc '*hot_cold_table*'

```
Table hot_cold_table is ENABLED
hot_cold_table
COLUMN FAMILIES DESCRIPTION
{NAME => 'f', VERSIONS => '1', KEEP_DELETED_CELLS => 'FALSE', DATA_BLOCK_ENCODING =>
'NONE', TTL => 'FOREVER', MIN_VERSIONS => '0', REPLICATION_SCOPE => '0', BLOOMFILTER
=> 'ROW', IN_MEMORY => 'false', COMPRE
SSION => 'NONE', BLOCKCACHE => 'true', BLOCKSIZE => '65536', METADATA =>
{'COLD_BOUNDARY' => '1200'}}
1 row(s)
Quota is disabled
Took 0.0339 seconds
```

NOTE

You must perform a major compaction before you move the data between the cold storage and the hot storage.

Writing Data

You can write data to a table with separated cold and hot storage in the same way that you write data to a regular table. Newly written data is stored in hot storage (HDFS). If the storage duration of a data record exceeds the value specified by the **COLD_BOUNDARY** parameter, the system automatically moves the data to cold storage (OBS) during the compaction process.

- Insert a data record to a table.

  Run the **put** command to insert a data record to the specified table. Specify the table name, primary key, custom column, and value. The following is an example:

  put '*hot_cold_table*','*row1*','cf:*a*','*value1*'

  The following parameters are required in the command:

  - **hot_cold_table**: table name
  - **row1**: primary key
  - **cf: a**: custom column
  - **value1**: value to insert

Querying Data

Both cold data and hot data are in the same HBase table. You can query the data only on one table. You can configure **TimeRange** to specify the time range of the

data you want to query. The system automatically determines whether the hot storage, cold storage, or both will be searched based on the specified time range. If the time range is not specified during the query, only cold storage will be searched. The throughput of reading cold data is lower than that of reading hot data.

NOTE

- The cold storage is used to archive data that is rarely accessed. If your cluster receives a large number of queries that hit cold data, you can check whether the time boundary (**COLD_BOUNDARY**) is set to an appropriate value. The query performance deteriorates if data that is frequently accessed are stored in the cold storage.
- If you update a field in a row that is stored in the cold storage, the field is moved to the hot storage after the update. When this row is hit by a query that carries the **HOT_ONLY** hint or has a time range that is configured to hit hot data, only the updated field in the hot storage is returned. If you want the system to return the entire row, you must delete the **HOT_ONLY** hint from the query statement or make sure that the specified time range covers the time period from when this row is inserted to when this row is last updated. It is recommended that you do not update data that is stored in the cold storage.

- Random queries with Get
  - Shell
    - Query data in cold storage without the **HOT_ONLY** hint.

      get '*hot_cold_table*', '*row1*'
    - Query data in hot storage with the **HOT_ONLY** hint.

      get '*hot_cold_table*', '*row1*', **{HOT_ONLY=>true}**
    - Query data within a time range that is specified by **TimeRange**. The system determines whether the query hits cold or hot data based on the values of **TIMERANGE** and **COLD_BOUNDARY**.

      get '*hot_cold_table*', '*row1*', {TIMERANGE => [0, 1568203111265]}

      NOTE

      TimeRange specifies the query time range. The time in the range is a UNIX timestamp, which is the number of milliseconds that have elapsed since the Unix epoch.
- SCAN queries
  - Shell
    - Query data in cold storage without the **HOT_ONLY** hint.

      scan '*hot_cold_table*', {STARTROW =>'*row1*', STOPROW=>'*row9*'}
    - Query data in hot storage with the **HOT_ONLY** hint.

      scan '*hot_cold_table*', {STARTROW =>'*row1*', STOPROW=>'*row9*', **HOT_ONLY=>true**}
    - Query data within a time range that is specified by **TimeRange**. The system determines whether the query hits cold or hot data based on the values of **TIMERANGE** and **COLD_BOUNDARY**.

      scan '*hot_cold_table*', {STARTROW =>'*row1*', STOPROW=>'*row9*', TIMERANGE => [0, 1568203111265]}

NOTE

TimeRange specifies the query time range. The time in the range is a UNIX timestamp, which is the number of milliseconds that have elapsed since the Unix epoch.

- Prioritizing hot data query

  HBase can search cold storage and hot storage for SCAN queries, for example, that are submitted to search all records of a customer. The query results are returned based on the timestamps when the data records are written in descending order. In most cases, hot data appears before cold data. If the SCAN queries do not carry the **HOT_ONLY** hint, HBase must scan data in both cold and hot storage. As a result, the query takes more time. If you prioritize hot data query, HBase preferentially queries hot data. Cold data is queried only when the number of rows in hot storage is less than the minimum number of rows to be queried. This reduces access to cold storage and improves the response speed.

  – Shell

    scan '*hot_cold_table*', {STARTROW =>'*row1*', STOPROW=>'*row9*',COLD_HOT_MERGE=>true}

- Major compaction

  – Shell

    ▪ Merge hot data areas of all partitions in a table.

      major_compact '*hot_cold_table*', nil, 'NORMAL', 'HOT'

    ▪ Merge cold data areas of all partitions in a table.

      major_compact '*hot_cold_table*', nil, 'NORMAL', 'COLD'

    ▪ Merge hot and cold data areas of all partitions in a table.

      major_compact '*hot_cold_table*', nil, 'NORMAL', 'ALL'

7.21 Configuring HBase Table-Level Overload Control

Scenario

When the HBase requests soar in a short period of time, the system is overloaded. As a result, the P99 latency of requests increases, which severely affects services that relay on quick responses. HBase table-level overload prevention is used to control request latency of core tables (core services).

Procedure

Step 1 Modify the properties of core tables and set table-level priorities.

1. Log in to the node where the HBase client is installed as the client installation user and configure environment variables.

   cd *HBase client installation directory*

   source bigdata_env

2. If Kerberos authentication is enabled for the cluster (the cluster is in security mode), run the following command to authenticate the user:

kinit *Component service user*

3. Run the following commands to log in to the HBase client and modify the table description:

   hbase shell

   alter '*test_table***', PRIORITY=>'1'**

   NOTE

   - The table priority can be set through the **PRIORITY** property. When the value of **PRIORITY** is greater than or equal to 1, the priority is high. You are advised to set **PRIORITY** to **1**.
   - You can specify the **PRIORITY** property when creating a core table. For example:

     create '*test_table***','cf',PRIORITY=>'1'**

Step 2 Log in to FusionInsight Manager, choose **Cluster** > **Services** > **HBase** > **Configurations** > **All Configurations**, search for the parameters listed in **Configuring HBase Table-Level Overload Control**, and change the parameter values.

Table 7-12 Parameters for HBase table-level overload control

Parameter	Description	Suggestion
hbase.ipc.server.default.callqueue.size.overload.threshold	RegionServer queue threshold. When the percentage of the request size in the queue exceeds the threshold, requests to low-priority tables are discarded. This configuration is used to control the request latency of core tables.	• The number of core table requests and latency requirements must be considered. A smaller value is recommended. Generally, the value ranges from 0.5 to 1.0. • The two types of overload control can be enabled independently or at the same time. RegionServer queue overload control is used when there is a large number of requests. RegionServer handler overload control is used when there is a large number of concurrent requests.
hbase.ipc.server.handler.overload.threshold	RegionServer handler threshold. When the percentage of active handlers exceeds the threshold, requests to low-priority tables are discarded. This configuration is used to control the request latency of core tables.	

Step 3 Click **Save**. In the displayed dialog box, click **OK**.

Step 4 Click **Instances**, select all RegionServer instances, and choose **More** > **Restart Instance**.

----End

7.22 HBase Log Overview

Log Description

Log path: The default storage path of HBase logs is **/var/log/Bigdata/hbase/***Role name*.

- HMaster: **/var/log/Bigdata/hbase/hm** (run logs) and **/var/log/Bigdata/audit/hbase/hm** (audit logs)
- RegionServer: **/var/log/Bigdata/hbase/rs** (run logs) and **/var/log/Bigdata/audit/hbase/rs** (audit logs)
- ThriftServer: **/var/log/Bigdata/hbase/ts2** (run logs, **ts2** is the instance name) and **/var/log/Bigdata/audit/hbase/ts2** (audit logs, **ts2** is the instance name)
- MetricController: **/var/log/Bigdata/hbase/mc** (run logs) and **/var/log/Bigdata/audit/hbase/mc** (audit logs)

Log archive rule: The automatic log compression and archiving function of HBase is enabled. By default, when the size of a log file exceeds 30 MB, the log file is automatically compressed. The naming rule of a compressed log file is as follows: <*Original log name*>-<*yyyy-mm-dd_hh-mm-ss*>.[*ID*].**log.zip** A maximum of 20 latest compressed files are reserved. The number of compressed files can be configured on the Manager portal.

Table 7-13 HBase log list

Type	Name	Description
Run logs	hbase-<SSH_USER>-<process_name>-<hostname>.log	HBase system log that records the startup time, startup parameters, and most logs generated when the HBase system is running.
	hbase-<SSH_USER>-<process_name>-<hostname>.out	Log that records the HBase running environment information.
	<process_name>-<SSH_USER>-<DATE>-<PID>-gc.log	Log that records HBase junk collections.
	checkServiceDetail.log	Log that records whether the HBase service starts successfully.

Type	Name	Description
	hbase.log	Log generated when the HBase service health check script and some alarm check scripts are executed.
	sendAlarm.log	Log that records alarms reported after execution of HBase alarm check scripts.
	hbase-haCheck.log	Log that records the active and standby status of HMaster.
	stop.log	Log that records the startup and stop processes of HBase.
	ranger-hbase-plugin-enable.log	Log that records Ranger authentication enabling or disabling of the HBase service.
	hbase-trace.log	HBase full-link trace log.
	rolling-restart-prepare.log	Rolling upgrade log of the HBase service.
	startDetail.log	RegionServer startup log.
Audit logs	hbase-audit-<process_name>.log	Log that records HBase security audit.

Log Level

Table 7-14 describes the log levels supported by HBase. The priorities of log levels are FATAL, ERROR, WARN, INFO, and DEBUG in descending order. Logs whose levels are higher than or equal to the specified level are printed. The number of printed logs decreases as the specified log level increases.

Table 7-14 Log levels

Level	Description
FATAL	Logs of this level record fatal error information about the current event processing that may result in a system crash.
ERROR	Logs of this level record error information about the current event processing, which indicates that system running is abnormal.
WARN	Logs of this level record abnormal information about the current event processing. These abnormalities will not result in system faults.

Level	Description
INFO	Logs of this level record normal running status information about the system and events.
DEBUG	Logs of this level record the system information and system debugging information.

To modify log levels, perform the following operations:

Step 1 Go to the **All Configurations** page of the HBase service. For details, see **Modifying Cluster Service Configuration Parameters**.

Step 2 On the left menu bar, select the log menu of the target role.

Step 3 Select a desired log level.

Step 4 Save the configuration. In the displayed dialog box, click **OK** to make the configurations take effect.

NOTE

The configurations take effect immediately without the need to restart the service.

----End

Log Formats

The following table lists the HBase log formats.

Table 7-15 Log formats

Type	Component	Format	Example
Run logs	HMaster	<yyyy-MM-dd HH:mm:ss,SSS>|<Log Level>|<*Thread that generates the log*>|<*Message in the log*>|<*Location of the log event*>	2020-01-19 16:04:53,558 | INFO | main | env:HBASE_THRIFT_OPTS= | org.apache.hadoop.hbase.util.ServerCommandLine.logProcessInfo(ServerCommandLine.java:113)
	RegionServer	<yyyy-MM-dd HH:mm:ss,SSS>|<Log Level>|<*Thread that generates the log*>|<*Message in the log*>|<*Location of the log event*>	2020-01-19 16:05:18,589 | INFO | regionserver16020-SendThread(linux-k6da:2181) | Client will use GSSAPI as SASL mechanism. | org.apache.zookeeper.client.ZooKeeperSaslClient$1.run(ZooKeeperSaslClient.java:285)

Type	Component	Format	Example
	ThriftServer	<yyyy-MM-dd HH:mm:ss,SSS>|<Log Level>|<*Thread that generates the log*>|<*Message in the log*>|<*Location of the log event*>	2020-02-16 09:42:55,371 | INFO | main | loaded properties from hadoop-metrics2.properties | org.apache.hadoop.metrics2.impl.MetricsConfig.loadFirst(MetricsConfig.java:111)
	MetricController	<yyyy-MM-dd HH:mm:ss,SSS>|<Log Level>|<*Thread that generates the log*>|<*Message in the log*>|<*Location of the log event*>	2023-07-29 18:20:16,374 | WARN | hotspot-analysis-pool1 | Start to analysis later because of empty metric map | com.xxx.hadoop.hbase.metric.analysis.HotspotAnalyzer.analysisHotspot(HotspotAnalyzer.java:118)
Audit logs	HMaster	<yyyy-MM-dd HH:mm:ss,SSS>|<Log Level>|<*Thread that generates the log*>|<*Message in the log*>|<*Location of the log event*>	2020-02-16 09:42:40,934 | INFO | master:linux-k6da:16000 | Master: [master:linux-k6da:16000] start operation called. | org.apache.hadoop.hbase.master.HMaster.run(HMaster.java:581)
	RegionServer	<yyyy-MM-dd HH:mm:ss,SSS>|<Log Level>|<*Thread that generates the log*>|<*Message in the log*>|<*Location of the log event*>	2020-02-16 09:42:51,063 | INFO | main | RegionServer: [regionserver16020] start operation called. | org.apache.hadoop.hbase.regionserver.HRegionServer.startRegionServ-er(HRegionServer.java:2396)
	ThriftServer	<yyyy-MM-dd HH:mm:ss,SSS>|<Log Level>|<*Thread that generates the log*>|<*Message in the log*>|<*Location of the log event*>	2020-02-16 09:42:55,512 | INFO | main | thrift2 server start operation called. | org.apache.hadoop.hbase.thrift2.ThriftServer.main(ThriftServer.java:421)

Type	Component	Format	Example
	MetricController	<yyyy-MM-dd HH:mm:ss,SSS>|<Log Level>|<*Thread that generates the log*>|<*Message in the log*>|<*Location of the log event*>	-

7.23 HBase Performance Tuning

7.23.1 Improving the BulkLoad Efficiency

Scenario

BulkLoad uses MapReduce jobs to directly generate files that comply with the internal data format of HBase, and then loads the generated StoreFiles to a running cluster. Compared with HBase APIs, BulkLoad saves more CPU and network resources.

ImportTSV is an HBase table data loading tool.

Prerequisites

When using BulkLoad, the output path of the file has been specified using the **Dimporttsv.bulk.output** parameter.

Procedure

Add the following parameter to the BulkLoad command when performing a batch loading task:

Table 7-16 Parameter for improving BulkLoad efficiency

Parameter	Description	Value
-Dimporttsv.mapper.class	The construction of key-value pairs is moved from the user-defined mapper to reducer to improve performance. The mapper only needs to send the original text in each row to the reducer. The reducer parses the record in each row and creates a key-value) pair. **NOTE** When this parameter is set to **org.apache.hadoop.hbase.mapreduce.TsvImporterByteMapper**, this parameter is used only when the batch loading command without the *HBASE_CELL_VISIBILITY OR HBASE_CELL_TTL* option is executed. The **org.apache.hadoop.hbase.mapreduce.TsvImporterByteMapper** provides better performance.	org.apache.hadoop.hbase.mapreduce.TsvImporterByteMapper and org.apache.hadoop.hbase.mapreduce.TsvImporterTextMapper

7.23.2 Improving Put Performance

Scenario

In the scenario where a large number of requests are continuously put, setting the following two parameters to **false** can greatly improve the Put performance.

- **hbase.regionserver.wal.durable.sync**
- **hbase.regionserver.hfile.durable.sync**

When the performance is improved, there is a low probability that data is lost if three DataNodes are faulty at the same time. Exercise caution when configuring the parameters in scenarios that have high requirements on data reliability.

Procedure

Navigation path for setting parameters:

Log in to FusionInsight Manager and choose **Cluster** > **Services** > **HBase**. Click **Configurations** then **All Configurations**, enter a parameter name in the search box, and change the parameter value.

Table 7-17 Parameters for improving put performance

Parameter	Description	Value
hbase.wal.hsync	Specifies whether to enable WAL file durability to make the WAL data persistence on disks. If this parameter is set to **true**, the performance is affected because each WAL file is synchronized to the disk by the Hadoop fsync.	false
hbase.hfile.hsync	Specifies whether to enable the HFile durability to make data persistence on disks. If this parameter is set to true, the performance is affected because each Hfile file is synchronized to the disk by the Hadoop fsync.	false

7.23.3 Optimizing Put and Scan Performance

Scenario

HBase has many configuration parameters related to read and write performance. The configuration parameters need to be adjusted based on the read/write request loads. This section describes how to optimize read and write performance by modifying the RegionServer configurations.

Procedure

- JVM GC parameters

  Suggestions on setting the RegionServer **GC_OPTS** parameter:

  - Set **-Xms** and **-Xmx** to the same value based on your needs. Increasing the memory can improve the read and write performance. For details, see the description of **hfile.block.cache.size** in **Table 7-19** and **hbase.regionserver.global.memstore.size** in **Table 7-18**.
  - Set **-XX:NewSize** and **-XX:MaxNewSize** to the same value. You are advised to set the value to **512M** in low-load scenarios and **2048M** in high-load scenarios.
  - Set **X-XX:CMSInitiatingOccupancyFraction** to be less than and equal to 90, and it is calculated as follows: **100 x (hfile.block.cache.size + hbase.regionserver.global.memstore.size + 0.05)**.
  - **-XX:MaxDirectMemorySize** indicates the non-heap memory used by the JVM. You are advised to set this parameter to **512M** in low-load scenarios and **2048M** in high-load scenarios.

NOTE

The **-XX:MaxDirectMemorySize** parameter is not used by default. If you need to set this parameter, add it to the **GC_OPTS** parameter.

- Put parameters

  RegionServer processes the data of the put request and writes the data to memstore and HLog.

  - When the size of memstore reaches the value of **hbase.hregion.memstore.flush.size**, memstore is updated to HDFS to generate HFiles.
  - Compaction is triggered when the number of HFiles in the column cluster of the current region reaches the value of **hbase.hstore.compaction.min**.
  - If the number of HFiles in the column cluster of the current region reaches the value of **hbase.hstore.blockingStoreFiles**, the operation of refreshing the memstore and generating HFiles is blocked. As a result, the put request is blocked.

Table 7-18 Put parameters

Parameter	Description	Default Value
hbase.wal.hsync	Indicates whether each WAL is persistent to disks. For details, see **Improving Put Performance**.	true
hbase.hfile.hsync	Indicates whether HFile write operations are persistent to disks. For details, see **Improving Put Performance**.	true
hbase.hregion.memstore.flush.size	If the size of MemStore (unit: Byte) exceeds a specified value, MemStore is flushed to the corresponding disk. The value of this parameter is checked by each thread running **hbase.server.thread.wakefrequency**. It is recommended that you set this parameter to an integer multiple of the HDFS block size. You can increase the value if the memory is sufficient and the put load is heavy.	134217728

Parameter	Description	Default Value
hbase.regionserver.global.memstore.size	Updates the size of all MemStores supported by the RegionServer before locking or forcible flush. It is recommended that you set this parameter to **hbase.hregion.memstore.flush.size x Number of regions with active writes/ RegionServer GC -Xmx**. The default value is **0.4**, indicating that 40% of RegionServer GC -Xmx is used.	0.4
hbase.hstore.flusher.count	Indicates the number of memstore flush threads. You can increase the parameter value in heavy-put-load scenarios.	2
hbase.regionserver.thread.compaction.small	Indicates the number of small compaction threads. You can increase the parameter value in heavy-put-load scenarios.	10
hbase.hstore.blockingStoreFiles	If the number of HStoreFile files in a Store exceeds the specified value, the update of the HRegion will be locked until a compression is completed or the value of **base.hstore.blockingWaitTime** is exceeded. Each time MemStore is flushed, a StoreFile file is written into MemStore. Set this parameter to a larger value in heavy-put-load scenarios.	15

- Scan parameters

Table 7-19 Scan parameters

Parameter	Description	Default Value
hbase.client.scanner.timeout.period	Client and RegionServer parameters, indicating the lease timeout period of the client executing the scan operation. You are advised to set this parameter to an integer multiple of 60000 ms. You can set this parameter to a larger value when the read load is heavy. The unit is milliseconds.	60000
hfile.block.cache.size	Indicates the data cache percentage in the RegionServer GC –Xmx. You can increase the parameter value in heavy-read-load scenarios, in order to improve cache hit ratio and performance. It indicates the percentage of the maximum heap (-Xmx setting) allocated to the block cache of HFiles or StoreFiles.	When offheap is disabled, the default value is **0.25**. When offheap is enabled, the default value is **0.1**.

- Handler parameters

Table 7-20 Handler parameters

Parameter	Description	Default Value
hbase.regionserver.handler.count	Indicates the number of RPC server instances on RegionServer. The recommended value ranges from 200 to 400.	200
hbase.regionserver.metahandler.count	Indicates the number of program instances for processing prioritized requests. The recommended value ranges from 200 to 400.	200

7.23.4 Improving Real-time Data Write Performance

Scenario

Scenarios where data needs to be written to HBase in real time, or large-scale and consecutive put scenarios

Prerequisites

The HBase put or delete interface can be used to save data to HBase.

Procedure

- **Data writing server tuning**

  Parameter portal:

  Go to the **All Configurations** page of the HBase service. For details, see **Modifying Cluster Service Configuration Parameters**.

  Table 7-21 Configuration items that affect real-time data writing

Parameter	Description	Default Value
hbase.wal.hsync	Controls the synchronization degree when HLogs are written to the HDFS. If the value is **true**, HDFS returns only when data is written to the disk. If the value is **false**, HDFS returns when data is written to the OS cache. Set the parameter to **false** to improve write performance.	true
hbase.hfile.hsync	Controls the synchronization degree when HFiles are written to the HDFS. If the value is **true**, HDFS returns only when data is written to the disk. If the value is **false**, HDFS returns when data is written to the OS cache. Set the parameter to **false** to improve write performance.	true

Parameter	Description	Default Value
GC_OPTS	You can increase HBase memory to improve HBase performance because read and write operations are performed in HBase memory. **HeapSize** and **NewSize** need to be adjusted. When you adjust **HeapSize**, set **Xms** and **Xmx** to the same value to avoid performance problems when JVM dynamically adjusts **HeapSize**. Set **NewSize** to 1/8 of **HeapSize**. • **HMaster**: If HBase clusters enlarge and the number of Regions grows, properly increase the **GC_OPTS** parameter value of the HMaster. • **RegionServer**: A RegionServer needs more memory than an HMaster. If sufficient memory is available, increase the **HeapSize** value. **NOTE** When the value of **HeapSize** for the active HMaster is 4 GB, the HBase cluster can support 100,000 regions. Empirically, each time 35,000 regions are added to the cluster, the value of **HeapSize** must be increased by 2 GB. It is recommended that the value of **HeapSize** for the active HMaster not exceed 32 GB.	• HMaster -server -Xms4G -Xmx4G -XX:NewSize=512M -XX:MaxNewSize=512M -XX:MetaspaceSize=128M -XX:MaxMetaspaceSize=512M -XX:+UseConcMarkSweepGC -XX:+CMSParallelRemarkEnabled -XX:CMSInitiatingOccupancyFraction=65 -XX:+PrintGCDetails -Dsun.rmi.dgc.client.gcInterval=0x7FFFFFFFFFFFFFE -Dsun.rmi.dgc.server.gcInterval=0x7FFFFFFFFFFFFFE -XX:-OmitStackTraceInFastThrow -XX:+PrintGCTimeStamps -XX:+PrintGCDateStamps -XX:+UseGCLogFileRotation -XX:NumberOfGCLogFiles=10 -XX:GCLogFileSize=1M

Parameter	Description	Default Value
		• Region Server -server -Xms6G -Xmx6G -XX:NewSize=1024M -XX:MaxNewSize=1024M -XX:MetaspaceSize=128M -XX:MaxMetaspaceSize=512M -XX:+UseConcMarkSweepGC -XX:+CMSParallelRemarkEnabled -XX:CMSInitiatingOccupancyFraction=65 -XX:+PrintGCDetails -Dsun.rmi.dgc.client.gcInterval=0x7FFFFFFFFFFFFFE -Dsun.rmi.dgc.server.gcInterval=0x7FFFFFFFFFFFFFE -XX:-OmitStackTraceInFastThrow -XX:+PrintGCTimeStamps -XX:+PrintGCDateStamps -XX:+UseGCLogFileRotation -XX:NumberOfGCLogFiles=10 -XX:GCLogFileSize=1M

Parameter	Description	Default Value
hbase.regionserver.handler.count	Indicates the number of RPC server instances started on RegionServer. If the parameter is set to an excessively large value, threads will compete fiercely. If the parameter is set to an excessively small value, requests will be waiting for a long time in RegionServer, reducing the processing capability. You can add threads based on resources. It is recommended that the value be set to **100** to **300** based on the CPU usage.	200
hbase.hregion.max.filesize	Indicates the maximum size of an HStoreFile, in bytes. If the size of any HStoreFile exceeds the value of this parameter, the managed Hregion is divided into two parts.	10737418240
hbase.hregion.memstore.flush.size	On the RegionServer, when the size of memstore that exists in memory of write operations exceeds **memstore.flush.size**, MemStoreFlusher performs the Flush operation to write the memstore to the corresponding store in the format of HFile. If RegionServer memory is sufficient and active Regions are few, increase the parameter value and reduce compaction times to improve system performance. The Flush operation may be delayed after it takes place. Write operations continue and memstore keeps increasing during the delay. The maximum size of memstore is: **memstore.flush.size** x **hbase.hregion.memstore.block.multiplier**. When the memstore size exceeds the maximum value, write operations are blocked. Properly increasing the value of **hbase.hregion.memstore.block.multiplier** can reduce the blocks and make performance become more stable. Unit: byte	134217728

Parameter	Description	Default Value
hbase.regionserver.global.memstore.size	Updates the size of all MemStores supported by the RegionServer before locking or forcible flush. On the RegionServer, the MemStoreFlusher thread performs the flush. The thread regularly checks memory occupied by write operations. When the total memory volume occupied by write operations exceeds the threshold, MemStoreFlusher performs the flush. Larger memstore will be flushed first and then smaller ones until the occupied memory is less than the threshold. Threshold = hbase.regionserver.global.memstore.size x hbase.regionserver.global.memstore.size.lower.limit x HBase_HEAPSIZE **NOTE** The sum of the parameter value and the value of **hfile.block.cache.size** cannot exceed 0.8, that is, memory occupied by read and write operations cannot exceed 80% of **HeapSize**, ensuring stable running of other operations.	0.4

Parameter	Description	Default Value
hbase.hstore.blockingStoreFiles	Check whether the number of files is larger than the value of **hbase.hstore.blockingStoreFiles** before you flush regions. If it is larger than the value of **hbase.hstore.blockingStoreFiles**, perform a compaction and configure **hbase.hstore.blockingWaitTime** to 90s to make the flush delay for 90s. During the delay, write operations continue and the memstore size keeps increasing and exceeds the threshold (**memstore.flush.size** x **hbase.hregion.memstore.block.multiplier**), blocking write operations. After compaction is complete, a large number of writes may be generated. As a result, the performance fluctuates sharply. Increase the value of **hbase.hstore.blockingStoreFiles** to reduce block possibilities.	15
hbase.regionserver.thread.compaction.throttle	The compression whose size is greater than the value of this parameter is executed by the large thread pool. The unit is bytes. Indicates a threshold of a total file size for compaction during a Minor Compaction. The total file size affects execution duration of a compaction. If the total file size is large, other compactions or flushes may be blocked.	1610612736
hbase.hstore.compaction.min	Indicates the minimum number of HStoreFiles on which minor compaction is performed each time. When the size of a file in a Store exceeds the value of this parameter, the file is compacted. You can increase the value of this parameter to reduce the number of times that the file is compacted. If there are too many files in the Store, read performance will be affected.	6

Parameter	Description	Default Value
hbase.hstore.compaction.max	Indicates the maximum number of HStoreFiles on which minor compaction is performed each time. The functions of the parameter and **hbase.hstore.compaction.max.size** are similar. Both are used to limit the execution duration of one compaction.	10
hbase.hstore.compaction.max.size	If the size of an HFile is larger than the parameter value, the HFile will not be compacted in a Minor Compaction but can be compacted in a Major Compaction. The parameter is used to prevent HFiles of large sizes from being compacted. After a Major Compaction is forbidden, multiple HFiles can exist in a Store and will not be merged into one HFile, without affecting data access performance. The unit is byte.	9223372036854775807
hbase.hregion.majorcompaction	Main compression interval of all HStoreFile files in a region. The unit is milliseconds. Execution of Major Compactions consumes much system resources and will affect system performance during peak hours. If service updates, deletion, and reclamation of expired data space are infrequent, set the parameter to **0** to disable Major Compactions. If a major compaction must be performed to reclaim more space, increase the parameter value to increase the execution period and reduce frequent resource occupation, in milliseconds.	604800000

Parameter	Description	Default Value
• hbase.regionserver.maxlogs • hbase.regionserver.hlog.blocksize	• Indicates the threshold for the number of HLog files that are not flushed on a RegionServer. If the number of HLog files is greater than the threshold, the RegionServer forcibly performs flush operations. • Indicates the maximum size of an HLog file. If the size of an HLog file is greater than the value of this parameter, a new HLog file is generated. The old HLog file is disabled and archived. The two parameters determine the number of HLogs that are not flushed in a RegionServer. When the data volume is less than the total size of memstore, the flush operation is forcibly triggered due to excessive HLog files. In this case, you can adjust the values of the two parameters to avoid forcible flush. Unit: byte	• 32 • 134217728

- **Data writing client tuning**

  It is recommended that data be written using Put List if it can be, which greatly improves write performance. The length of each put list needs to be set based on the single put size and parameters of the actual environment. You are advised to do some basic tests before configuring parameters.

- **Data table writing design optimization**

  Table 7-22 Parameters affecting real-time data writing

Parameter	Description	Default Value
COMPRESSION	The compression algorithm compresses blocks in HFiles. For compressible data, configure the compression algorithm to efficiently reduce disk I/Os and improve performance. **NOTE** Some data cannot be efficiently compressed. For example, a compressed figure can hardly be compressed again. The common compression algorithm is SNAPPY, because it has a high encoding/decoding speed and acceptable compression rate.	NONE

Parameter	Description	Default Value
BLOCKSIZE	Different block sizes affect HBase data read and write performance. You can configure sizes for blocks in an HFile. Larger blocks have a higher compression rate. However, they have poor performance in random data read, because HBase reads data in a unit of blocks. Set the parameter to 128 KB or 256 KB to improve data write efficiency without greatly affecting random read performance. The unit is byte.	65536
IN_MEMORY	Whether to cache table data in the memory first, which improves data read performance. If you will frequently access some small tables, set the parameter.	false

7.23.5 Improving Real-time Data Read Performance

Scenario

HBase data needs to be read.

Prerequisites

The get or scan interface of HBase has been invoked and data is read in real time from HBase.

Procedure

- **Data reading server tuning**

  Parameter portal:

  Go to the **All Configurations** page of the HBase service. For details, see **Modifying Cluster Service Configuration Parameters**.

Table 7-23 Configuration items that affect real-time data reading

Parameter	Description	Default Value
GC_OPTS	You can increase HBase memory to improve HBase performance because read and write operations are performed in HBase memory. **HeapSize** and **NewSize** need to be adjusted. When you adjust **HeapSize**, set **Xms** and **Xmx** to the same value to avoid performance problems when JVM dynamically adjusts **HeapSize**. Set **NewSize** to 1/8 of **HeapSize**. ● **HMaster**: If HBase clusters enlarge and the number of Regions grows, properly increase the **GC_OPTS** parameter value of the HMaster. ● **RegionServer**: A RegionServer needs more memory than an HMaster. If sufficient memory is available, increase the **HeapSize** value. **NOTE** When the value of **HeapSize** for the active HMaster is 4 GB, the HBase cluster can support 100,000 regions. Empirically, each time 35,000 regions are added to the cluster, the value of **HeapSize** must be increased by 2 GB. It is recommended that the value of **HeapSize** for the active HMaster not exceed 32 GB.	For versions earlier than MRS 3.x: ● HMaster: -server -Xms2G -Xmx2G -XX:NewSize=256M -XX:MaxNewSize=256M -XX:MetaspaceSize=128M -XX:MaxMetaspaceSize=512M -XX:MaxDirectMemorySize=512M -XX:+UseConcMarkSweepGC -XX:+CMSParallelRemarkEnabled -XX:CMSInitiatingOccupancyFraction=65 -XX:+PrintGCDetails -Dsun.rmi.dgc.client.gcInterval=0x7FFFFFFFFFFFFE -Dsun.rmi.dgc.server.gcInterval=0x7FFFFFFFFFFFFE -XX:-OmitStackTraceInFastThrow -XX:+PrintGCTimeStamps

Parameter	Description	Default Value
		-XX:+PrintGCDateStamps -XX:+UseGCLogFileRotation -XX:NumberOfGCLogFiles=10 -XX:GCLogFileSize=1M • RegionServer: -server -Xms4G -Xmx4G -XX:NewSize=512M -XX:MaxNewSize=512M -XX:MetaspaceSize=128M -XX:MaxMetaspaceSize=512M -XX:MaxDirectMemorySize=512M -XX:+UseConcMarkSweepGC -XX:+CMSParallelRemarkEnabled -XX:CMSInitiatingOccupancyFraction=65 -XX:+PrintGCDetails -Dsun.rmi.dgc.client.gcInterval=0x7FFFFFFFFFFFFE -Dsun.rmi.dgc.server.gcIn

Parameter	Description	Default Value
		terval=0x7FFFFFFFFFFFFFE -XX:-OmitStackTraceInFastThrow -XX:+PrintGCTimeStamps -XX:+PrintGCDateStamps -XX:+UseGCLogFileRotation -XX:NumberOfGCLogFiles=10 -XX:GCLogFileSize=1M For MRS 3.*x* or later: ● HMaster -server -Xms4G -Xmx4G -XX:NewSize=512M -XX:MaxNewSize=512M -XX:MetaspaceSize=128M -XX:MaxMetaspaceSize=512M -XX:+UseConcMarkSweepGC -XX:+CMSParallelRemarkEnabled -XX:CMSInitiatingOccupancyFraction=65 -XX:+PrintGCDetails -

Parameter	Description	Default Value
		Dsun.rmi.dgc.client.gcInterval=0x7FFFFFFFFFFFFFE -Dsun.rmi.dgc.server.gcInterval=0x7FFFFFFFFFFFFFE -XX:-OmitStackTraceInFastThrow -XX:+PrintGCTimeStamps -XX:+PrintGCDateStamps -XX:+UseGCLogFileRotation -XX:NumberOfGCLogFiles=10 -XX:GCLogFileSize=1M • RegionServer -server -Xms6G -Xmx6G -XX:NewSize=1024M -XX:MaxNewSize=1024M -XX:MetaspaceSize=128M -XX:MaxMetaspaceSize=512M -XX:+UseConcMarkSweepGC -XX:+CMSParallelRemarkEnabled -XX:CMSIniti

Parameter	Description	Default Value
		atingOccupancyFraction=65 -XX:+PrintGCDetails -Dsun.rmi.dgc.client.gcInterval=0x7FFFFFFFFFFFFE -Dsun.rmi.dgc.server.gcInterval=0x7FFFFFFFFFFFFE -XX:-OmitStackTraceInFastThrow -XX:+PrintGCTimeStamps -XX:+PrintGCDateStamps -XX:+UseGCLogFileRotation -XX:NumberOfGCLogFiles=10 -XX:GCLogFileSize=1M
hbase.regionserver.handler.count	Indicates the number of requests that RegionServer can process concurrently. If the parameter is set to an excessively large value, threads will compete fiercely. If the parameter is set to an excessively small value, requests will be waiting for a long time in RegionServer, reducing the processing capability. You can add threads based on resources. It is recommended that the value be set to 100 to 300 based on the CPU usage.	200

Parameter	Description	Default Value
hfile.block.cache.size	HBase cache sizes affect query efficiency. Set cache sizes based on query modes and query record distribution. If random query is used to reduce the hit ratio of the buffer, you can reduce the buffer size.	When **offheap** is disabled, the default value is **0.25**. When **offheap** is enabled, the default value is **0.1**.

NOTE

If read and write operations are performed at the same time, the performance of the two operations affects each other. If flush and compaction operations are frequently performed due to data writes, a large number of disk I/O operations are occupied, affecting read performance. If a large number of compaction operations are blocked due to write operations, multiple HFiles exist in the region, affecting read performance. Therefore, if the read performance is unsatisfactory, you need to check whether the write configurations are proper.

- **Data reading client tuning**

  When scanning data, you need to set **caching** (the number of records read from the server at a time. The default value is **1**.). If the default value is used, the read performance will be extremely low.

  If you do not need to read all columns of a piece of data, specify the columns to be read to reduce network I/O.

  If you only need to read the row key, add a filter (FirstKeyOnlyFilter or KeyOnlyFilter) that only reads the row key.

- **Data table reading design optimization**

Table 7-24 Parameters affecting real-time data reading

Parameter	Description	Default Value
COMPRESSION	The compression algorithm compresses blocks in HFiles. For compressible data, configure the compression algorithm to efficiently reduce disk I/Os and improve performance. **NOTE** Some data cannot be efficiently compressed. For example, a compressed figure can hardly be compressed again. The common compression algorithm is SNAPPY, because it has a high encoding/decoding speed and acceptable compression rate.	NONE

Parameter	Description	Default Value
BLOCKSIZE	Different block sizes affect HBase data read and write performance. You can configure sizes for blocks in an HFile. Larger blocks have a higher compression rate. However, they have poor performance in random data read, because HBase reads data in a unit of blocks. Set the parameter to 128 KB or 256 KB to improve data write efficiency without greatly affecting random read performance. The unit is byte.	65536
DATA_BLOCK_ENCODING	Encoding method of the block in an HFile. If a row contains multiple columns, set **FAST_DIFF** to save data storage space and improve performance.	NONE

7.23.6 Optimizing JVM Parameters

Scenario

When the number of clusters reaches a certain scale, the default settings of the Java virtual machine (JVM) cannot meet the cluster requirements. In this case, the cluster performance deteriorates or the clusters may be unavailable. Therefore, JVM parameters must be properly configured based on actual service conditions to improve the cluster performance.

Procedure

Navigation path for setting parameters:

The JVM parameters related to the HBase role must be configured in the **hbase-env.sh** file in the **${BIGDATA_HOME}/FusionInsight_HD_*/install/FusionInsight-HBase-*/hbase/conf/** directory of the node where the HBase service is installed.

Each role has JVM parameter configuration variables, as shown in **Table 7-25**.

Table 7-25 HBase-related JVM parameter configuration variables

Variable	Affected Role
HBASE_OPTS	All roles of HBase
SERVER_GC_OPTS	All roles on the HBase server, such as Master and RegionServer
CLIENT_GC_OPTS	Client process of HBase

Variable	Affected Role
HBASE_MASTER_OPTS	Master of HBase
HBASE_REGIONSERVER_OPTS	RegionServer of HBase
HBASE_THRIFT_OPTS	Thrift of HBase

Configuration example:

```
export HADOOP_NAMENODE_OPTS="-Dhadoop.security.logger=${HADOOP_SECURITY_LOGGER:-INFO,RFAS} -Dhdfs.audit.logger=${HDFS_AUDIT_LOGGER:-INFO,NullAppender} $HADOOP_NAMENODE_OPTS"
```

7.23.7 Optimization for HBase Overload

Scenario

When the HBase service peaks suddenly and a large number of requests are sent to a RegionServer/HMaster in a short period of time, the RegionServer/HMaster is overloaded. If the HBase service is overloaded, the read and write performance of the application deteriorates, GC occurs frequently on the HBase service, and even the service instance restarts.

Currently, HBase can prevent overloading. It can reject oversized requests, protect internal requests, and record improper requests, reducing the impact on HBase services in overload scenarios and ensuring service stability.

Sharp Traffic Increase

When service traffic peaks, for example, the number of requests increases by 10 times, you can perform the following operations to manage the traffic:

Step 1 Log in to FusionInsight Manager, choose **Cluster** > **Services** > **HBase** > **Chart**, select **Handler** in the chart category on the left, and check whether "Number of Active RegionServer Handlers for Processing User Table Requests-All Instances" is used up for a long time. If they are used up, click **Configure**. The following table lists the RegionServer parameters to be configured.

Table 7-26 Optimizing parameters when RegionServer handlers are used up

Parameter	Description	Optimization
hbase.regionserver.handler.count	Number of RPC server instances started on RegionServer	Increase the value of this parameter. However, the value should be less than or equal to **1000**.

Parameter	Description	Optimization
hbase.ipc.server.max.default.callqueue.size.ratio	Maximum percentage of common requests in the RegionServer queue. When the total size of common requests in the queue exceeds the threshold, the requests are discarded.	Adjust the value to about **0.8** to limit the proportion of queues occupied by external requests and protect internal requests.

Step 2 Check whether "*XXX* is too large for table *XXX*" or "Client scan caching *XXX* is too large for table *XXX*" exists in the service run logs on the application side. If yes, improper requests exist. Check the requests and reduce the data volume of each request (reduce the data volume for Put/Delete batch requests and decrease the Caching value for Scan). If services on the service side cannot be optimized temporarily, you can add or modify the following parameters in the ***Client installation directory*/HBase/hbase/conf/hbase-site.xml** file on the application side. (**This only reduces recorded alarm logs but does not relieve overload**.)

Table 7-27 Parameters for reducing recorded alarm logs

Parameter	Description	Optimization
hbase.rpc.rows.warning.threshold	Threshold of the number of data records written, updated, or deleted by the HBase client at a time. If the threshold is exceeded, a log is recorded.	Increase the value of this parameter.
hbase.client.scanner.warning.threshold.scanning.ratio	If the caching of a single scan on the HBase client is too large (40% of the maximum value by default), a log is recorded when the threshold is exceeded.	Change the value of this parameter to **1.0**.

Step 3 If the service side sends too many oversized requests, the server processes the requests slowly. As a result, the requests are stacked and overloaded. **If oversized requests can be considered as abnormal requests**, adjust the parameters in the HBase configuration on FusionInsight Manager to reject the requests. The following table lists the RegionServer parameters to be configured.

Table 7-28 Parameters for rejecting requests

Parameter	Description	Optimization
hbase.ipc.max.request.size	Maximum size of a RegionServer request. If a request is bigger than the specified size, the request is discarded. The default value is **256 MB**.	If the application retried for multiple times and "RPC data length *XXX* of received from *XXX* is greater than max allowed" is displayed in RegionServer logs, reduce the amount of data sent at a time on the application side. If the amount cannot be reduced, you can increase the value of this parameter. It is recommended that the value be less than or equal to **1 GB**.
hbase.server.keyvalue.maxsize	Maximum size of a single cell for RegionServer write/update operations. If the value of this parameter is exceeded, RegionServer write/update operations are not allowed. The default value is **10 MB**.	If a single cell is too large, the read and write performance is degraded and abnormal data may exist. You can evaluate the data range based on the written data and set the upper limit. If the evaluation cannot be performed, you are advised to retain the default value.

Parameter	Description	Optimization
hbase.rpc.rows.size.threshold.reject	Whether to reject a RegionServer request when the number of data operations in the request exceeds the specified limit.	If there is a request contains a large number of write, update, and delete operations on a node, the number of operations may exceed the value of **hbase.rpc.rows.warning.threshold**. In this case, overloading occurs and the performance deteriorates. If this parameter is set to **true**, large requests will be rejected. If the pre-partitioning is improper, too many requests may be rejected. Set this parameter to **true** only when stable.

----End

Server Restart in a Large Number of Regions

When multiple RegionServers of large-scale clusters in a number of regions (more than 100,000) are restarted at the same time, HMaster may be overloaded.

You can configure the parameters listed in **Table 7-29** in the HBase configuration on FusionInsight Manager to accelerate HMaster processing of high-priority requests and reduce HMaster overload.

Table 7-29 Parameters for handling overloading caused by online/offline switches in a large number of regions

Instance Name	Parameter	Description	Optimization
HMaster	hbase.regionserver.metahandler.count	Number of handlers used by HMaster to process high-priority requests	Increase the value of this parameter. However, the value should be less than or equal to **1000**.
	hbase.ipc.server.metacallqueue.read.ratio	Ratio of read queues in a high-priority request queue, which affects the number of meta read/write handlers	Retain the default value **0.5**.

Instance Name	Parameter	Description	Optimization
RegionServer	hbase.regionserver.msginterval	Interval for transmitting messages between RegionServer and HMaster	Increase the value of this parameter can release the pressure on HMaster. The recommended value is **15s**.

7.23.8 Enabling CCSMap Functions

Scenario

CompactedConcurrentSkipListMap (CCSMap) optimizes the Memstore data structure and uses less memory in data write scenarios, reducing GC times for higher data write performance. You can enable this feature to handle tasks that require high data write performance.

Procedure

Step 1 Log in to FusionInsight Manager of the cluster and choose **Cluster** > **Services** > **HBase** > **Configurations** > **All Configurations**.

Step 2 Search for and modify the following parameters to enable the CCSMap feature:

- **hbase.regionserver.memstore.class**: Memstore implementation class. Set this parameter to **org.apache.hadoop.hbase.regionserver.CCSMapMemStore**.
- **hbase.hregion.compacting.memstore.type**: Memstore memory compaction policy. Set this parameter to **NONE**.

Step 3 Click **Save**.

Step 4 Click **Instances**, select all RegionServer instances, choose **More** > **Instance Rolling Restart**, and enter the password of the user to restart the RegionServer instances.

----End

7.23.9 Enabling Succinct Trie

Scenario

Succinct Trie optimizes the HFile Block structure. It uses less cache space, reduces the cache data eviction rate, and improves the cache hit ratio. You can enable this feature to improve performance of tasks that frequently read data.

NOTICE

If Succinct Trie is enabled, open-source versions of HFiles are incompatible. If you are using an HFile to migrate data to MRS 3.2.1- or an earlier version, disable this feature and then run the **major compaction** command on the data table to generate a new HFile file.

Procedure

Step 1 Log in to FusionInsight Manager of the cluster and choose **Cluster** > **Services** > **HBase** > **Configurations**.

Step 2 In the search box, search for and modify the configuration in **Table 7-30** to enable Succinct Trie.

Table 7-30 Succinct Trie parameters

Parameter	Description	New Value	Must Be Modified
hbase.write.tries	Whether to enable Succinct Tries • **true**: Enable Succinct Tries • **false**: Disable Succinct Tries	true	Yes
hbase.tries.cache.enabled	If this parameter is set to **true**, LoudsTriesLruBlockCache uses off-heap memory to cache index blocks, reducing the eviction rate of index blocks and improving cache efficiency.	true	No
hbase.index.block.cache.size	Cache size ratio of the LoudsTriesLruBlockCache index block to the **blocksize** If the value of **blocksize** is small, you are advised to increase the value.	-	No

Step 3 Click **Save**.

Step 4 Click **Instances**, select all RegionServer instances, choose **More** > **Instance Rolling Restart**, and enter the password of the user to restart the RegionServer instances.

----End

7.24 Common Issues About HBase

7.24.1 Why Does a Client Keep Failing to Connect to a Server for a Long Time?

Question

A HBase server is faulty and cannot provide services. In this case, when a table operation is performed on the HBase client, why is the operation suspended and no response is received for a long time?

Answer

Problem Analysis

When the HBase server malfunctions, the table operation request from the HBase client is tried for several times and times out. The default timeout value is **Integer.MAX_VALUE (2147483647 ms)**. The table operation request is retired constantly during such a long period of time and is suspended at last.

Solution

The HBase client provides two configuration items to configure the retry and timeout of the client. **Table 7-31** describes them.

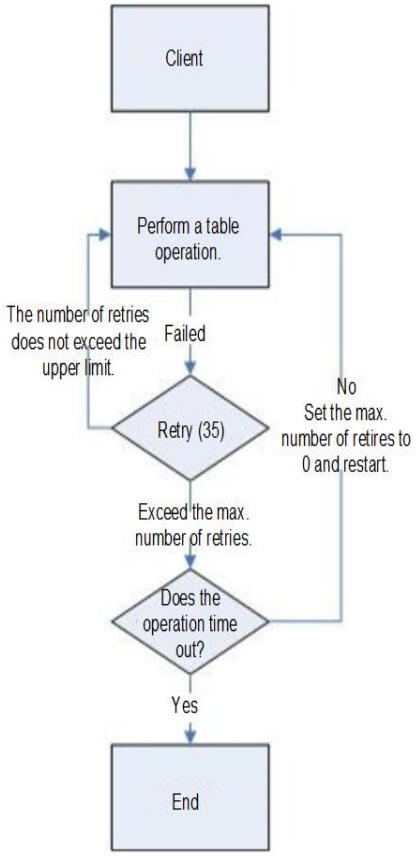
Set the following parameters in the ***Client installation path*/HBase/hbase/conf/hbase-site.xml** configuration file:

Table 7-31 Configuration parameters of retry and timeout

Parameter	Description	Default Value
hbase.client.operation.timeout	Client operation timeout period You need to manually add the information to the configuration file.	2147483647 ms
hbase.client.retries.number	Maximum retry times supported by all retryable operations.	35

Figure 7-7 describes the working principles of retry and timeout.

Figure 7-7 Process for HBase client operation retry timeout



The process indicates that a suspension occurs if the preceding parameters are not configured based on site requirements. It is recommended that a proper timeout period be set based on scenarios. If the operation takes a long time, set a long timeout period. If the operation takes a shot time, set a short timeout period. The number of retries can be set to **(hbase.client.retries.number)*60*1000(ms)**. The timeout period can be slightly greater than **hbase.client.operation.timeout**.

7.24.2 Operation Failures Occur in Stopping BulkLoad On the Client

Question

Why submitted operations fail by stopping BulkLoad on the client during BulkLoad data importing?

Answer

When BulkLoad is enabled on the client, a partitioner file is generated and used to demarcate the range of Map task data inputting. The file is automatically deleted when BulkLoad exists on the client. In general, if all map tasks are enabled and running, the termination of BulkLoad on the client does not cause the failure of submitted operations. However, due to the retry and speculative execution

mechanism of Map tasks, a Map task is performed again if failures of the Reduce task to download the data of the completed Map task exceed the limit. In this case, if BulkLoad already exists on the client, the retry Map task fails and the operation failure occurs because the partitioner file is missing. Therefore, it is recommended not to stop BulkLoad on the client during BulkLoad data importing.

7.24.3 Why May a Table Creation Exception Occur When HBase Deletes or Creates the Same Table Consecutively?

Question

When HBase consecutively deletes and creates the same table, why may a table creation exception occur?

Answer

Execution process: Disable Table > Drop Table > Create Table > Disable Table > Drop Table > And more

1. When a table is disabled, HMaster sends an RPC request to RegionServer, and RegionServer brings the region offline. When the time required for closing a region on RegionServer exceeds the timeout period for HBase HMaster to wait for the region to enter the RIT state, HMaster considers that the region is offline by default. Actually, the region may be in the flush memstore phase.
2. After an RPC request is sent to close a region, HMaster checks whether all regions in the table are offline. If the closure times out, HMaster considers that the regions are offline and returns a message indicating that the regions are successfully closed.
3. After the closure is successful, the data directory corresponding to the HBase table is deleted.
4. After the table is deleted, the data directory is recreated by the region that is still in the flush memstore phase.
5. When the table is created again, the **temp** directory is copied to the HBase data directory. However, the HBase data directory is not empty. As a result, when the HDFS rename API is called, the data directory changes to the last layer of the **temp** directory and is appended to the HBase data directory, for example, **$rootDir/data/$nameSpace/$tableName/$tableName**. In this case, the table fails to be created.

Solution

When this problem occurs, check whether the HBase data directory corresponding to the table exists. If it exists, rename the directory.

The HBase data directory consists of **$rootDir/data/$nameSpace/$tableName**, for example, **hdfs://hacluster/hbase/data/default/TestTable**. **$rootDir** is the HBase root directory, which can be obtained by configuring **hbase.rootdir.perms** in **hbase-site.xml**. The **data** directory is a fixed directory of HBase. **$nameSpace** indicates the nameSpace name. **$tableName** indicates the table name.

7.24.4 Why Other Services Become Unstable If HBase Sets up A Large Number of Connections over the Network Port?

Question

Why other services become unstable if HBase sets up a large number of connections over the network port?

Answer

When the OS command ***lsof*** or ***netstat*** is run, it is found that many TCP connections are in the CLOSE_WAIT state and the owner of the connections is HBase RegionServer. This can cause exhaustion of network ports or limit exceeding of HDFS connections, resulting in instability of other services. The HBase CLOSE_WAIT phenomenon is the HBase mechanism.

The reason why HBase CLOSE_WAIT occurs is as follows: HBase data is stored in the HDFS as HFile, which can be called StoreFiles. HBase functions as the client of the HDFS. When HBase creates a StoreFile or starts loading a StoreFile, it creates an HDFS connection. When the StoreFile is created or loaded successfully, the HDFS considers that the task is completed and transfers the connection close permission to HBase. However, HBase may choose not to close the connection to ensure real-time response; that is, HBase may maintain the connection so that it can quickly access the corresponding data file upon request. In this case, the connection is in the CLOSE_WAIT, which indicates that the connection needs to be closed by the client.

When a StoreFile will be created: HBase executes the Flush operation.

When Flush is executed: The data written by HBase is first stored in memstore. The Flush operation is performed only when the usage of memstore reaches the threshold or the ***flush*** command is run to write data into the HDFS.

To resolve the issue, use either of the following methods:

Because of the HBase connection mechanism, the number of StoreFiles must be restricted to reduce the occupation of HBase ports. This can be achieved by triggering HBase's the compaction action, that is, HBase file merging.

Method 1: On HBase shell client, run ***major_compact***.

Method 2: Compile HBase client code to invoke the compact method of the HBaseAdmin class to trigger HBase's compaction action.

If the HBase port occupation issue cannot be resolved through compact, it indicates that the HBase usage has reached the bottleneck. In such a case, you are advised to perform the following:

- Check whether the initial number of Regions configured in the table is appropriate.
- Check whether useless data exists.

If useless data exists, delete the data to reduce the number of storage files for the HBase. If the preceding conditions are not met, then you need to consider a capacity expansion.

7.24.5 Why Does the HBase BulkLoad Task (One Table Has 26 TB Data) Consisting of 210,000 Map Tasks and 10,000 Reduce Tasks Fail?

Question

The HBase bulkLoad task (a single table contains 26 TB data) has 210,000 maps and 10,000 reduce tasks, and the task fails.

Answer

ZooKeeper I/O bottleneck observation methods:

1. On the monitoring page of Manager, check whether the number of ZooKeeper requests on a single node exceeds the upper limit.
2. View ZooKeeper and HBase logs to check whether a large number of I/O Exception Timeout or SocketTimeout Exception exceptions occur.

Optimization suggestions:

1. Change the number of ZooKeeper instances to 5 or more. You are advised to set **peerType** to **observer** to increase the number of observers.
2. Control the number of concurrent maps of a single task or reduce the memory for running tasks on each node to lighten the node load.
3. Upgrade ZooKeeper data disks, such as SSDs.

7.24.6 How Do I Restore a Region in the RIT State for a Long Time?

Question

How do I restore a region in the RIT state for a long time?

Answer

Log in to the HMaster Web UI, choose **Procedure & Locks** in the navigation tree, and check whether any process ID is in the **Waiting** state. If yes, run the following command to release the procedure lock:

hbase hbck -j *Client installation directory*/**HBase/hbase/tools/hbase-hbck2-*.jar bypass -o** *pid*

Check whether the state is in the **Bypass** state. If the procedure on the UI is always in **RUNNABLE(Bypass)** state, perform an active/standby switchover. Run the **assigns** command to bring the region online again.

hbase hbck -j *Client installation directory*/**HBase/hbase/tools/hbase-hbck2-*.jar assigns -o** *regionName*

7.24.7 Why Does HMaster Exits Due to Timeout When Waiting for the Namespace Table to Go Online?

Question

Why does HMaster exit due to timeout when waiting for the namespace table to go online?

Answer

During the HMaster active/standby switchover or startup, HMaster performs WAL splitting and region recovery for the RegionServer that failed or was stopped previously.

Multiple threads are running in the background to monitor the HMaster startup process.

- TableNamespaceManager

  This is a help class, which is used to manage the allocation of namespace tables and monitoring table regions during HMaster active/standby switchover or startup. If the namespace table is not online within the specified time (**hbase.master.namespace.init.timeout**, which is 3,600,000 ms by default), the thread terminates HMaster abnormally.

- InitializationMonitor

  This is an initialization thread monitoring class of the primary HMaster, which is used to monitor the initialization of the primary HMaster. If a thread fails to be initialized within the specified time (**hbase.master.initializationmonitor.timeout**, which is 3,600,000 ms by default), the thread terminates HMaster abnormally. If **hbase.master.initializationmonitor.haltontimeout** is started, the default value is **false**.

During the HMaster active/standby switchover or startup, if the **WAL hlog** file exists, the WAL splitting task is initialized. If the WAL hlog splitting task is complete, it initializes the table region allocation task.

HMaster uses ZooKeeper to coordinate log splitting tasks and valid RegionServers and track task development. If the primary HMaster exits during the log splitting task, the new primary HMaster attempts to resend the unfinished task, and RegionServer starts the log splitting task from the beginning.

The initialization of the HMaster is delayed due to the following reasons:

- Network faults occur intermittently.
- Disks run into bottlenecks.
- The log splitting task is overloaded, and RegionServer runs slowly.
- RegionServer (region opening) responds slowly.

In the preceding scenarios, you are advised to add the following configuration parameters to enable HMaster to complete the restoration task earlier. Otherwise, the Master will exit, causing a longer delay of the entire restoration process.

- Increase the online waiting timeout period of the namespace table to ensure that the Master has enough time to coordinate the splitting tasks of the RegionServer worker and avoid repeated tasks.

  hbase.master.namespace.init.timeout (default value: 3,600,000 ms)

- Increase the number of concurrent splitting tasks through RegionServer worker to ensure that RegionServer worker can process splitting tasks in parallel (RegionServers need more cores). Add the following parameters to *Client installation path* **/HBase/hbase/conf/hbase-site.xml**:

  hbase.regionserver.wal.max.splitters (default value: 2)

- If all restoration processes require time, increase the timeout period for initializing the monitoring thread.

  hbase.master.initializationmonitor.timeout (default value: 3,600,000 ms)

7.24.8 Why Does SocketTimeoutException Occur When a Client Queries HBase?

Question

Why does the following exception occur on the client when I use the HBase client to operate table data?

```
2015-12-15 02:41:14,054 | WARN  | [task-result-getter-2] | Lost task 2.0 in stage 58.0 (TID 3288, linux-175):
org.apache.hadoop.hbase.client.RetriesExhaustedException: Failed after attempts=36, exceptions:
Tue Dec 15 02:41:14 CST 2015, null, java.net.SocketTimeoutException: callTimeout=60000,
callDuration=60303:
row 'xxxxxx' on table 'xxxxxx' at region=xxxxxx,\x05\x1E
\x80\x00\x00\x00\x80\x00\x00\x00\x00\x00\x00\x00\x80\x00\x00\x00\x00\x00\x000\x00\x80\x00\x00\x0
0\x80\x00\x00\x00\x80\x00\x00,
1449912620868.6a6b7d0c272803d8186930a3bfdb10a9., hostname=xxxxxx,16020,1449941841479,
seqNum=5
at
org.apache.hadoop.hbase.client.RpcRetryingCallerWithReadReplicas.throwEnrichedException(RpcRetryingCall
erWithReadReplicas.java:275)
at org.apache.hadoop.hbase.client.ScannerCallableWithReplicas.call(ScannerCallableWithReplicas.java:223)
at org.apache.hadoop.hbase.client.ScannerCallableWithReplicas.call(ScannerCallableWithReplicas.java:61)
at org.apache.hadoop.hbase.client.RpcRetryingCaller.callWithoutRetries(RpcRetryingCaller.java:200)
at org.apache.hadoop.hbase.client.ClientScanner.call(ClientScanner.java:323)
```

At the same time, the following log is displayed on RegionServer:

```
2015-12-15 02:45:44,551 | WARN  | PriorityRpcServer.handler=7,queue=1,port=16020 | (responseTooSlow):
{"call":"Scan(org.apache.hadoop.hbase.protobuf.generated.ClientProtos$ScanRequest)
","starttimems":1450118730780,"responsesize":416,"method":"Scan","processingtimems":13770,"client":"10.9
1.8.175:41182","queuetimems":0,"class":"HRegionServer"} |
org.apache.hadoop.hbase.ipc.RpcServer.logResponse(RpcServer.java:2221)
2015-12-15 02:45:57,722 | WARN  | PriorityRpcServer.handler=3,queue=1,port=16020 | (responseTooSlow):
{"call":"Scan(org.apache.hadoop.hbase.protobuf.generated.ClientProtos
$ScanRequest)","starttimems":1450118746297,"responsesize":416,
"method":"Scan","processingtimems":11425,"client":"10.91.8.175:41182","queuetimems":1746,"class":"HRegi
onServer"} | org.apache.hadoop.hbase.ipc.RpcServer.logResponse(RpcServer.java:2221)
2015-12-15 02:47:21,668 | INFO  | LruBlockCacheStatsExecutor | totalSize=7.54 GB, freeSize=369.52 MB,
max=7.90 GB, blockCount=406107,
accesses=35400006, hits=16803205, hitRatio=47.47%, , cachingAccesses=31864266, cachingHits=14806045,
cachingHitsRatio=46.47%,
evictions=17654, evicted=16642283, evictedPerRun=942.69189453125 |
org.apache.hadoop.hbase.io.hfile.LruBlockCache.logStats(LruBlockCache.java:858)
2015-12-15 02:52:21,668 | INFO  | LruBlockCacheStatsExecutor | totalSize=7.51 GB, freeSize=395.34 MB,
max=7.90 GB, blockCount=403080,
accesses=35685793, hits=16933684, hitRatio=47.45%, , cachingAccesses=32150053, cachingHits=14936524,
cachingHitsRatio=46.46%,
```

```
evictions=17684, evicted=16800617, evictedPerRun=950.046142578125 |
org.apache.hadoop.hbase.io.hfile.LruBlockCache.logStats(LruBlockCache.java:858)
```

Answer

The memory allocated to RegionServer is too small and the number of Regions is too large. As a result, the memory is insufficient during the running, and the server responds slowly to the client. Modify the following memory allocation parameters in the **hbase-site.xml** configuration file of RegionServer:

Table 7-32 RegionServer memory allocation parameters

Parameter	Description	Default Value
GC_OPTS	Initial memory and maximum memory allocated to RegionServer in startup parameters.	-Xms8G -Xmx8G
hfile.block.cache.size	Percentage of the maximum heap (-Xmx setting) allocated to the block cache of HFiles or StoreFiles.	When **offheap** is disabled, the default value is **0.25**. When **offheap** is enabled, the default value is **0.1**.

7.24.9 Why Modified and Deleted Data Can Still Be Queried by Using the Scan Command?

Question

Why modified and deleted data can still be queried by using the **scan** command?

```
scan '<table_name>',{FILTER=>"SingleColumnValueFilter('<column_family>','column',=,'binary:<value>')"}
```

Answer

Because of the scalability of HBase, all values specific to the versions in the queried column are all matched by default, even if the values have been modified or deleted. For a row where column matching has failed (that is, the column does not exist in the row), the HBase also queries the row.

If you want to query only the new values and rows where column matching is successful, you can use the following statement:

```
scan '<table_name>',
{FILTER=>"SingleColumnValueFilter('<column_family>','column',=,'binary:<value>',true,true)"}
```

This command can filter all rows where column query has failed. It queries only the latest values of the current data in the table; that is, it does not query the values before modification or the deleted values.

NOTE

The related parameters of **SingleColumnValueFilter** are described as follows:

SingleColumnValueFilter(final byte[] family, final byte[] qualifier, final CompareOp compareOp, ByteArrayComparable comparator, final boolean filterIfMissing, final boolean latestVersionOnly)

Parameter description:

- family: family of the column to be queried.
- qualifier: column to be queried.
- compareOp: comparison operation, such as = and >.
- comparator: target value to be queried.
- filterIfMissing: whether a row is filtered out if the queried column does not exist. The default value is false.
- latestVersionOnly: whether values of the latest version are queried. The default value is false.

7.24.10 Why "java.lang.UnsatisfiedLinkError: Permission denied" exception thrown while starting HBase shell?

Question

Why "java.lang.UnsatisfiedLinkError: Permission denied" exception thrown while starting HBase shell?

Answer

During HBase shell execution JRuby create temporary files under **java.io.tmpdir** path and default value of **java.io.tmpdir** is **/tmp**. If NOEXEC permission is set to /tmp directory then HBase shell start will fail with "java.lang.UnsatisfiedLinkError: Permission denied" exception.

So "java.io.tmpdir" must be set to a different path in HBASE_OPTS/ CLIENT_GC_OPTS if NOEXEC is set to /tmp directory.

7.24.11 When does the RegionServers listed under "Dead Region Servers" on HMaster WebUI gets cleared?

Question

When does the RegionServers listed under "Dead Region Servers" on HMaster WebUI gets cleared?

Answer

When an online RegionServer goes down abruptly, it is displayed under "Dead Region Servers" in the HMaster WebUI. When dead RegionServer restarts and reports back to HMaster successfully, the "Dead Region Servers" in the HMaster WebUI gets cleared.

The "Dead Region Servers" is also gets cleared, when the HMaster failover operation is performed successfully.

In cases when an Active HMaster hosting some regions is abruptly killed, Backup HMaster will become the new Active HMater and displays previous Active HMaster as dead RegionServer.

7.24.12 Why Are Different Query Results Returned After I Use Same Query Criteria to Query Data Successfully Imported by HBase bulkload?

Question

If the data to be imported by HBase bulkload has identical rowkeys, the data import is successful but identical query criteria produce different query results.

Answer

Data with an identical rowkey is loaded into HBase in the order in which data is read. The data with the latest timestamp is considered to be the latest data. By default, data is not queried by timestamp. Therefore, if you query for data with an identical rowkey, only the latest data is returned.

While data is being loaded by bulkload, the memory processes the data into HFiles quickly, leading to the possibility that data with an identical rowkey has a same timestamp. In this case, identical query criteria may produce different query results.

To avoid this problem, ensure that the same data file does not contain identical rowkeys while you are creating tables or loading data.

7.24.13 What Should I Do If I Fail to Create Tables Due to the FAILED_OPEN State of Regions?

Question

What should I do if I fail to create tables due to the FAILED_OPEN state of Regions?

Answer

If a network, HDFS, or Active HMaster fault occurs during the creation of tables, some Regions may fail to go online and therefore enter the FAILED_OPEN state. In this case, tables fail to be created.

The tables that fail to be created due to the preceding mentioned issue cannot be repaired. To solve this problem, perform the following operations to delete and re-create the tables:

1. Run the following command on the cluster client to repair the state of the tables:

   hbase hbck -j ${CLIENT_HOME}**/HBase/hbase/tools/hbase-hbck2-1.1.0-h0.cbu.mrs.*.jar setTableState** <table_name> **ENABLED**
2. Enter the HBase shell and run the following commands to delete the tables that fail to be created:

disable *'<table_name>'*

drop *'<table_name>'*

3. Create the tables using the recreation command.

7.24.14 How Do I Delete Residual Table Names in the /hbase/table-lock Directory of ZooKeeper?

Question

In security mode, names of tables that failed to be created are unnecessarily retained in the table-lock node (default directory is /hbase/table-lock) of ZooKeeper. How do I delete these residual table names?

Answer

Perform the following steps:

1. On the client, run the kinit command as the hbase user to obtain a security certificate.
2. Run the ***hbase zkcli*** command to launch the ZooKeeper Command Line Interface (zkCLI).
3. Run the ***ls /hbase/table*** command on the zkCLI to check whether the table name of the table that fails to be created exists.
   - If the table name exists, no further operation is required.
   - If the table name does not exist, run ***ls /hbase/table-lock*** to check whether the table name of the table fail to be created exist. If the table name exists, run the ***delete /hbase/table-lock/<table>*** command to delete the table name. In the ***delete /hbase/table-lock/<table>*** command, ***<table>*** indicates the residual table name.

7.24.15 Why Does HBase Become Faulty When I Set a Quota for the Directory Used by HBase in HDFS?

Question

Why does HBase become faulty when I set quota for the directory used by HBase in HDFS?

Answer

The flush operation of a table is to write memstore data to HDFS.

If the HDFS directory does not have sufficient disk space quota, the flush operation will fail and the region server will stop.

```
Caused by: org.apache.hadoop.hdfs.protocol.DSQuotaExceededException: The DiskSpace quota of /hbase/data/<namespace>/<tableName> is exceeded: quota = 1024 B = 1 KB but diskspace consumed = 402655638 B = 384.00 MB
?at org.apache.hadoop.hdfs.server.namenode.DirectoryWithQuotaFeature.verifyStoragespaceQuota(DirectoryWithQuotaFeature.java:211)
?at
```

```
org.apache.hadoop.hdfs.server.namenode.DirectoryWithQuotaFeature.verifyQuota(DirectoryWithQuotaFeature.java:239)
?at org.apache.hadoop.hdfs.server.namenode.FSDirectory.verifyQuota(FSDirectory.java:882)
?at org.apache.hadoop.hdfs.server.namenode.FSDirectory.updateCount(FSDirectory.java:711)
?at org.apache.hadoop.hdfs.server.namenode.FSDirectory.updateCount(FSDirectory.java:670)
?at org.apache.hadoop.hdfs.server.namenode.FSDirectory.addBlock(FSDirectory.java:495)
```

In the preceding exception, the disk space quota of the **/hbase/data/<namespace>/<tableName>** table is 1 KB, but the memstore data is 384.00 MB. Therefore, the flush operation fails and the region server stops.

When the region server is terminated, HMaster replays the WAL file of the terminated region server to restore data. The disk space quota is limited. As a result, the replay operation of the WAL file fails, and the HMaster process exits unexpectedly.

```
2016-07-28 19:11:40,352 | FATAL | MASTER_SERVER_OPERATIONS-10-91-9-131:16000-0 | Caught throwable while processing event M_SERVER_SHUTDOWN |
org.apache.hadoop.hbase.master.HMaster.abort(HMaster.java:2474)
java.io.IOException: failed log splitting for 10-91-9-131,16020,1469689987884, will retry
?at
org.apache.hadoop.hbase.master.handler.ServerShutdownHandler.resubmit(ServerShutdownHandler.java:365)
?at
org.apache.hadoop.hbase.master.handler.ServerShutdownHandler.process(ServerShutdownHandler.java:220)
?at org.apache.hadoop.hbase.executor.EventHandler.run(EventHandler.java:129)
?at java.util.concurrent.ThreadPoolExecutor.runWorker(ThreadPoolExecutor.java:1142)
?at java.util.concurrent.ThreadPoolExecutor$Worker.run(ThreadPoolExecutor.java:617)
?at java.lang.Thread.run(Thread.java:745)
Caused by: java.io.IOException: error or interrupted while splitting logs in [hdfs://hacluster/hbase/WALs/<RS-Hostname>,<RS-Port>,<startcode>-splitting] Task = installed = 6 done = 3 error = 3
?at org.apache.hadoop.hbase.master.SplitLogManager.splitLogDistributed(SplitLogManager.java:290)
?at org.apache.hadoop.hbase.master.MasterFileSystem.splitLog(MasterFileSystem.java:402)
?at org.apache.hadoop.hbase.master.MasterFileSystem.splitLog(MasterFileSystem.java:375)
```

Therefore, you cannot set the quota value for the HBase directory in HDFS. If the exception occurs, perform the following operations:

Step 1 Run the **kinit** *Username* command on the client to enable the HBase user to obtain security authentication.

Step 2 Run the **hdfs dfs -count -q** */hbase/data/<namespace>/<tableName>* command to check the allocated disk space quota.

Step 3 Run the following command to cancel the quota limit and restore HBase:

hdfs dfsadmin -clrSpaceQuota */hbase/data/<namespace>/<tableName>*

----End

7.24.16 Why HMaster Times Out While Waiting for Namespace Table to be Assigned After Rebuilding Meta Using OfflineMetaRepair Tool and Startups Failed

Question

Why HMaster times out while waiting for namespace table to be assigned after rebuilding meta using OfflineMetaRepair tool and startups failed?

HMaster abort with following FATAL message,

```
2017-06-15 15:11:07,582 FATAL [Hostname:16000.activeMasterManager] master.HMaster: Unhandled exception. Starting shutdown.
```

```
java.io.IOException: Timedout 120000ms waiting for namespace table to be assigned
    at org.apache.hadoop.hbase.master.TableNamespaceManager.start(TableNamespaceManager.java:98)
    at org.apache.hadoop.hbase.master.HMaster.initNamespace(HMaster.java:1054)
    at org.apache.hadoop.hbase.master.HMaster.finishActiveMasterInitialization(HMaster.java:848)
    at org.apache.hadoop.hbase.master.HMaster.access$600(HMaster.java:199)
    at org.apache.hadoop.hbase.master.HMaster$2.run(HMaster.java:1871)
    at java.lang.Thread.run(Thread.java:745)
```

Answer

When meta is rebuilt by OfflineMetaRepair tool then HMaster wait for all region server's WAL split during start up to avoid the data inconsistency problem. HMaster trigger user regions assignment once WAL split completes. So when the cluster is in the unusual scenario, there are chances WAL splitting may take long time which depends on multiple factors like too many WALs, slow I/O, region servers are not stable etc.

HMaster should be able to finish all region server WAL splitting successfully. Perform the following steps.

1. Make sure cluster is stable, no other problem exist. If any problem occurs, please correct them first.
2. Configure a large value to **hbase.master.initializationmonitor.timeout** parameters, default value is **3600000** milliseconds.
3. Restart HBase service.

7.24.17 Why Messages Containing FileNotFoundException and no lease Are Frequently Displayed in the HMaster Logs During the WAL Splitting Process?

Question

Why messages containing FileNotFoundException and no lease are frequently displayed in the HMaster logs during the WAL splitting process?

```
2017-06-10 09:50:27,586 | ERROR | split-log-closeStream-2 | Couldn't close log at hdfs://hacluster/hbase/
data/default/largeT1/2b48346d087275fe751fc049334fda93/recovered.edits/0000000000000000000.temp |
org.apache.hadoop.hbase.wal.WALSplitter$LogRecoveredEditsOutputSink$2.call(WALSplitter.java:1330)
java.io.FileNotFoundException: No lease on /hbase/data/default/
largeT1/2b48346d087275fe751fc049334fda93/recovered.edits/0000000000000000000.temp (inode
1092653): File does not exist. [Lease.  Holder: DFSClient_NONMAPREDUCE_1202985678_1, pendingcreates:
1936]
?at org.apache.hadoop.hdfs.server.namenode.FSNamesystem.checkLease(FSNamesystem.java:3432)
?at org.apache.hadoop.hdfs.server.namenode.FSNamesystem.analyzeFileState(FSNamesystem.java:3223)
?at org.apache.hadoop.hdfs.server.namenode.FSNamesystem.getNewBlockTargets(FSNamesystem.java:3057)
?at org.apache.hadoop.hdfs.server.namenode.FSNamesystem.getAdditionalBlock(FSNamesystem.java:3011)
?at org.apache.hadoop.hdfs.server.namenode.NameNodeRpcServer.addBlock(NameNodeRpcServer.java:842)
?at
org.apache.hadoop.hdfs.protocolPB.ClientNamenodeProtocolServerSideTranslatorPB.addBlock(ClientNameno
deProtocolServerSideTranslatorPB.java:526)
?at org.apache.hadoop.hdfs.protocol.proto.ClientNamenodeProtocolProtos$ClientNamenodeProtocol
$2.callBlockingMethod(ClientNamenodeProtocolProtos.java)
?at org.apache.hadoop.ipc.ProtobufRpcEngine$Server$ProtoBufRpcInvoker.call(ProtobufRpcEngine.java:616)
?at org.apache.hadoop.ipc.RPC$Server.call(RPC.java:973)
?at org.apache.hadoop.ipc.Server$Handler$1.run(Server.java:2260)
?at org.apache.hadoop.ipc.Server$Handler$1.run(Server.java:2256)
?at java.security.AccessController.doPrivileged(Native Method)
?at javax.security.auth.Subject.doAs(Subject.java:422)
?at org.apache.hadoop.security.UserGroupInformation.doAs(UserGroupInformation.java:1769)
?at org.apache.hadoop.ipc.Server$Handler.run(Server.java:2254)
```

```
?at sun.reflect.GeneratedConstructorAccessor40.newInstance(Unknown Source)
?at sun.reflect.DelegatingConstructorAccessorImpl.newInstance(DelegatingConstructorAccessorImpl.java:45)
?at java.lang.reflect.Constructor.newInstance(Constructor.java:423)
?at org.apache.hadoop.ipc.RemoteException.instantiateException(RemoteException.java:106)
?at org.apache.hadoop.ipc.RemoteException.unwrapRemoteException(RemoteException.java:73)
?at org.apache.hadoop.hdfs.DataStreamer.locateFollowingBlock(DataStreamer.java:1842)
?at org.apache.hadoop.hdfs.DataStreamer.nextBlockOutputStream(DataStreamer.java:1639)
?at org.apache.hadoop.hdfs.DataStreamer.run(DataStreamer.java:665)
```

Answer

During the WAL splitting process, the WAL splitting timeout period is specified by the **hbase.splitlog.manager.timeout** parameter. If the WAL splitting process fails to complete within the timeout period, the task is submitted again. Multiple WAL splitting tasks may be submitted during a specified period. If the **temp** file is deleted when one WAL splitting task completes, other tasks cannot find the file and the FileNotFoudException exception is reported. To avoid the problem, perform the following modifications:

The default value of **hbase.splitlog.manager.timeout** is 600,000 ms. The cluster specification is that each RegionServer has 2,000 to 3,000 regions. When the cluster is normal (HBase is normal and HDFS does not have a large number of read and write operations), you are advised to adjust this parameter based on the cluster specifications. If the actual specifications (the actual average number of regions on each RegionServer) are greater than the default specifications (the default average number of regions on each RegionServer, that is, 2,000), the adjustment solution is (actual specifications/default specifications) x Default time.

Set the **splitlog** parameter in the **hbase-site.xml** file on the server. **Table 7-33** describes the parameter.

Table 7-33 Description of the **splitlog** parameter

Parameter	Description	Default Value
hbase.splitlog.manager.timeout	Timeout period for receiving worker response by the distributed SplitLog management program.	600000

7.24.18 Insufficient Rights When a Tenant Accesses Phoenix

Question

When a tenant accesses Phoenix, a message is displayed indicating that the tenant has insufficient rights.

Answer

You need to associate the HBase service and Yarn queues when creating a tenant.

The tenant must be granted additional rights to perform operations on Phoenix, that is, the RWX permission on the Phoenix system table.

Example:

Tenant **hbase** has been created. Log in to the HBase Shell as user **admin** and run the **scan 'hbase:acl'** command to query the role of the tenant. The role is **hbase_1450761169920** (in the format of tenant name_timestamp).

Run the following commands to grant rights to the tenant (if the Phoenix system table has not been generated, log in to the Phoenix client as user **admin** first and then grant rights on the HBase Shell):

grant '@hbase_1450761169920','RWX','SYSTEM.CATALOG'

grant '@hbase_1450761169920','RWX','SYSTEM.FUNCTION'

grant '@hbase_1450761169920','RWX','SYSTEM.SEQUENCE'

grant '@hbase_1450761169920','RWX','SYSTEM.STATS'

Create user **phoenix** and bind it with tenant **hbase**, so that tenant **hbase** can access the Phoenix client as user **phoenix**.

7.24.19 What Can I Do When HBase Fails to Recover a Task and a Message Is Displayed Stating "Rollback recovery failed"?

Question

The system automatically rolls back data after an HBase recovery task fails. If "Rollback recovery failed" is displayed, the rollback fails. After the rollback fails, data stops being processed and the junk data may be generated. How can I resolve this problem?

Answer

You need to manually clear the junk data before performing the backup or recovery task next time.

Step 1 Install the cluster client in **/opt/client**.

Step 2 Run **source /opt/client/bigdata_env** as the client installation user to configure environment variables.

Step 3 Run the **kinit admin** command.

Step 4 Run **zkCli.sh -server** *business IP address of ZooKeeper*:**2181** to connect to the ZooKeeper.

Step 5 Run **deleteall /recovering** to delete the junk data. Run **quit** to disconnect ZooKeeper.

NOTE

Running this command will cause data loss. Exercise caution.

Step 6 Run **hdfs dfs -rm -f -r /user/hbase/backup** to delete temporary data.

Step 7 Log in to FusionInsight Manager and choose **O&M**. In the navigation pane on the left, choose **Backup and Restoration** > **Restoration Management**. In the task list, locate the row that contains the target task and click **View History** in the

Operation column. In the displayed dialog box, click ⌄ before a specified execution record to view the snapshot name.

Snapshot [*snapshot name*] is created successfully before recovery.

Step 8 Switch to the client, run **hbase shell**, and then **delete_all_snapshot** '*snapshot name*.*' to delete the temporary snapshot.

----End

7.24.20 How Do I Fix Region Overlapping?

Question

When the HBaseFsck tool is used to check the region status, if the log contains **ERROR: (regions region1 and region2) There is an overlap in the region chain** or **ERROR: (region region1) Multiple regions have the same startkey: xxx**, overlapping exists in some regions. How do I solve this problem?

Answer

To rectify the fault, perform the following steps:

Step 1 Run the **hbase hbck -j ${CLIENT_HOME}/HBase/hbase/tools/hbase-hbck2-1.1.0-h0.cbu.mrs.*.jar fixInconsistencies tableName** command to repair the tables whose regions overlap.

Step 2 Run the **hbase hbck -j ${CLIENT_HOME}/HBase/hbase/tools/hbase-hbck2-1.1.0-h0.cbu.mrs.*.jar listInconsistencies -run tableName** command to check whether the region of the restored table overlaps.

- If overlapping does not exist, go to **Step 3**.
- If overlapping exists, go to **Step 1**.

Step 3 Log in to FusionInsight Manager and choose **Cluster** > **Services** > **HBase**. Click **More** and select **Perform HMaster Switchover** to complete the HMaster active/standby switchover.

Step 4 Run the **hbase hbck -j ${CLIENT_HOME}/HBase/hbase/tools/hbase-hbck2-1.1.0-h0.cbu.mrs.*.jar listInconsistencies -run tableName** command to verify whether the problem is solved.

- If overlapping does not exist, no further action is required.
- If overlapping still exists, start from **Step 1** to perform the recovery again.

----End

7.24.21 Why Does RegionServer Fail to Be Started When GC Parameters Xms and Xmx of HBase RegionServer Are Set to 31 GB?

Question

Check the **hbase-omm-*.out** log of the node where RegionServer fails to be started. It is found that the log contains **An error report file with more**

information is saved as: /tmp/hs_err_pid*.log. Check the **/tmp/hs_err_pid*.log** file. It is found that the log contains **#Internal Error (vtableStubs_aarch64.cpp:213), pid=9456, tid=0x0000ffff97fdd200 and #guarantee(__ pc() <= s->code_end()) failed: overflowed buffer**, indicating that the problem is caused by JDK. How do I solve this problem?

Answer

To rectify the fault, perform the following steps:

Step 1 Run the **su - omm** command on a node where RegionServer fails to be started to switch to user **omm**.

Step 2 Run the **java -XX:+PrintFlagsFinal -version |grep HeapBase** command as user **omm**. Information similar to the following is displayed:

```
uintx HeapBaseMinAddress = 2147483648 {pd product}
```

Step 3 Change the values of **-Xms** and **-Xmx** in **GC_OPTS** to values that are not between **32G-HeapBaseMinAddress** and **32G**, excluding the values of **32G** and **32G-HeapBaseMinAddress**.

Step 4 Log in to FusionInsight Manager and choose **Cluster** > **Services** > **HBase**. Click **Instance**, select the failed instance, click **More**, and select **Restart Instance** to restart the instance.

----End

7.24.22 Why Does the LoadIncrementalHFiles Tool Fail to Be Executed and "Permission denied" Is Displayed When Nodes in a Cluster Are Used to Import Data in Batches?

Question

Why does the LoadIncrementalHFiles tool fail to be executed and "Permission denied" is displayed when a Linux user is manually created in a normal cluster and DataNode in the cluster is used to import data in batches?

```
2020-09-20 14:53:53,808 WARN  [main] shortcircuit.DomainSocketFactory: error creating DomainSocket
java.net.ConnectException: connect(2) error: Permission denied when trying to connect to '/var/run/
FusionInsight-HDFS/dn_socket'
    at org.apache.hadoop.net.unix.DomainSocket.connect0(Native Method)
    at org.apache.hadoop.net.unix.DomainSocket.connect(DomainSocket.java:256)
    at org.apache.hadoop.hdfs.shortcircuit.DomainSocketFactory.createSocket(DomainSocketFactory.java:168)
    at org.apache.hadoop.hdfs.client.impl.BlockReaderFactory.nextDomainPeer(BlockReaderFactory.java:804)
    at
org.apache.hadoop.hdfs.client.impl.BlockReaderFactory.createShortCircuitReplicaInfo(BlockReaderFactory.java
:526)
    at org.apache.hadoop.hdfs.shortcircuit.ShortCircuitCache.create(ShortCircuitCache.java:785)
    at org.apache.hadoop.hdfs.shortcircuit.ShortCircuitCache.fetchOrCreate(ShortCircuitCache.java:722)
    at
org.apache.hadoop.hdfs.client.impl.BlockReaderFactory.getBlockReaderLocal(BlockReaderFactory.java:483)
    at org.apache.hadoop.hdfs.client.impl.BlockReaderFactory.build(BlockReaderFactory.java:360)
    at org.apache.hadoop.hdfs.DFSInputStream.getBlockReader(DFSInputStream.java:663)
    at org.apache.hadoop.hdfs.DFSInputStream.blockSeekTo(DFSInputStream.java:594)
    at org.apache.hadoop.hdfs.DFSInputStream.readWithStrategy(DFSInputStream.java:776)
    at org.apache.hadoop.hdfs.DFSInputStream.read(DFSInputStream.java:845)
    at java.io.DataInputStream.readFully(DataInputStream.java:195)
    at org.apache.hadoop.hbase.io.hfile.FixedFileTrailer.readFromStream(FixedFileTrailer.java:401)
    at org.apache.hadoop.hbase.io.hfile.HFile.isHFileFormat(HFile.java:651)
```

```
    at org.apache.hadoop.hbase.io.hfile.HFile.isHFileFormat(HFile.java:634)
    at org.apache.hadoop.hbase.tool.LoadIncrementalHFiles.visitBulkHFiles(LoadIncrementalHFiles.java:1090)
    at
org.apache.hadoop.hbase.tool.LoadIncrementalHFiles.discoverLoadQueue(LoadIncrementalHFiles.java:1006)
    at
org.apache.hadoop.hbase.tool.LoadIncrementalHFiles.prepareHFileQueue(LoadIncrementalHFiles.java:257)
    at org.apache.hadoop.hbase.tool.LoadIncrementalHFiles.doBulkLoad(LoadIncrementalHFiles.java:364)
    at org.apache.hadoop.hbase.tool.LoadIncrementalHFiles.run(LoadIncrementalHFiles.java:1263)
    at org.apache.hadoop.hbase.tool.LoadIncrementalHFiles.run(LoadIncrementalHFiles.java:1276)
    at org.apache.hadoop.hbase.tool.LoadIncrementalHFiles.run(LoadIncrementalHFiles.java:1311)
    at org.apache.hadoop.util.ToolRunner.run(ToolRunner.java:76)
    at org.apache.hadoop.hbase.tool.LoadIncrementalHFiles.main(LoadIncrementalHFiles.java:1333)
```

Answer

If the client that the LoadIncrementalHFiles tool depends on is installed in the cluster and is on the same node as DataNode, HDFS creates short-circuit read during the execution of the tool to improve performance. The short-circuit read depends on the **/var/run/FusionInsight-HDFS** directory (**dfs.domain.socket.path**). The default permission on this directory is **750**. This user does not have the permission to operate the directory.

To solve the preceding problem, perform the following operations:

Method 1: Create a user (recommended).

Step 1 Create a user on Manager. By default, the user group contains the **ficommon** group.

```
[root@xxx-xxx-xxx-xxx ~]# id test
uid=20038(test) gid=9998(ficommon) groups=9998(ficommon)
```

Step 2 Import data again.

----End

Method 2: Change the owner group of the current user.

Step 1 Add the user to the **ficommon** group.

```
[root@xxx-xxx-xxx-xxx ~]# usermod -a -G ficommon test
[root@xxx-xxx-xxx-xxx ~]# id test
uid=2102(test) gid=2102(test) groups=2102(test),9998(ficommon)
```

Step 2 Import data again.

----End

7.24.23 Why Is the Error Message "import argparse" Displayed When the Phoenix sqlline Script Is Used?

Question

When the sqlline script is used on the client, the error message "import argparse" is displayed.

Answer

Step 1 Log in to the node where the HBase client is installed as user **root**. Perform security authentication using the **hbase** user.

Step 2 Go to the directory where the sqlline script of the HBase client is stored and run the **python3 sqlline.py** command.

----End

7.24.24 How Do I Deal with the Restrictions of the Phoenix BulkLoad Tool?

Question

When the indexed field data is updated, if a batch of data exists in the user table, the BulkLoad tool cannot update the global and partial mutable indexes.

Answer

Problem Analysis

1. Create a table.

```
CREATE TABLE TEST_TABLE(
DATE varchar not null,
NUM integer not null,
SEQ_NUM integer not null,
ACCOUNT1 varchar not null,
ACCOUNTDES varchar,
FLAG varchar,
SALL double,
CONSTRAINT PK PRIMARY KEY (DATE,NUM,SEQ_NUM,ACCOUNT1)
);
```

2. Create a global index.

   CREATE INDEX TEST_TABLE_INDEX ON TEST_TABLE(ACCOUNT1,DATE,NUM,ACCOUNTDES,SEQ_NUM);

3. Insert data.

   UPSERT INTO TEST_TABLE (DATE,NUM,SEQ_NUM,ACCOUNT1,ACCOUNTDES,FLAG,SALL) values ('20201001',30201001,13,'367392332','sffa1','','');

4. Execute the BulkLoad task to update data.

   hbase org.apache.phoenix.mapreduce.CsvBulkLoadTool -t TEST_TABLE -i /tmp/test.csv, where the content of **test.csv** is as follows:

20201001	30201001	13	367392332	sffa888	1231243	23

5. Symptom: The existing index data cannot be directly updated. As a result, two pieces of index data exist.

```
+------------+-----------+-----------+---------------+----------------+
| :ACCOUNT1 |  :DATE  |  :NUM  | 0:ACCOUNTDES | :SEQ_NUM |
+------------+-----------+-----------+---------------+----------------+
| 367392332 | 20201001 | 30201001 | sffa1        | 13              |
| 367392332 | 20201001 | 30201001 | sffa888      | 13              |
+------------+-----------+-----------+---------------+----------------+
```

Solution

Step 1 Delete the old index table.

DROP INDEX TEST_TABLE_INDEX ON TEST_TABLE;

Step 2 Create an index table in asynchronous mode.

CREATE INDEX TEST_TABLE_INDEX ON TEST_TABLE(ACCOUNT1,DATE,NUM,ACCOUNTDES,SEQ_NUM) ASYNC;

Step 3 Recreate a index.

hbase org.apache.phoenix.mapreduce.index.IndexTool --data-table TEST_TABLE --index-table TEST_TABLE_INDEX --output-path /user/test_table

----End

7.24.25 Why a Message Is Displayed Indicating that the Permission is Insufficient When CTBase Connects to the Ranger Plug-ins?

Question

When CTBase accesses the HBase service with the Ranger plug-ins enabled and you are creating a cluster table, a message is displayed indicating that the permission is insufficient.

```
ERROR: Create ClusterTable failed. Error: org.apache.hadoop.hbase.security.AccessDeniedException:
Insufficient permissions for user 'ctbase2@HADOOP.COM' (action=create)
at org.apache.ranger.authorization.hbase.AuthorizationSession.publishResults(AuthorizationSession.java:278)
at
org.apache.ranger.authorization.hbase.RangerAuthorizationCoprocessor.authorizeAccess(RangerAuthorizatio
nCoprocessor.java:654)
at
org.apache.ranger.authorization.hbase.RangerAuthorizationCoprocessor.requirePermission(RangerAuthorizati
onCoprocessor.java:772)
at
org.apache.ranger.authorization.hbase.RangerAuthorizationCoprocessor.preCreateTable(RangerAuthorization
Coprocessor.java:943)
at
org.apache.ranger.authorization.hbase.RangerAuthorizationCoprocessor.preCreateTable(RangerAuthorization
Coprocessor.java:428)
at org.apache.hadoop.hbase.master.MasterCoprocessorHost$12.call(MasterCoprocessorHost.java:351)
at org.apache.hadoop.hbase.master.MasterCoprocessorHost$12.call(MasterCoprocessorHost.java:348)
at org.apache.hadoop.hbase.coprocessor.CoprocessorHost
$ObserverOperationWithoutResult.callObserver(CoprocessorHost.java:581)
at org.apache.hadoop.hbase.coprocessor.CoprocessorHost.execOperation(CoprocessorHost.java:655)
at
org.apache.hadoop.hbase.master.MasterCoprocessorHost.preCreateTable(MasterCoprocessorHost.java:348)
at org.apache.hadoop.hbase.master.HMaster$5.run(HMaster.java:2192)
at
org.apache.hadoop.hbase.master.procedure.MasterProcedureUtil.submitProcedure(MasterProcedureUtil.java:1
34)
at org.apache.hadoop.hbase.master.HMaster.createTable(HMaster.java:2189)
at org.apache.hadoop.hbase.master.MasterRpcServices.createTable(MasterRpcServices.java:711)
at org.apache.hadoop.hbase.shaded.protobuf.generated.MasterProtos$MasterService
$2.callBlockingMethod(MasterProtos.java)
at org.apache.hadoop.hbase.ipc.RpcServer.call(RpcServer.java:458)
at org.apache.hadoop.hbase.ipc.CallRunner.run(CallRunner.java:133)
at org.apache.hadoop.hbase.ipc.RpcExecutor$Handler.run(RpcExecutor.java:338)
at org.apache.hadoop.hbase.ipc.RpcExecutor$Handler.run(RpcExecutor.java:318)
```

Answer

CTBase users can configure permission policies on the Ranger page and grant the READ, WRITE, CREATE, ADMIN, and EXECUTE permissions to the CTBase metadata table **_ctmeta_**, cluster table, and index table.

7.24.26 How Do I View Regions in the CLOSED State in an ENABLED Table?

Question

How do I view regions in the CLOSED state in an ENABLED table on the HBase client?

Procedure

Step 1 Log in to the node on which the HBase client is installed as a client installation user.

Step 2 Go to the client installation directory and configure the environment variables:

cd *Client installation directory*

source bigdata_env

Step 3 If Kerberos authentication is enabled for the cluster (the cluster is in security mode), run the following command to perform security authentication. If Kerberos authentication is disabled for the cluster (the cluster is in normal mode), skip this step.

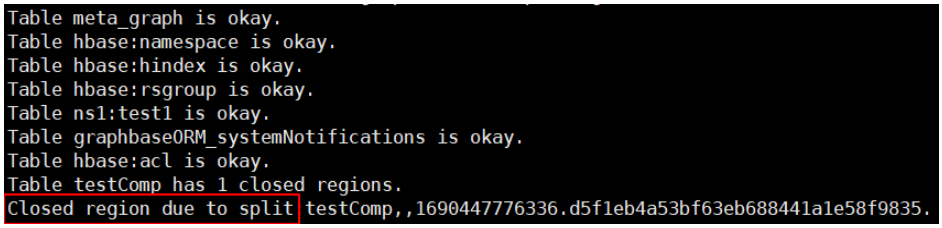
kinit *Component service user*

Step 4 Run the following command to check the regions in the CLOSED state in an ENABLED table:

hbase hbck -j HBase/hbase/tools/hbase-hbck2-*.jar reportClosedRegions [-details] [<TABLENAME>...]

The command parameters are as follows:

- If **-details** is not specified, only the number of CLOSED regions is displayed. If **-details** is specified, the names of all CLOSED regions are displayed.
- If *TABLENAME* is not specified, all tables are queried by default.
- If "Closed region due to split" is displayed after the command is executed, the region status changes to CLOSED due to an ongoing split task. After the task is complete, the region is automatically removed from the meta table.



----End

7.24.27 How Can I Quickly Recover the Service When HBase Files Are Damaged Due to a Cluster Power-Off?

Symptom

The StoreFile or WAL files are damaged due to an unexpected cluster power-off. How can I quickly restore the service?

Cause Analysis

If the StoreFile file is damaged, related regions fail to be brought online and system keeps retry the operation. As a result, the HBase service is abnormal. If the WAL file is damaged, log splitting fails and the system keeps retry the operation. As a result, the service is abnormal. Related regions cannot be brought online and provide services for external systems.

Procedure

The HBase server provides two configuration items to determine whether to skip damaged StoreFile and WAL files. Log in to FusionInsight Manager, choose **Cluster** > **Services** > **HBase** and click **Configuration**, search for and set the parameters listed in **Table 7-34**. The parameters take effect dynamically. Save the configuration, log in to the HBase shell, and run the **update_all_config** command for the parameters to take effect.

Skipping damaged files may cause data loss. If the following parameters are set to **true** and damaged StoreFile or WAL file is skipped, **ALM-19025 Damaged StoreFile in HBase** or **ALM-19026 Damaged WAL Files in HBase** is reported, rectify the fault by referring to the alarm help.

Table 7-34 Parameters for skipping damaged files on the HBase server

Parameter	Description	Default Value
hregion.hfile.skip.errors	Whether to skip damaged HBase Files and and move them to the **/hbase/autocorrupt** or **/hbase/MasterData/autocorrupt** directory when a region is brought online. You are not advised to enable this parameter in DR scenarios.	false
hbase.hlog.split.skip.errors	Whether to skip damaged WAL files and move them to the **/hbase/corrupt** directory during log splitting.	false

7.24.28 How Do I Disable HDFS Hedged Read on HBase?

Symptom

HDFS hedged read is enabled by default to reduce read latency and adapt to network changes. **Table 7-35** describes related parameters.

Table 7-35 Parameters of HDFS hedged read

Parameter	Description	Default Value	Value Range
dfs.client.hedged.read.threshold.millis	The number of milliseconds the HDFS client waits for the first byte of the first data block before deciding whether to start a hedged read	250	Greater than or equal to 1
dfs.client.hedged.read.threadpool.size	Size of the hedged read thread pool. If this parameter is set to a value greater than 0, multiple read channels are enabled.	200	Greater than or equal to 0

HDFS hedged read may cause performance deterioration when the disk I/O is high. You need to disable this function on HBase by referring to **Procedure**.

Procedure

Step 1 Log in to FusionInsight Manager.

Step 2 Choose **Cluster** > **Service** > **HBase** > **Configurations** > **All Configurations**. The **All Configurations** page is displayed.

Step 3 Search for **dfs.client.hedged.read.threadpool.size** and change its value to **0**.

Step 4 Click **Save**.

Step 5 Click **Instances**, select all RegionServer instances, and choose **More** > **Instance Rolling Restart** to apply the changes.

----End

8 Using Guardian

8.1 Setting Common Guardian Parameters

Page Access

Go to the Guardian configuration page by referring to **Modifying Cluster Service Configuration Parameters**.

Description

Table 8-1 Guardian parameters

Parameter	Description	Default Value
token.server.access.label.agency.name	Name of an IAM agency.	-
token.server.access.iam.domain.id	Domain ID corresponding to the user who accesses IAM. This parameter is mandatory only when the ECS agency cannot be configured on physical machines.	-

Parameter	Description	Default Value
token.server.access.iam.endpoint	Endpoint of IAM. This parameter is used only when the ECS agency cannot be configured on physical machines. If the OBS endpoint is configured in the meta component, the configuration is automatically generated based on the **https://iam-apigateway-proxy.${obs_endpoint_region_id}.${obs_endpoint_domain_name}** rule.	If the OBS endpoint is configured in the meta component, the configuration is automatically generated based on the **https://iam-apigateway-proxy.${obs_endpoint_region_id}.${obs_endpoint_domain_name}** rule.
token.server.access.iam.sk	Secret key for accessing IAM. This parameter is mandatory only when the ECS agency cannot be configured on physical machines.	-
token.server.access.iam.ak	Access key for accessing IAM. This parameter is mandatory only when the ECS agency cannot be configured on physical machines. The user must have the **Agent Operator** role permission.	-
fs.obs.delegation.token.providers	By default, this parameter is left blank. If this parameter is **true**, both **com.xxx.mrs.dt.MRSDelegationTokenProvider** and **com.xxx.mrs.dt.GuardianDTProvider** must be set.	-
fs.obs.guardian.accesslabel.enabled	Whether to enable **access label** for using Guardian to connect to OBS.	false

Parameter	Description	Default Value
fs.obs.guardian.enabled	Whether to enable Guardian. **NOTE** After you change the value of this parameter, you need to synchronize the configuration again, restart the cluster, and refresh the client configuration.	false

8.2 Guardian Log Overview

Log Description

Log path: **/var/log/Bigdata/guardian/token-server**

Log archive rule: The automatic compression and archive function is enabled for Guardian run logs. When the total size of all log files exceeds 50 MB (configurable, see *Configuring the Log Level and Log File Size*), the log files are automatically compressed into a package named in the format of **token-server.log.[***ID***]**. A maximum of 20 latest compressed files are retained. The number of compressed files and compression threshold can be configured.

Table 8-2 Guardian log list

Log Type	Log File Name	Description
Run log	token-server.log	Guardian run log
	startDetail.log	Guardian service prestart log
	stopDetail.log	Guardian service stop log
	gc.log	Guardian service GC log

Log Levels

The following table describes the log levels provided by Guardian.

The log levels are ERROR, WARN, INFO, and DEBUG in descending order of priority. Only logs whose levels are higher than or equal to the specified level are recorded. The higher the log level specified, the fewer the logs are recorded.

Table 8-3 Log levels

Level	Description
ERROR	Logs of this level record error information about system running
WARN	Logs of this level record exception information about the current event processing
INFO	Logs of this level record normal running status information about the system and events
DEBUG	Logs of this level record the system information and system debugging information

To modify log levels, perform the following operations:

Step 1 Log in to FusionInsight Manager.

Step 2 Choose **Cluster** > **Services** > **Guardian**. Click **Configurations** then **All Configurations**.

Step 3 On the menu bar on the left, select the log menu of the target role.

Step 4 Select a desired log level.

Step 5 Click **Save** then **OK**.

NOTE

The configurations take effect immediately without the need to restart the service.

----End

9 Using HetuEngine

9.1 Using HetuEngine from Scratch

This section describes how to use HetuEngine to connect to the Hive data source and query database tables of the Hive data source of the cluster through HetuEngine.

Prerequisites

- The HetuEngine and Hive services and their dependent services (DBService, KrbServer, ZooKeeper, HDFS, Yarn, and MapReduce) have been installed in the cluster and are running properly.
- If Kerberos authentication has been enabled for the cluster, you need to create a HetuEngine user and grant related permissions to the user in advance. For details, see **Creating a HetuEngine User**. In addition, you need to configure the permissions to manage the databases, tables, and columns of the data source for the user using Ranger. For details, see **Adding a Ranger Access Permission Policy for HetuEngine**.
- The cluster client has been installed in a directory, for example, **/opt/client**.

Procedure

Step 1 Create and start a HetuEngine compute instance.

1. Log in to FusionInsight Manager as a HetuEngine administrator and choose **Cluster** > **Services** > **HetuEngine**. The **HetuEngine** service page is displayed.
2. In the **Basic Information** area on the **Dashboard** tab page, click the link next to **HSConsole WebUI**. The HSConsole page is displayed.
3. Click **Compute Instance** then **Create Configuration**.
   a. In the **Basic Configuration** area, set **Tenant** to the tenant associated with the user and configure **Instance Deployment Timeout Period (s)** and **Node Count**.
   b. Configure parameters in the **Coordinator Container Resource Configuration**, **Worker Container Resource Configuration**, and **Advanced Configuration** areas based on the actual resource plan. For

details about the parameter configuration, see **Creating a HetuEngine Compute Instance** or retain the default values.

NOTICE

When you create a compute instance, you only need to apply for a few resources to test basic functions. You need to configure parameters based on actual service requirements and available resources. For details, see **Configuring Resource Groups** and **Configuring the Number of Worker Nodes**.

c. Set **Start Now** to **Yes**, click **OK**, and wait until the instance configuration is complete.

Step 2 Log in to the node where the HetuEngine client is installed and run the following command to switch to the client installation directory:

cd /opt/client

Step 3 Run the following command to configure environment variables:

source bigdata_env

Step 4 Authenticate or specify a user.

- For a cluster in security mode, run the following command to authenticate the user:

  kinit *HetuEngine operation user*

  Example:

  kinit hetu_test

  Enter the password as prompted and change the password upon your first login.

- For a cluster in normal mode, run the following command to authenticate the user:

  hetu-cli --user *HetuEngine operation user*

  Example:

  hetu-cli --user hetu_test

Step 5 Run the following command to log in to the catalog of the data source. You can choose to log in to the data source through ZooKeeper or HSFabric by configuring the **--mode** parameter.

- Through ZooKeeper (This mode is used by default if **--mode** is not configured.)

  hetu-cli --catalog *Data source name*

  For example, run the following command:

  hetu-cli --catalog hive

- Through HSFabric (Ensure that HSFabric instances exist.)

  hetu-cli --mode hsfabric --catalog *Data source name*

  For example, run the following command:

  hetu-cli --mode hsfabric --catalog hive

NOTE

- The default name of the Hive data source of the cluster is **hive**. To connect to data sources outside the cluster, configure external data sources on HSConsole by referring to **Configuring Data Sources**.
- **--mode**: Optional. The mode used to log in to a data source.
- **--catalog**: Optional. The name of a specified data source.
- **--tenant**: Optional. The tenant resource queue started by the cluster. If this parameter is not specified, the default tenant queue is used. If this parameter is used, service users must have the permissions of the role corresponding to the tenant.
- **--schema**: Optional. The name of the schema of the data source to be accessed.
- **--user**: Mandatory in normal mode. The name of the user who logs in to the client to execute services. The user must have at least the role of the queue specified by **--tenant**.

```
java -Djava.security.auth.login.config=/opt/client/HetuEngine/hetuserver/conf/jaas.conf -
Dzookeeper.sasl.clientconfig=Client -Dzookeeper.auth.type=kerberos -Djava.security.krb5.conf=/opt/client/
KrbClient/kerberos/var/krb5kdc/krb5.conf -Djava.util.logging.config.file=/opt/client/HetuEngine/hetuserver/
conf/hetuserver-client-logging.properties -jar /opt/client/HetuEngine/hetuserver/jars/hetu-cli-*-
executable.jar --catalog hive --deployment-mode on_yarn --server https://
10.112.17.189:24002,10.112.17.228:24002,10.112.17.150:24002?
serviceDiscoveryMode=zooKeeper&zooKeeperNamespace=hsbroker --krb5-remote-service-name HTTP --
krb5-config-path /opt/client/KrbClient/kerberos/var/krb5kdc/krb5.conf
hetuengine>
```

Step 6 Run the following command to view the database information:

show schemas;

```
    Schema
--------------------
 default
 information_schema
(2 rows)
Query 20230228_064136_00023_9kpap@default@HetuEngine, FINISHED, 3 nodes
Splits: 36 total, 36 done (100.00%)
0:02 [2 rows, 35B] [0 rows/s, 15B/s]
```

----End

9.2 HetuEngine Permission Management

9.2.1 Overview

HetuEngine provides the following two permission control models when Kerberos authentication is enabled for the cluster (the cluster is in security mode). By default, the Ranger permission model is used. When Kerberos authentication is disabled for the cluster (the cluster is in normal mode), the Ranger permission model is provided but disabled by default.

- For details about the Ranger model, see **HetuEngine Ranger-based Permission Control**.
- For details about the MetaStore model, see **HetuEngine MetaStore-based Permission Control**.

The following table lists the differences between Ranger and MetaStore. Both Ranger and MetaStore support user, user group, and role authentication.

Table 9-1 Differences between Ranger and MetaStore

Permission Control Mode	Permission Model	Supported Data Source	Description
Ranger	PBAC	Hive, HBase, Elasticsearch, GaussDB, HetuEngine, ClickHouse, IoTDB, Hudi, MySQL	Row filtering, column masking, and fine-grained permission control are supported.
MetaStore	RBAC	Hive	-

Permission Principles and Constraints

- Accessing data sources in the same cluster using HetuEngine

  If Ranger authentication is enabled for HetuEngine, the PBAC permission policy of Ranger is used for authentication.

  If Ranger authentication is disabled for HetuEngine, the RBAC permission policy of MetaStore is used for authentication.
- Accessing data sources in different clusters using HetuEngine

  The permission policy is controlled by the permissions of the HetuEngine client and the data source. (In Hive scenarios, it depends on HDFS.)
- When querying a view, you only need to grant the select permission on the target view. When querying a join table using a view, you need to grant the select permission on the view and table.
- Columns in GaussDB and HetuEngine data sources cannot be masked.

NOTE

When the permission control type of HetuEngine is changed, the HetuEngine service, including the HetuEngine compute instance running on the HSConsole page, needs to be restarted.

9.2.2 HetuEngine Ranger-based Permission Control

By default, Ranger authentication is used for newly installed clusters. For clusters upgraded from earlier versions or clusters where Ranger authentication is manually disabled, you can enable Ranger authentication again by referring to **Enabling Ranger Authentication**. For a cluster with Ranger authentication enabled, cluster administrators can use Ranger to configure the permissions to manage databases, tables, and columns of data sources for HetuEngine users. For details, see **Adding a Ranger Access Permission Policy for HetuEngine**.

Enabling Ranger Authentication

Step 1 Log in to FusionInsight Manager.

Step 2 If Kerberos authentication is disabled for the cluster (the cluster is in normal mode), add the **ranger.usersync.sync.source** parameter. If Kerberos authentication is enabled for the cluster (the cluster is in security mode), skip this step.

1. Choose **Cluster** > **Services** > **Ranger**. Click **Configurations** then **All Configurations**.
2. Search for the **ranger.usersync.config.expandor** parameter, set its name to **ranger.usersync.sync.source**, set its value to **ldap**, and save the settings.
3. On the **Dashboard** page, click **More** > **Restart Service** in the upper right corner, enter the password, and restart Ranger.

Step 3 Choose **Cluster** > **Services** > **HetuEngine** > **More** > **Enable Ranger**.

Step 4 Choose **Cluster** > **Services** > **HetuEngine** > **More** > **Restart Service**.

Step 5 Restart the compute instance on HSConsole. For details, see **Managing HetuEngine Compute Instances**.

----End

9.2.3 HetuEngine MetaStore-based Permission Control

Constraints: This function applies only to Hive data sources.

When multiple HetuEngine clusters are deployed for collaborative computing, the metadata is centrally managed by the management cluster. Data computing is performed in all clusters. The user permission for accessing HetuEngine clusters must be configured in the management cluster. Users who belong to the Hive user group and share the same name are added to all compute instances.

Enabling MetaStore Authentication

Step 1 Log in to FusionInsight Manager.

Step 2 Choose **Cluster** > **Services** > **HetuEngine**. Click **More** and select **Disable Ranger**.

Step 3 Choose **Cluster** > **Services** > **HetuEngine**. Click **More** and select **Restart Service**.

Step 4 Restart the compute instance on the HSConsole page.

----End

MetaStore Permission

Similar to Hive, HetuEngine is a data warehouse framework built on Hadoop, providing storage of structured data like SQL.

Permissions in a cluster must be assigned to roles which are bound to users or user groups. Users can obtain permissions only by binding a role or joining a group that is bound with a role.

Permission Management

HetuEngine permission management is performed by the permission system to manage users' operations on the database, ensuring that different users can operate databases independently and securely. A user can operate another user's tables and databases only with the corresponding permissions. Otherwise, operations will be rejected.

HetuEngine permission management integrates the functions of Hive permission management. MetaStore service of Hive and the function of granting permissions on the web page are required to enable the HetuEngine permission management.

- Granting permissions on the web page: HetuEngine supports only granting permissions on the web page. On Manager, choose **System** > **Permission** to add or delete a user, user group, or a role, and to grant or cancel permissions.
- Obtaining and judging a service: When the DDL and DML commands are received from the client, HetuEngine will obtain the client user's permissions on database information from MetaStore, and check whether the required permissions are included. If the required permissions have been obtained, the user's operations are allowed. If the permissions are not obtained, the user's operation will be rejected. After the MetaStore permissions are checked, ACL permission also needs to be checked on HDFS.

HetuEngine Permission Model

If a user uses HetuEngine to perform SQL query, the user must be granted with permissions of HetuEngine databases and tables (include external tables and views). The complete permission model of HetuEngine consists of the metadata permission and HDFS file permission. Permissions required to use a database or a table are just one type of HetuEngine permission.

- Metadata permissions

  Metadata permissions are controlled at the metadata level. Similar to traditional relational databases, the HetuEngine database contains the CREATE and SELECT permissions. Tables and columns contain the SELECT, INSERT, UPDATE, and DELETE permissions. HetuEngine also supports the owner permission OWNERSHIP and cluster administrator permission ADMIN.
- Data file permissions (that is, HDFS file permissions)

  HetuEngine database and table files are stored in HDFS. The created databases or tables are saved in the **/user/hive/warehouse** directory of HDFS by default. The system automatically creates subdirectories named after database names and database table names. To access a database or a table, the corresponding file permissions (READ, WRITE, and EXECUTE) on HDFS are required.

To perform various operations on HetuEngine databases or tables, you need to associate the metadata permission and the HDFS file permission. For example, to query HetuEngine data tables, you need to associate the metadata permission SELECT with the READ and EXECUTE permissions on HDFS files.

To use the management function of FusionInsight Manager GUI to manage the permissions of HetuEngine databases and tables, you only need to configure the metadata permission, and the system will automatically associate and configure the HDFS file permission. In this way, operations on the interface are simplified, improving efficiency.

HetuEngine Application Scenarios and Related Permissions

A user needs to join in the Hive group if a database is created using the HetuEngine service, and role authorization is not required. Users have all permissions on the databases or tables created by themselves in Hive or HDFS.

They can create tables, select, delete, insert, or update data, and grant permissions to other users to allow them to access the tables and corresponding HDFS directories and files.

A user can access the tables or database only with permissions. Permissions required for the user vary depending on different HetuEngine scenarios.

Table 9-2 Typical HetuEngine scenarios and required permissions

Scenario	Required Permission
Using HetuEngine tables, columns, or databases	Permissions required in different scenarios are as follows: • To create a table, the CREATE permission is required. • To query data, the SELECT permission is required. • To insert data, the INSERT permission is required.

In some special HetuEngine scenarios, other permissions must be configured separately.

Table 9-3 Typical HetuEngine authentication scenarios and required permissions

Scenario	Required Permission
Creating HetuEngine databases, tables, and foreign tables, or adding partitions to created tables or foreign tables when data files specified by Hive users are saved to other HDFS directories except **/user/hive/warehouse**.	The directory must exist, the client user must be the owner of the directory, and the user must have the READ, WRITE, and EXECUTE permissions on the directory. The user must have the READ and EXECUTE permissions of all the upper-layer directories of the directory.
Performing operations on all databases and tables in Hive	The user must be added to the **supergroup** user group, and be assigned the ADMIN permission.

Configuring Permissions for Tables, Columns, and Databases

After MetaStore authentication is enabled, if a user needs to access HetuEngine tables or databases created by other users, the user needs to be granted with related permissions. HetuEngine supports permission control based on columns for strict permission control. If a user needs to access some columns in tables created by other users, the user must be granted the permission for columns.

NOTE

- Any permission for a table in the database is automatically associated with the HDFS permission for the database directory to facilitate permission management. When any permission for a table is canceled, the system does not automatically cancel the HDFS permission for the database directory to ensure performance. In this case, users can only log in to the database and view table names.
- When the query permission on a database is added to or deleted from a role, the query permission on tables in the database is automatically added to or deleted from the role. This mechanism is inherited from Hive.
- In HetuEngine, the name of a column of the **struct** type data cannot contain special characters, that is, characters other than letters, digits, and underscores (_). If the column name of the struct data type contains special characters, the column cannot be displayed on the FusionInsight Manager console when you grant permissions to roles on the **Role** page.

Procedure

Step 1 Log in to FusionInsight Manager.

Step 2 Choose **System** > **Permission** > **Role**.

Step 3 Click **Create Role**, and set **Role Name** and **Description**.

Step 4 In the **Configure Resource Permission** area, choose *Name of the desired cluster* > **Hive** and set role permissions. For details, see **Table 9-4**.

- **Hive Admin Privilege**: Hive administrator permission.
- **Hive Read Write Privileges**: Hive data table management permission, which is the operation permission to set and manage the data of created tables.

NOTE

- Hive role management supports the administrator permission, and the permissions of accessing tables and views, without granting the database permission.
- The permissions of the Hive administrator do not include the permission to manage HDFS.
- If there are too many tables in the database or too many files in tables, the permission granting may last a while. For example, if a table contains 10,000 files, the permission granting lasts about 2 minutes.

Table 9-4 Configuring a role

Scenario	Role Authorization
Setting the permission to query a table of another user in the default database	1. In the **View Name** area, click **Hive Read Write Privileges**. 2. Click the name of the specified database in the database list. Tables in the database are displayed. 3. In the **Rights** column of the specified table, choose **Select**.

Scenario	Role Authorization
Setting the permission to import data to a table of another user in the default database	1. In the **View Name** area, click **Hive Read Write Privileges**. 2. Click the name of the specified database in the database list. Tables in the database are displayed. 3. In the **Permission** column of the specified indexes, select **Delete** and **Insert**.

Step 5 Click **OK**. Return to the **Role** page.

NOTE

After the role is created, you can create a HetuEngine user and assign related role permissions to the user by referring to **Creating a HetuEngine User**.

----End

Table 9-5 describes the permission requirements when SQL statements are processed in HetuEngine.

Table 9-5 Using HetuEngine tables, columns, or data

Scenario	Required Permission
DESCRIBE TABLE	Select
ANALYZE TABLE	Select and Insert
SHOW COLUMNS	Select
SHOW TABLE STATUS	Select
SHOW TABLE PROPERTIES	Select
SELECT	Select
EXPLAIN	Select
CREATE VIEW	Select, Grant Of Select, and Create
CREATE TABLE	Create
ALTER TABLE ADD PARTITION	Insert
INSERT	Insert
INSERT OVERWRITE	Insert and Delete
ALTER TABLE DROP PARTITION	The table-level Alter and Delete, and column-level Select permissions need to be granted.
ALTER DATABASE	Hive Admin Privilege

9.2.4 Proxy User Authentication

You can use Ranger to authenticate a specified proxy user in HetuEngine for FusionInsight Manager user authentication. When you use the HetuEngine client, you can set **--session-user** to specify a proxy user.

For details about how to create an authentication user or proxy user, see **Creating a HetuEngine User**.

You need to enable Ranger authentication and grant the proxy user the permissions to manage the databases, tables, and columns of the data source. For details, see **Adding a Ranger Access Permission Policy for HetuEngine**.

- Kerberos authentication is enabled for the cluster (the cluster is in security mode)
  a. Use **kinit** to specify a user to be authenticated, for example, **hetuadmin1**. (The user must be a HetuEngine administrator and added to the **supergroup** user group to authenticate other users.)

     kinit hetuadmin1

     Enter the password as prompted and change the password upon your first login.
  b. Use **--session-user** to specify a proxy user, for example, **user1**.

     hetu-cli --session-user user1
- Kerberos authentication is disabled for the cluster (the cluster is in normal mode)

  Use **--user** to specify a user to be authenticated, for example, **user** (must belong to the **hetuuser** user group). Use **--session-user** to specify a proxy user, for example, **user1**.

  hetu-cli --user user --session-user user1

NOTE

This function is not suitable when both HiveMetastore data source authentication and multi-user mapping are enabled.

9.3 Creating a HetuEngine User

Scenarios

Before using the HetuEngine service in a security cluster, a cluster administrator needs to create a user and grant operation permissions to the user to meet service requirements.

HetuEngine users are classified into administrators and common users. The default HetuEngine administrator group is **hetuadmin**, and the user group of HetuEngine common users is **hetuuser**.

- Users associated with the **hetuadmin** user group can obtain the O&M administrator permissions on the HetuEngine HSConsole web UI and HetuEngine compute instance web UI.
- Users associated with the **hetuuser** user group can obtain the SQL execution permission. They also have permissions to access the HSConsole web UI, view

information about clusters of associated tenants and basic information about all data sources, access the web UI of compute instances, and query and maintain SQL statements of the current user.

If Ranger authentication is enabled and you need to configure the permissions to manage databases, tables, and columns of data sources for a user after it is created, see **Adding a Ranger Access Permission Policy for HetuEngine**.

Prerequisites

Before you use the HetuEngine service, ensure that the tenant to be associated with the HetuEngine user has been planned and created.

Procedure

Creating a HetuEngine administrator

Step 1 Log in to FusionInsight Manager.

Step 2 Choose **System** > **Permission** > **User** > **Create**.

Step 3 Enter a username, for example, **hetu_admin**.

Step 4 Set **User Type** to **Human-machine**.

Step 5 Set **New Password** and **Confirm Password**.

Step 6 In the **User Group** area, click **Add** to add the **hive**, **hetuadmin**, **hadoop**, **hetuuser**, and **yarnviewgroup** user groups for the user.

Step 7 In the **Primary Group** drop-down list, select **hive** as the primary group.

Step 8 In the **Role** area, click **Add** to assign the **default**, **System_administrator**, and desired tenant role permissions to the user.

Step 9 Click **OK**.

----End

Creating a common HetuEngine user

Step 1 Log in to FusionInsight Manager.

Step 2 Choose **System** > **Permission** > **User** > **Create**.

Step 3 Enter a username, for example, **hetu_test**.

Step 4 Set **User Type** to **Human-machine**.

Step 5 Set **New Password** and **Confirm Password**.

Step 6 In the **User Group** area, click **Add** to add the **hetuuser** user group for the user.

NOTE

- Ranger authentication is enabled for the HetuEngine service in the MRS cluster by default. HetuEngine common users only need to be associated with the **hetuuser** user group. If Ranger authentication is disabled, you must associate the user with the **hive** user group and set it as the primary group. Otherwise, the HetuEngine service may be unavailable.
- If Ranger authentication is enabled and you need to configure the permissions to manage databases, tables, and columns of data sources for a user after it is created, see **Adding a Ranger Access Permission Policy for HetuEngine**.

Step 7 In the **Role** area, click **Add** to assign the **default** or desired tenant role permissions to the user.

Step 8 Click **OK**.

----End

9.4 Creating a HetuEngine Compute Instance

Scenario

This section describes how to create a HetuEngine compute instance. If you want to stop the cluster where compute instances are successfully created, you need to manually stop the compute instances first. If you want to use the compute instances after the cluster is restarted, you need to manually start them.

A single tenant can create multiple compute instances to balance loads, improving performance and fault tolerance.

Prerequisites

- You have created a user for accessing the HetuEngine web UI, for example, **hetu_user**. For details, see **Creating a HetuEngine User**.
- You have created a tenant in the cluster to be operated. Ensure that the tenant has sufficient memory and CPUs when modifying the HetuEngine compute instance configuration.

  NOTE

  - You must use a leaf tenant when you create a HetuEngine compute instance because YARN jobs can only be submitted to the queues of a leaf tenant.
  - To avoid uncertainties caused by resource competition, you are advised to create independent resource pools for tenants used by HetuEngine.

- The startup of HetuEngine compute instances depends on Python 3. Ensure that Python 3 has been installed on all nodes in the cluster and the Python soft link has been added to the **/usr/bin/** directory. For details, see **How Do I Do If an Error Is Reported Indicating that Python Does Not Exist When a Compute Instance Fails to Start?**.
- The HetuEngine service is running properly.

Procedure

Step 1 Log in to FusionInsight Manager as user **hetu_user** and choose **Cluster** > **Services** > **HetuEngine**.

Step 2 In the **Basic Information** area on the **Dashboard** page, click the link next to **HSConsole WebUI**. The HSConsole page is displayed.

Step 3 Click **Compute Instance** then **Create Configuration** and configure the compute instance parameters.

1. Set parameters in the **Basic Configuration** area. For details about the parameters, see **Table 9-6**.

   Table 9-6 Basic configuration

Parameter	Description	Example Value
Tenant	Tenant to which the instance belongs. Only tenants without compute instances can be selected for new compute instances.	Select a value from the **Tenant** drop-down list.
Instance Deployment Timeout Period (s)	Timeout interval for starting a compute instance by Yarn service deployment. The system starts timing when the compute instance is started. If the compute instance is still in the **Creating** or **Starting** state after the time specified by this parameter expires, the compute instance status is displayed as **Error** and the compute instance that is being created or started on Yarn is stopped.	300 The value ranges from 1 to 2147483647.
Instance Count	The number of compute instances created under the current tenant.	1 Value range: 1 to 50

2. Set parameters in the **Coordinator Container Resource Configuration** area. For details about the parameters, see **Table 9-7**.

   Table 9-7 Parameters for configuring Coordinator container resources

Parameter	Description	Example Value
Container Memory (MB)	Memory size (MB) allocated by Yarn to a single container of the compute instance Coordinator	Default value: 5120 The value ranges from 1 to 2147483647.

Parameter	Description	Example Value
vcore	Number of vCPUs (vCores) allocated by Yarn to a single container of the compute instance Coordinator	Default value: 1 The value ranges from 1 to 2147483647.
Quantity	Number of containers allocated by Yarn to the compute instance Coordinator	Default value: 2 The value ranges from 1 to 3.
JVM	Log in to FusionInsight Manager and choose **Cluster** > **Services** > **HetuEngine** > **Configurations**. On the **All Configurations** tab page, search for **extraJavaOptions**. The value of this parameter in the **coordinator.jvm.config** parameter file is the value of the JVM parameter.	-

3. Set parameters in the **Worker Container Resource Configuration** area. For details about the parameters, see **Table 9-8**.

Table 9-8 Parameters for configuring Worker container resources

Parameter	Description	Example Value
Container Memory (MB)	Memory size (MB) allocated by Yarn to a single container of the compute instance Worker	Default value: 10240 The value ranges from 1 to 2147483647.
vcore	Number of vCPUs (vCores) allocated by Yarn to a single container of the compute instance Worker	Default value: 1 The value ranges from 1 to 2147483647.
Quantity	Number of containers allocated by Yarn to the compute instance Worker	Default value: 2 The value ranges from 1 to 256.
JVM	Log in to FusionInsight Manager and choose **Cluster** > **Services** > **HetuEngine** > **Configurations**. On the **All Configurations** tab page, search for **extraJavaOptions**. The value of this parameter in the **worker.jvm.config** parameter file is the value of the JVM parameter.	-

4. Set parameters in the **Advanced Configuration** area. For details about the parameters, see **Table 9-9**.

   Table 9-9 Advanced configuration parameters

Parameter	Description	Example Value
Ratio of Query Memory	This parameter indicates the ratio of the node query memory to the JVM memory and is set to 0.7 by default. When it is set to 0, the compute function is disabled. In this case, you can start the compute instance only if the value of -Xmx in the JVM configuration is no less than the sum of memory.heap-headroom-per-node and query.max-memory-per-node configured for the coordinator or worker.	0.7
Scaling	If auto scaling is enabled, you can increase or decrease the number of workers without restarting the instance. However, the instance performance may deteriorate. In multi-instance mode, automatic scaling cannot be enabled. For details about the parameters for enabling dynamic scaling, see **Configuring the Number of Worker Nodes**.	-
Maintenance Instance	To enable automatic refresh for materialized views, there must be one compute instance that is set as the maintenance instance and the compute instance is globally unique. If there are multiple compute instances, only one compute instance can be used as the maintenance instance.	-

5. Configure **Custom Configuration** parameters. You can add custom parameters to a specified parameter file. Select the specified parameter file from the **Parameter File** drop-down list.
   - You can click **Add** to add custom configuration parameters.
   - You can click **Delete** to delete custom configuration parameters.
   - You can set **Parameter File** to **resource-groups.json** to configure the resource group mechanism. **Table 9-10** describe the resource group configuration parameter. For details about how to configure a resource group, see **Configuring Resource Groups**.

Table 9-10 Resource group configuration parameter

Parameter	Description	Example Value

resourcegroups	Resource management group configuration of the cluster. Select **resource-groups.json** from the drop-down list of the parameter file.	{
		"rootGroups": [{
		"name": "global",
		"softMemoryLimit": "100%",
		"hardConcurrencyLimit": 1000,
		"maxQueued": 10000,
		"killPolicy": "no_kill"
		}],
		"selectors": [{
		"group": "global"
		}]
		}

NOTE

- After a custom parameter is configured in the **coordinator.config.properties**, **worker.config.properties**, **log.properties**, and **resource-groups.json** parameter files, if the parameter already exists in another specified parameter file, the value of this custom parameter will replace the values of this parameter in the specified parameter file. If the custom parameter does not exist in another specified parameter file, the custom parameter is added to the specified parameter file.
- **killPolicy**: After a query is submitted to worker, if the total memory usage exceeds **softMemoryLimit**, you can select one of the following policies to terminate running queries:
  - **no_kill** (default value): Do not terminate the queries.
  - **recent_queries**: Terminate the queries based on the execution sequence in descending order.
  - **oldest_queries**: Terminate the queries based on the execution sequence.
  - **finish_percentage_queries**: Terminate the queries based on query execution percentage. The query with the smallest percentage of execution will be terminated first.
  - **high_memory_queries**: Terminate the queries based on memory usage. Queries with high memory usage are terminated first to free up more memory with the minimum number of query terminations. If the memory usage of two queries is less than 10%, the query with slower progress (smaller execution percentage) is terminated. If the difference between the execution percentages of two queries is less than 5%, the query with larger memory usage is terminated.

6. Determine whether to start the instance immediately after the configuration is complete.
   - If yes, the instance is automatically restarted immediately after the configuration is complete.
   - If no, you need to manually start the instance after the configuration is complete.

Step 4 Click **OK** and wait until the instance configuration is complete.

----End

Precautions for Maintaining Compute Instances

- During the restart or rolling restart of the HetuEngine service, do not create, start, stop, or delete HetuEngine compute instances on HSConsole.
- By default, a maximum of 10 compute instances can be in the starting, creating, deleting, stopping, scaling out, scaling in, or rolling restart state at the same time. O&M tasks that exceed 10 will wait to be executed in the background. To change the number of concurrent tasks, log in to FusionInsight Manager, choose **HetuEngine** and click the **Configurations** tab and then **All Configurations**. On the displayed page, search for **hsbroker.event.task.executor.threads** and change its value.
- Precautions for restarting HetuEngine compute instances
  - During the restart or rolling restart of HetuEngine compute instances, do not perform any change operations on the data sources on the HetuEngine and HetuEngine web UI, including restarting HetuEngine and changing its configurations.
  - If a compute instance has only one coordinator or worker node, do not perform a rolling restart of the instance.
  - If the number of worker nodes is greater than 10, the rolling restart of the instance may take more than 200 minutes. During this period, do not perform other O&M operations.
  - During the rolling restart of compute instances, HetuEngine releases YARN resources and applies for them again. Ensure that the CPU and memory of YARN are sufficient for starting 20% workers and YARN resources are not preempted by other jobs. Otherwise, the rolling restart will fail.

    Viewing YARN resources: Log in to FusionInsight Manager and choose **Tenant Resources**. On the navigation pane on the left, choose **Tenant Resources Management** to view the available queue resources of YARN in the **Resource Quota** area.

    Viewing the CPU and memory of a worker container: Log in to FusionInsight Manager as a user who can access the HetuEngine WebUI and choose **Cluster** > **Services** > **HetuEngine**. In the **Basic Information** area, click the link next to **HSConsole WebUI** to go to the HSConsole page. Click **Operation** in the row where the target instance is located and click **Configure**.
  - During the rolling restart, ensure that Application Manager of coordinators or workers in the YARN queue runs stably.
- HetuEngine compute instance restart exception handling
  - If Application Manager of coordinators or workers in the YARN queues is restarted during the rolling restart, the compute instances may be abnormal. In this case, you need to stop the compute instances and then start the compute instance for recovery.
  - After the rolling restart of a compute instance fails, the instance is in the subhealthy state. As a result, the configuration or number of coordinator or worker nodes may become incosistent. In this case, the subhealthy state of the compute instance cannot be automatically recovered. You need to manually check and rectify the fault, perform the rolling restart again, or stop and then restart the compute instance.

Compute Instance Statuses

After a compute instance is created, you can view information about the created instance on the **Compute Instance** tab page, including the tenant name, number of instances, instance status, and total resources. Instance statuses are as follows:

Figure 9-1 Compute instance statuses

- Green icon: The instance is in the running or subhealthy state.
- Red icon: The instance is faulty.
- Gray icon: The instance has been stopped and is to be started.
- Blue icon: The instance is in other states, including scaling out, scaling in, rolling restart, creating, starting, safely starting, shutting down, safely shutting down, terminating, terminated, and stopping.

9.5 Managing HetuEngine Compute Instances

9.5.1 Configuring Resource Groups

Resource Group Introduction

The resource group mechanism controls the overall query load of the instance from the perspective of resource allocation and implements queuing policies for queries. Multiple resource groups can be created under a compute instance resource, and each submitted query is assigned to a specific resource group for execution. Before a resource group executes a new query, it checks whether the resource load of the current resource group exceeds the amount of resources allocated to it by the instance. If it is exceeded, new incoming queries are blocked, placed in a queue, or even rejected directly.

Application Scenarios of Resource Groups

Resource groups are used to manage resources in compute instances. Different resource groups are allocated to different users and queries to isolate resources. This prevents a single user or query from exclusively occupying resources in the compute instance. In addition, the weight and priority of resource components can be configured to ensure that important tasks are executed first. **Table 9-11** describes the typical application scenarios of resource groups.

Table 9-11 Typical application scenarios of resource groups

Typical Scenarios	Solution
As the number of business teams using the compute instance increases, there is no resource when a team's task becomes more important and does not want to execute a query.	Allocate a specified resource group to each team. Important tasks are assigned to resource groups with more resources. When the sum of the proportions of sub-resource groups is less than or equal to 100%, the resources of a queue cannot be preempted by other resource groups. This is similar to static resource allocation.
When the instance resource load is high, two users submit a query at the same time. At the beginning, both queries are queuing. When there are idle resources, the query of a specific user can be scheduled to obtain resources first.	Two users are allocated with different resource groups. Important tasks can be allocated to resource groups with higher weights or priorities. The scheduling policy is configured by schedulingPolicy. Different scheduling policies have different resource allocation sequences.
For ad hoc queries and batch queries, resources can be allocated more properly based on different SQL types.	You can match different resource groups for different query types, such as EXPLAIN, INSERT, SELECT, and DATA_DEFINITION, and allocate different resources to execute the query.

Enabling a Resource Group

When creating a compute instance, add custom configuration parameters to the **resource-groups.json** file. For details, see **Step 3.5** in **Creating a HetuEngine Compute Instance**.

Resource Group Properties

For details about how to configure resource group attributes, see **Table 9-12**.

Table 9-12 Resource group properties

Configuration Item	Mandatory	Description
name	Yes	Resource group name
maxQueued	Yes	Maximum number of queued queries. When this threshold is reached, new queries will be rejected.

Configuration Item	Mandatory	Description
hardConcurrencyLimit	Yes	Maximum number of running queries.
softMemoryLimit	No	Maximum memory usage of a resource group. When the memory usage reaches this threshold, new tasks are queued. The value can be a fixed value (for example, 10 GB) or a percentage (for example, 10% of the cluster memory).
softCpuLimit	No	The CPU time that can be used in a period (see the **cpuQuotaPeriod** parameter in **Global Attributes**). You must also specify the **hardCpuLimit** parameter. When the threshold is reached, the CPU resources occupied by the query that occupies the maximum CPU resources in the resource group are reduced.
hardCpuLimit	No	Maximum CPU time that can be used in a period.
schedulingPolicy	No	The scheduling policy for a specific query from the queuing state to the running state • fair (default) When multiple sub-resource groups in a resource group have queuing queries, the sub-resource groups obtain resources in turn based on the defined sequence. The query of the same sub-resource group obtains resources based on the first-come-first-executed rule. • weighted_fair The **schedulingWeight** attribute is configured for each resource group that uses this policy. Each sub-resource group calculates a ratio: *Number of queried sub-resource groups*/Scheduling weight. A sub-resource group with a smaller ratio obtains resources first. • weighted The default value is **1**. A larger value of **schedulingWeight** indicates that resources are obtained earlier. • query_priority All sub-resource groups must be set with **query_priority**. Resources are obtained in the sequence specified by **query_priority**.
schedulingWeight	No	Weight of the group. For details, see **schedulingPolicy**. The default value is **1**.
jmxExport	No	If this parameter is set to **true**, group statistics are exported to the JMX for monitoring. The default value is **false**.

Configuration Item	Mandatory	Description
subGroups	No	Subgroup list
killPolicy	No	After a query is submitted to worker, if the total memory usage exceeds **softMemoryLimit**, you can select one of the following policies to terminate running queries: • **no_kill** (default value): Do not terminate the queries. • **recent_queries**: Terminate the queries based on the execution sequence in descending order. • **oldest_queries**: Terminate the queries based on the execution sequence. • **finish_percentage_queries**: Terminate the queries based on query execution percentage. The query with the smallest percentage of execution will be terminated first. **high_memory_queries**: Terminate the queries based on memory usage. Queries with high memory usage are terminated first to free up more memory with the minimum number of query terminations. If the memory usage of two queries is less than 10%, the query with slower progress (smaller execution percentage) is terminated. If the difference between the execution percentages of two queries is less than 5%, the query with larger memory usage is terminated.

Selector Rules

The selector matches resource groups in sequence. The first matched resource group is used. Generally, you are advised to configure a default resource group. If no default resource group is configured and other resource group selector conditions are not met, the query will be rejected. For details about how to set selector rule parameters, see **Table 9-13**.

Table 9-13 Selector rules

Configuration Item	Mandatory	Description
user	No	Regular expression for matching the user name.
source	No	Request source of the match. For details, see the value of **--source** in **Configuration of Selector Attributes**.

Configuration Item	Mandatory	Description
queryType	No	Task types: • **DATA_DEFINITION**: indicates that you can modify, create, or delete the metadata of schemas, tables, and views, and manage the query of prepared statements, permissions, sessions, and transactions. • **DELETE**: indicates the DELETE queries. • **DESCRIBE**: indicates the DESCRIBE, DESCRIBE INPUT, DESCRIBE OUTPUT, and SHOW queries. • **EXPLAIN**: indicates the EXPLAIN queries. • **INSERT**: indicates the INSERT and CREATE TABLE AS queries. • **SELECT**: indicates the SELECT queries.
clientTags	No	Match client tag to be matched with. Each tag must be in the tag list of the task submitted by the user. For details, see the value of **--client-tags** in **Configuration of Selector Attributes**.
group	Yes	The resource group with running queries

Global Attributes

For details about how to configure global attributes, see **Table 9-14**.

Table 9-14 Global attributes

Configuration Item	Mandatory	Description
cpuQuotaPeriod	No	Time range during which the CPU quota takes effect. This parameter is used together with **softCpuLimit** and **hardCpuLimit** in **Resource Group Properties**.

Configuration of Selector Attributes

The data source name (**source**) can be set as follows:

- **CLI**: Use the **--source** option.
- **JDBC**: Set the ApplicationName client information property on the Connection instance.

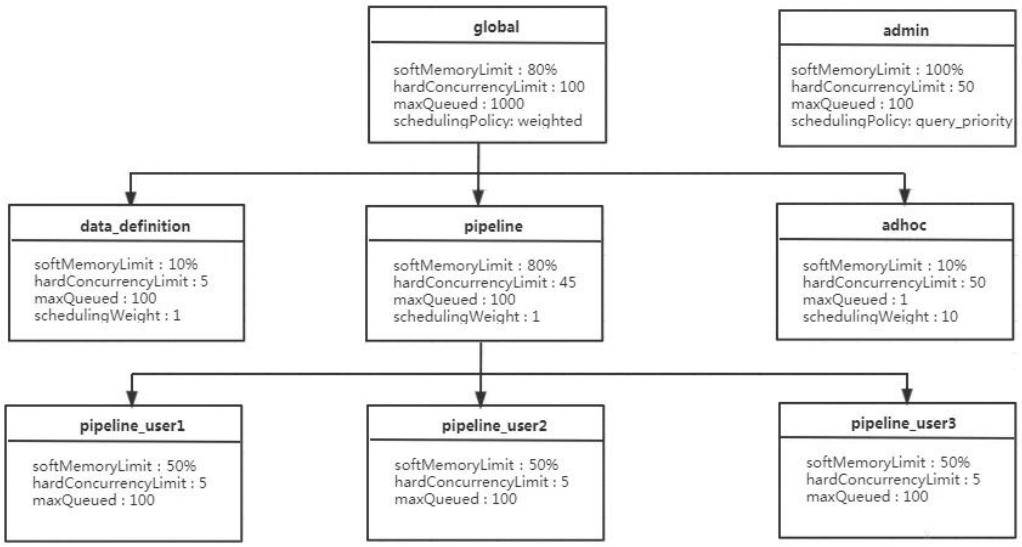
The client tag (**clientTags**) can be configured as follows:

- **CLI**: Use the **--client-tags** option.

- **JDBC**: Set the **ClientTags client info** property on the Connection instance.

Configuration Example

Figure 9-2 Configuration example



As shown in **Figure 9-2**.

- For the **global** resource group, a maximum of 100 queries can be executed at the same time. 1000 queries are in the queuing state. The **global** resource group has three sub-resource groups: **data_definition**, **adhoc**, and **pipeline**.
- Each user in the **pipeline** resource group can run a maximum of five queries at the same time, which occupy 50% of the memory resources of the pipeline resource group. By default, the **fair** scheduling policy is used in the **pipeline** resource group. Therefore, the query is executed in the sequence of "first come, first served".
- To make full use of instance resources, the total memory quota of all child resource groups can be greater than that of the parent resource group. For example, the sum of the memory quota of the **global** resource group (80%) and that of the **admin** resource group (100%) is 180%, which is greater than 100%.

In the following example configuration, there are multiple resource groups, some of which are templates. HetuEngine administrators can use templates to dynamically build a resource group tree. For example, in the **pipeline**_*${USER}* group, *${USER}* is the name of the user who submits a query. *${SOURCE}* is also supported, which will be the source where a query is submitted later. You can also use custom variables in **source** expressions and **user** regular expressions.

The following is an example of a resource group selector:

```
"selectors": [{
   "user": "bob",
   "group": "admin"
},
{
   "source": ".*pipeline.*",
   "queryType": "DATA_DEFINITION",
```

```
    "group": "global.data_definition"
},
{
    "source": ".*pipeline.*",
    "group": "global.pipeline.pipeline_${USER}"
},
{
    "source": "jdbc#(?<toolname>.*)",
    "clientTags": ["hipri"],
    "group": "global.adhoc.bi-${toolname}.${USER}"
},
{
    "group": "global.adhoc.other.${USER}"
}]
```

There are four selectors that define which resource group to run the query:

- The first selector matches queries from **bob** and places them in the **admin** group.
- The second selector matches all data definition language (DDL) queries from the source name that includes the **pipeline** and places them in the **global.data_definition** group. This helps reduce the queuing time of such queries.
- The third selector matches queries from sources that include the **pipeline** and places them in a single-user pipe group that is dynamically created under the **global.pipeline** group.
- The fourth selector matches queries from BI tools whose source matches the regular expression **jdbc#(?.*)**, and the tags provided by the client are the superset of **hi-pri**. These queries are placed in subgroups dynamically created under the **global.adhoc** group. Dynamic subgroups are created based on the naming variable **toolname** that is extracted from the regular expression of the source. Assume that there is a query whose source is **jdbc#powerfulbi**, user is **kayla**, and client labels are **hipri** and **fast**. This query will be routed to the **global.adhoc.bi-powerfulbi.kayla** resource group.
- The last selector is a default selector that puts all the unmatched queries into the resource group.

These selectors work together to implement the following policies:

- HetuEngine administrator **bob** can run 50 queries concurrently. Queries are run in a sequence of priority in descending order.
- For the remaining users:
  - The total number of concurrent queries cannot exceed 100.
  - You can use the source pipeline to run a maximum of five concurrent DDL queries. The query is performed in the FIFO sequence.
  - Non-DDL queries are executed in the **global.pipeline** group. The total number of concurrent queries is 45, and each user can run 5 queries concurrently. The query is performed in the FIFO sequence.
  - Each BI tool can run a maximum of 10 concurrent queries, and each user can run a maximum of three concurrent queries. If the total number of concurrent queries exceeds 10, the user who runs the least queries gets the next concurrency slot. This policy makes it fairer to compete for resources.
  - All the remaining queries are placed in each of the user groups under **global.adhoc.other**.

The description of the query match selector is as follows:

- Each pair of braces represents a selector that matches the resource group. Five selectors are configured to match the five resource groups.

```
admin
global.data_definition
global.pipeline.pipeline_${USER}
global.adhoc.bi-${toolname}.${USER}
global.adhoc.other.${USER}
```

- Only when all the conditions of the selector are met, the task can be put into the current queue for execution. For example, if user **amy** submits a query request in JDBC mode and **clientTags** is not configured, the query request cannot be allocated to the resource group **global.adhoc.bi-${toolname}.${USER}**.
- When a query meets the conditions of two selectors at the same time, the first selector that meets the requirements is matched. For example, if the **bob** user submits a DATA_DEFINITION job whose source is **pipeline**, only the resource corresponding to the resource group **admin** is matched, not the resource corresponding to **global.data_definition**.
- If none of the four selectors is matched, resources in the resource group **global.adhoc.other.${USER}** specified by the last selector are used. This resource group functions as a default resource group. If the default resource group is not set and does not meet the conditions of other resource group selectors, the resource group will be rejected.

  The following is a complete example:

```
{
  "rootGroups": [{
    "name": "global",
    "softMemoryLimit": "80%",
    "hardConcurrencyLimit": 100,
    "maxQueued": 1000,
    "schedulingPolicy": "weighted",
    "jmxExport": true,
    "subGroups": [{
      "name": "data_definition",
      "softMemoryLimit": "10%",
      "hardConcurrencyLimit": 5,
      "maxQueued": 100,
      "schedulingWeight": 1
    },
    {
      "name": "adhoc",
      "softMemoryLimit": "10%",
      "hardConcurrencyLimit": 50,
      "maxQueued": 1,
      "schedulingWeight": 10,
      "subGroups": [{
        "name": "other",
        "softMemoryLimit": "10%",
        "hardConcurrencyLimit": 2,
        "maxQueued": 1,
        "schedulingWeight": 10,
        "schedulingPolicy": "weighted_fair",
        "subGroups": [{
          "name": "${USER}",
          "softMemoryLimit": "10%",
          "hardConcurrencyLimit": 1,
          "maxQueued": 100
        }]
      },
      {
        "name": "bi-${toolname}",
```

```
            "softMemoryLimit": "10%",
            "hardConcurrencyLimit": 10,
            "maxQueued": 100,
            "schedulingWeight": 10,
            "schedulingPolicy": "weighted_fair",
            "subGroups": [{
                "name": "${USER}",
                "softMemoryLimit": "10%",
                "hardConcurrencyLimit": 3,
                "maxQueued": 10
            }]
        }]
    },
    {
        "name": "pipeline",
        "softMemoryLimit": "80%",
        "hardConcurrencyLimit": 45,
        "maxQueued": 100,
        "schedulingWeight": 1,
        "jmxExport": true,
        "subGroups": [{
            "name": "pipeline_${USER}",
            "softMemoryLimit": "50%",
            "hardConcurrencyLimit": 5,
            "maxQueued": 100
        }]
    }]
},
{
    "name": "admin",
    "softMemoryLimit": "100%",
    "hardConcurrencyLimit": 50,
    "maxQueued": 100,
    "schedulingPolicy": "query_priority",
    "jmxExport": true
}],
"selectors": [{
    "user": "bob",
    "group": "admin"
},
{
    "source": ".*pipeline.*",
    "queryType": "DATA_DEFINITION",
    "group": "global.data_definition"
},
{
    "source": ".*pipeline.*",
    "group": "global.pipeline.pipeline_${USER}"
},
{
    "source": "jdbc#(?<toolname>.*)",
    "clientTags": ["hipri"],
    "group": "global.adhoc.bi-${toolname}.${USER}"
},
{
    "group": "global.adhoc.other.${USER}"
}],
"cpuQuotaPeriod": "1h"
}
```

9.5.2 Configuring the Number of Worker Nodes

Scenario

On the HetuEngine web UI, you can adjust the number of worker nodes for a compute instance so that worker nodes can be added when they are insufficient

and reduced when they are idle. The number of worker nodes can be adjusted manually or automatically.

Prerequisites

You have created a user for accessing the HetuEngine web UI. For details, see **Creating a HetuEngine User**.

NOTE

- When an instance is being scaled in or out, the original services are not affected and the instance can still be used.
- Dynamic instance scale-in/out is delayed to implement smooth adjustment of resource consumption within a long period of time. It cannot respond to the requirements of running SQL tasks for available resources in real time.
- After instances are dynamically scaled in or out, the number of worker nodes displayed in the instance configuration area on the HSConsole page remains the initial value and does not change with dynamic scaling.
- The dynamic instance scale in/out function will be affected if the HSBroker and Yarn services are restarted after the function is enabled. Disable the function before you restart the services.
- Before scaling out a compute instance, ensure that the current queue has sufficient resources. Otherwise, the scale-out cannot reach the expected result and subsequent scale-in operations will be affected.
- You can set the timeout period for manual instance scale in/out. For this, log in to Manager, choose **HetuEngine** > **Configurations** > **All Configurations**, search for **application.customized.properties**, and add the **yarn.hetuserver.engine.flex.timeout.sec** parameter. The default value is **300** (in seconds).

Procedure

Step 1 Log in to FusionInsight Manager as a user who can access the HetuEngine web UI and choose **Cluster** > **Services** > **HetuEngine**. The **HetuEngine** service page is displayed.

Step 2 In the **Basic Information** area on the **Dashboard** tab page, click the link next to **HSConsole WebUI**. The HSConsole page is displayed.

Step 3 In the **Compute Instance** page, locate the row that contains the tenant to which the target instance belongs and click **Configure** in the **Operation** column.

- If manual scaling is required, change the value of **Quantity** in the **Worker Container Resource Configuration** area on the configuration page and click **OK**. The compute instance status changes to **SCALING OUT** or **SCALING IN**. After the scaling is complete, the compute instance status changes to **RUNNING**.
- If automatic scaling is required, set **Scaling** in **Advanced Configuration** to **Yes** and configure the following parameters according to **Table 9-15** to enable dynamic scaling.

  NOTE

  Compute instances in the **Running** state are scaled in or out based on the configured auto scaling parameters. For compute instances in other states, only the configuration is saved, and the saved configuration takes effect when the compute instances are restarted.

Table 9-15 Dynamic scaling parameters

Parameter	Description	Example Value
Load Collection Period	The interval for collecting instance load information, in seconds.	10
Scale-out Threshold	When the average value of the instance resource usage in the scale-in/out decision-making period exceeds the threshold, the instance starts to scale out.	0.9
Scale-out Size	The number of worker nodes to be added each time when the instance starts to scale out.	1
Scale-out Decision Period	The interval for determining whether to scale out an instance, in seconds.	200
Scale-out Timeout Period	The timeout period of the scale-out operation, in seconds.	400
Scale-in Threshold	When the average value of the instance resource usage in the scale-in/out decision-making period exceeds the threshold, the instance starts to scale in.	0.1
Scale-in Size	The number of worker nodes to be reduced each time when the instance starts to scale in.	1
Scale-in Decision Period	The interval for determining whether to scale in an instance, in seconds.	300
Scale-in Timeout Period	The timeout period of the scale-in operation, in seconds.	600

Step 4 After the configuration, click **OK**.

----End

9.5.3 Configuring a HetuEngine Maintenance Instance

Scenario

A maintenance instance is a special compute instance that performs automatic tasks. Maintenance instances are used to automatically refresh, create, and delete materialized views.

In a cluster, only one compute instance can be set as a maintenance instance, and the maintenance instance can also carry original computing services at the same

time. If a tenant has multiple compute instances, only one compute instance can be used as the maintenance instance.

Prerequisites

- You have created a user for accessing the HetuEngine web UI. For details, see **Creating a HetuEngine User**.
- The compute instance to be configured must be in the stopped state.

Procedure

Step 1 Log in to FusionInsight Manager as a user who can access the HetuEngine web UI.

Step 2 Choose **Cluster** > **Services** > **HetuEngine** to go its service page.

Step 3 In the **Basic Information** area on the **Dashboard** page, click the link next to **HSConsole WebUI**. The HSConsole page is displayed.

Step 4 In the **Compute Instance** page, locate the row that contains the tenant to which the target instance belongs and click **Configure** in the **Operation** column.

Step 5 Check whether **Maintenance Instance** in **Advanced Configuration** is set to **Yes**. If not, change the value to **Yes**.

Step 6 Set **Start Now** to **Yes** and click **OK**.

----End

9.5.4 Configuring the Nodes on Which Coordinator Is Running

By default, coordinator and worker nodes randomly start on Yarn NodeManager nodes, and you have to open all ports on all NodeManager nodes. Using resource labels of Yarn, HetuEngine allows you to specify NodeManager nodes to run coordinators.

Prerequisites

You have created a user for accessing the HetuEngine web UI. For details, see **Creating a HetuEngine User**.

Procedure

Step 1 Log in to FusionInsight Manager as a user who can access the HetuEngine web UI.

Step 2 Set Yarn parameters to specify the scheduler to handle PlacementConstraints.

1. Choose **Cluster** > **Services** > **Yarn**. Click the **Configurations** tab and then **All Configurations**. On the displayed page, search for **yarn.resourcemanager.placement-constraints.handler**, set **Value** to **scheduler**, and click **Save**.
2. Click the **Instance** tab, select the active and standby ResourceManager instances, click **More**, and select **Restart Instance** to restart the ResourceManager instances of Yarn. Then wait until they are restarted successfully.

Step 3 Configure resource labels.

1. Choose **Tenant Resources** > **Resource Pool**. On the displayed page, click **Add Resource Pool**.
2. Select a cluster, and enter a resource pool name and a resource label name, for example, **pool1**. Select the desired hosts, click >> to add the selected hosts to the new resource pool, and click **OK**.

Step 4 Set HetuEngine parameters to enable the coordinator placement policy and enter the node resource label.

1. Choose **Cluster** > **Service** > HetuEngine. Click the **Configurations** tab and then **All Configurations**. On the displayed page, set parameters and click **Save**.

   Table 9-16 Setting HetuEngine parameters

Parameter	Setting
yarn.hetuserver.engine.coordinator.placement.enabled	true
yarn.hetuserver.engine.coordinator.placement.label	Node resource label created in **Step 3**, for example, **pool1**

2. Click **Dashboard**, click **More**, and select **Restart Service**. Wait until the HetuEngine service is restarted successfully.

Step 5 Restart the HetuEngine compute instance.

1. In the **Basic Information** area on the **Dashboard** page, click the link next to **HSConsole WebUI**. The HSConsole page is displayed.
2. Stop the running compute instance and click **Start** in the **Operation** column to start the HetuEngine compute instance.

Step 6 Check the node on which the coordinator is running.

1. Return to FusionInsight Manager.
2. Choose **Cluster** > **Services** > **Yarn**. In the **Basic Information** area on the **Dashboard** page, click the link next to **ResourceManager WebUI**.
3. In the navigation pane on the left, choose **Cluster** > **Nodes**. You can view that the coordinator has been started on the node in the resource pool created in **Step 3**.

----End

9.5.5 Importing and Exporting Compute Instance Configurations

Scenarios

On the HetuEngine web UI, you can import or export the instance configuration file and download the instance configuration template.

Prerequisites

You have created a user for accessing the HetuEngine web UI. For details, see **Creating a HetuEngine User**.

Procedure

Step 1 Log in to FusionInsight Manager as a user who can access the HetuEngine web UI and choose **Cluster** > **Services** > **HetuEngine**. The **HetuEngine** service page is displayed.

Step 2 In the **Basic Information** area on the **Dashboard** tab page, click the link next to **HSConsole WebUI**. The HSConsole page is displayed.

Step 3 Click **Compute Instance**.

- Importing an instance configuration file: Click **Import**, select an instance configuration file in JSON format from the local PC, and click **Open**.

  NOTICE

  The import and export functions save only the configuration of compute instances. The instance ID, name, start time, end time, and status are not saved. After the import is complete, the information is generated again.

- Exporting an instance configuration file: Select the instances to be exported and click **Export** to export the current instance configuration file to the local PC.

----End

9.5.6 Viewing the Instance Monitoring Page

Scenarios

On the HetuEngine web UI, you can view the detailed information about a specified service, including the execution status of each SQL statement.

Prerequisites

You have created an administrator for accessing the HetuEngine web UI. For details, see **Creating a HetuEngine User**.

Procedure

Step 1 Log in to FusionInsight Manager as an administrator who can access the HetuEngine web UI and choose **Cluster** > *Name of the desired cluster* > **Services** > **HetuEngine**. The **HetuEngine** service page is displayed.

Step 2 In the **Basic Information** area on the **Dashboard** tab page, click the link next to **HSConsole WebUI**. The HSConsole page is displayed.

Step 3 Click **Compute Instance** then the tenant name corresponding to the instance to which operations are to be performed.

Step 4 Click **LINK** in the **WebUI** column to access the compute instance task monitoring page. If you access the CLUSTER OVERVIEW page for the first time, you can view information on the compute instance task monitoring page.

Table 9-17 Metric description

Metric	Description
Running Queries	Indicates the number of tasks concurrently executed on the current instance.
Active Workers	Indicates the number of valid worker nodes on the current instance.
ROWS/SEC	Indicates the number of data rows processed by the current instance per second.
Queued Queries	Indicates the number of tasks to be executed in the waiting queue on the current instance.
RUNNABLE DRIVERS	Indicates the number of running drivers on the current instance.
BYTES/SEC	Indicates the amount of data read from the current instance per second.
Blocked Queries	Indicates the number of blocked tasks on the current instance.
RESERVED MEMORY (B)	Indicates the memory occupied by running tasks on the current instance.
WORKER PARALLEISM	Indicates the average CPU time slice used by each worker on the current instance per second.
Avg CPU cycles per worker	Indicates the average CPU cycles of each worker node of the current instance.

Step 5 Filter query tasks by **State** on the **QUERY DETAILS** page.

Table 9-18 State description

State	Description
Running	Views running tasks.
Queued	Views the tasks to be executed in the waiting queue.
Finished	Views the finished tasks.
Failed	Views failed tasks, which can be filtered by failure cause.

Step 6 Click a task ID to view the basic information, resource usage, stages, and tasks. For a failed task, you can view related logs on the detail query page.

Figure 9-3 Viewing task details

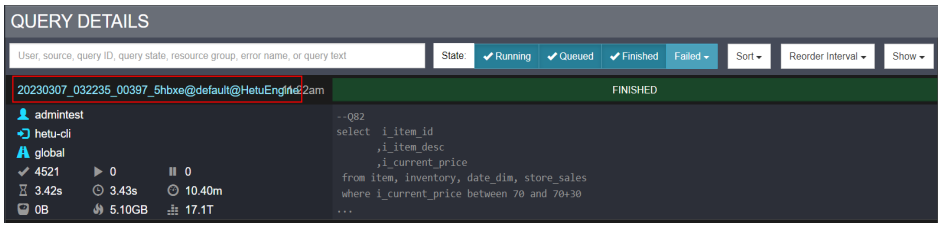


Figure 9-4 Task resource utilization summary

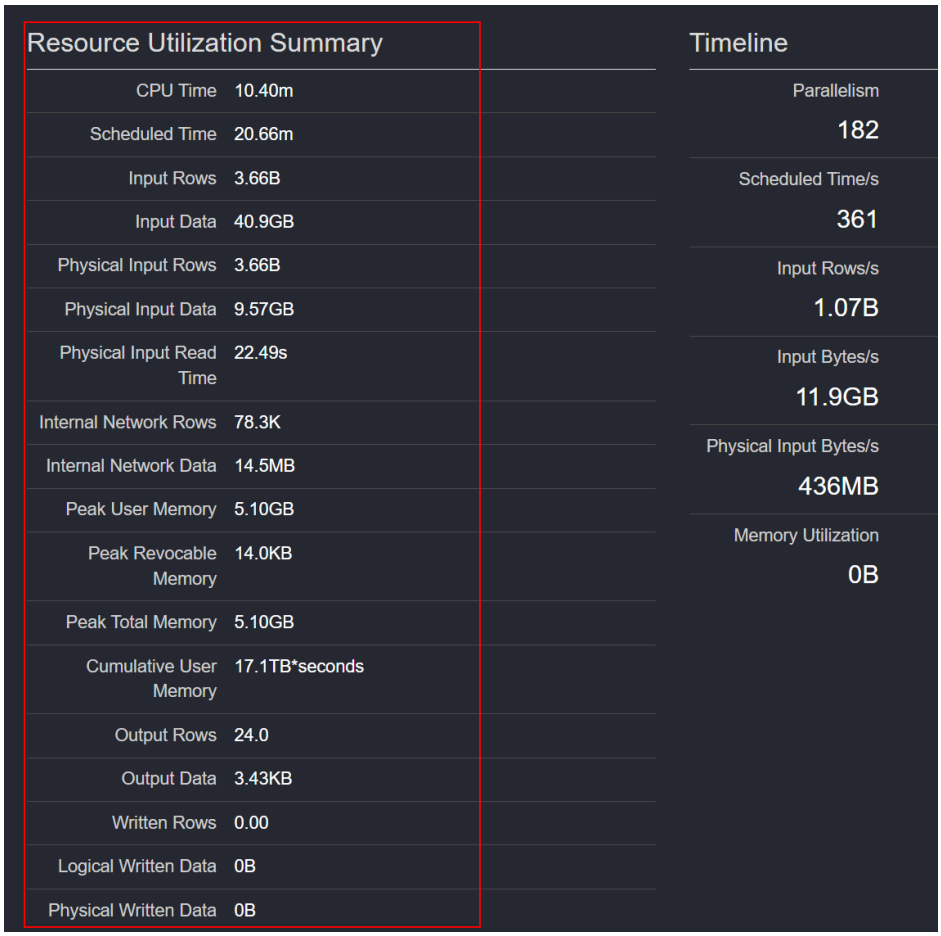


Figure 9-5 Stages

Table 9-19 Stages monitoring information

Monitoring Item	Description
SCHEDULED TIME SKEW	Indicates the scheduled time of the concurrent tasks on a node in the current stage.
CPU TIME SKEW	Indicates whether concurrent tasks have computing skew in any stage phase.

Figure 9-6 Tasks (Clicking the triangle on the right of each stage to view the tasks)

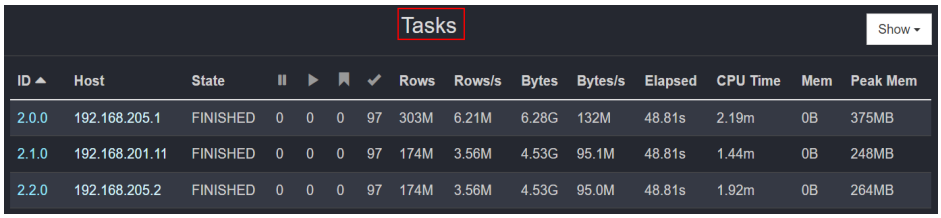


Table 9-20 Tasks monitoring items

Monitoring Item	Description
ID	Indicates the ID of the task that is concurrently executed in multiple phases. The format is *Stage ID*:*Task ID*.
Host	Indicates the Worker node where the current task is being executed.
State	Indicates the task execution status, including **PLANNED**, **RUNNING**, **FINISHED**, **CANCELED**, **ABORTED**, and **FAILED**.

Monitoring Item	Description
Rows	Indicates the total number of data records read by a task. The unit is thousand (k) or million (M). By analyzing the number of data records read by different tasks in the same stage, you can quickly determine whether data skew occurs in the current task.
Rows/s	Indicates the number of data records read by a task per second. By analyzing the number of data records read by different tasks in the same stage, you can quickly determine whether the network bandwidth of the node is different and whether the node NIC is faulty.
Bytes	Indicates the data volume read by a task.
Bytes/s	Indicates the data volume read by a task per second.
Elapsed	Indicates the task execution duration.
CPU Time	Indicates the CPU time used by a task.
Mem	Task memory
Peak Mem	Peak memory usage of tasks

Step 7 Click the "Host" link to view the task resource usage of each node.

Figure 9-7 Resource usage of the Task node

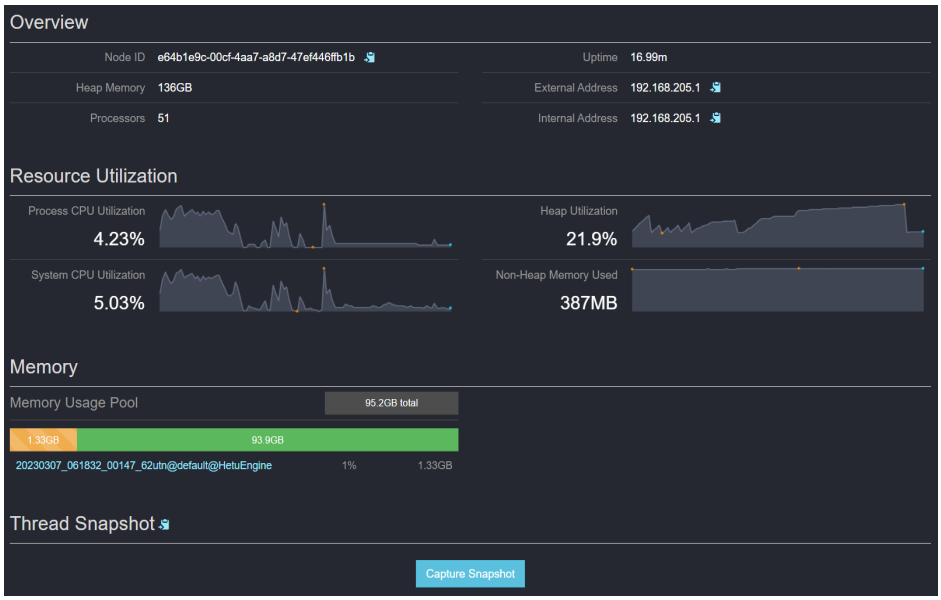


Table 9-21 Monitoring metrics of node resources

Name	Description
Node ID	Indicates the host ID.
Heap Memory	Indicates the maximum heap memory size.
Processors	Indicates the number of processors.
Uptime	Indicates the running duration.
External Address	Indicates the external IP address.
Internal Address	Indicates the internal IP address.
Process CPU Utilization	Indicates the physical CPU utilization.
System CPU Utilization	Indicates the system CPU utilization.
Heap Utilization	Indicates the heap memory utilization.
Non-Heap Memory Used	Indicates the non-Heap memory size.
Memory Usage Pool	Indicates the memory pool size of the current Worker node.

----End

9.5.7 Viewing Coordinator and Worker Logs

Scenario

On the HetuEngine web UI, you can click the LogUI link to go to the YARN web UI and view Coordinator and Worker logs.

Prerequisites

You have created a user for accessing the HetuEngine web UI. For details, see **Creating a HetuEngine User**.

Procedure

Step 1 Log in to FusionInsight Manager as a user who can access the HetuEngine web UI and choose **Cluster** > **Services** > **HetuEngine**. The **HetuEngine** service page is displayed.

Step 2 In the **Basic Information** area on the **Dashboard** page, click the link next to **HSConsole WebUI**. The HSConsole page is displayed.

Step 3 Click **Compute Instance** and select the compute instance on which operations are to be performed under the corresponding tenant. Click **Coordinator** or **Worker** in the **LogUI** column to view coordinator or worker logs on the YARN web UI.

----End

9.5.8 Configuring Query Fault Tolerance Execution

Scenario

When a node in the cluster is faulty due to network, hardware, or software problems, all query tasks running on the node are lost. This seriously affects cluster productivity and wastes resources, especially for queries running for a long time. HetuEngine provides a fault recovery mechanism, that is, the fault tolerance execution capability. The cluster can reduce the probability of query failure by automatically re-running affected queries or their component tasks. This reduces manual intervention and improves fault tolerance, but prolongs the total execution time.

Currently, the following fault tolerance execution mechanisms are supported:

- Query-level retry policy: If query-level fault tolerance is enabled, intermediate data will not be flushed to disks. If a query job fails, all tasks of the query job will be automatically retried. This policy is recommended when most of the cluster's workloads are small queries.
- Task-level retry policy: If task-level fault tolerance is enabled, HDFS is configured as the swap area by default to flush exchange intermediate data to disks. If a query job fails, the failed tasks are retried. You are advised to use this policy when performing a large number of queries. In this way, the cluster can efficiently retry small-granularity tasks in the query instead of the entire query.

This example describes how to set the fault tolerance execution mechanism of the task-level retry policy.

Notes

- Fault tolerance does not apply to corrupted queries or other user error scenarios. For example, resources are not spent retrying query tasks that fail because SQL statements cannot be parsed.
- Different data sources have different fault tolerance capabilities for SQL statements.
  - All data sources support fault-tolerant execution of **read operations**.
  - Hive data sources are fault-tolerant of write operations.
- This tolerance function is good for large-scale queries. If you run a large number of short small queries on a fault-tolerant cluster at the same time, a latency may occur. Therefore, it is recommended that you use dedicated fault-tolerant compute instances when processing batch operations, which are isolated from compute instances with higher query volume for interactive queries.

Procedure

Step 1 Log in to FusionInsight Manager as a user who can access the HetuEngine web UI and choose **Cluster** > **Services** > **HetuEngine**. The **HetuEngine** service page is displayed.

Step 2 In the **Basic Information** area on the **Dashboard** tab page, click the link next to **HSConsole WebUI**. The HSConsole page is displayed.

Step 3 On the **Compute Instance** tab, locate the row containing the tenant to which the desired instance belongs and click **Configure** in the **Operation** column.

Step 4 In the **Custom Configuration** area, click **Add** to add the following parameters:

Table 9-22 Fault tolerance execution parameters

Parameter	Example Value	Configuration File	Description
retry-policy	TASK	• coordinator.config.properties • worker.config.properties	• Retry policy for fault tolerance execution. • Value range: **QUERY** and **TASK**
task-retry-attempts-per-task	4	• coordinator.config.properties • worker.config.properties	• Maximum number of attempts to retry a single task before a query failure is declared when task fault tolerance is enabled. • Default value: **4**
query-retry-attempts	4	• coordinator.config.properties • worker.config.properties	• Maximum number of attempts to retry a single query before a query failure is declared when query fault tolerance is enabled. • Default value: **4**
fault-tolerant-execution-task-memory	5GB	• coordinator.config.properties • worker.config.properties	• This parameter is available when **retry-policy** is set to **TASK**. If this parameter is not set, the default value **5** GB is used. The node allocates tasks based on the available memory and estimated memory usage. • This parameter is used to estimate the memory required for initial task allocation. A larger value indicates that each task uses more memory but the cluster concurrency capability decreases. You can dynamically adjust the value based on service requirements.

Step 5 Set **Start Now** to **Yes** and click **OK**.

NOTICE

- After task-level fault tolerance is enabled, intermediate data is generated and cached in the file system. A large number of concurrent queries cause great disk pressure on the file system. By default, HetuEngine can buffer intermediate data to the temporary directory in HDFS. When OBS is connected in the scenario where storage and compute are decoupled, task-level fault tolerance is supported, but intermediate data is still flushed to the disk of the HDFS temporary directory.
- By default, the cluster clears buffer files when the query is complete, and checks and clears residual buffer files that have expired for one day every hour. You can perform the following operations to disable the periodic clearing function:

  Log in to FusionInsight Manager, choose **Cluster** > **Services** > **HetuEngine**, click **Configurations** then **All Configurations**, click **HSBroker(Role)**, select **Fault-tolerance execution**, set **fte.exchange.clean.task.enabled** to **false**, and save the configuration. Click **Instance**, select all HSBroker instances, click **More**, select **Restart Instance**, and restart the instances as prompted for the configuration to take effect.

----End

9.6 Using the HetuEngine Client

Scenario

If a compute instance is not created or started, you can log in to the HetuEngine client to create or start the compute instance. This section describes how to manage a compute instance on the client in the O&M or service scenario.

HetuEngine provides service-level default resource queue configuration items. If no tenant information is specified, the default Yarn tenant is used. Multiple users may use the same queue by default.

If you need to isolate resources and properly allocate SQL statements to specified queues, you can enable strict tenant verification by setting **tenant.strict.mode.enabled** to **true** and use the **--tenant** parameter to specify the queues when you use the client.

NOTE

- Method to enable strict tenant verification:

  Log in to Manager, choose **Cluster** > **Services** > **HetuEngine**, click **Configuration** and then **All Configurations**, search for **tenant.strict.mode.enabled**, set it to **true**, and save the settings. Click **Instance**, select all instances whose configurations expired, click **More**, select **Restart Instance**, and restart the instances as prompted for the configurations to take effect.
- If strict tenant verification is enabled and cross-domain functions of HetuEngine are used, you need to set the **hsfabric.local.tenant** parameter of the HetuEngine data source. For details, see **Configuring a HetuEngine Data Source**.

Prerequisites

- The cluster client has been installed in a directory, for example, **/opt/client**.
- You have created a common HetuEngine user, for example, **hetu_test** who has the permissions of the Hive (with Ranger disabled), **hetuuser**, and **default** queues.

  For details about how to create a user, see **Creating a HetuEngine User**.

Procedure

Step 1 Log in to the node where the HetuEngine client resides as the user who installs the client, and switch to the client installation directory.

cd /opt/client

Step 2 Run the following command to configure environment variables:

source bigdata_env

Step 3 Log in to the HetuEngine client based on the cluster authentication mode.

- In security mode, run the following command to complete user authentication and log in to the HetuEngine client:

  kinit hetu_test

  hetu-cli --catalog hive --tenant default --schema default

- In normal mode, run the following command to log in to the HetuEngine client:

  hetu-cli --catalog hive --tenant default --schema default --user hetu_test

  NOTE

  hetu_test is a service user who has at least the tenant role specified by **--tenant** and cannot be an OS user.

Parameter description:

- **--catalog:** (Optional) Specifies the name of the specified data source.
- **--tenant**: Specifies the tenant resource queue started by the cluster. Do not specify the default queue. To use this parameter, the service user must have the role permission of the tenant.
  - This parameter is optional if strict verification is disabled.
  - This parameter is mandatory if strict verification is enabled.
- **--schema**: (Optional) Specifies the name of the schema of the data source to be accessed.
- **--user**: (Mandatory in normal mode) Specifies the name of the user who logs in to the client to execute services. The user must have at least the role of the queue specified by **--tenant**.

NOTE

- It takes about 120 seconds for your first login to the client because the HetuEngine cluster needs to be started in the background.
- You can run the **hetu-cli --help** command to view other parameters.

----End

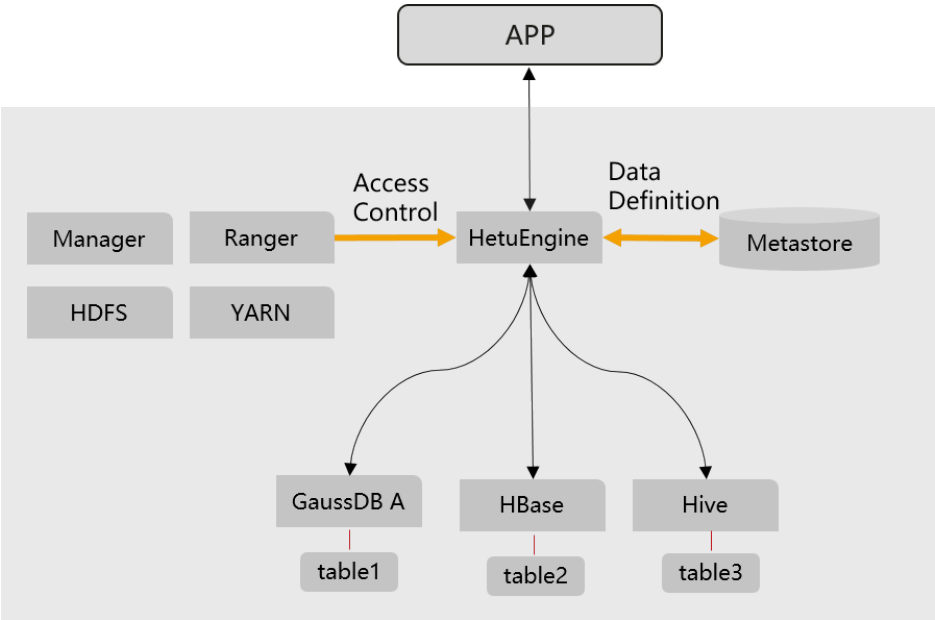
9.7 Using the HetuEngine Cross-Source Function

Using the HetuEngine Cross-Source Function

Enterprises usually store massive data, such as from various databases and warehouses, for management and information collection. However, diversified data sources, hybrid dataset structures, and scattered data storage rise the development cost for cross-source query and prolong the cross-source query duration.

HetuEngine provides unified standard SQL statements to implement cross-source collaborative analysis, simplifying cross-source analysis operations.

Figure 9-8 HetuEngine cross-source function



Key Technologies and Advantages

- Compute pushdown: When HetuEngine is used for cross-source collaborative analysis, HetuEngine enhances the compute pushdown capability from the dimensions listed in the following table to improve access efficiency.
  - Basic pushdown: predicate, projection, subquery, and limit
  - Aggregate pushdown: GROUP BY, ORDER BY, COUNT, SUM, MIN, and MAX
  - Operator pushdown: <, >, LIKE, and OR.
- Multi-source heterogeneous data: Collaborative analysis supports both structured data sources such as Hive, GaussDB, and ClickHouse, and unstructured data sources such as HBase and Elasticsearch.
- Global metadata: A mapping table is provided to map unstructured schemas to structured schemas, enabling HetuEngine to access HBase using SQL statements. Global management for data source information is provided.

- Global permission control: Data source permissions can be opened to Ranger through HetuEngine for centralized management and control.

Usage Guide of Cross-Source Function

HetuEngine supports quick joint query of multiple data sources and GUI-based data source configuration and management. You can quickly add the following data sources on the HSConsole page by referring to **Before You Start**:

- **Configuring a Hive Data Source**
- **Configuring a Hudi Data Source**
- **Configuring a ClickHouse Data Source**
- **Configuring an Elasticsearch Data Source**
- **Configuring a GaussDB Data Source**
- **Configuring an HBase Data Source**
- **Configuring a HetuEngine Data Source**
- **Configuring an IoTDB Data Source**
- **Configuring a MySQL Data Source**

Process of Using Cross-Source Collaborative Analysis

1. Log in to the HetuEngine client by referring to **Using the HetuEngine Client**.
2. Register data sources such as Hive, HBase, and GaussDB A.

```
hetuengine> show catalogs;
  Catalog
----------
dws
hive
hive_dg
hbase
system
systemremote
(6 rows)
```

3. Compile SQL statements for cross-source collaborative analysis.

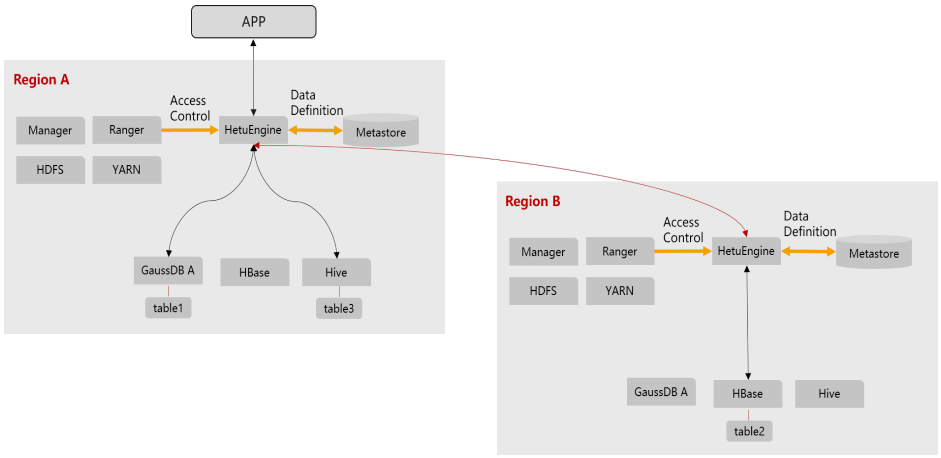
```
select * from hive_dg.schema1.table1 t1 join hbase.schema3.table3 t2 join dws.schema02.table4 t3 on t1.name = t2.item and t2.id = t3.cardNo;
```

9.8 Using the HetuEngine Cross-Domain Function

Using the HetuEngine Cross-Domain Function

HetuEngine provide unified standard SQL to implement efficient access to multiple data sources distributed in multiple regions (or data centers), shields data differences in the structure, storage, and region, and decouples data and applications.

Figure 9-9 HetuEngine cross-region functions



Key Technologies and Advantages

- No single-point failure bottleneck: HSFabric supports horizontal scale-out and multi-channel parallel transmission, maximizing the transmission rate. Cross-domain latency is no longer a bottleneck.
- Better computing resource utilization: Data compression and serialization tasks are delivered to Worker for parallel computing.
- Efficient serialization: The data serialization format is optimized to reduce the amount of data to be transmitted at the same data volume level.
- Streaming transmission: Based on HTTP 2.0 stream, ensure the universality of the HTTP protocol and reduce the repeated invoking of RPC during the transmission of a large amount of data.
- Resumable transmission: A large amount of data is prevented from being retransmitted after the connection is interrupted abnormally during data transmission.
- Traffic control: The network bandwidth occupied by data transmission can be limited by region to prevent other services from being affected due to exclusive traffic occupation in cross-region limited bandwidth scenarios.

HetuEngine Cross-Domain Function Usage

Prerequisites:

- At least one HSFabric instance has been deployed on the data nodes of the local and remote clusters.
- The nodes where the HSFabric instances of the local and remote clusters have been deployed can communicate with each other.

Procedure

Step 1 Open the data source in the local domain. You can create a virtual schema to shield the real schema information and instance information of the physical data source in the local domain from remote access requests. The remote end can use the virtual schema name to access the data source in the local domain.

```
CREATE VIRTUAL SCHEMA hive01.vschema01 WITH (
  catalog = 'hive01',
  schema = 'ins1'
);
```

Step 2 Register the data source of the HetuEngine type on the remote HetuEngine and add the local domain HetuEngine by referring to **Configuring a HetuEngine Data Source**.

Step 3 Use cross-domain collaborative analysis.

```
// 1. Open the hive1.ins2 data source on the remote HetuEngine.
CREATE VIRTUAL SCHEMA hive1.vins2 WITH (
  catalog = 'hive1',
  schema = 'ins2'
);

// 2. Register three types of data sources, including Hive, GaussDB A, and HetuEngine, on HetuEngine in the local domain.
hetuengine> show catalogs;
  Catalog
----------
dws
hetuengine_dc
hive
hive_dg
system
systemremote
(6 rows)

// 3. Perform cross-source collaborative analysis on HetuEngine in the local domain.
select * from hive_dg.schema1.table1 t1 join hetuengine_dc.vins2.table3 t2 join dws.schema02.table4 t3 on t1.name = t2.item and t2.id = t3.cardNo;
```

----End

9.9 Configuring Data Sources

9.9.1 Before You Start

HetuEngine supports quick joint query of multiple data sources and GUI-based data source configuration and management. You can quickly add a data source on the HSConsole page.

Table 9-23 lists the data sources supported by HetuEngine of the current version.

Table 9-23 List for connecting HetuEngine to data sources

HetuEngine Mode	Data Source	Data Source Mode	Supported Data Source Version
Security mode	Hive	Security mode	MRS 3.x and FusionInsight 6.5.1
	HBase		MRS 3.x
	Elasticsearch		MRS 3.1.2 and later
	HetuEngine		MRS 3.1.1 and later
	Hudi		MRS 3.1.2 and later
	ClickHouse		MRS 3.1.1 and later
	IoTDB		MRS 3.2.0 and later

HetuEngine Mode	Data Source	Data Source Mode	Supported Data Source Version
	GaussDB		GaussDB 200 and GaussDB A 8.0.0 and later
	MySQL		MySQL 5.7, MySQL 8.0, and later
Normal mode	Hive	Normal mode	MRS 3.x and FusionInsight 6.5.1
	HBase		MRS 3.x
	Elasticsearch		MRS 3.1.2 and later
	Hudi		MRS 3.1.2 and later
	ClickHouse		MRS 3.1.1 and later
	IoTDB		MRS 3.2.0 and later
	MySQL	Security mode	MySQL 5.7, MySQL 8.0 and later
	GaussDB		GaussDB 200 and GaussDB A 8.0.0 or later

Operations such as adding, configuring, and deleting a HetuEngine data source takes effect dynamically without restarting the cluster.

A configured data source takes effect dynamically and you cannot disable this function. By default, the interval for a data source to dynamically take effect is 60 seconds. You can change the interval to a desired one by changing the value of **catalog.scanner-interval** in **coordinator.config.properties** and **worker.config.properties** by referring to **Step 3.5** in **Creating a HetuEngine Compute Instance**. See the following example.

```
catalog.scanner-interval =120s
```

HetuEngine supports query pushdown. It can push down queries or partial queries to connected data sources. This means that special predicates, aggregate functions, or other operations can be passed to the underlying database or file system for processing. Query pushdown brings the following benefits:

1. Improves the overall query performance.
2. Reduces the network traffic between HetuEngine and data sources.
3. Reduces the load of remote data sources.

Whether HetuEngine supports query pushdown depends on specific connectors and the underlying data sources or storage systems related to the connectors.

NOTE

- The data source cluster and the HetuEngine cluster must use different domain names. Two data sources (Hive, HBase, and Hudi) with the same domain name cannot be connected to HetuEngine at the same time.
- Nodes in the data source cluster and the HetuEngine cluster can communicate with each other on the service plane.

9.9.2 Configuring a Hive Data Source

9.9.2.1 Configuring a Co-deployed Hive Data Source

Scenario

Add a Hive data source that is in the same Hadoop cluster as HetuEngine on HSConsole.

- Currently, HetuEngine supports data sources of the following data formats: AVRO, TEXT, RCTEXT, ORC, Parquet, and SequenceFile.
- When HetuEngine interconnects with Hive, you cannot specify multiple delimiters during table creation. However, if the MultiDelimitSerDe class is specified as the serialization class for a Hive data source to create a multi-delimiter table in text format, you can query the table using HetuEngine.
- The Hive data source interconnected with HetuEngine supports Hudi table redirection. Hudi table access requests are redirected to the Hudi connector, so the advanced functions of the Hudi connector are available. To use this function, you need to configure the target Hudi data source, ensure that the Metastore URL of the Hudi data source is the same as that of the current Hive data source, and enable Hudi redirection for the Hive data source.

NOTE

During HetuEngine installation, the co-deployed Hive data source is interconnected by default. The data source name is **hive** and cannot be deleted. Some default configurations, such as the data source name, data source type, server principal, and client principal, cannot be modified. When the environment configuration changes, for example, the local domain name of the cluster is changed, restarting the HetuEngine service can automatically synchronize the configurations of the co-deployed Hive data source, such as server principal and client principal.

Prerequisites

- A HetuEngine compute instance has been created.
- To use the isolation function of Hive Metastore, you need to configure **HIVE_METASTORE_URI_HETU** on Hive and restart the Hsbroke instance of the HetuEngine service to update the Hive Metastore URI.

Procedure

Step 1 Log in to FusionInsight Manager as a HetuEngine administrator and choose **Cluster** > **Services** > **HetuEngine**.

Step 2 In the **Basic Information** area on the **Dashboard** page, click the link next to **HSConsole WebUI**.

Step 3 On HSConsole, choose **Data Source**. Locate the row that contains the target Hive data source, click **Edit** in the **Operation** column, and modify the configurations. The following table describes data source configurations that can be modified.

Parameter	Description	Example Value
Enable Data Source Authentication	Whether to use the permission policy of the Hive data source for authentication. After this function is enabled, HetuEngine uses SQL standard-based Hive authorization. ● Clusters with Kerberos authentication disabled (in normal mode): HetuEngine uses the default Hive authorization. This parameter is unavailable. ● Clusters with Kerberos authentication enabled (in security mode): When Ranger is enabled, HetuEngine additionally uses Ranger authentication in addition to the default Hive authorization. If this function is enabled, Ranger authentication is added on the basis of SQL standard-based Hive authorization. When Ranger is disabled, HetuEngine uses only SQL standard-based Hive authorization.	No
Hudi Redirection	This parameter is available only when the Metastore URL of the target Hudi data source is the same as that of the current Hive data source. This function redirects Hudi table access request to the Hudi connector, so the advanced functions of the Hudi connector can be used.	No
Hudi Data Source	This parameter is required for Hudi redirection. All configured Hudi data sources are displayed in the drop-down list box. Select only the Hudi data source that has the same Metastore URL.	-
Enable Connection Pool	Whether to enable the connection pool when accessing Hive MetaStore. The default value is **Yes**	Yes
Maximum Connections	Maximum number of connections in the connection pool when accessing Hive MetaStore.	50 (Value range: 20–200)

Step 4 (Optional) If you need to add **Custom Configuration**, complete the configurations by referring to **Step 6.7** and click **OK** to save the configurations.

----End

Data Type Mapping

Currently, Hive data sources support the following data types: BOOLEAN, TINYINT, SMALLINT, INT, BIGINT, REAL, DOUBLE, DECIMAL, NUMERIC, DEC, VARCHAR, VARCHAR (X), CHAR, CHAR (X), STRING, DATE, TIMESTAMP, TIME WITH TIMEZONE, TIMESTAMP WITH TIME ZONE, TIME, ARRAY, MAP, STRUCT, and ROW.

Performance Optimization

- Metadata caching

  Hive connectors support metadata caching to provide metadata requests for various operations faster. For details, see **Adjusting Metadata Cache**.

- Dynamic filtering

  Enabling dynamic filtering helps optimize the calculation of the Join operator of Hive connectors. For details, see **Enabling Dynamic Filtering**.

- Query with partition conditions

  Creating a partitioned table and querying data with partition filter criteria help filter out some partition data, improving performance.

- INSERT statement optimization

  You can improve insert performance by setting **task.writer-count** to **1** and choosing a larger value for **hive.max-partitions-per-writers**. For details, see **Optimizing INSERT Statements**.

Constraints

- The DELETE syntax can be used to delete data from an entire table or a specified partition in a partitioned table.
- The Hive metabase does not support schema renaming, that is, the ALTER SCHEMA RENAME syntax is not supported.

9.9.2.2 Configuring an Independently Deployed Hive Data Source

Scenario

Add a Hive data source outside a cluster on HSConsole.

- Currently, HetuEngine supports data sources of the following traditional data formats: AVRO, TEXT, RCTEXT, ORC, Parquet, and SequenceFile.
- When HetuEngine interconnects with Hive, you cannot specify multiple delimiters during table creation. However, if the MultiDelimitSerDe class is specified as the serialization class for a Hive data source to create a multi-delimiter table in text format, you can query the table using HetuEngine.
- The Hive data source interconnected with HetuEngine supports Hudi table redirection. Hudi table access requests are redirected to the Hudi connector, so the advanced functions of the Hudi connector are available. To use this function, you need to configure the target Hudi data source, ensure that the

Metastore URL of the Hudi data source is the same as that of the current Hive data source, and enable Hudi redirection for the Hive data source.

Prerequisites

- The domain name of the cluster where the data source is located must be different from the HetuEngine cluster domain name.
- The cluster where the data source is located and the HetuEngine cluster nodes can communicate with each other.
- In the **/etc/hosts** file of all nodes in the cluster where HetuEngine is located, add the mapping between the host names and IP addresses of the cluster where the data source to be connected is located, and add **10.10.10.10 hadoop.***System domain name* in the **/etc/hosts** file (for example, **10.10.10.10 hadoop.hadoop.com**). Otherwise, HetuEngine cannot connect to the nodes that are not in the cluster based on the host name.
- A HetuEngine compute instance has been created.

Procedure

Step 1 Obtain the **hdfs-site.xml** and **core-site.xml** configuration files of the Hive data source cluster.

1. Log in to FusionInsight Manager of the cluster where the Hive data source is located.
2. In the upper right corner of the homepage, click **Download Client** to download the complete client to the local PC as prompted.
3. Decompress the downloaded client file package and obtain the **core-site.xml** and **hdfs-site.xml** files in the **FusionInsight_Cluster_1_Services_ClientConfig/HDFS/config** directory.
4. Check whether the **core-site.xml** file contains the **fs.trash.interval** configuration item. If not, add the following configuration items:

   ```
   <property>
   <name>fs.trash.interval</name>
   <value>2880</value>
   </property>
   ```

5. Change the value of **dfs.client.failover.proxy.provider.***NameService name* in the **hdfs-site.xml** file to **org.apache.hadoop.hdfs.server.namenode.ha.ConfiguredFailoverProxyProvider**.

   For example, if the NameService name is **hacluster**, the configuration is as follows:

   ```
   <property>
   <name>dfs.client.failover.proxy.provider.hacluster</name>
   <value>org.apache.hadoop.hdfs.server.namenode.ha.ConfiguredFailoverProxyProvider</value>
   </property>
   ```

NOTICE

If the Hive data source to be interconnected is in the same Hadoop cluster with HetuEngine, you can log in to the HDFS client and run the following commands to obtain the **hdfs-site.xml** and **core-site.xml** configuration files. For details, see **Using the HDFS Client**.

hdfs dfs -get /user/hetuserver/fiber/restcatalog/hive/core-site.xml

hdfs dfs -get /user/hetuserver/fiber/restcatalog/hive/hdfs-site.xml

Step 2 Obtain the **user.keytab** and **krb5.conf** files of the proxy user of the Hive data source.

1. Log in to FusionInsight Manager of the cluster where the Hive data source is located.
2. Choose **System** > **Permission** > **User**.
3. Locate the row that contains the target data source user, click **More** in the **Operation** column, and select **Download Authentication Credential**.
4. Decompress the downloaded package to obtain the **user.keytab** and **krb5.conf** files.

   NOTE

   The proxy user of the Hive data source must be associated with at least the **hive** user group.

Step 3 Obtain the MetaStore URL and the Principal of the server.

1. Decompress the client package of the cluster where the Hive data source is located and obtain the **hive-site.xml** file from the **FusionInsight_Cluster_1_Services_ClientConfig/Hive/config** directory.
2. Open the **hive-site.xml** file and search for **hive.metastore.uris**. The value of **hive.metastore.uris** is the value of MetaStore URL. Search for **hive.server2.authentication.kerberos.principal**. The value of **hive.server2.authentication.kerberos.principal** is the value of Principal on the server.

Step 4 Log in to FusionInsight Manager as a HetuEngine administrator and choose **Cluster** > **Services** > **HetuEngine**. The **HetuEngine** service page is displayed.

Step 5 In the **Basic Information** area on the **Dashboard** page, click the link next to **HSConsole WebUI**. The HSConsole page is displayed.

Step 6 Choose **Data Source** and click **Add Data Source**. Configure parameters on the **Add Data Source** page.

1. In the **Basic Configuration** area, configure **Name** and choose **Hive** for **Data Source Type**.
2. Configure parameters in the **Hive Configuration** area. For details, see **Table 9-24**.

Table 9-24 Hive Configuration

Parameter	Description	Example Value
Driver	The default value is **fi-hive-hadoop**.	fi-hive-hadoop
hdfs-site File	Select the **hdfs-site.xml** configuration file obtained in **Step 1**. The file name is fixed.	-
core-site File	Select the **core-site.xml** configuration file obtained in **Step 1**. The file name is fixed.	-
yarn-site File	Obtain the file from the **Yarn/config** directory on the data source client. Upload this file only when the Hudi data source is connected.	-
krb5 File	Configure this parameter when the security mode is enabled. It is the configuration file used for Kerberos authentication. Select the **krb5.conf** file obtained in **Step 2**.	krb5.conf
Enable Data Source Authentication	Whether to use the permission policy of the Hive data source for authentication. If Ranger is disabled for the HetuEngine service, select **Yes**. If Ranger is enabled, select **No**.	No

3. In the **Metastore Configuration** area, configure the parameters according to **Table 9-25**.

Table 9-25 MetaStore Configuration

Parameter	Description	Example Value
Metastore URL	URL of the MetaStore of the data source. For details, see **Step 3**.	thrift://10.92.8.42:21088,thrift://10.92.8.43:21088,thrift://10.92.8.44:21088
Hudi Redirection	This parameter is available only when the Metastore URL of the target Hudi data source is the same as that of the current Hive data source. This function redirects Hudi table access request to the Hudi connector, so the advanced functions of the Hudi connector can be used.	No

Parameter	Description	Example Value
Hudi Data Source	This parameter is required for Hudi redirection. All configured Hudi data sources are displayed in the drop-down list box. Select only the Hudi data source that has the same Metastore URL.	-
Security Authentication Mechanism	After the security mode is enabled, the default value is **KERBEROS**.	KERBEROS
Server Principal	Configure this parameter when the security mode is enabled. Value of **hive-site.xml** in **hive.server2.authentication.kerberos.principal** on the data source client. It specifies the username with domain name used by meta to access MetaStore. For details, see **Step 3**.	hive/hadoop.hadoop.com@HADOOP.COM
Client Principal	Configure this parameter when the security mode is enabled. The parameter format is as follows: *username for accessing MetaStore*@*domain name (uppercase)*. *Username for accessing MetaStore* is the user to which the **user.keytab** file obtained in **Step 2** belongs. **NOTE** You can log in to FusionInsight Manager, choose **System** > **Permission** > **Domain and Mutual Trust**, and view the value of **Local Domain**, which is the current system domain name, for example, HADOOP.COM.	admintest@HADOOP.COM
Keytab File	Configure this parameter when the security mode is enabled. It specifies the keytab credential file of the MetaStore user name. The file name is fixed. Select the **user.keytab** file obtained in **Step 2**.	user.keytab

4. Configure parameters in the **Connection Pool Configuration** area. For details, see **Table 9-26**.

   Table 9-26 Connection Pool Configuration

Parameter	Description	Example Value
Enable Connection Pool	Whether the connection pool is enabled when Hive MetaStore is accessed.	Yes
Maximum Connections	Maximum number of connections between a single Coordinator and Hive Metastore. Value range: 20 to 200; default value: 50	50

5. Configure parameters in **Hive User Information Configuration**. For details, see **Table 9-27**.

   Hive User Information Configuration and **HetuEngine-Hive User Mapping Configuration** must be used together. When HetuEngine is connected to the Hive data source, user mapping enables HetuEngine users to have the same permissions of the mapped Hive data source user. Multiple HetuEngine users can correspond to one Hive user.

   Table 9-27 Hive User Information Configuration

Parameter	Description
Data Source User	Data source user information If the data source user is set to **hiveuser1**, a HetuEngine user mapped to **hiveuser1** must exist. For example, create **hetuuser1** and map it to **hiveuser1**.
Keytab File	Obtain the authentication credential of the user corresponding to the data source.

6. (Optional) Configure parameters in the **HetuEngine-Hive User Mapping Configuration** area. For details, see **Table 9-28**.

   Table 9-28 HetuEngine-Hive User Mapping Configuration

Parameter	Description
HetuEngine User	HetuEngine user information.
Data Source User	Data source user information, for example, **hiveuser1** (data source user configured in **Table 9-27**)

7. (Optional) Modify custom configurations.
   - You can click **Add** to add custom configuration parameters by referring to **Table 9-29**.

Table 9-29 Custom parameters

Parameter	Description	Example Value
hive.metastore.connection.pool.maxTotal	Maximum number of connections in the connection pool.	50 (The value ranges from 20 to 200.)
hive.metastore.connection.pool.maxIdle	Maximum number of idle threads in the connection pool. When the number of idle threads reaches the maximum number, new threads are not released. Default value: **8**	8 (The value ranges from 0 to 200 and cannot exceed the maximum number of connections.)
hive.metastore.connection.pool.minIdle	Minimum number of idle threads in the connection pool. When the number of idle threads reaches the minimum number, the thread pool does not create new threads. Default value: **0**	0 (The value ranges from 0 to 200 and cannot exceed the value of **hive.metastore.connection.pool.maxIdle**.)
hive.rcfile.time-zone	Adjusts the binary-encoded timestamp value to a specific time zone. When the table storage format is **RCBINARY** or **RCFILE**, the query result of timestamp data inserted by HetuEngine in Hive 3.1.0 or later is 8 hours earlier than that in HetuEngine. In this case, set this parameter to **UTC**. Default value: **JVM default** (obtaining the local time zone from JVM)	UTC
hive.orc.use-column-names	Whether to access ORC storage files by column name. The options are as follows: ■ **true**: yes ■ **false** (default value): no	false

Parameter	Description	Example Value
hive.parquet.use-column-names	Whether to access Parquet storage files by column name. The options are as follows: ■ **true**: yes ■ **false** (default value): no	false
hive.hdfs.wire-encryption.enabled	This parameter needs to be added and set to **false** if the **hadoop.rpc.protection** parameter of the HDFS is set to **authentication** or **integrity**.	false
hive.strict-mode-restrictions	You can configure the following constraints to restrict user query: ■ **NONE**: no constraints ■ **DISALLOW_EXCEEDED_SCAN_ON_PARTITION** (default value): The maximum number of partitions scanned in a single Hive partitioned table cannot be greater than the value of **hive.max-partitions-per-scan**.	DISALLOW_EXCEEDED_SCAN_ON_PARTITION
hive.ignore-absent-partitions	Query whether any file is missing in a partition. Value options are as follows: ■ **true**: Queries whether files are missing in the partition. ■ **false**: Do not query whether files are missing in the partition. In this case, an error is reported. If this parameter is left blank when data sources are manually connected, **false** is used by default.	true

- You can click **Delete** to delete custom configuration parameters.

  NOTE

  - You can prefix **coordinator.** or **worker.** to the custom parameters so that the parameters apply only to coordinator or worker nodes. For example, if you prefix **worker.** to **hive.metastore.connection.pool.maxTotal**, the custom parameter becomes **worker.hive.metastore.connection.pool.maxTotal**. If you set this new parameter to **50**, it indicates that a maximum number of 50 connections are allowed for worker nodes to access Hive MetaStore. If a custom parameter is not prefixed, the custom parameter is available for both coordinator and worker nodes.
  - By default, the maximum number of connections for coordinator nodes to access Hive MetaStore is 50, and the maximum and minimum numbers of idle data source connections are 8 and 0, respectively. The maximum number of connections for worker nodes to access Hive MetaStore is 20, and the maximum and minimum numbers of idle data source connections are both 0.
  - **hive.max-partitions-per-scan**: The maximum number of partitions scanned in a single Hive partitioned table. The default value is **100000**.
  - The default value of **hive.ignore-absent-partitions** of the Hive data source co-deployed during HetuEngine installation is **true**.

8. Click **OK**.

Step 7 Log in to the node where the cluster client is located and run the following commands to switch to the client installation directory and authenticate the user:

cd /opt/client

source bigdata_env

kinit *User performing HetuEngine operations* (If the cluster is in normal mode, skip this step.)

Step 8 Run the following command to log in to the catalog of the data source:

hetu-cli --catalog *Data source name* **--schema** *Database name*

For example, run the following command:

hetu-cli --catalog hive_1 --schema default

Step 9 Run the following command. If the database table information can be viewed or no error is reported, the connection is successful.

show tables;

----End

Data Type Mapping

Currently, Hive data sources support the following data types: BOOLEAN, TINYINT, SMALLINT, INT, BIGINT, REAL, DOUBLE, DECIMAL, NUMERIC, DEC, VARCHAR, VARCHAR (X), CHAR, CHAR (X), STRING, DATE, TIMESTAMP, TIME WITH TIMEZONE, TIMESTAMP WITH TIME ZONE, TIME, ARRAY, MAP, STRUCT, and ROW.

Performance Optimization

- Metadata caching

  Hive connectors support metadata caching to provide metadata requests for various operations faster. For details, see **Adjusting Metadata Cache**.

- Dynamic filtering

  Enabling dynamic filtering helps optimize the calculation of the Join operator of Hive connectors. For details, see **Enabling Dynamic Filtering**.

- Query with partition conditions

  Creating a partitioned table and querying data with partition filter criteria help filter out some partition data, improving performance.

- INSERT statement optimization

  You can improve insert performance by setting **task.writer-count** to **1** and choosing a larger value for **hive.max-partitions-per-writers**. For details, see **Optimizing INSERT Statements**.

Constraints

- The DELETE syntax can be used to delete data from an entire table or a specified partition in a partitioned table.
- The Hive metabase does not support schema renaming, that is, the ALTER SCHEMA RENAME syntax is not supported.

9.9.3 Configuring a Hudi Data Source

Scenario

HetuEngine supports the query of COW/MOR table data. Configure a Hudi data source on HSConsole.

NOTE

HetuEngine cannot read Hudi bootstrap tables.

Prerequisites

- You have created the proxy user of the Hudi data source. The proxy user is a human-machine user and must belong to the **hive** group.
- In the **/etc/hosts** file of all nodes in the cluster where HetuEngine is located, add the mapping between the host names and IP addresses of the cluster where the data source to be connected is located, and add **10.10.10.10 hadoop.***System domain name* in the **/etc/hosts** file (for example, **10.10.10.10 hadoop.hadoop.com**). Otherwise, HetuEngine cannot connect to the nodes that are not in the cluster based on the host name.
- You have created a HetuEngine administrator by referring to **Creating a HetuEngine User**.

Procedure

Step 1 Obtain the **hdfs-site.xml** and **core-site.xml** configuration files of the Hudi data source cluster.

1. Log in to FusionInsight Manager of the cluster where the Hudi data source is.
2. In the upper right corner of the homepage, click **Download Client** to download the complete client to the local PC as prompted.
3. Decompress the downloaded client file package and obtain **core-site.xml** and **hdfs-site.xml** from the **FusionInsight_Cluster_1_Services_ClientConfig/HDFS/config** directory.
4. Check whether the **core-site.xml** file contains the **fs.trash.interval** configuration item. If not, add the following configuration items:

```
<property>
<name>fs.trash.interval</name>
<value>2880</value>
</property>
```

5. Change the value of **dfs.client.failover.proxy.provider.***NameService name* in the **hdfs-site.xml** file to **org.apache.hadoop.hdfs.server.namenode.ha.ConfiguredFailoverProxyProvider**.

   For example, if the NameService name is **hacluster**, the configuration is as follows:

```
<property>
<name>dfs.client.failover.proxy.provider.hacluster</name>
<value>org.apache.hadoop.hdfs.server.namenode.ha.ConfiguredFailoverProxyProvider</value>
</property>
```

NOTICE

If the Hudi data source to be connected and HetuEngine are in the same Hadoop cluster, obtain the **hdfs-site.xml** and **core-site.xml** configuration files from the HDFS client of the cluster. To be specific, log in to the HDFS client by referring to **Using the HDFS Client** and run the following commands:

hdfs dfs -get /user/hetuserver/fiber/restcatalog/hive/core-site.xml

hdfs dfs -get /user/hetuserver/fiber/restcatalog/hive/hdfs-site.xml

Step 2 Obtain the **user.keytab** and **krb5.conf** files of the proxy user of the Hudi data source.

1. Log in to FusionInsight Manager of the cluster where the Hudi data source is.
2. Choose **System** > **Permission** > **User**.
3. Locate the row that contains the target data source user, click **More** in the **Operation** column, and select **Download Authentication Credential**.
4. Decompress the downloaded package to obtain **user.keytab** and **krb5.conf**.

   NOTE

   The proxy user of the Hive data source must be associated with at least the **hive** user group.

Step 3 Obtain the MetaStore URL and the Principal of the server.

1. Decompress the client package of the cluster where the Hudi data source is and obtain the **hive-site.xml** file from the **FusionInsight_Cluster_1_Services_ClientConfig/Hive/config** directory.
2. Open **hive-site.xml** and search for **hive.metastore.uris**. The value of **hive.metastore.uris** is the value of MetaStore URL. Search for

hive.server2.authentication.kerberos.principal. The value of **hive.server2.authentication.kerberos.principal** is the value of Principal on the server.

Step 4 Log in to FusionInsight Manager as a HetuEngine administrator and choose **Cluster** > **Services** > **HetuEngine**. The **HetuEngine** service page is displayed.

Step 5 In the **Basic Information** area on the **Dashboard** page, click the link next to **HSConsole WebUI**. The HSConsole page is displayed.

Step 6 Choose **Data Source** and click **Add Data Source**. Configure parameters on the **Add Data Source** page.

1. In the **Basic Configuration** area, configure **Name** and choose **Hudi** for **Data Source Type**.
2. In the **Hudi Configuration** area, configure the parameters according to **Table 9-30**.

Table 9-30 Hudi configuration

Parameter	Description	Example Value
Driver	The default value is **hudi**.	hudi
hdfs-site File	Select the **hdfs-site.xml** configuration file obtained in **Step 1**. The file name is fixed.	-
core-site File	Select the **core-site.xml** configuration file obtained in **Step 1**. The file name is fixed.	-
krb5 File	Configure this parameter when the security mode is enabled. It is the configuration file used for Kerberos authentication. Select the **krb5.conf** file obtained in **Step 2**.	krb5.conf

3. In the **Metastore Configuration** area, configure the parameters according to **Table 9-31**.

Table 9-31 MetaStore Configuration

Parameter	Description	Example Value
Metastore URL	URL of the MetaStore of the data source. For details, see **Step 3**.	thrift://10.92.8.42:21088,thrift://10.92.8.43:21088,thrift://10.92.8.44:21088
Security Authentication Mechanism	After the security mode is enabled, the default value is **KERBEROS**.	KERBEROS

Parameter	Description	Example Value
Server Principal	Configure this parameter when the security mode is enabled. It specifies the username with domain name used by meta to access MetaStore. For details, see **Step 3**.	hive/hadoop.hadoop.com@HADOOP.COM
Client Principal	Configure this parameter when the security mode is enabled. The parameter format is as follows: *Username for accessing MetaStore*@*Domain name (uppercase)*.**COM**. *Username for accessing MetaStore* is the user to which the **user.keytab** file obtained in **Step 2** belongs.	admintest@HADOOP.COM
Keytab File	Configure this parameter when the security mode is enabled. It specifies the keytab credential file of the MetaStore username. The file name is fixed. Select the **user.keytab** file obtained in **Step 2**.	user.keytab

4. Click **OK**.

Step 7 Log in to the node where the cluster client is located and run the following commands to switch to the client installation directory and authenticate the user:

cd /opt/client

source bigdata_env

kinit *User performing HetuEngine operations* (If the cluster is in normal mode, skip this step.)

Step 8 Run the following command to log in to the catalog of the data source:

hetu-cli --catalog *Data source name* **--schema** *Database name*

For example, run the following command:

hetu-cli --catalog hudi_1 --schema default

Step 9 Run the following command. If the database table information can be viewed or no error is reported, the connection is successful.

show tables;

----End

Data Type Mapping

Currently, the Hudi data source supports the following data types: INT, BIGINT, FLOAT, DOUBLE, DECIMAL, STRING, DATE, TIMESTAMP, BOOLEAN, BINARY, MAP, STRUCT and ARRAY.

Performance Optimization

- Metadata caching

  Hudi connectors support metadata caching to provide metadata requests for various operations faster. For details, see **Adjusting Metadata Cache**.

- Dynamic filtering

  Enabling dynamic filtering helps optimize the calculation of the Join operator of Hudi connectors. For details, see **Enabling Dynamic Filtering**.

- Query with partition conditions

  Creating a partitioned table and querying data with partition filter criteria help filter out some partition data, improving performance.

Constraints

Hudi data sources support only the QUERY operation.

9.9.4 Configuring a ClickHouse Data Source

Scenario

In a ClickHouse data source, a schema or database cannot contain tables with the same name but different case formats, for example, cktable (lowercase), CKTABLE (uppercase), and CKtable (uppercase and lowercase). Otherwise, HetuEngine cannot use the tables in the schema or database.

Prerequisites

You have created a HetuEngine administrator by referring to **Creating a HetuEngine User**.

Procedure

Step 1 Log in to FusionInsight Manager as a HetuEngine administrator and choose **Cluster** > **Services** > **HetuEngine**. The **HetuEngine** service page is displayed.

Step 2 In the **Basic Information** area on the **Dashboard** tab page, click the link next to **HSConsole WebUI**. The HSConsole page is displayed.

Step 3 Choose **Data Source** and click **Add Data Source**. On the **Add Data Source** page that is displayed, configure parameters.

1. In the **Basic Configuration** area, configure **Name** and choose **JDBC** > **ClickHouse** for **Data Source Type**.
2. Configure parameters in the **ClickHouse Configuration** area. For details, see **Table 9-32**.

Table 9-32 ClickHouse Configuration

Parameter	Description	Example Value
Driver	The default value is **clickhouse**.	clickhouse
JDBC URL	JDBC URL of the ClickHouse data source. – If the ClickHouse data source uses IPv4, the format is **jdbc:clickhouse://<host>:<port>**. – If the ClickHouse data source uses IPv6, the format is **jdbc:clickhouse://[<host>]:<port>**. – To obtain the value of **<host>**, log in to Manager of the cluster where the ClickHouse data source is located, choose **Cluster** > **Services** > **ClickHouse** > **Instance**, and view the ClickHouseBalancer service IP address. Select an IP address randomly. Currently, only one IP address can be entered. – To obtain the value of **<port>**, log in to FusionInsight Manager, click **Cluster**, choose **Services** > **ClickHouse**, and click **Logic Cluster**. On the displayed page, view the HTTP Balancer port number of the logical cluster.	**jdbc:clickhouse://10.162.156.243:21426** or **jdbc:clickhouse://10.162.156.243:21425**
Username	Username used for connecting to the ClickHouse data source.	Change the value based on the username being connected with the data source.
Password	User password used for connecting to the ClickHouse data source.	Change the value based on the user password for connecting to the data source.

Parameter	Description	Example Value
Case-sensitive Table/ Schema Name	Whether to support case-sensitive schema/ table names of the data source. HetuEngine supports case-sensitive schema/table names of the data source. – **No**: If multiple table names exist in the same schema of a data source, for example, **cktable** (lowercase), **CKTABLE** (uppercase), and **CKtable** (lowercase and uppercase), only **cktable** (lowercase) can be used by HetuEngine. – **Yes**: Only one table name can exist in the same schema of the data source, for example, **cktable** (lowercase), **CKTABLE** (uppercase), or **CKtable** (lowercase and uppercase). Otherwise, all tables in the schema cannot be used by HetuEngine.	-

3. (Optional) Customize the configuration.

   You can click **Add** to add custom configuration parameters. Configure custom parameters of the ClickHouse data source. For details, see **Table 9-33**.

Table 9-33 Custom parameters of the ClickHouse data source

Parameter	Description	Example Value
use-connection-pool	Whether to use the JDBC connection pool.	true
jdbc.connection.pool.maxTotal	Maximum number of connections in the JDBC connection pool.	8
jdbc.connection.pool.maxIdle	Maximum number of idle connections in the JDBC connection pool.	8
jdbc.connection.pool.minIdle	Minimum number of idle connections in the JDBC connection pool.	0
jdbc.connection.pool.testOnBorrow	Whether to check the connection validity when using a connection obtained from the JDBC connection pool.	false
clickhouse.map-string-as-varchar	Whether to convert the ClickHouse data source of the String and FixedString types to the Varchar type. Default value: **true**	true

Parameter	Description	Example Value
clickhouse.socket-timeout	Timeout interval for connecting to the ClickHouse data source. Unit: millisecond Default value: **120000**	120000
case-insensitive-name-matching.cache-ttl	Timeout interval for caching case-sensitive names of schemas or tables of the data sources. Unit: minute Default value: **1**	1

You can click **Delete** to delete custom configuration parameters.

4. Click **OK**.

Step 4 Log in to the node where the cluster client is located and run the following commands to switch to the client installation directory and authenticate the user:

cd /opt/client

source bigdata_env

kinit *User performing HetuEngine operations* (If the cluster is in normal mode, skip this step.)

Step 5 Run the following command to log in to the catalog of the data source:

hetu-cli --catalog *Data source name* **--schema** *Database name*

For example, run the following command:

hetu-cli --catalog clickhouse_1 --schema default

Step 6 Run the following command. If the database table information can be viewed or no error is reported, the connection is successful.

show tables;

----End

Data Type Mapping

Mapping from ClickHouse data types to HetuEngine data types

ClickHouse Data Type	HetuEngine Data Type
BOOLEAN	BOOLEAN
UInt8	SMALLINT
UInt16	INTEGER

ClickHouse Data Type	HetuEngine Data Type
UInt32	BIGINT
UInt64	DECIMAL(20, 0)
Int8	TINYINT
Int16	SMALLINT
Int32	INTEGER
Int64	BIGINT
Float32	REAL
Float64	DOUBLE
Decimal(P, S)	DECIMAL(P, S)
Decimal32(S)	DECIMAL(P, S)
Decimal64(S)	DECIMAL(P, S)
Decimal128(S)	DECIMAL(P, S)
IPv4	VARCHAR
IPv6	VARCHAR
UUID	VARCHAR
Enum8	VARCHAR
Enum16	VARCHAR
String	VARCHAR / VARBINARY
Fixedstring(N)	VARCHAR / VARBINARY
Date	DATE
DateTime	TIMESTAMP

Performance Optimization

- Subquery pushdown

  The query pushdown function is supported to improve query speed.
- Scalar UDF pushdown

  The Scalar UDF pushdown function is enabled by default. Before you use this function, create a mapping function in HetuEngine as needed.

Constraints

- HetuEngine supports interconnecting with ClickHouse using the following SQL syntaxes: SHOW CATALOGS, SCHEMAS, TABLES, COLUMNS, DESCRIBE, USE, and SELECT TABLE/VIEW.

- Tables and views that support interconnection between HetuEngine and ClickHouse:

Item	Supported Table and View
Tables that support interconnection between HetuEngine and ClickHouse	Local table (MergeTree)
	Replicated table (ReplicatedReplacingMergeTree)
	Distributed table
Views that support interconnection between HetuEngine and ClickHouse	Normal view
	Materialized view

9.9.5 Configuring an Elasticsearch Data Source

Scenario

This section describes how to add an Elasticsearch data source on HSConsole.

NOTE

- If Ranger authentication is enabled for the connected Elasticsearch data source, you need to grant permissions to the user who accesses the Elasticsearch data source from HetuEngine on Ranger of the data source cluster.
- HetuEngine is case insensitive to the metadata information of the Elasticsearch data source and can process only the metadata information in lowercase.

Procedure

Step 1 Obtain the **ca.crt** file of the Elasticsearch data source.

1. Log in to FusionInsight Manager of the cluster where the Elasticsearch data source is located.
2. In the upper right corner of the homepage, click **Download Client** to download the complete client to the local PC as prompted.
3. Decompress the client file to obtain the **ca.crt** file in the **FusionInsight_Cluster_1_Services_ClientConfig** directory.

Step 2 Generate the keystore file, in JKS format, of the Elasticsearch data source after TLS is enabled.

1. Configure the Java environment for the node where the client file is obtained.
2. Run the following command to generate the **keystore.jks** file in the directory where the **ca.crt** file is stored:

   keytool -import -alias es -file ca.crt -keystore keystore.jks -storepass *Password of the custom* ***keystore.jks*** *file*

Step 3 Log in to FusionInsight Manager as a HetuEngine administrator and choose **Cluster** > **Services** > **HetuEngine**. The **HetuEngine** service page is displayed.

Step 4 In the **Basic Information** area on the **Dashboard** tab page, click the link next to **HSConsole WebUI**. The HSConsole page is displayed.

Step 5 Choose **Data Source** and click **Add Data Source**. Configure parameters on the **Add Data Source** page.

1. In the **Basic Configuration** area, configure **Name** and choose **Elasticsearch** for **Data Source Type**.
2. Configure **Elasticsearch Configuration** parameters. For details, see **Table 9-34**.

Table 9-34 Elasticsearch Configuration

Parameter	Description	Example Value
Driver	The default value is **elasticsearch**.	elasticsearch
Host IP Address	IP address of the Elasticsearch host. Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Elasticsearch** > **Instance**. In the instance list, you can view the IP address of the host where the EsNode node is located. Select an IP address randomly. Currently, only one IP address can be entered.	– IPV4: 10.10.10.11 – IPV6: [10:10::10:11]
HTTP Port	HTTP port of Elasticsearch. The default value is **24100**.	24100
Schema Name	Name of the default schema generated by HetuEngine.	default
Security Authentication Mechanism	After the security mode is enabled, the default value is **PASSWORD**.	PASSWORD
Username	Configure this parameter when the security mode is enabled. Username for connecting to Elasticsearch.	Change the value based on the username being connected with Elasticsearch.
Password	Configure this parameter when the security mode is enabled. Password for connecting to Elasticsearch.	Change the value based on the username password for connecting to Elasticsearch.
Enabling TLS	Specifies whether TLS is enabled in Elasticsearch.	Yes

Parameter	Description	Example Value
Keystore File	Configure this parameter when the security mode is enabled. Keystore file used for enabling TLS. Select the generated **keystore.jks** file generated in **Step 2** on the local PC.	keystore.jks
Keystore Password	This parameter is mandatory when the security mode is enabled. The value is the password of the custom **keystore.jks** file entered in **Step 2.2**. Password of the keystore file for enabling TLS.	N/A

3. (Optional) Customize the configuration.
   - You can click **Add** to add custom configuration parameters. Configure custom parameters of the Elasticsearch data source. For details, see **Table 9-35**.

     Table 9-35 Custom parameters of the Elasticsearch data source

Name	Description	Example Value
allow-aggregation-pushdown	Whether to enable the aggregation pushdown function. The function is enabled by default. Value options are as follows: ■ **true**: Enable the pushdown function. ■ **false**: Disable the pushdown function.	true

Name	Description	Example Value
elasticsearch.query-data-immediate.enabled	Whether to enable the operation to take effect immediately after a table operation is performed on the Elasticsearch data source. The default value is **false**. Value options are as follows: ■ **true**: Enable the function. ■ **false**: Disable the function.	false

  - You can click **Delete** to delete custom configuration parameters.

4. Click **OK**.

Step 6 Log in to the node where the cluster client is located and run the following commands to switch to the client installation directory and authenticate the user:

cd /opt/client

source bigdata_env

kinit *User performing HetuEngine operations* (If the cluster is in normal mode, skip this step.)

Step 7 Run the following command to log in to the catalog of the data source:

hetu-cli --catalog *Data source name* **--schema** *Database name*

For example, run the following command:

hetu-cli --catalog elasticsearch_1 --schema default

Step 8 Run the following command. If the database table information can be viewed or no error is reported, the connection is successful.

show tables;

----End

Data Type Mapping

Elasticsearch Data Type	HetuEngine Data Type
boolean	BOOLEAN
binary	VARBINARY
byte	TINYINT
short	SMALLINT
integer	INTEGER
long	BIGINT
float	REAL
double	DOUBLE
keyword	VARCHAR
text	VARCHAR
ip	IPADDRESS

Performance Optimization

The query pushdown function is supported to improve query speed.

Constraints

- HetuEngine supports the following SQL syntax for interconnecting with Elasticsearch: SHOW CATALOGS/SCHEMAS/TABLES, SELECT, DROP TABLE, DELETE, UPDATE, and DESCRIBE.
- The following syntaxes are not supported: CREATE SCHEMA, CREATE TABLE, CREATE VIEW, ALTER TABLE, and ALTER VIEW.
- Tables with duplicate column names in Elasticsearch cannot be queried, for example, column names are **name** or **NAME**.
- You are not advised to query Elasticsearch tables whose names contain special characters, such as hyphens (-) and periods (.). To add special characters to the name of a table, use double quotation marks ("") to enclose the table name when you query the table.

9.9.6 Configuring a GaussDB Data Source

Scenario

Add a GaussDB JDBC data source on HSConsole.

Prerequisites

- The cluster where the data source is located and the HetuEngine cluster nodes can communicate with each other.

- In the **/etc/hosts** file of all nodes in the cluster where HetuEngine is located, add the mapping between the host names and IP addresses of the cluster where the data source to be connected is located, and add **10.10.10.10 hadoop.***System domain name* in the **/etc/hosts** file (for example, **10.10.10.10 hadoop.hadoop.com**). Otherwise, HetuEngine cannot connect to the nodes that are not in the cluster based on the host name.
- A HetuEngine compute instance has been created.

Procedure

Step 1 Log in to FusionInsight Manager as a HetuEngine administrator and choose **Cluster** > **Services** > **HetuEngine**. The **HetuEngine** service page is displayed.

Step 2 In the **Basic Information** area on the **Dashboard** page, click the link next to **HSConsole WebUI**. The HSConsole page is displayed.

Step 3 Choose **Data Source** and click **Add Data Source**. Configure parameters on the **Add Data Source** page.

1. In the **Basic Configuration** area, configure **Name** and choose **JDBC** > **GAUSSDB-A** for **Data Source Type**.
2. Configure parameters in the **GAUSSDB-A Configuration** area. For details, see **Table 9-36**.

Table 9-36 GAUSSDB-A Configuration

Parameter	Description	Example Value
Driver	The default value is **gaussdba**.	gaussdba
JDBC URL	JDBC URL for connecting to GaussDB A. The format is as follows: **jdbc:postgresql://***CN service IP address***:***Port number***/***Database name*	jdbc:postgresql://10.0.136.1:25308/postgres
Username	Username for connecting to the GaussDB data source.	Change the value based on the username being connected with the data source.
Password	Password for connecting to the GaussDB data source.	Change the value based on the username and password for connecting to the data source.

3. (Optional) Configure GaussDB user information according to **Table 9-37**.

   GaussDB User Information Configuration and **HetuEngine-GaussDB User Mapping Configuration** must be used together. When HetuEngine is

connected to the GaussDB data source, HetuEngine users can have the same permissions of the mapped GaussDB data source user through mapping. Multiple HetuEngine users can correspond to one GaussDB user.

In the GaussDB database, the created user name must comply with the identifier naming convention and contain a maximum of 63 characters. If a username contains uppercase letters, the database automatically converts the uppercase letters into lowercase letters. To create a username that contains uppercase letters, enclose the username with double quotation marks (""). Therefore, you must use the converted username to set the **Data Source User** parameter.

The examples are as follows:

- If the user name created in the GaussDB database is **Gaussuser1**, the value of **Data Source User** must be **gaussuser1**.
- If the user name created in the GaussDB database is **"Gaussuser1"**, the value of **Data Source User** must be **Gaussuser1**.

Table 9-37 GaussDB User Information Configuration

Parameter	Description
Data Source User	Data source user name If the data source user is set to **gaussuser1**, a HetuEngine user mapped to **gaussuser1** must exist. For example, create **hetuuser1** and map it to **gaussuser1**.
Password	User authentication password of the corresponding data source

4. (Optional) Configure HetuEngine-GaussDB user mapping according to **Table 9-38**.

   Multiple HetuEngine accounts are configured in the format of **HetuEngine User** and **Data Source User** key-value pairs, corresponding to one of the users configured in the **GaussDB User Information Configuration** area. When different HetuEngine users are used to access GaussDB, different GaussDB usernames and passwords can be used.

   Table 9-38 HetuEngine-GaussDB User Mapping Configuration

Parameter	Description
HetuEngine User	HetuEngine username
Data Source User	Data source user, for example, **gaussuser1** (data source user configured in **Table 9-37**)

5. (Optional) Customize the configuration.
   - You can click **Add** to add custom configuration parameters. Configure custom parameters of the GaussDB data source. For details, see **Table 9-39**.

Table 9-39 Custom parameters of the GaussDB data source

Parameter	Description	Example Value
use-connection-pool	Whether to use the JDBC connection pool.	true
jdbc.connection.pool.maxTotal	Maximum number of connections in the JDBC connection pool.	8
jdbc.connection.pool.maxIdle	Maximum number of idle connections in the JDBC connection pool.	8
jdbc.connection.pool.minIdle	Minimum number of idle connections in the JDBC connection pool.	0
join-pushdown.enabled	▪ **true**: JOIN statements can be pushed down to the data source for execution. ▪ **false**: JOIN statements are not pushed down to the data source for execution. As a result, more network and compute resources are consumed.	true
join-pushdown.strategy	The JOIN push-down function should be enabled in advance. Value options are as follows: ▪ **AUTOMATIC**: cost-based JOIN pushdown ▪ **EAGER**: JOIN pushdown as much as possible	AUTOMATIC
source-encoding	GaussDB data source encoding mode.	UTF-8
multiple-cnn-enabled	Whether to use the GaussDB multi-CN configuration. To use it, ensure that the JDBC connection pool is disabled and the JDBC URL format is as follows: jdbc:postgresql://host:port/database,jdbc:postgresql://host:port/database,jdbc:postgresql://host:port/database.	false

Parameter	Description	Example Value
parallel-read-enabled	Whether to use the parallel data read function. If the parallel data read function is enabled, the actual number of splits is determined based on the node distribution and the value of **max-splits**. Multiple connections to the data source will be created for parallel read operations. The dependent data source should support the load.	false
split-type	Type of the parallel data read function. ■ **NODE**: The degree of parallelism (DOP) is categorized based on the GaussDB data source DataNodes. ■ **PARTITION**: The DOP is categorized based on table partitions. ■ **INDEX**: The DOP is categorized based on table indexes.	NODE
max-splits	Maximum degree of parallelism.	5
use-copymanager-for-insert	Whether to use CopyManager for batch import.	false
unsupported-type-handling	If the connector does not support the data of a certain type, convert it to VARCHAR. ■ After the **CONVERT_TO_VARCHAR** parameter is configured, the data of BIT VARYING, CIDR, MACADDR, INET, OID, REGTYPE, REGCONFIG and POINT types are converted to the varchar type during query and data of these types can only be read. ■ The default value is IGNORE, indicating that unsupported types will be not displayed in the result.	CONVERT_TO_VARCHAR
max-bytes-in-a-batch-for-copymanager-in-mb	Maximum volume of data imported by CopyManager in a batch, in MB.	10

Parameter	Description	Example Value
decimal-mapping	By default, data of the DECIMAL, NUMBER, or NUMERIC type whose precision is not specified or exceeds the maximum precision of 38 digits is ignored. You can map the data to the DECIMAL(38, *x*) data type by setting the **decimal-mapping=allow_overflow** parameter. The value of *x* is the value of **decimal-default-scale**.	allow_overflow
decimal-default-scale	Decimal precision when data of the DECIMAL, NUMBER, or NUMERIC type is mapped into DECIMAL(38, *x*). The value ranges from 0 to 38 and the default value is **0**.	0
case-insensitive-name-matching	HetuEngine supports case-sensitive table and schema names of the GaussDB data source. ▪ **false**: Only schemas or tables whose names contain only lowercase letters can be queried. The default value is **false**. ▪ **true**: If there are no schemas or tables with the same name after the case-insensitive matching, the schemas or tables can be queried. Otherwise, the schemas or tables cannot be queried.	false

  - You can click **Delete** to delete custom configuration parameters.

6. Click **OK**.

Step 4 Log in to the node where the cluster client is located and run the following commands to switch to the client installation directory and authenticate the user:

cd /opt/client

source bigdata_env

kinit *User performing HetuEngine operations* (If the cluster is in normal mode, skip this step.)

Step 5 Run the following command to log in to the catalog of the data source:

hetu-cli --catalog *Data source name* **--schema** *Database name*

For example, run the following command:

hetu-cli --catalog guassdb_1 --schema admin

Step 6 Run the following command. If the database table information can be viewed or no error is reported, the connection is successful.

show tables;

----End

Data Type Mapping

GaussDB Data Type	HetuEngine Data Type
BOOLEAN	BOOLEAN
TINYINT	TINYINT
SMALLINT	SMALLINT
INTEGER	INTEGER
BINARY_INTEGER	INTEGER
BIGINT	BIGINT
SMALLSERIAL	SMALLINT
SERIAL	INTEGER
BIGSERIAL	BIGINT
FLOAT4 (REAL)	REAL
FLOAT8(DOUBLE PRECISION)	DOUBLE PRECISION
DECIMAL[p (,s)]	DECIMAL[p (,s)]
NUMERIC[p (,s)]	DECIMAL[p (,s)]
CHAR(n)	CHAR(n)
CHARACTER(n)	CHAR(n)
NCHAR(n)	CHAR(n)
VARCHAR(n)	VARCHAR(n)
CHARACTER VARYING(55)	VARCHAR(n)
VARCHAR2(n)	VARCHAR(n)
NVARCHAR2(n)	VARCHAR
TEXT(CLOB)	VARCHAR
DATE	TIMESTAMP
TIMESTAMP	TIMESTAMP
UUID	UUID
JSON	JSON

Constraints

- The following syntaxes are not supported: GRANT, REVOKE, SHOW GRANTS, SHOW ROLES, and SHOW ROLE GRANTS.
- The UPDATE and DELETE syntaxes cannot be used to filter clauses containing cross-catalog conditions, for example, **UPDATE mppdb.table SET column1=value WHERE column2 IN (SELECT column2 from hive.table)**.
- The UPDATE syntax cannot be used to update the DATE, TIMESTAMP, and VARBINARY fields.
- WHERE statements whose condition is REAL cannot be queried, for example, **SELECT * FROM mppdb.table WHERE column1 = REAL '1.1'**.
- The DELETE syntax cannot be used to filter clauses containing subqueries, for example, **DELETE FROM mppdb.table WHERE column IN (SELECT column FROM mppdb.table1)**.
- HetuEngine supports a maximum precision of 38 digits for GaussDB data sources, including the DECIMAL, NUMBER, and NUMERIC data types.
- If either end of a predicate contains a subquery, the predicate will not be pushed down. For example, if a subquery exists after the example statement **count(*)**, the predicate will not be pushed down, but the **min** function in the subquery can be pushed down.

```
select count(*) from item where i_current_price = (select min(i_current_price) from item);
```

9.9.7 Configuring an HBase Data Source

Scenario

This section describes how to add an HBase data source on HSConsole.

Prerequisites

- The domain name of the cluster where the data source is located must be different from the HetuEngine cluster domain name.
- The cluster where the data source is located and the HetuEngine cluster nodes can communicate with each other.
- In the **/etc/hosts** file of all nodes in the cluster where HetuEngine is located, add the mapping between the host names and IP addresses of the cluster where the data source to be connected is located, and add **10.10.10.10 hadoop.***System domain name* in the **/etc/hosts** file (for example, **10.10.10.10 hadoop.hadoop.com**). Otherwise, HetuEngine cannot connect to the nodes that are not in the cluster based on the host name.
- A HetuEngine compute instance has been created.
- The SSL communication encryption configuration of ZooKeeper in the cluster where the data source is located must be the same as that of ZooKeeper in the cluster where HetuEngine is located.

  NOTE

  To check whether SSL communication encryption is enabled, log in to FusionInsight Manager, choose **Cluster** > **Services** > **ZooKeeper** > **Configurations** > **All Configurations**, and enter **ssl.enabled** in the search box. If the value of **ssl.enabled** is **true**, SSL communication encryption is enabled. If the value is **false**, SSL communication encryption is disabled.

Procedure

Step 1 Obtain the **hbase-site.xml**, **hdfs-site.xml**, and **core-site.xml** configuration files of the HBase data source.

1. Log in to FusionInsight Manager of the cluster where the HBase data source is located.
2. In the upper right corner of the homepage, click **Download Client** to download the complete client as prompted.
3. Decompress the downloaded client file package and obtain the **hbase-site.xml**, **core-site.xml**, and **hdfs-site.xml** files in the **FusionInsight_Cluster_1_Services_ClientConfig/HBase/config** directory.

Step 2 Obtain the **user.keytab** and **krb5.conf** files of the proxy user of the HBase data source.

1. Log in to FusionInsight Manager of the cluster where the HBase data source is located.
2. Choose **System** > **Permission** > **User**.
3. Locate the row that contains the target data source user, click **More** in the **Operation** column, and select **Download Authentication Credential**.
4. Decompress the downloaded package to obtain the **user.keytab** and **krb5.conf** files.

NOTE

The proxy user of the data source must have the permission to perform HBase operations.

Step 3 Log in to FusionInsight Manager as a HetuEngine administrator and choose **Cluster** > **Services** > **HetuEngine**. The **HetuEngine** service page is displayed.

Step 4 In the **Basic Information** area on the **Dashboard** page, click the link next to **HSConsole WebUI**. The HSConsole page is displayed.

Step 5 Choose **Data Source** and click **Add Data Source**. Configure parameters on the **Add Data Source** page.

1. In the **Basic Configuration** area, configure **Name** and choose **HBase** for **Data Source Type**.
2. Configure parameters in the **HBase Configuration** area. For details, see **Table 9-40**.

Table 9-40 HBase Configuration

Parameter	Description	Example Value
Driver	The default value is **hbase-connector**.	hbase-connector

Parameter	Description	Example Value
ZooKeeper Quorum Address	Service IP addresses of all quorumpeer instances of the ZooKeeper service for the data source. If the ZooKeeper service of the data source uses IPv6, you need to specify the client port number in the ZooKeeper Quorum address. Log in to FusionInsight Manager, choose **Cluster** > **Services** > **ZooKeeper** > **Instance**, and view the IP addresses of all the hosts housing the quorumpeer instances.	– IPv4: 10.10.10.10,10.10.10.11,10.10.10.12 – IPv6: [10:10::10:11]:24002
ZooKeeper Client Port Number	Port number of the ZooKeeper client. Log in to FusionInsight Manager and choose **Cluster** > **Service** > **ZooKeeper**. On the **Configurations** tab page, check the value of **clientPort**.	2181
HBase RPC Communication Protection	Set this parameter based on the value of **hbase.rpc.protection** in the **hbase-site.xml** file obtained in **Step 1**. – If the value is **authentication**, set this parameter to **No**. – If the value is **privacy**, set this parameter to **Yes**.	No
Security Authentication Mechanism	After the security mode is enabled, the default value is **KERBEROS**.	KERBEROS
Principal	Configure this parameter when the security authentication mechanism is enabled. Set the parameter to the user to whom the **user.keytab** file obtained in **Step 2** belongs.	user_hbase@HADOOP2.COM
Keytab File	Configure this parameter when the security mode is enabled. It specifies the security authentication key. Select the **user.keytab** file obtained in **Step 2**.	user.keytab
krb5 File	Configure this parameter when the security mode is enabled. It is the configuration file used for Kerberos authentication. Select the **krb5.conf** file obtained in **Step 2**.	krb5.conf

Parameter	Description	Example Value
hbase-site File	Configure this parameter when the security mode is enabled. It is the configuration file required for connecting to HDFS. Select the **hbase-site.xml** file obtained in **Step 1**.	hbase-site.xml
core-site File	Configure this parameter when the security mode is enabled. This file is required for connecting to HDFS. Select the **core-site.xml** file obtained in **Step 1**.	core-site.xml
hdfs-site File	Configure this parameter when the security mode is enabled. This file is required for connecting to HDFS. Select the **hdfs-site.xml** file obtained in **Step 1**.	hdfs-site.xml

3. (Optional) Customize the configuration.
4. Click **OK**.

Step 6 Log in to the node where the cluster client is located and run the following commands to switch to the client installation directory and authenticate the user:

cd /opt/client

source bigdata_env

kinit *User performing HetuEngine operations* (If the cluster is in normal mode, skip this step.)

Step 7 Run the following command to log in to the catalog of the data source:

hetu-cli --catalog *Data source name* **--schema** *Database name*

For example, run the following command:

hetu-cli --catalog hbase_1 --schema default

Step 8 Run the following command. If the database table information can be viewed or no error is reported, the connection is successful.

show tables;

Step 9 Create a structured mapping table.

The format of the statement for creating a mapping table is as follows:

```
CREATE TABLE schemaName.tableName (
  rowId VARCHAR,
  qualifier1 TINYINT,
  qualifier2 SMALLINT,
  qualifier3 INTEGER,
  qualifier4 BIGINT,
  qualifier5 DOUBLE,
  qualifier6 BOOLEAN,
  qualifier7 TIME,
```

```
  qualifier8 DATE,
  qualifier9 TIMESTAMP
)
WITH (
column_mapping =
'qualifier1:f1:q1,qualifier2:f1:q2,qualifier3:f2:q3,qualifier4:f2:q4,qualifier5:f2:q5,qualifier6:f3:q1,qualifier7:f3:q2,
qualifier8:f3:q3,qualifier9:f3:q4',
row_id = 'rowId',
hbase_table_name = 'hbaseNamespace:hbaseTable',
external = true
);
```

NOTICE

The value of **schemaName** must be the same as that of **hbaseNamespace** in **hbase_table_name**.

- Supported mapping tables: Mapping tables can be directly associated with tables in the HBase data source or created and associated with new tables that do not exist in the HBase data source.
- Supported data types in a mapping table: VARCHAR, TINYINT, SMALLINT, INTEGER, BIGINT, DOUBLE, BOOLEAN, TIME, DATE, and TIMESTAMP
- The following table describes the keywords in the statements for creating mapping tables.

Table 9-41 Keywords in the statements for creating mapping tables

Keyword	Type	Mandatory	Default Value	Remarks
column_mapping	String	No	All columns belong to the same Family column family.	Specify the mapping between columns in the mapping table and column families in the HBase data source table. To associate a table in the HBase data source, set this parameter to the same value as that configured in the HBase data source. To create a table that does not exist in the HBase data source, configure this parameter. Value format: *Mapping table column name*:*HBase column family*:*HBase column name*. Mapping table column names must be in lowercase. HBase column names must be the same as that in HBase.

Keyword	Type	Mandatory	Default Value	Remarks
row_id	String	No	First column in the mapping table	Column name corresponding to the rowkey table in the HBase data source
hbase_table_name	String	No	N/A	Tablespace and table name of the HBase data source to be associated. Use a colon (:) to separate them. The default tablespace is **default**. If a new table that does not exist in the HBase data source is created, **hbase_table_name** does not need to be specified.
external	Boolean	No	true	If **external** is set to **true**, the table is a mapping table in the HBase data source and the original table in the HBase data source cannot be deleted. If **external** is set to false, the table in the HBase data source is deleted when the **Hetu-HBase** table is deleted.

----End

Data Type Mapping

HBase is a byte-based distributed storage system that stores all data types as byte arrays. To represent HBase data in HetuEngine, select a data type that matches the value of the HBase column qualifier for the HetuEngine column qualifier by creating a mapping table in HetuEngine.

Currently, HetuEngine column qualifiers support the following data types: VARCHAR, TINYINT, SMALLINT, INTEGER, BIGINT, DOUBLE, BOOLEAN, TIME, DATE, and TIMESTAMP.

Performance Optimization

- Predicate pushdown

  Queries support pushdown of most operators. The following predicate conditions are supported: **=**, **>=**, **>**, **<**, **<=**, **!=**, **IN**, **NOT IN**, **IS NULL**, **IS NOT NULL**, and **BETWEEN AND**.

- Batch GET query

  Multiple row keys to be queried are encapsulated into one List<Get> in the HBase API, and then the list is requested to query data. In this way, each row key does not need to initiate a request separately.

- HBase single-table query range scanning optimization

  The HBase single-table query range scanning optimization is to automatically infer the start and end addresses of rowkeys based on the predicate conditions of HBase columns and configure the start and end addresses of HBase scan during tableScan for higher access performance.

  For example, assume that the rowkey of the HBase data table consists of four columns: **building_code**:**house_code**:**floor**:**uuid**. For the search criteria **where building_code = '123' and house_code = '456'**, the HetuEngine single-table query optimization scans only columns whose rowkey range prefixes are 123 to 456, improving performance.

  To enable the single HBase table query range scanning optimization function, add the custom parameter **hbase.rowkey.adaptive.optimization.enabled** to **5.3** and set it to **true**.

  In addition, you need to specify the columns and separators of rowkeys in the table creation property of table creation statements.

  Table 9-42 Columns and separators of HBase rowkeys

Table Property	Description	Example Value
row_id_construct_columns	Columns of rowkeys in an HBase data table	building_code:house_code:floor:uuid
row_id_construct_columns_terminal	Separator of columns of rowkeys in an HBase data table	:

  For example, a table creation statement containing a rowkey consisting of four columns building_code:house_code:floor:uuid is as follows:

```
CREATE TABLE test.table_hbase_test (
row_id string,
col1 string,
col2 string,
col3 string,
building_code string,
house_code string,
floor string,
uuid string)
WITH (column_mapping = '
col1:attr:col1,
col2:attr:col2,
col3:attr:col3,
building_code:attr:building_code,
house_code:attr:house_code,
floor:attr:floor,
uuid:attr:uuid',
row_id = 'row_id',
row_id_construct_columns = 'building_code:house_code:floor:uuid',
row_id_construct_columns_terminal = ':',
hbase_table_name='test:table_hbase_test',
external = true)
```

- Dynamic filtering optimization for HBase multi-table join query

  HBase supports dynamic filtering optimization.

  To enable the dynamic filtering function, enable the HBase single table query range scanning optimization function, add the custom parameter **enable-**

dynamic-filtering in the **coordinator.config.properties** and **worker.config.properties** parameter files of compute instances, and set the parameter to **true**. For details, see **Step 3.5**.

Constraints

The ALTER and VIEW syntaxes are not supported.

9.9.8 Configuring a HetuEngine Data Source

Scenario

This section describes how to add another HetuEngine data source on the HSConsole page for a cluster in security mode.

Procedure

Step 1 Obtain the **user.keytab** file of the proxy user of the HetuEngine cluster in a remote domain.

1. Log in to FusionInsight Manager of the HetuEngine cluster in the remote domain.
2. Choose **System** > **Permission** > **User**.
3. Locate the row that contains the target data source user, click **More** in the **Operation** column, and select **Download Authentication Credential**.
4. The **user.keytab** file extracted from the downloaded file is the user credential file.

Step 2 Log in to FusionInsight Manager as a HetuEngine administrator and choose **Cluster** > **Services** > **HetuEngine**. The **HetuEngine** service page is displayed.

Step 3 In the **Basic Information** area on the **Dashboard** page, click the link next to **HSConsole WebUI**. The HSConsole page is displayed.

Step 4 Choose **Data Source** and click **Add Data Source**. Configure parameters on the **Add Data Source** page.

1. In the **Basic Configuration** area, configure **Name** and choose **HetuEngine** for **Data Source Type**.
2. Configure parameters in the **HetuEngine Configuration** area. For details, see **Table 9-43**.

Table 9-43 HetuEngine Configuration

Parameter	Description	Example Value
Driver	The default value is **hsfabric-initial**.	hsfabric-initial

Parameter	Description	Example Value
Username	Configure this parameter when the security mode is enabled. It specifies the user who accesses the remote HetuEngine. Set the parameter to the user to whom the **user.keytab** file obtained in **Step 1** belongs.	hetu_test
Keytab File	Configure this parameter when the security mode is enabled. This is the Keytab file of the user who accesses the remote DataCenter. Select the **user.keytab** file obtained in **Step 1**.	user.keytab
Two Way Transmission	This parameter indicates whether to enable bidirectional transmission for cross-domain data transmission. The default value is **Yes**. – **Yes**: Two-way transmission: Requests are forwarded to the remote HSFabric through the local HSFabric. If two-way transmission is enabled, the local HSFabric address must be configured. – No: Unidirectional transmission: Requests are directly sent to the remote HSFabric.	Yes
Local Configuration	Host IP address and port number of the HSFabric instance that is responsible for external communication of the HetuEngine service in the local MRS cluster. 1. Log in to FusionInsight Manager of the local cluster, choose **Cluster** > **Services** > **HetuEngine** > **Instance**, and check the service IP address of the HSFabric. 2. Click **HSFabric**, choose **Instance Configuration**, and check the value of **server.port**. The default value is **29900**.	192.162.157.32:29900

Parameter	Description	Example Value
Remote Address	Host IP address and port number of the HSFabric instance that is responsible for external communication of the HetuEngine service in the remote MRS cluster. 1. Log in to FusionInsight Manager of the remote cluster, choose **Cluster** > **Services** > **HetuEngine** > **Instance**, and check the service IP address of the HSFabric. 2. Click **HSFabric**, choose **Instance Configuration**, and check the value of **server.port**. The default value is **29900**.	192.168.1.1:29900
Region	Region to which the current request initiator belongs. The value can contain only digits and underscores (_).	0755_01
Receiving Data Timeout (s)	Timeout interval for receiving data, in seconds.	60
Total Task Timeout (s)	Total timeout duration for executing a cross-domain task, in seconds.	300
Tasks Used by Worker Nodes	Number of tasks used by each worker node to receive data.	5
Data Compression	– **Yes**: Data compression is enabled. – **No**: Data compression is disabled.	Yes

3. (Optional) Customize the configuration.
   – You can click **Add** to add custom configuration parameters. Configure custom parameters of the HetuEngine data source. For details, see **Table 9-44**.

   Table 9-44 Custom parameters of the HetuEngine data source

Parameter	Description	Example Value
hsfabric.health.check.time	Interval for checking the HSFabric instance status, in seconds.	60

Parameter	Description	Example Value
hsfabric.subquery.pushdown	Whether to enable cross-domain query pushdown. The function is enabled by default. ■ **true**: enables cross-domain query pushdown. ■ **false**: disables cross-domain query pushdown.	true
hsfabric.local.tenant	Tenant queue used by the remote HetuEngine for computing ■ If this parameter is not set, the system randomly selects the tenant to which the user belongs based on the configured user. ■ If this parameter is set, the specified tenant will be used. This parameter applies to scenarios where strict tenant verification is enabled.	-

  - You can click **Delete** to delete custom configuration parameters.

4. Click **OK**.

Step 5 Log in to the node where the cluster client is located and run the following commands to switch to the client installation directory and authenticate the user:

cd /opt/client

source bigdata_env

kinit *User performing HetuEngine operations* (If the cluster is in normal mode, skip this step.)

Step 6 Run the following command to log in to the catalog of the data source:

hetu-cli --catalog *Data source name* **--schema** *Database name*

For example, run the following command:

hetu-cli --catalog hetuengine_1 --schema default

Step 7 Run the following command. If the database table information can be viewed or no error is reported, the connection is successful.

show tables;

----End

Data Type Mapping

Currently, HetuEngine data sources support the following data types: BOOLEAN, TINYINT, SMALLINT, INT, BIGINT, REAL, DOUBLE, DECIMAL, VARCHAR, CHAR,

DATE, TIMESTAMP, ARRAY, MAP, TIME WITH TIMEZONE, TIMESTAMP WITH TIME ZONE, and TIME.

Performance Optimization

The query pushdown function is supported to improve query speed.

This function is enabled by default. You can also enable it by adding related custom parameters according to **Step 4.3**.

Constraints

The following syntaxes are not supported: CREATE, ALTER, DROP VIEW, INSERT OVERWRITE, UPDATE, and DELETE.

INSERT is not supported for cross-domain data sources.

9.9.9 Configuring an IoTDB Data Source

Scenario

Add an IoTDB JDBC data source on HSConsole of a cluster in security mode.

Prerequisites

- The domain name of the cluster where the data source is located must be different from that of the HetuEngine cluster.
- The cluster where the data source is located and the HetuEngine cluster nodes can communicate with each other.
- A HetuEngine compute instance has been created.
- By default, SSL is enabled for the IoTDB service in a security cluster. After SSL is enabled, you need to upload the **truststore.jks** file. For details about how to obtain the file, see **Using the IoTDB Client**.

Procedure

Step 1 Log in to FusionInsight Manager as a HetuEngine administrator and choose **Cluster** > **Services** > **HetuEngine**.

Step 2 On the **Dashboard** tab page that is displayed, find the **Basic Information** area, and click the link next to **HSConsole WebUI**.

Step 3 Choose **Data Source** and click **Add Data Source**. Configure parameters on the **Add Data Source** page.

1. In the **Basic Configuration** area, configure **Name** and choose **JDBC** > **IoTDB** for **Data Source Type**.
2. Configure parameters in the **IoTDB Configuration** area by referring to **Table 9-45**.

Table 9-45 IoTDB configuration parameters

Parameter	Description	Example Value
Driver	The default value is **iotdb**.	iotdb
JDBC URL	JDBC URL for connecting to IoTDB. – If the IoTDB data source uses an IPv4 address, the format is **jdbc:iotdb://** *P address 1 of the IoTDBServer service, IP address 2 of the IoTDBServer service***:***Port*. – If the IoTDB data source uses an IPv6 address, the format is **jdbc:iotdb://[** *P address 1 of the IoTDBServer service, IP address 2 of the IoTDBServer service***]:***Port*.	– IPV4: **jdbc:iotdb://10.10.10.11,10.10.10.12:22260** – IPV6: **jdbc:iotdb://[10:10::10:11,10:10::10:12]:22260**
Username	IoTDB username for connecting to the IoTDB data source	**NOTE** If the cluster where IoTDB resides is in non-security mode, set this parameter to the default IoTDB user **root**.
Password	Password of the IoTDB username for connecting to the IoTDB data source	**NOTE** If the cluster where the IoTDB service is installed is in non-security mode, obtain the password of user **root** from the administrator of this cluster.
Enable SSL	Whether SSL is enabled for the IoTDB service. SSL is enabled by default in a security cluster.	Yes
truststore File	After SSL is enabled for IoTDB, upload the **truststore.jks** file.	-

NOTE

- Service IP addresses of IoTDBServer:

  Log in to FusionInsight Manager, choose **Cluster** > **Services** > **IoTDB**. On the page that is displayed, click the **Instance** tab. On this tab page, check **Service IP Address** of IoTDBServer.

- Port number:

  Log in to FusionInsight Manager, choose **Cluster** > **Services** > **IoTDB**. On the page that is displayed, click the **Configurations** tab. On this tab page, search for and check the value of **IOTDB_SERVER_RPC_PORT**. The default value is **22260**.

3. (Optional) Add custom configurations as needed.
4. Click **OK**.

Step 4 Log in to the node where the cluster client is located and run the following commands to switch to the client installation directory and authenticate the user:

cd /opt/client

source bigdata_env

kinit *User performing HetuEngine operations* (If the cluster is in normal mode, skip this step.)

Step 5 Run the following command to log in to the catalog of the data source:

hetu-cli --catalog *Data source name* **--schema** *Database name*

For example, run the following command:

hetu-cli --catalog iotdb_1 --schema root.ln

Step 6 Run the following command. If the database table information can be viewed or no error is reported, the connection is successful.

show tables;

----End

Data Type Mapping

IoTDB Data Type	HetuEngine Data Type
BOOLEAN	BOOLEAN
INT32	BIGINT
INT64	BIGINT
FLOAT	DOUBLE
DOUBLE	DOUBLE
TEXT	VARCHAR

Function Enhancement

- IoTDB can configure any label fields for time series. These IoTDB label fields and other data sources can be jointly queried through HetuEngine.
- Any nodes from the IoTDB database level to the time series can be used as tables for data query on HetuEngine.

Constraints

- IoTDB data cannot be created but can be queried.
- The IoTDB user who uses HetuEngine for query must at least be configured with the read permission on the root directory.

9.9.10 Configuring a MySQL Data Source

You can interconnect HetuEngine with MySQL data sources to access and query MySQL data. This section describes how to add a MySQL JDBC data source on HSConsole.

Prerequisites

- The data source and the HetuEngine cluster nodes can communicate with each other.
- If Kerberos authentication is enabled for the cluster (the cluster is in security mode), create a HetuEngine administrator user. If Kerberos authentication is disabled for the cluster (the cluster is in normal mode), create a HetuEngine service user, and assign the HDFS administrator permission to the user. That is, the user is added to both the **hadoop** and **hadoopmanager** user groups. For details about how to create a user, see **Creating a HetuEngine User**.
- A HetuEngine compute instance has been created. For details, see **Creating a HetuEngine Compute Instance**.
- You have obtained the IP address, port number, username, and password for logging in to the MySQL database.

Constraints on Interconnection Between HetuEngine and MySQL Data Sources

- HetuEngine supports interconnecting with MySQL using the following SQL syntaxes: SHOW CATALOGS, SCHEMAS, TABLES, COLUMNS, DESCRIBE, USE, and SELECT TABLE/VIEW.
- The schema and table names of MySQL data sources supported by HetuEngine are case insensitive.
- Predicate pushups or pushdowns are not allowed on columns of text types such as CHAR or VARCHAR.

  For example, if **name** is a column of the VARCHAR type, the predicates of the following two queries cannot be pushed down.

  ```
  SELECT * FROM nation WHERE name>'abcd';
  SELECT * FROM nation WHERE name='abcd';
  ```

Configuring a MySQL Data Source

Installing a cluster client

Step 1 Install the cluster client that contains the HetuEngine service in the **/opt/hadoopclient** directory.

Prepare the MySQL driver

Step 2 Obtain the MySQL driver file (*xxx*.jar) from the MySQL official website. The supported versions are MySQL 5.7, MySQL 8.0, and later versions.

Step 3 Upload the MySQL driver file to the cluster where HetuEngine is deployed.

You can use either of the following methods:

- Upload the file to HDFS on FusionInsight Manager.
  a. Log in to FusionInsight Manager as a HetuEngine administrator and choose **Cluster** > **Services** > **HDFS**.
  b. In the **Basic Information** area on the **Dashboard** page, click the link next to **NameNode Web UI**.
  c. Select **Utilities** > **Browse the file system**, click  , and create the **/user/hetuserver/fiber/extra_file/driver/mysql** directory.
  d. Go to the **/user/hetuserver/fiber/extra_file/driver/mysql** directory and click  to upload the MySQL driver file obtained in **Step 2**.
  e. Click the value in the **Permission** column in the row containing the driver file, select **Read** and **Write** in the **User** column, **Read** in the **Group** column, and **Read** in the **Other** column, and click **Set**.
- Run HDFS commands to upload the file.
  a. Log in to the node where the HDFS service client is deployed and switch to the client installation directory, for example, **/opt/hadoopclient**.
     cd /opt/hadoopclient
  b. Configure environment variables.
     source bigdata_env
  c. If the cluster is in security mode, authenticate the user. For a normal cluster, user authentication is not required.
     kinit *HetuEngine administrator username*
     Enter the password as prompted.
  d. Run the following commands to create **/user/hetuserver/fiber/extra_file/driver/mysql**, upload the MySQL driver obtained in **Step 2**, and modify the permission:
     hdfs dfs -mkdir -p /user/hetuserver/fiber/extra_file/driver/mysql
     hdfs dfs -put ./*MySQL driver file* **/user/hetuserver/fiber/extra_file/driver/mysql**
     hdfs dfs -chmod -R 644 /user/hetuserver/fiber/extra_file/driver/mysql

Configuring a MySQL Data Source

Step 4 Log in to FusionInsight Manager as a HetuEngine administrator and choose **Cluster** > **Services** > **HetuEngine**.

Step 5 In the displayed**Dashboard** tab, find the **Basic Information** area, and click the link next to **HSConsole WebUI**.

Step 6 Choose **Data Source** and click **Add Data Source**. Configure parameters on the **Add Data Source** page.

1. In the **Basic Configuration** area, configure **Name** and choose **JDBC** > **MySQL** for **Data Source Type**.
2. In the **MySQL Configuration** area, configure the parameters according to **Table 9-46**.

Table 9-46 MySQL configuration

Parameter	Description	Example Value
Driver	The default value is **mysql**.	mysql
Driver Name	Select the MySQL driver that has been uploaded in **Step 2**. The driver format is *xxx*.jar.	mysql-connector-java-8.0.11.jar
JDBC URL	JDBC URL for connecting to MySQL. Format: **jdbc:mysql://***IP address of the MySQL database*:*Port number*. The default port number is **3306**.	– IPV4: jdbc:mysql://10.10.10.11:3306 – IPV6: jdbc:mysql://[10:10::10:11]:3306
Username	MySQL username for connecting to the MySQL data source	-
Password	Password of the MySQL username for connecting to the MySQL data source	-

3. (Optional) Customize the configuration.

   Click **Add** to add custom configuration parameters. Configure custom parameters of the MySQL data source. For details, see **Table 9-47**.

Table 9-47 Custom parameters of the MySQL data source

Parameter	Description	Example Value
mysql.auto-reconnect	Whether to reconnect automatically – **true** (default value): Enable automatic reconnection. – **false**: Disable automatic reconnection.	true
mysql.max-reconnects	Maximum number of reconnection attempts. The default value is 3.	3

Parameter	Description	Example Value
mysql.jdbc.use-information-schema	Whether the driver should use INFORMATION_SCHEMA to derive the information used by DatabaseMetaData.	true
use-connection-pool	Whether to use the JDBC connection pool. The default value is **false**.	false
jdbc.connection.pool.maxTotal	Maximum number of connections in the JDBC connection pool. The default value is **8**.	8
jdbc.connection.pool.maxIdle	Maximum number of idle connections in the JDBC connection pool. The default value is **8**.	8
jdbc.connection.pool.minIdle	Minimum number of idle connections in the JDBC connection pool. The default value is **0**.	0
case-insensitive-name-matching	The schema and table names of MySQL data sources supported by HetuEngine are case sensitive. – **false** (default value): Only schemas and tables whose names contain only lowercase letters can be queried. – **true**: ▪ If no schema or table is matched ignoring case sensitivity, the schema and table can be queried. ▪ If schemas and tables are matched ignoring case sensitivity, the schema and table cannot be queried.	false
case-insensitive-name-matching.cache-ttl	Timeout interval for caching case-sensitive schema and table names of the MySQL data source. The default value is 1 minute.	1m
dynamic-filtering.enabled	Whether dynamic filters will be pushed down to JDBC queries. – **true** (default value): Enable pushdown. – **false**: Disable pushdown.	true
dynamic-filtering.wait-timeout	The maximum duration that HetuEngine will wait to collect dynamic filters from the build side of the connection before starting a JDBC query. Using a larger value may result in a more detailed dynamic filter. However, the latency of some queries is increased. The default value is 20s.	20s

Parameter	Description	Example Value
unsupported-type-handling	How data types that are not supported by the connector will be processed – **CONVERT_TO_VARCHAR**: Convert unsupported types to **VARCHAR** and allow only read operations on them. – **IGNORE** (default value): Do not display the unsupported types.	IGNORE
join-pushdown.enabled	Whether join pushdown is enabled. – **true** (default value): Enable join pushdown. – **false**: Disable join pushdown.	true
join-pushdown.strategy	Policy used to evaluate whether the Join operation is pushed down. – **AUTOMATIC** (default value): Enable cost-based connection pushdown. – **EAGER**: Push down joins as much as possible. Even if table statistics are unavailable, using **EAGER** will push down joins, which may cause query performance deterioration. Use **EAGER** only in test and troubleshooting scenarios.	AUTOMATIC

Click **Delete** to delete custom configuration parameters.

4. Click **OK**

Step 7 Log in to the node where the cluster client is deployed and run the following commands to switch to the client installation directory and authenticate the user:

cd /opt/hadoopclient

source bigdata_env

kinit *User performing HetuEngine operations* (If the cluster is in normal mode, skip this command.)

Step 8 Log in to the catalog of the data source.

hetu-cli --catalog *Data source name* **--schema** *Database name*

For example, run the following command:

hetu-cli --catalog mysql_1 --schema mysql

Step 9 Run the following command. If the database table information can be viewed or no error is reported, the connection is successful.

show tables;

----End

Mapping Between MySQL and HetuEngine Data Types

Mapping from MySQL data types to HetuEngine data types

MySQL Type	HetuEngine Data Type
BIT	BOOLEAN
BOOLEAN	TINYINT
TINYINT	TINYINT
SMALLINT	SMALLINT
INTEGER	INTEGER
BIGINT	BIGINT
DOUBLE PRECISION	DOUBLE
FLOAT	REAL
REAL(m, d)	REAL(m, d)
DECIMAL(p, s)	DECIMAL(p, s)
CHAR(n)	CHAR(n)
VARCHAR(n)	VARCHAR(n)
TINYTEXT	VARCHAR(255)
TEXT	VARCHAR(65535)
MEDIUMTEXT	VARCHAR(16777215)
LONGTEXT	VARCHAR
ENUM(n)	VARCHAR(n)
BINARY, VARBINARY, TINYBLOB, BLOB, MEDIUMBLOB, LONGBLOB	VARBINARY
JSON	JSON
DATE	DATE
TIME(n)	TIME(n)
DATETIME(n)	TIMESTAMP(n)
TIMESTAMP(n)	TIMESTAMP(n)

9.9.11 Managing Configured Data Sources

Scenarios

On the HetuEngine web UI, you can view, edit, and delete an added data source.

Prerequisites

You have created a HetuEngine administrator for accessing the HetuEngine web UI. For details, see **Creating a HetuEngine User**.

Procedure

Step 1 Log in to Manager as a HetuEngine administrator and choose **Cluster** > **Services** > **HetuEngine**. The HetuEngine service page is displayed.

Step 2 In the **Basic Information** area on the **Dashboard** tab page, click the link next to **HSConsole WebUI**. The HSConsole page is displayed.

Step 3 Click **Data Source**. In the data source list, view the data source name, description, type, and creation time. You can also edit or delete a data source in the **Operation** column.

NOTE

During HetuEngine installation, the co-deployed Hive data source is interconnected by default. The data source name is **hive** and cannot be deleted.

----End

9.10 Using HetuEngine Materialized Views

9.10.1 Overview of Materialized Views

Background

HetuEngine provides the materialized view capability. It enables you to pre-compute frequently accessed and time-consuming operators (such as join and aggregation operators) through materialized views. In this way, queries or subqueries that can match the materialized views are converted into corresponding materialized views, avoiding repeated data computing and improving the query response efficiency.

A materialized view is typically created based on the results of queries that aggregate and join multiple data tables.

Materialized views support query rewrite. It is an optimization technique that converts query statements compiled based on an original table into equivalent requests for querying one or more materialized view statements. The following is an example of the SQL statement of a materialized view:

```
create materialized view mv.default.mv1 with(storage_table='hive.default.mv1') AS select id from hive.mvschema.t1;
```

The actual data of the materialized view is stored in the **hive.default.mv1** table. During query rewriting, the SQL statement **select id from hive.mvschema.t1** is rewritten as the table for querying the materialized view, that is, **select id from hive.default.mv1**.

Scenario

Compared with common views, materialized views occupy storage resources and cause data delay because of actual data storage and pre-computation. Therefore, materialized views are recommended in the following scenarios:

- Frequently executed queries are required.
- Queries involve time-consuming operations like aggregation and join operations.
- A certain delay is allowed for the query result data.
- Materialized views can only be connected to co-deployed Hive and external Hive data sources. Data source tables are stored in ORC or PARQUET format. Cross-source and cross-domain scenarios are not supported.

Permission Introduction

Table 9-48 lists materialized view permissions. Permission control for materialized views depends on the Ranger. If Ranger authentication is disabled, permissions may become invalid.

Table 9-48 HetuEngine materialized view permissions

Operation	Permission on catalog mv	Permission on Tables Stored in MVs	Permission on Original Physical Table
Creating a materialized view	Permission to create tables	NA	Column query permission
Deleting a materialized view	Permission to delete tables	N/A	N/A
Refreshing a materialized view	Permission to update tables	N/A	Column query permission
Modifying the properties or state of a materialized view	Permission to alter tables	NA	NA
Overwriting query statements using materialized views	N/A	N/A	Column query permission

Operation	Permission on catalog mv	Permission on Tables Stored in MVs	Permission on Original Physical Table
Using materialized views to rewrite the execution plan of query statements (EXPLAIN)	N/A	Column query permission	Column query permission
Querying a materialized view	Column query permission	N/A	N/A
Querying physical tables of materialized and non-materialized views	Column query permission	N/A	Column query permission
Viewing a materialized view	N/A	N/A	N/A
Viewing the statement for creating a materialized view	Permission to show tables	Permission to show tables	N/A

How to Use

Table 9-49 Introduction to materialized views

Phase	Description	Reference
SQL statement example of materialized views	This section describes the operations supported by materialized views, including creating, listing, and querying materialized views.	**SQL Statement Example of Materialized Views**
Configuring rewriting of materialized views	Enables the materialized view capability for faster query response.	**Configuring Rewriting of Materialized Views**
Configuring recommendation of materialized views	Automatically learns and recommends materialized view SQL statements that are most valuable to services, improving online query efficiency and reducing system load pressure.	**Configuring Recommendation of Materialized Views**

Phase	Description	Reference
Configuring caching of materialized views	The SQL statements that have been executed and rewritten for multiple times can be saved to the cache. When the SQL statements are executed again, the rewritten SQL statements are directly obtained from the cache instead of rewriting the SQL statements, improving query efficiency.	**Configuring Caching of Materialized Views**
Configuring the validity period and data update of materialized views	• Configures the validity period of the materialized view. Currently, only the materialized view within the validity period is automatically overwritten. • Configures periodic data update. Materialized views can be refreshed manually or automatically.	**Configuring the Validity Period and Data Update of Materialized Views**
Configuring intelligent materialized views	Provides automatic creation of materialized views. You do not need to manually execute SQL statements to create materialized views (recommended).	**Configuring Intelligent Materialized Views**
Viewing automatic tasks of materialized views	Views the task execution status to evaluate the cluster health status.	**Viewing Automatic Tasks of Materialized Views**

9.10.2 SQL Statement Example of Materialized Views

For details about the SQL statements for materialized views, see **Table 9-50**.

Table 9-50 Operations on materialized views

Operation	Function	SQL Statement Example of Materialized View	Remarks
Creating a materialized view (When a materialized view is created, only the definition of the materialized view is created. To fill in data, run the **refresh materialized view name** command.)	Create a materialized view that never expires.	create materialized view mv.default.mv1 with(storage_table='hive.default.mv11') AS select id from hive.mvschema.t1;	• **storage_table** specifies the location where the materialized view data is materialized into a physical table. • When creating a materialized view, you must specify **mv** for the catalog. You can also create a schema. • For the **AS SELECT** clause, pay attention to the items listed in **Creating the AS SELECT Clause for a Materialized View**.
	Create a materialized view that is valid for one day and cannot automatically refresh.	create materialized view mv.default.mv1 with(storage_table='hive.default.mv11', mv_validity = '24h') AS select id from hive.mvschema.t1;	**mv_validity** specifies the validity of a materialized view.

Operation	Function	SQL Statement Example of Materialized View	Remarks
	Create a materialized view that automatically refreshes data every hour.	create materialized view mv.default.mv1 with(storage_table='hive.default.mv1', need_auto_refresh = true, mv_validity = '1h', start_refresh_ahead_of_expiry = 0.2, refresh_priority = 3, refresh_duration = '5m') AS select id from hive.mvschema.t1;	• **need_auto_refresh**: indicates whether to enable automatic refresh. • **start_refresh_ahead_of_expiry**: a refresh task is triggered for the materialized view at the time specified by **mv_validity*** (**1-start_refresh_ahead_of_expiry**) so that the task status is changed to **Refreshable**. • **refresh_priority** specifies the priority of refreshing tasks. • **refresh_duration** specifies the maximum duration of a refreshing task.
Showing materialized views	Show all MVs whose catalog name is **mv** and schema name is **mvschema**.	show materialized views from mvschema;	**mvschema** indicates the schema name. The value of **catalog** is fixed to **mv**.
	Use the LIKE clause to filter the materialized views whose names meet the rule expression.	show MATERIALIZED VIEWs in mvschema tables like '*mvtb_0001';	**mvschema** indicates the schema name.

Operation	Function	SQL Statement Example of Materialized View	Remarks
Querying the statement for creating a materialized view	Query the statement for creating the the materialized view of **mv.default.mv1**.	show create materialized view mv.default.mv1;	**mv1** indicates the name of the materialized view.
Querying a materialized view	Query data in **mv.default.mv1**.	select * from mv.default.mv1;	**mv1** indicates the name of the materialized view.
Refreshing a materialized view	Refresh the materialized view of **mv.default.mv1**.	refresh materialized view mv.default.mv1;	-
Modifying the properties of materialized views	Modifying the properties of the **mv.default.mv1** materialized view	Alter materialized view mv.mvtestprop.pepa_ss set PROPERTIES refresh_priority = 2;	**refresh_priority = 2** is the property of the materialized view.

Operation	Function	SQL Statement Example of Materialized View	Remarks
Changing the status of materialized views	Changing the status of the **mv.default.mv1** materialized view	alter materialized view mv.default.mv1 set status SUSPEND;	**SUSPEND** is the status of the materialized view. The status can be: • **SUSPEND**: The materialized view is suspended. The suspended materialized view is not rewritten. • **ENABLE**: The materialized view is available. • **REFRESHING**: The materialized view data is being refreshed and cannot be rewritten. • **DISABLE**: The materialized view is disabled. You can only convert the status between **ENABLE** and **SUSPEND**, and chang the **DISABLE** state to **SUSPEND** or **ENABLE**.
Deleting a materialized view	Delete the materialized view of **mv.default.mv1**.	drop materialized view mv.default.mv1;	-
Enabling materialized view rewriting capability to optimize SQL statements	Enabling materialized view rewriting capability at the session level to optimize SQL statements	set session materialized_view_rewrite_enabled=true;	-

Operation	Function	SQL Statement Example of Materialized View	Remarks
Verifying whether SQL statements can be optimized by rewriting a query to a materialized view	Verify whether the SELECT statement can be rewritten and optimized by **mv.default.mv1**.	verify materialized view mvname(mv.default.mv1) originalsql select id from hive.mvschema.t1;	-
Enabling the specified materialized view at the SQL level to optimize the SQL statements	Forcibly use **mv.default.mv1** for SQL statement optimization in queries.	/*+ REWRITE(mv.default.mv1) */ select id from hive.mvschema.t1;	-
Disabling materialized views at the SQL level to optimize the SQL statements	Do not use materialized views for SQL statement optimization in queries.	/*+ NOREWRITE */ select id from hive.mvschema.t1;	-
Refreshing the metadata cache of materialized views	Synchronize the metadata cache of materialized views between tenants.	refresh catalog mv;	-

Creating the AS SELECT Clause for a Materialized View

The **AS SELECT** clause for creating materialized views cannot contain reserved keywords in Calcite SQL parsing and rewriting functions, such as **default**. To use reserved keywords in the **AS SELECT** clause, use either of the following solutions:

- When creating MVs and executing original queries, you need to add double quotes to the default schema name.

  The following uses reserved keyword **default** in the **AS SELECT** clause as an example:

  Creating a materialized view

  ```
  CREATE MATERIALIZED VIEW mv.default.mv1 WITH(storage_table='hive.default.mv11') AS SELECT id FROM hive."default".t1;
  ```

  SELECT query

  ```
  SELECT id FROM hive."default".t1;
  ```

- Set the corresponding catalog and schema at the Session level, rather than passing fully qualified names in the query.

  For example, set **catalogname** to **hive** and **schemaname** to **default**.

  ```
  USE hive.default;
  ```

  Creating a materialized view

  ```
  CREATE MATERIALIZED VIEW mv.default.mv1 WITH(storage_table='hive.default.mv11') AS SELECT id FROM t1;
  ```

  SELECT query

  ```
  SELECT id FROM t1;
  ```

9.10.3 Configuring Rewriting of Materialized Views

Enabling Rewriting of Materialized Views

HetuEngine provides the materialized view rewriting capability at the system or session level.

- Enabling the materialized view rewriting capability at the session level:

  Run the **set session materialized_view_rewrite_enabled=true** command on the HetuEngine client by referring to HetuEngine.

- Enabling the materialized view rewriting capability at the system level:

  a. Log in to FusionInsight Manager as a user who can access the HetuEngine web UI.

  b. Choose **Cluster** > **Services** > **HetuEngine** to go its service page.

  c. In the **Basic Information** area on the **Dashboard** page, click the link next to **HSConsole WebUI**. The HSConsole page is displayed.

  d. Click **Compute Instance** to view the instance status of the tenant to which operations are to be performed. When the number of green and blue icons is 0, you can perform **e** to enable materialized view rewriting.

  e. In the **Compute Instance** page, locate the row that contains the tenant to which the target instance belongs and click **Configure** in the **Operation** column. On the tab page displayed, add the following custom parameters:

Parameter	Value	Parameter File
materialized.view.rewrite.enabled	true	coordinator.config.properties
materialized.view.rewrite.timeout	5	coordinator.config.properties

NOTE

- **materialized.view.rewrite.timeout**: timeout interval for overwriting a materialized view, in seconds. The recommended value is 5 seconds. Materialized view rewrite takes some time. This parameter can be added to limit the performance loss caused by rewrite. After materialized view rewrite times out, the original SQL statement is executed.
- To enable the materialized view function at the session level and enable the timeout control for materialized view rewrite, run the **set session materialized_view_rewrite_timeout = 5** command first.

f. Set **Start Now** to **Yes** and click **OK**.

Scope of Materialized View Rewriting

- Supported materialized view types

  BOOLEAN, DECIMAL, DOUBLE, REAL/FLOAT, INT, BIGINT, SMALLINT, TINYINT, CHAR/VARCHAR, DATE, TIME, TIMESTAMP, INTERVAL YEAR TO MONTH, INTERVAL DAY TO SECOND, BINARY/VARBINARY, and UUID.

- Supported functions for materialized view rewriting
  - Conversion function: Only the CAST function is supported.
  - String function: All string functions are supported, including char_length, character_length, chr, codepoint, decode, encode, find_in_set, format_number, locate, hamming_distance, instr, levenshtein, levenshtein_distance, ltrim, lpad, octet_length, position, quote, and repeat2.
  - Mathematical operator: All mathematical operators are supported.
  - Aggregate function: **COUNT**, **SUM**, **MIN**, **MAX**, **AVG**, **LEAD**, **LAG**, **FIRST_VALUE**, **LAST_VALUE**, **COVAR_POP**, **COVAR_SAMP**, **REGR_SXX**, **REGR_SYY**, **STDDEV_POP**, **STDDEV_SAMP**, **VAR_POP**, **VAR_SAMP**, **ROW_NUMBER**, **RANK**, **PERCENT_RANK**, **DENSE_RANK**, and **CUME_DIST** are supported.

NOTICE

In the following scenarios, materialized views cannot be used to rewrite SQL queries that contain functions:

- SQL queries contain parameterless functions.
- SQL queries contain functions supported by HetuEngine that obtain different types of return values based on parameter types.
- SQL queries contain nested functions or contain functions that throw exceptions and cause rewrite failures.

Example of Materialized View Rewriting Scenarios

The core principle of materialized view rewriting is that the data of the logically created materialized view must contain the data to be queried in the future query statements or all the data to be included in the subquery in the future query. It is recommended that you enable the automatic creation of materialized views to create materialized views. The following is an example of some scenarios:

In the SQL statement example for creating a materialized view, **CREATE MATERIALIZED VIEW** *xxx* **WITH(***xxx***) AS** is omitted. For details about the complete statement template, see **Table 9-50**.

Table 9-51 Example of materialized view rewriting scenarios

Scenario	Description	SQL Statement Example for Creating a Materialized View	SQL Statement Example for a User Query	SQL Statement Rewritable	Remarks
Full table query	Basic full table query scenario	select * from tb_a;	select * from tb_a;	No	Creating a materialized view for full table scanning is meaningless and is not supported.
Column query	Basic column query scenario	select col1,col2,col3 from tb_a;	select col1,col2,col3 from tb_a;	Yes	-
	User query renaming	select col1 from tb_a;	select col1 as a from tb_a;	Yes	-
		select col1,col2,col3 from tb_a;	select col1 as a,col2 as b,col3 as c from tb_a;	Yes	-
	Mathematical expression	select col1*col2 from tb_a;	select col2*col1 from tb_a;	Yes	The two columns must have the same type.

Scenario	Description	SQL Statement Example for Creating a Materialized View	SQL Statement Example for a User Query	SQL Statement Rewritable	Remarks
	Source column used by a materialized view; and **cast** is used for user query.	select col1,col2 from tb_a;	select cast(col1 as varchar),col2 from tb_a;	No	Original data columns used by a materialized view, which are not rewritten if no filter criteria are configured in the functions used for user query. Original data columns used by a materialized view, which can be rewritten if the original data columns and filter criteria are used for user query.
	case when scenario	select col1, (case col2 when 1 then 'b' when 2 'a' end) as col from tb_a;	select col1, (case col2 when 1 then 'b' when 2 'a' end) as col from tb_a;	No	The case when scenario is not supported in query columns.

Scenario	Description		SQL Statement Example for Creating a Materialized View	SQL Statement Example for a User Query	SQL Statement Rewritable	Remarks
	String function		select col13 from tb_a;	select length(col13) from tb_a;	No	All string functions use the original table data to create materialized views. The materialized views are not rewritten when queries without filter criteria configured.
			select length(col13) from tb_a;	select length(col13) from tb_a;	Yes	-
Aggregate function column query	count	Materialized views and user queries use **count**.	select count(col1) from tb_a;	select count(col1) from tb_a;	Yes	-

Scenario	Description		SQL Statement Example for Creating a Materialized View	SQL Statement Example for a User Query	SQL Statement Rewritable	Remarks
		Source data used by a materialized view, and **count** is used for user queries.	select col1 from tb_a;	select count(col1) from tb_a;	Yes	-
	sum	**sum** is used for materialized views and user queries.	select sum(col1) from tb_a;	select sum(col1) from tb_a;	Yes	-
		Source data used by a materialized view, and **sum** is used for user queries.	select col1 from tb_a;	select sum(col1) from tb_a;	Yes	-

Scenario	Description		SQL Statement Example for Creating a Materialized View	SQL Statement Example for a User Query	SQL Statement Rewritable	Remarks
Querying information by specifying filter criteria (The core is that the data in materialized views is logically the same as or more than that in query SQL statements.)	where filtering	Maximum range of materialized views (<)	select col1 from tb_a;	select col1 from tb_a where col1<11;	Yes	-
		The materialized view range is greater than the user query range (<).	select col1 from tb_a where col1<50;	select col1 from tb_a where col1<45;	Yes	-
			select col1 from tb_a where col1<50;	select col1 from tb_a where col1<=45;	Yes	-
			select col1 from tb_a where col1<50;	select col1 from tb_a where col1 between 21 and 29;	Yes	-
		The materialized view range is equal to the user query range (>).	select col1 from tb_a where col1<50;	select col1 from tb_a where col1<50;	Yes	-
		The materialized view range is greater than the user query range (and).	select col1 from tb_a where col1<60 and col1>30;	select col1 from tb_a where col1<55 and col1>30;	Yes	-
			select col1 from tb_a where col1<60 and col1>30;	select col1 from tb_a where col1 between 35 and 55;	Yes	-

Scenario	Description		SQL Statement Example for Creating a Materialized View	SQL Statement Example for a User Query	SQL Statement Rewritable	Remarks
			select col1 from tb_a where col1<60 and col1>30;	select col1 from tb_a where (col1<55 and col1>30) and col1 = 56;	Yes	-
	where nested subquery	Subquery source table as a materialized view	select col1 from tb_a;	select count(col1) from tb_a where col1=(select min(col1) from tb_a);	Yes	-
		Subquery as a materialized view	select min(col1) from tb_a;	select count(col1) from tb_a where col1=(select min(col1) from tb_a);	Yes	-
		Parent query source table as a materialized view	select col1 from tb_a where col1=(select min(col1) from tb_a);	select count(col1) from tb_a where col1=(select min(col1) from tb_a);	Yes	-
		Parent query as a materialized view	select count(col1) from tb_a where col1=(select min(col1) from tb_a);	select count(col1) from tb_a where col1=(select min(col1) from tb_a);	Yes	-
	limit	limit in a query	select col1 from tb_a;	select col1 from tb_a limit 5;	Yes	-

Scenario	Description		SQL Statement Example for Creating a Materialized View	SQL Statement Example for a User Query	SQL Statement Rewritable	Remarks
			select col1 from tb_a limit 5;	select col1 from tb_a limit 5;	Yes	-
			select col1 from tb_a limit 5;	select col1 from tb_a;	No	-
		limit combined with order by	select col1 from tb_a;	select col1 from tb_a order by col1 limit 5;	Yes	If **order by** is used to create a materialized view, the result may be disordered. If query rewrite for materialized views is enabled, do not use **limit** or **order by** in the materialized view creation statement.
			select col1 from tb_a order by col1;	select col1 from tb_a order by col1 limit 5;	Yes	
			select col1 from tb_a order by col1 limit 5;	select col1 from tb_a order by col1 limit 5;	No	

Scenario	Description		SQL Statement Example for Creating a Materialized View	SQL Statement Example for a User Query	SQL Statement Rewritable	Remarks
	having filtering	Maximum range of materialized views (<)	select col1 from tb_a;	select col1 from tb_a group by col1 having col1 <11;	Yes	group by + having: The scenario of having is different from that of where. The having condition cannot be compensated. The materialized view SQL statements must not have the having condition or must be the same as that of user query SQL statements.
		The materialized view range is greater than the user query range (<).	select col1 from tb_a group by col1 having col1<50;	select col1 from tb_a group by col1 having col1<45;	No	
			select col1 from tb_a group by col1 having col1<50;	select col1 from tb_a group by col1 having col1<=45;	No	
			select col1 from tb_a group by col1 having col1<50;	select col1 from tb_a group by col1 having col1=45;	No	
			select col1 from tb_a group by col1 having col1<50;	select col1 from tb_a group by col1 having col1 between 21 and 29;	No	
		The materialized view range is greater than the user query range (<).	select col1 from tb_a group by col1 having col1<50;	select col1 from tb_a group by col1 having col1<50;	Yes	

Scenario	Description	SQL Statement Example for Creating a Materialized View	SQL Statement Example for a User Query	SQL Statement Rewritable	Remarks
JOIN association query	Two subqueries as a materialized view	select col1,col3 from tb_a where col1<11;	with t1 as (select col1,col3 from tb_a where col1<11),t2 as (select cast(col2 as varchar) col2,col3 from tb_b) select col1,col2 from t1 join t2 on t1.col3=t2.col3;	Yes	-
		select cast(col2 as varchar) col2,col3 from tb_b;	with t1 as (select col1,col3 from tb_a where col1<11),t2 as (select cast(col2 as varchar) col2,col3 from tb_b) select col1,col2 from t1 join t2 on t1.col3=t2.col3;	Yes	-
	Parent query as a materialized view	with t1 as (select col1,col3 from tb_a),t2 as (select col2,col3 from tb_b) select col1,col2 from t1 join t2 on t1.col3=t2.col3;	with t1 as (select col1,col3 from tb_a where col1<11),t2 as (select cast(col2 as varchar) col2,col3 from tb_b) select col1,col2 from t1 join t2 on t1.col3=t2.col3;	Yes	-

Scenario	Description	SQL Statement Example for Creating a Materialized View	SQL Statement Example for a User Query	SQL Statement Rewritable	Remarks
Aggregate + JOIN query	Source table data as a materialized view	select col1,col3 from tb_a;	with t1 as (select col1,col3 from tb_a where col1<11),t2 as (select cast(col2 as varchar) col2,col3 from tb_b) select count(col1) from t1 join t2 on t1.col3=t2.col3;	Yes	-
		select col2,col3 from tb_b;	with t1 as (select col1,col3 from tb_a where col1<11),t2 as (select cast(col2 as varchar) col2,col3 from tb_b) select count(col1) from t1 join t2 on t1.col3=t2.col3;	Yes	-
	Subquery as a materialized view	select col1,col3 from tb_a where col1<11;	with t1 as (select col1,col3 from tb_a where col1<11),t2 as (select cast(col2 as varchar) col2,col3 from tb_b) select count(col1) from t1 join t2 on t1.col3=t2.col3;	Yes	-

Scenario	Description	SQL Statement Example for Creating a Materialized View	SQL Statement Example for a User Query	SQL Statement Rewritable	Remarks
		select cast(col2 as varchar) col2,col3 from tb_b;	with t1 as (select col1,col3 from tb_a where col1<11),t2 as (select cast(col2 as varchar) col2,col3 from tb_b) select count(col1) from t1 join t2 on t1.col3=t2.col3;	Yes	-
	Parent query (whose subqueries use the source table, non-aggregate query) as a materialized view	with t1 as (select col1,col3 from tb_a),t2 as (select col2,col3 from tb_b) select col1,col2 from t1 join t2 on t1.col3=t2.col3;	with t1 as (select col1,col3 from tb_a where col1<11),t2 as (select cast(col2 as varchar) col2,col3 from tb_b) select count(col1) from t1 join t2 on t1.col3=t2.col3;	Yes	-

Scenario	Description	SQL Statement Example for Creating a Materialized View	SQL Statement Example for a User Query	SQL Statement Rewritable	Remarks
	Parent query (non-aggregate query) as a materialized view	with t1 as (select col1,col3 from tb_a where col1<11),t2 as (select cast(col2 as varchar) col2,col3 from tb_b) select col1,col2 from t1 join t2 on t1.col3=t2.col3;	with t1 as (select col1,col3 from tb_a where col1<11),t2 as (select cast(col2 as varchar) col2,col3 from tb_b) select count(col1) from t1 join t2 on t1.col3=t2.col3;	Yes	-
	Parent query as a materialized view	with t1 as (select col1,col3 from tb_a where col1<11),t2 as (select cast(col2 as varchar) col2,col3 from tb_b) select count(col1) from t1 join t2 on t1.col3=t2.col3;	with t1 as (select col1,col3 from tb_a where col1<11),t2 as (select cast(col2 as varchar) col2,col3 from tb_b) select count(col1) from t1 join t2 on t1.col3=t2.col3;	Yes	-

9.10.4 Configuring Recommendation of Materialized Views

Scenario

HetuEngine QAS module provides automatic detection, learning, and diagnosis of historical SQL execution records. After the materialized view recommendation function is enabled, the system can automatically learn and recommend the most

valuable materialized view SQL statements, enabling HetuEngine to have the automatic precomputation acceleration capability. In related scenarios, the online query efficiency is improved by multiple times, and the system load pressure is effectively reduced.

Prerequisites

- The cluster is running properly and at least one QAS instance has been installed.
- You have created a user for accessing the HetuEngine web UI, for example, **Hetu_user**. For details, see **Creating a HetuEngine User**.

Enabling Materialized View Recommendation

Step 1 Log in to FusionInsight Manager as user **Hetu_user**.

Step 2 Choose **Cluster** > **Services** > **HetuEngine** and then choose **Configurations** > **All Configurations**. In the navigation tree, choose **QAS(Role)** > **Materialized View Recommendation**. Set materialized view recommendation parameters by referring to **Table 9-52** and retain the default values for other parameters.

Table 9-52 Materialized view recommendation parameters

Parameter	Example Value	Description
qas.enable.auto.recommendation	true	Whether to enable materialized view recommendation. The default value is **false**.
qas.sql.submitter	default,zuhu1	Name of the tenant for which the materialized view recommendation function is enabled. Use commas (,) to separate multiple tenants.
qas.schedule.fixed.delay	1d	Interval for recommending materialized views. Once a day is recommended.
qas.threshold.for.mv.recommend	0.05	Filtering threshold of materialized view recommendation. The value ranges from **0.001** to **1**. You are advised to adjust the value based on the site requirements.

Step 3 Click **Save**.

Step 4 Click **Instance**, select all QAS instances, click **More**, and select **Restart Instance**. In the displayed dialog box, enter the password to restart all QAS instances for the parameters to take effect.

----End

Viewing Materialized View Recommendation Results

Step 1 Log in to FusionInsight Manager as user **Hetu_user**.

Step 2 Choose **Cluster** > **Services** > **HetuEngine** to go its service page.

Step 3 In the **Basic Information** area on the **Dashboard** page, click the link next to **HSConsole WebUI**. The HSConsole page is displayed.

Step 4 Choose **SQL O&M** > **Automatic MV Recommendation**. You can search for materialized views by tenant, status, recommendation period, and materialized view name. Fuzzy search is supported. You can export the recommendation result of a specified materialized view.

The status of a materialized view task can be:

Table 9-53 Status of a materialized view task

Status Name	Description	Status Name	Description
To Be Created	To be created	Deleting	Terminating
Creating	Creating	Deleted	Terminated
Created	Created	Planning	Being planned
Failed	Creation failed	Aborted	Aborted
Updating	Updating	Duplicated	Repeated recommendation

----End

9.10.5 Configuring Caching of Materialized Views

After a materialized view is created for an SQL statement, the SQL statement is rewritten to be queried through the materialized view when the SQL statement is executed. If the rewrite cache function is enabled for materialized views, the rewritten SQL statements will be saved to the cache (a maximum of 10,000 records can be saved by default) after the SQL statement is executed for multiple times. When the SQL statement is executed within the cache validity period (24 hours by default), the system obtains the rewritten SQL statement from the cache instead of rewriting the SQL statement.

You can add user-defined parameters **rewrite.cache.timeout** and **rewrite.cache.limit** to a compute instance to set the cache validity period and the maximum number of rewritten SQL statements that can be saved.

- When a new materialized view is created or an existing materialized view is deleted, the cache becomes invalid.
- If the materialized view associated with a rewritten SQL query in the cache becomes invalid or is in the **Refreshing** status, the rewritten SQL query will not be used.
- When the cache is used, the executed SQL query cannot be changed. Otherwise, it will be treated as a new SQL query.

- A maximum of 500 materialized views can be rewritten for SQL queries. That is, if the materialized views used during SQL rewriting are included in the 500 materialized views, the views will be rewritten. Otherwise, the views will be executed as common SQL statements. You can refer to **System level** to add user-defined parameter **hetu.select.top.materialized.view** to compute instances to change the number of materialized views that can be used.

Enabling Rewrite Cache for Materialized Views

- Session level:

  Run the **set session rewrite_cache_enabled=true** command on the HetuEngine client by referring to **Using the HetuEngine Client**.

- Enabling the materialized view rewriting capability at the system level:

  a. Log in to FusionInsight Manager as a user who can access the HetuEngine web UI.

  b. Choose **Cluster** > **Services** > **HetuEngine** to go its service page.

  c. In the **Basic Information** area on the **Dashboard** page, click the link next to **HSConsole WebUI**. The HSConsole page is displayed.

  d. Click **Compute Instance** to view the instance status of the tenant to which operations are to be performed. When the number of green and blue icons is 0, you can perform **e** to enable materialized view rewriting.

  e. In the **Compute Instance** page, locate the row that contains the tenant to which the target instance belongs and click **Configure** in the **Operation** column. On the tab page displayed, add the following custom parameters:

Parameter	Value	Parameter File	Description
rewrite.cache.enabled	true	coordinator.config.properties	Enable the rewrite cache function for materialized views.
rewrite.cache.timeout	86400000	coordinator.config.properties	• Change the validity period of the rewrite cache. • If this parameter is left blank, **86400000** is used by default. The unit is ms.
rewrite.cache.limit	10000	coordinator.config.properties	• Modify the upper limit of the rewrite cache. • If this parameter is left blank, **10000** is used by default.

  f. Set **Start Now** to **Yes** and click **OK**.

9.10.6 Configuring the Validity Period and Data Update of Materialized Views

Validity Period of Materialized Views

The **mv_validity** field for creating a materialized view indicates the validity period of the materialized view. HetuEngine allows you to rewrite the SQL statements using only the materialized views within the validity period.

Refreshing Materialized View Data

If data needs to be updated periodically, you can use either of the following methods to periodically refresh the materialized views:

- Manually refreshing a materialized view

  Run the **refresh materialized view** *<mv name>* command on the HetuEngine client by referring to **Using the HetuEngine Client**, or run the **refresh materialized view** *<mv name>* command using JDBC in the service program to manually update the database.

- Automatically refreshing a materialized view

  a. To enable the automatic refresh capability of the materialized views, you must set a compute instance as the maintenance instance. For details, see **Configuring a HetuEngine Maintenance Instance**.

  b. Use **create materialized view** to create a materialized view that can be automatically refreshed.

  NOTE

  - If there are too many materialized views, some materialized views may expire due to too long waiting time.
  - The automatic refresh function does not automatically refresh materialized views in the **disable** status.

Automatically Refreshing Materialized Views When Querying External Hive Data Sources

By default, the maintenance instance uses the HetuEngine built-in user **hetuserver/hadoop.<*System domain name*>** for refreshing materialized views. When materialized view creation statements query external Hive data sources where authentication has been enabled, you need to change the user for automatically refreshing materialized views as follows:

Step 1 Check whether the HetuEngine service has been installed in the peer cluster.

- If yes, go to **Step 3**.
- If no, go to **Step 2**.

Step 2 Prepare the user used by the system for automated refresh.

1. Create a human-machine user with the same name in both the local and peer clusters.

Take **mvuser** as an example. In the peer cluster, add it to the **supergroup** user group. In the local cluster, add it to the **supergroup** and **hive** user groups and add the tenant role of the maintenance instance.

2. (Optional) If Ranger authentication is enabled in the local cluster, grant the permission to refresh materialized views and **set sessions** permission to the **mvuser** user. For details, see **Table 9-48** and **Table 20-23**.

Step 3 Log in to FusionInsight Manager as the HetuEngine administrator.

Step 4 Choose **Cluster** > **Services** > **HetuEngine** and click the **Configurations** tab and then **All Configurations**.

Step 5 Search for **jobsystem.customized.properties**, add a custom configuration named **hetuserver.engine.jobsystem.inner.principal**, and set its value according to the following content. Then, click **Save** and operate as prompted.

- If the HetuEngine service has been installed in the peer cluster, set the value to **hetuserver**.
- If the HetuEngine service is not installed in the peer cluster, set the value the user name created in **Step 2.1**.

Step 6 Click the **Instance** tab, select all HSBroker instances, click **More**, and select **Restart Instance** to restart the HSBroker instances as prompted.

Step 7 In the displayed **Dashboard** tab, find the **Basic Information** area, and click the link next to **HSConsole WebUI**. In the **Compute Instance** tab, locate the maintenance instance and click **Restart** in the **Operation** column and operate as prompted.

NOTE

Instances with the  icon displayed next to their names are maintenance instances. You can also confirm the maintenance instance by referring to **Configuring a HetuEngine Maintenance Instance**.

----End

9.10.7 Configuring Intelligent Materialized Views

Overview

HetuEngine intelligent materialized views provide intelligent precalculation and cache acceleration. The HetuEngine QAS role can automatically extract historical SQL statements for analysis and learning, and automatically generate candidate SQL statements for high-value materialized views based on the revenue maximization principle. In practice, HetuEngine administrators can enable automatic creation and refresh of materialized views by configuring maintenance instances. Service users can configure client sessions to implement automatic rewriting and acceleration based on automatically created materialized views.

This capability significantly simplifies the use of materialized views and accelerates analysis without interrupting services. HetuEngine administrators can intelligently accelerate high-frequency SQL services by using a small amount of compute and storage resources. In addition, this capability reduces the overall load (such as CPU, memory, and I/O) of the data platform and improves system stability.

The intelligent materialized view provides the following functions:

- Automatic recommendation of materialized views
- Automatic creation of materialized views
- Automatic refresh of materialized views
- Automatic deletion of materialized views

Prerequisites

The cluster is running properly and at least one QAS instance has been installed.

Application Process

Figure 9-10 Application process of HetuEngine intelligent materialized views

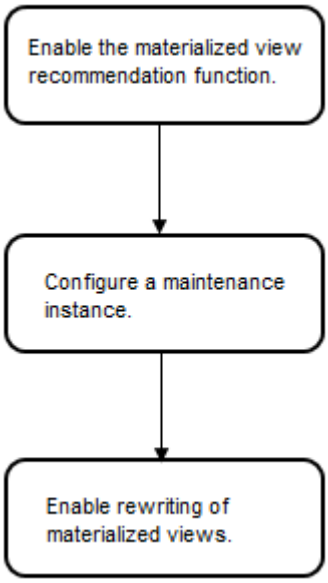


Table 9-54 Process description

Step	Description	Reference
Enable the materialized view recommendation function.	After this function is enabled, QAS instances automatically recommend SQL statements of high-value materialized views based on users' SQL execution records. You can view the recommended materialized view statements on the materialized view recommendation page on the HSConsole. For details, see **Viewing Materialized View Recommendation Results**.	**Enabling Materialized View Recommendation**

Step	Description	Reference
Configure a maintenance instance.	After a compute instance is set as a maintenance instance, the maintenance instance automatically creates, refreshes, and deletes the materialized view SQL statements recommended by the materialized view recommendation function. You can view the generated automatic task records on the HetuEngine automation task page. For details, see **Viewing Automatic Tasks of Materialized Views**.	**Configuring a HetuEngine Maintenance Instance**
Enable rewriting of materialized views.	After rewriting is enabled for materialized views, HetuEngine determines whether the materialized view rewriting requirements are met based on the SQL statements entered by users and converts queries or subqueries that match materialized views into materialized views, avoiding repeated data calculation.	**Configuring Rewriting of Materialized Views**

9.10.8 Viewing Automatic Tasks of Materialized Views

Scenario

View the status and execution result of an automatic HetuEngine task on HSConsol. You can periodically view the task execution status and evaluate the cluster health status.

Prerequisites

You have created a user for accessing the HetuEngine web UI. For details, see **Creating a HetuEngine User**.

Procedure

Step 1 Log in to FusionInsight Manager as a user who can access the HetuEngine web UI and choose **Cluster** > **Services** > **HetuEngine**. The **HetuEngine** service page is displayed.

Step 2 In the **Basic Information** area on the **Dashboard** page, click the link next to **HSConsole WebUI**. The HSConsole page is displayed.

Step 3 Choose **Automated Tasks**. On the displayed page, you can search for tasks by **Task Type**, **Status**, **Additional Info**, or **Start Time**. Fuzzy search is supported.

Search Criterion	Description
Task Type	**ALL**: all types

Search Criterion	Description
	Refresh of materialized view: refreshes materialized views.
	Recommendation of materialized view: recommends materialized views.
	Auto create materialized view: automatically creates materialized views.
	Drop auto created and stale materialized view: automatically deletes materialized views.
Status	ALL
	success
	failed
	waiting
	running
	skipped
	time out
	unknown

Step 4 Click **Query**. The tasks that match the search criteria are displayed.

----End

9.11 Using HetuEngine SQL Diagnosis

Scenario

The HetuEngine QAS module provides automatic detection, learning, and diagnosis of historical SQL execution records for more efficient online SQL O&M and faster online SQL analysis. After SQL diagnosis is enabled, the system provides the following capabilities:

- Automatically detects and displays tenant-level and user-level SQL execution statistics in different time periods to cluster administrators, helping them quickly predict service running status and potential risks.
- Automatically diagnoses large SQL statements, slow SQL statements, and related submission information, displays the information in multiple dimensions for cluster administrators, and provides diagnosis and optimization suggestions for these statements.

Prerequisites

- The cluster is running properly and at least one QAS instance has been installed.

- You have created a user for accessing the HetuEngine web UI, for example, **Hetu_user**. For details, see **Creating a HetuEngine User**.

Enabling SQL Diagnosis

The SQL diagnosis function of HetuEngine is enabled by default. You can perform the following steps to configure other common parameters or retain the default settings:

Step 1 Log in to FusionInsight Manager as user **Hetu_user**.

Step 2 Choose **Cluster** > **Services** > **HetuEngine**. Click **Configurations** then **All Configurations**, click **QAS(Role)**, and select **SQL Diagnosis**. If **qas.sql.auto.diagnosis.enabled** is set to **true**, the SQL diagnosis function is enabled. In this case, you can configure recommended SQL diagnosis parameters based on service requirements.

Step 3 Click **Save**.

Step 4 Click **Instance**, select all QAS instances, click **More**, and select **Restart Instance**. In the displayed dialog box, enter the password to restart all QAS instances for the parameters to take effect.

----End

Viewing SQL Diagnosis Results

Step 1 Log in to FusionInsight Manager as user **Hetu_user**.

Step 2 Choose **Cluster** > **Services** > **HetuEngine** to go its service page.

Step 3 In the **Basic Information** area on the **Dashboard** page, click the link next to **HSConsole WebUI**. The HSConsole page is displayed.

Step 4 Choose **SQL O&M** to view SQL diagnosis results.

- On the **Overview** page, you can view the overall running status of historical tasks, including the query duration distribution chart by segment, query user distribution chart, total submitted SQL queries, SQL execution success rate, average SQL query response time, number of queries, average execution time, and average waiting time.
- On the **Slow Query Distribution** page, view the slow query distribution of historical tasks, including:
  - Slow SQL statistics: collects statistics on the number of slow queries (the query time is greater than the slow query threshold) submitted by each tenant.
  - Top users with the maximum slow query requests: collects statistics on slow query statistics of each user. The statistics can be sorted in a list and exported.
- On the **Slow Queries** page, view the slow query list of historical tasks, diagnosis results, and optimization suggestions. Query results can be exported.

NOTE

The validity period of historical statistics depends on the JVM memory size of HSConsole instances and cannot exceed 60 days.

----End

9.12 Using a Third-Party Visualization Tool to Access HetuEngine

9.12.1 Using DBeaver to Access HetuEngine

Use DBeaver 22.1.5 as an example to describe how to access HetuEngine.

Prerequisites

- The DBeaver has been installed properly. Download the DBeaver software from **https://dbeaver.io/download/**.
- A human-machine user, for example, **hetu_user**, has been created in the cluster. For details, see **Creating a HetuEngine User**. For clusters with Ranger authentication enabled, the Ranger permission must be added to user **hetu_user** based on service requirements. For details, see **Adding a Ranger Access Permission Policy for HetuEngine**.
- A compute instance has been created and is running properly. For details, see **Creating a HetuEngine Compute Instance**.

Procedure

Step 1 Download the HetuEngine client to obtain the JDBC JAR package.

1. Log in to FusionInsight Manager.
2. Choose **Cluster** > **Services** > **HetuEngine** > **Dashboard**.
3. In the upper right corner of the page, choose **More** > **Download Client** and download the **Complete Client** to the local PC as prompted.
4. Decompress the HetuEngine client package **FusionInsight_Cluster**_*Cluster ID*_**HetuEngine_Client.tar** to obtain the JDBC file and save it to a local directory, for example, **D:\test**.

   NOTE

   Obtaining the JDBC file:

   Decompress the package in the **FusionInsight_Cluster**_*Cluster ID*_**HetuEngine_ClientConfig\HetuEngine\xxx** directory to obtain the **hetu-jdbc-*.jar** file.

   Note: **xxx** can be **arm** or **x86**.

Step 2 Add the host mapping to the local **hosts** file.

Add the mapping of the host where the instance is located in the HSFabric or HSBroker mode. The format is *Host IP address Host name*.

Example: **192.168.42.90 server-2110081635-0001**

NOTE

The local **hosts** file in a Windows environment is stored in, for example, **C:\Windows\System32\drivers\etc**.

Step 3 Open DBeaver, choose **Database** > **New Database Connection**, search for **Trino** in **ALL**, and open Trino.

Step 4 Click **Edit Driver Settings** and set parameters by referring to the following table.

Table 9-55 Driver settings

Parameter	Value
Class Name	io.trino.jdbc.TrinoDriver
URL Template	• Accessing HetuEngine using HSFabric jdbc:trino://<*HSFabricIP1:port1*>,<*HSFabricIP2:port2*>,<*HSFabricIP3:port3*>/*Catalog name*/*Schema name*?serviceDiscoveryMode=hsfabric&tenant=*Tenant name* Example: jdbc:trino://192.168.42.90:29902,192.168.42.91:29902,192.168.42.92:29902/hive/default?serviceDiscoveryMode=hsfabric&tenant=default • Accessing HetuEngine using HSBroker jdbc:trino://<*HSBrokerIP1:port1*>,<*HSBrokerIP2:port2*>,<*HSBrokerIP3:port3*>/*Catalog name*/*Schema name*?serviceDiscoveryMode=hsbroker&tenant=*Tenant name* Example: jdbc:trino://192.168.42.90:29860,192.168.42.91:29860,192.168.42.92:29860/hive/default?serviceDiscoveryMode=hsbroker&tenant=default

NOTE

- To obtain the IP addresses and port numbers of the HSFabric and HSBroker nodes, perform the following operations:
  1. Log in to FusionInsight Manager.
  2. Choose **Cluster** > **Services** > **HetuEngine**. Click the **Instance** tab to obtain the service IP addresses of all HSFabric or HSBroker instances. You can select one or more normal instances for connection.
  3. To obtain the port numbers, choose **Cluster** > **Services** > **HetuEngine**. Click **Configurations** then **All Configurations**.

     Search for **gateway.port** to obtain the HSFabric port number. The default port number is **29902** in security mode and **29903** in normal mode.

     Search for **server.port** to obtain the HSBroker port number. The default port number is **29860** in security mode and **29861** in normal mode.
- If the connection fails, disable the proxy and try again.
- The **tenant** parameter is optional. If it is not configured, a random tenant is used.

Step 5 Click **Add File** and upload the JDBC driver package obtained in **Step 1**.

Step 6 Click **Find Class**. The driver class is automatically obtained. Click **OK** to complete the driver setting. If **io.trino:trino-jdbc:RELEASE** exists in **Libraries**, delete it before clicking **Find Class**.

Figure 9-11 Configuring the driver in security mode (Settings)

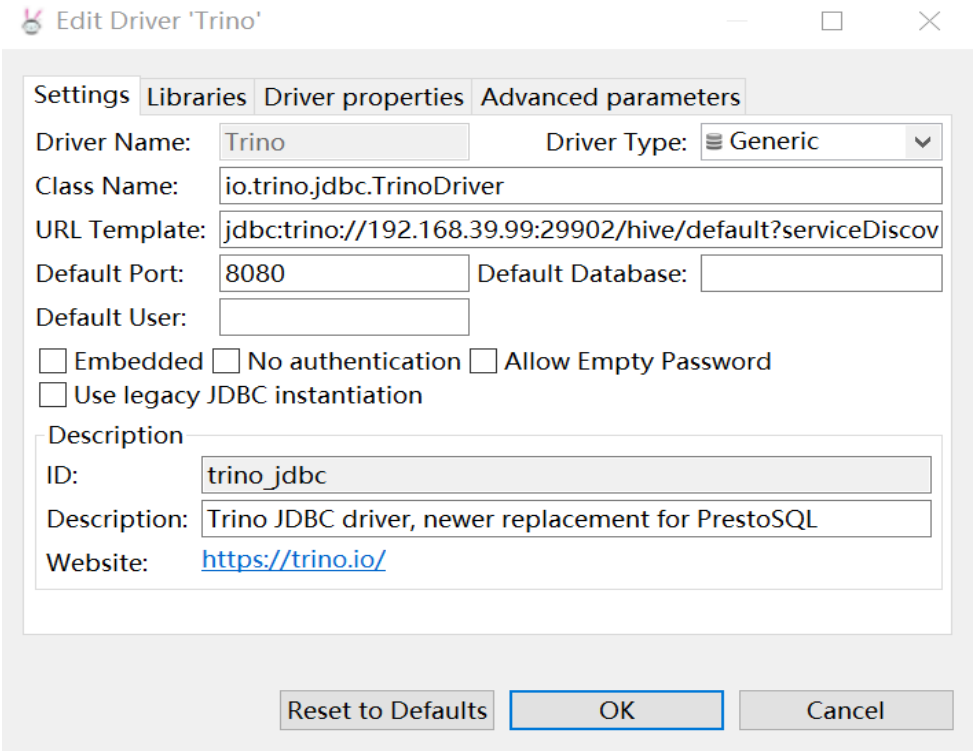
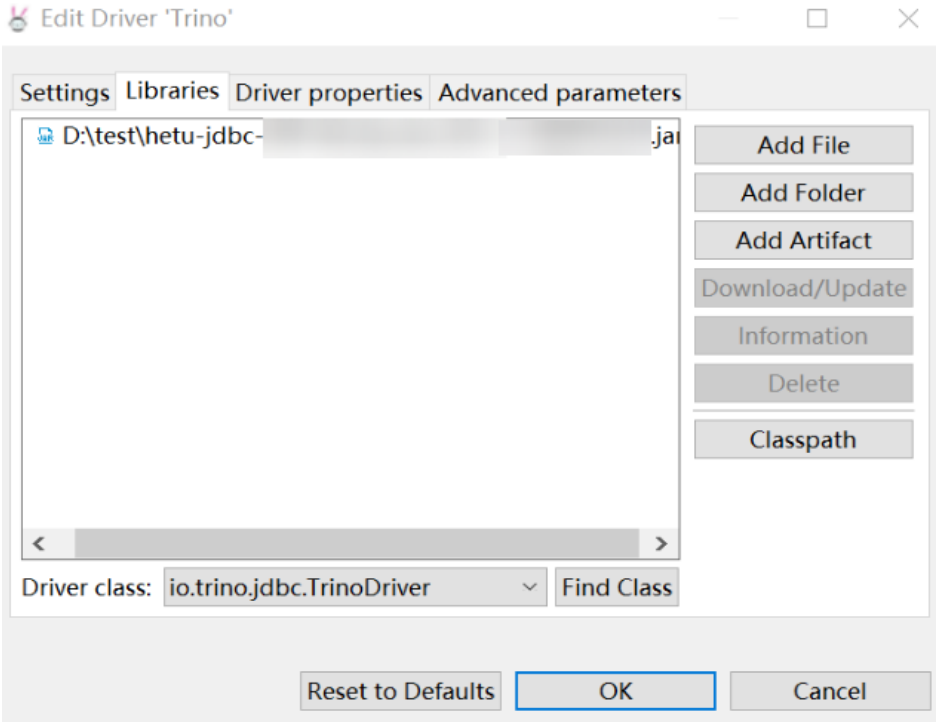


Figure 9-12 Configuring the driver in security mode (Library)

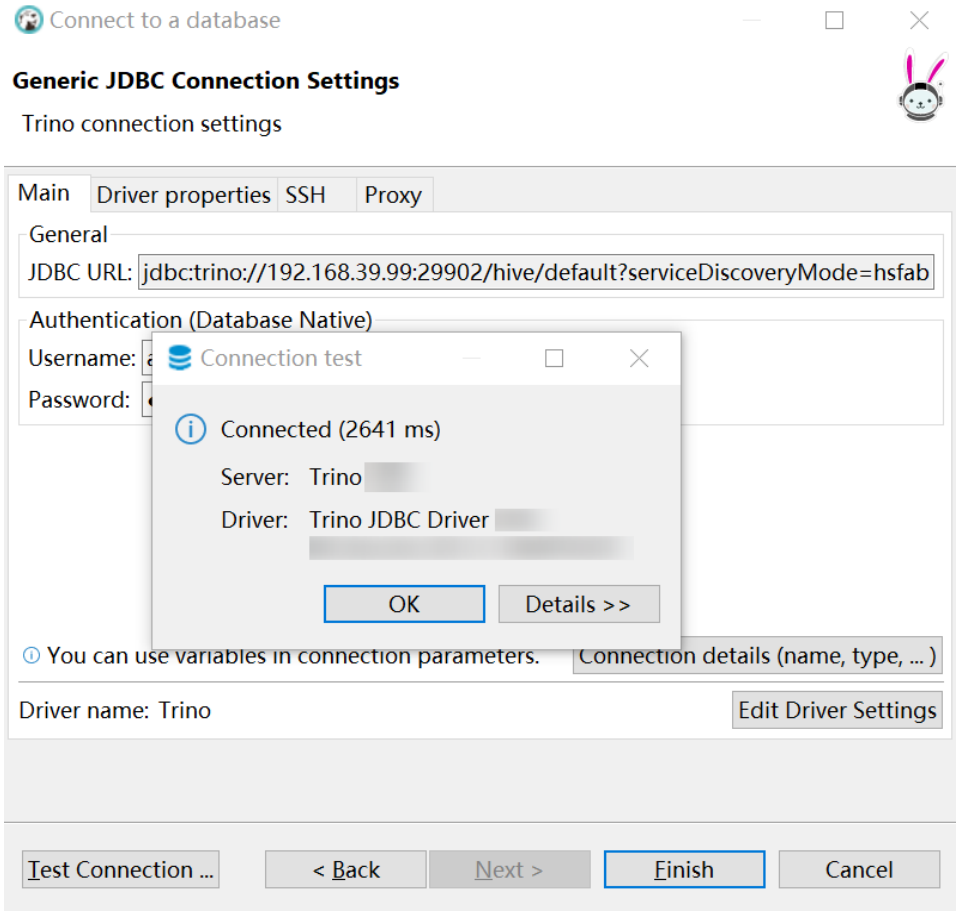


Step 7 Configure the connection.

- Security mode (clusters with Kerberos authentication enabled):

  On the **Main** tab page for creating a connection, enter the user name and password created in **Prerequisites**, and click **Test Connection**. After the connection is successful, click **OK** then **Finish**. You can click **Connection details (name, type, ...)** to change the connection name.

Figure 9-13 Configuring parameters on the Main tab in security mode

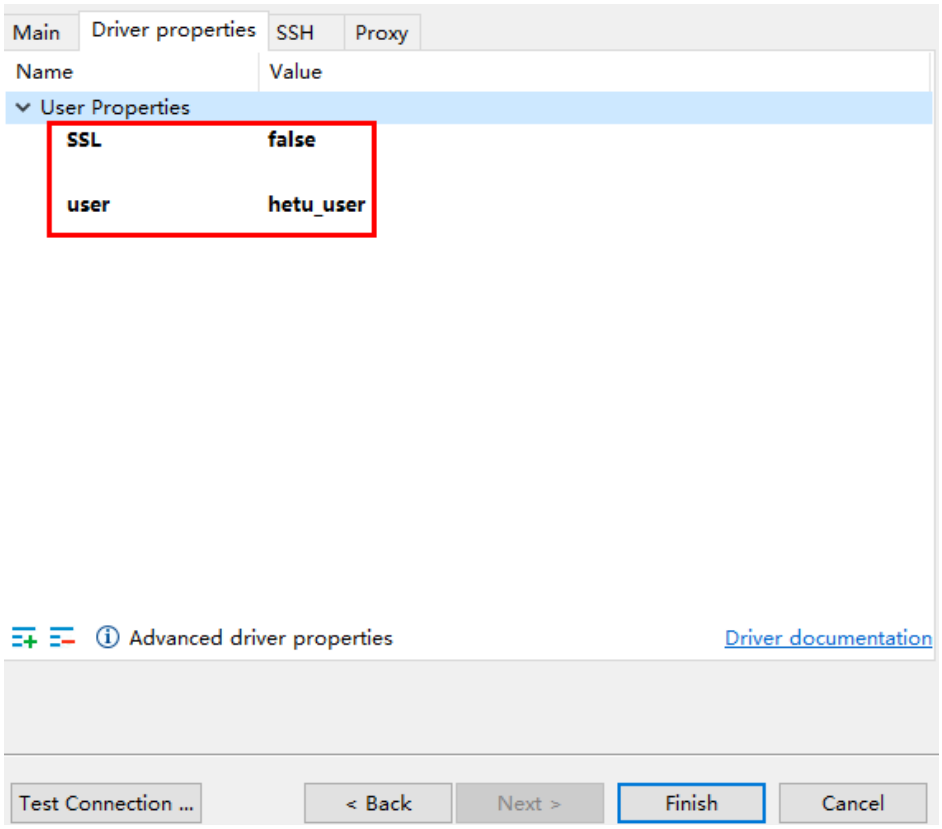


- Normal mode (clusters with Kerberos authentication disabled):

  On the **Main** tab page for creating a connection, set **JDBC URL** and do not enter the password of the username.

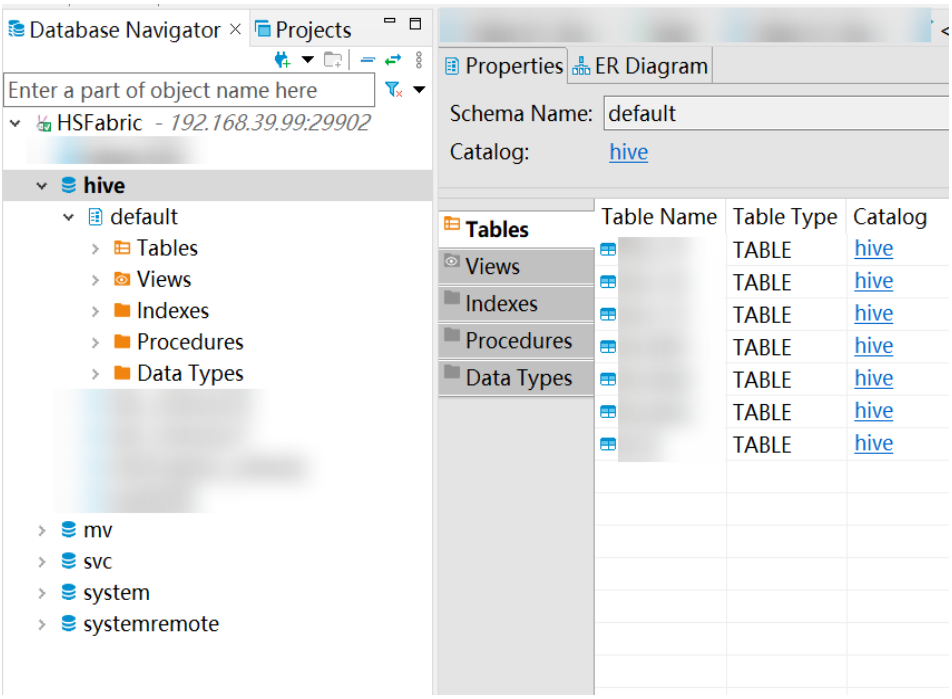
  On the page for creating a connection, configure the parameters on the **Driver properties** tab. Set **user** to the user created in **Prerequisites**. Click **Test Connection**. After the connection is successful, click **OK** then **Finish**. You can click **Connection details (name, type, ...)** to change the connection name.

Figure 9-14 Configuring parameters on the Driver properties tab in normal mode



Step 8 After the connection is successful, the page shown in the following figure is displayed.

Figure 9-15 Successful connection



----End

9.12.2 Using Tableau to Access HetuEngine

Use Tableau Desktop 2022.2 as an example to describe how to access HetuEngine.

Prerequisites

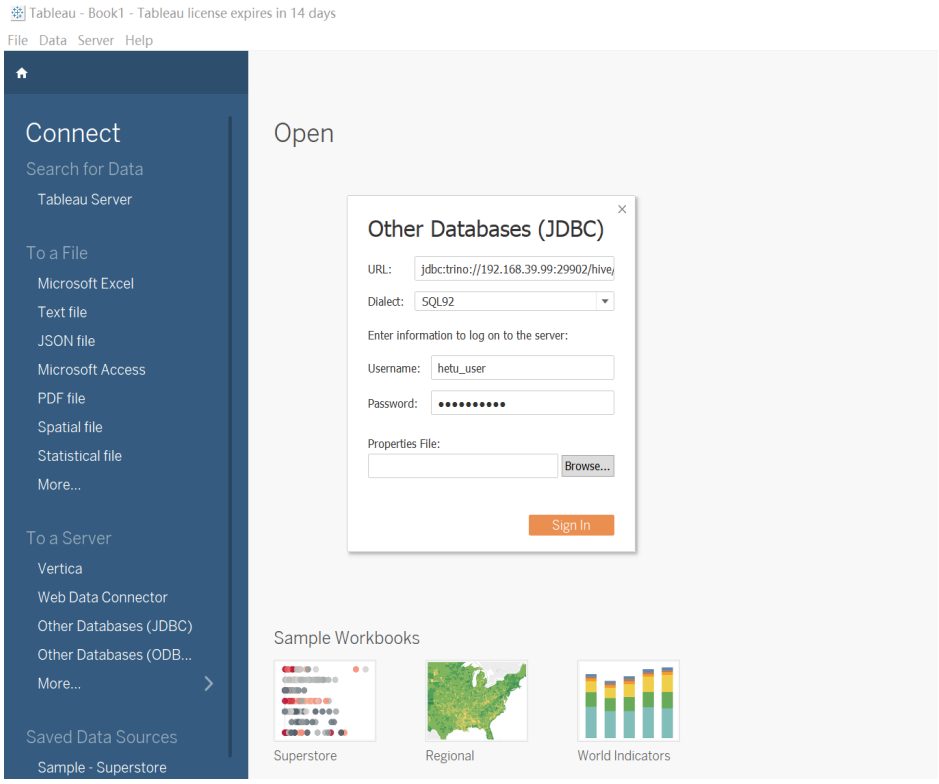
- Tableau Desktop has been installed.
- The JDBC JAR file has been obtained. For details, see **Step 1**.
- A human-machine user, for example, **hetu_user**, has been created in the cluster. For details, see **Creating a HetuEngine User**. For clusters with Ranger authentication enabled, the Ranger permission must be added to user **hetu_user** based on service requirements. For details, see **Adding a Ranger Access Permission Policy for HetuEngine**.
- A compute instance has been created and is running properly. For details, see **Creating a HetuEngine Compute Instance**.

Procedure

Step 1 Place the obtained JAR file to the Tableau installation directory, for example, **C:\Program Files\Tableau\Drivers**.

Step 2 Open Tableau, choose **To a Server** > **Other Databases (JDBC)**, enter the URL and the username and password of the created human-machine user, and click **Sign In**. HetuEngine is accessible either in the HSFabric or HSBroker mode. For details about the URL format, see **Table 9-55**.

Figure 9-16 Entering connection information



Step 3 After the login is successful, drag the data table to be operated to the operation window on the right and refresh data.

----End

9.12.3 Using Power BI to Access HetuEngine

Use Power BI 1.2.0 as an example to describe how to access HetuEngine in a security cluster.

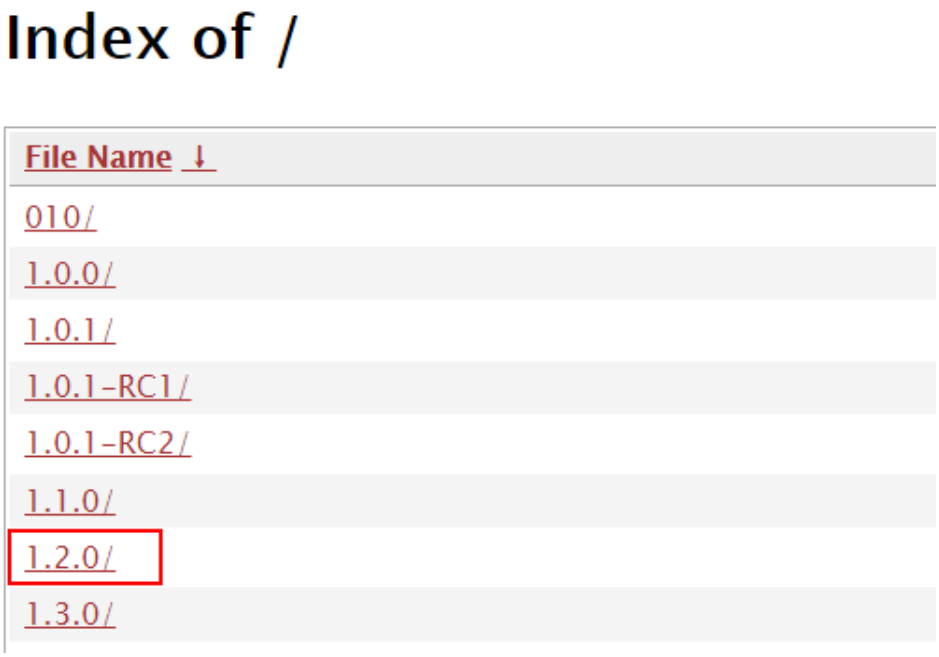
Prerequisites

- Power BI has been installed.
- The JDBC JAR file has been obtained. For details, see **Step 1**.
- A human-machine user, for example, **hetu_user**, has been created in the cluster. For details, see **Creating a HetuEngine User**. For clusters with Ranger authentication enabled, the Ranger permission must be added to user **hetu_user** based on service requirements. For details, see **Adding a Ranger Access Permission Policy for HetuEngine**.
- A compute instance has been created and is running properly. For details, see **Creating a HetuEngine Compute Instance**.

Procedure

Step 1 Use the default configuration to install the **hetu-odbc-win64.msi** driver. Download the driver from **https://download.openlookeng.io/**.

Figure 9-17 Downloading the driver



Step 2 Configure data source driver.

1. Run the following commands in the local command prompt to stop the ODBC service that is automatically started.

   cd C:\Program Files\openLooKeng\openLooKeng ODBC Driver 64-bit \odbc_gateway\mycat\bin

   mycat.bat stop

   If the following information is displayed, the ODBC service is stopped:

   ```
   wrapper  | Stopping the Mycat-server service...
   wrapper  | Mycat-server stopped.
   ```

2. Replace the JDBC driver.

   Copy the JDBC JAR file obtained in **Step 1** to the **C:\Program Files \openLooKeng\openLooKeng ODBC Driver 64-bit\odbc_gateway\mycat\lib** directory and delete the original **hetu-jdbc-1.0.1.jar** file from the directory.

3. Edit the protocol prefix of the ODBC **server.xml** file.

   Change the property value of **server.xml** in the **C:\Program Files \openLooKeng\openLooKeng ODBC Driver 64-bit\odbc_gateway\mycat \conf** directory from **<property name="jdbcUrlPrefix">jdbc:lk://</property>** to

   <property name="jdbcUrlPrefix">jdbc:trino://</property>.

4. Configure the connection mode of using the user name and password.

   Create a **jdbc_param.properties** file in a user-defined path, for example, **C:\hetu**, and add the following content to the file:

   ```
   user=admintest
   Password=Password
   ```

NOTE

user: indicates the username of the created human-machine user, for example, **admintest**.

password: indicates the password of the created human-machine user. Configuration files containing authentication passwords pose security risks. Delete such files after configuration or store them securely.

5. Run the following commands to restart the ODBC service:

   cd C:\Program Files\openLooKeng\openLooKeng ODBC Driver 64-bit \odbc_gateway\mycat\bin

   mycat.bat restart

   If the following information is displayed, the ODBC service is restarted:

```
wrapper  | The Mycat-server service was not running.
wrapper  | Starting the Mycat-server service...
wrapper  | Mycat-server started.
```

NOTE

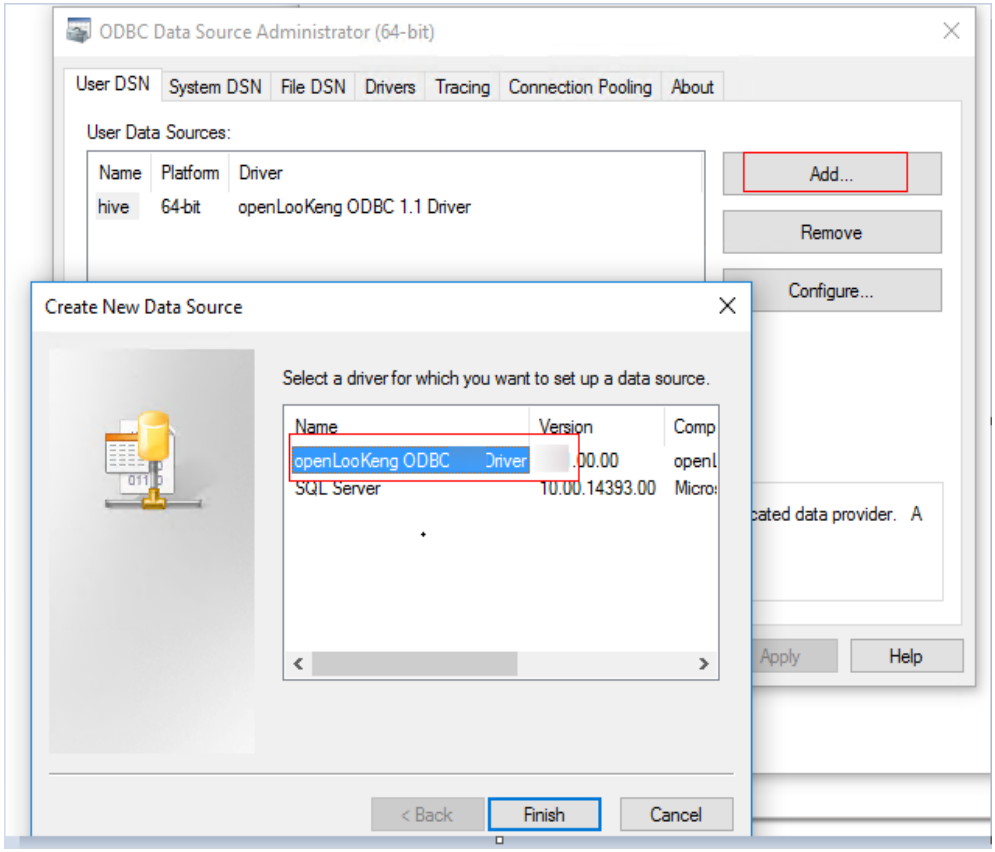
The ODBC service must be stopped each time the configuration is modified. After the modification is complete, restart the ODBC service.

Step 3 On the Windows **Control Panel**, enter **odbc** to search for the ODBC management program.

Figure 9-18 Searching for ODBC

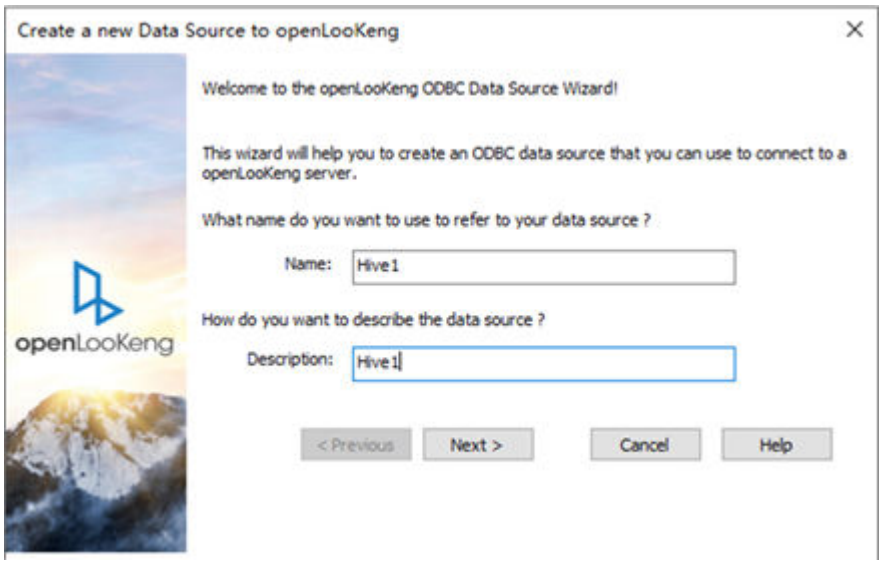
Step 4 Choose **Add** > **openLookeng ODBC 1.2.0 Driver** > **Finish**.

Figure 9-19 Adding a driver



Step 5 Enter the name and description as shown in the following figure and click **Next**.

Figure 9-20 Entering the name



Step 6 Configure parameters by referring to the following figure.

1. **Connect URL** indicates the URL format of the ODBC connection for accessing the HetuEngine service. The HSFabric and HSBroker modes are supported.
   - HSFabric mode

<HSFabricIP1:port1>,*<HSFabricIP2:port2>*,*<HSFabricIP3:port3>*|*Catalog name*|*Schema name*?serviceDiscoveryMode=hsfabric&tenant=*Tenant name*

Example:

192.168.8.37:29902,192.168.8.38:29902,192.168.8.39:29902/hive/default?serviceDiscoveryMode=hsfabric&tenant=default

- HSBroker mode

  <HSBrokerIP1:port1>,*<HSBrokerIP2:port2>*,*<HSBrokerIP3:port3>*|*Catalog name*|*Schema name*?serviceDiscoveryMode=hsbroker&tenant=default

  Example:

  192.168.8.37:29860,192.168.8.38:29860,192.168.8.39:29860/hive/default?serviceDiscoveryMode=hsbroker&tenant=*Tenant name*

  NOTE

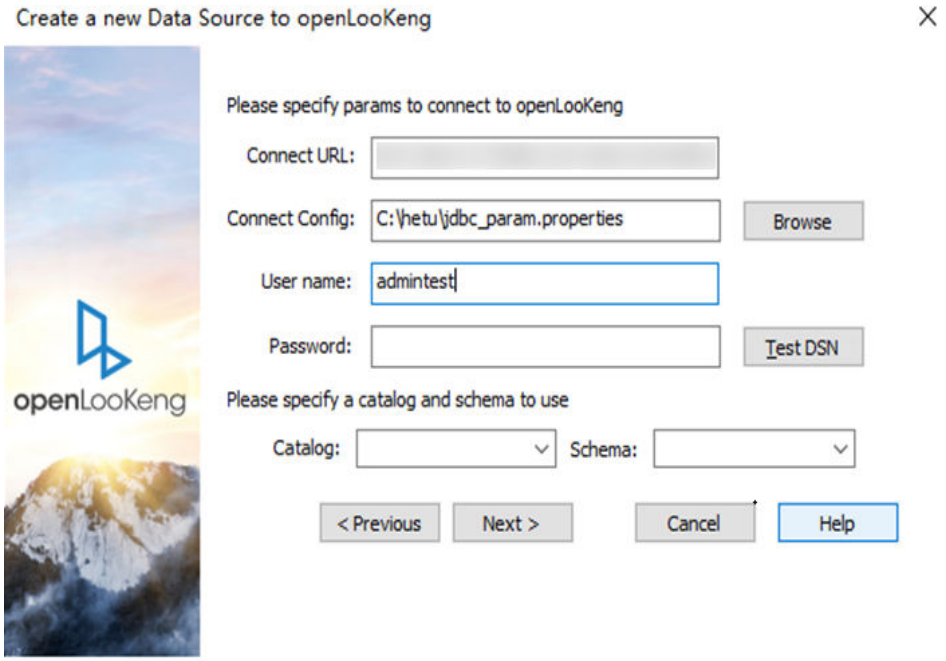
  - To obtain the IP addresses and port numbers of the HSFabric and HSBroker nodes, perform the following operations:
    1. Log in to FusionInsight Manager.
    2. Choose **Cluster** > **Services** > **HetuEngine**. Click the **Instance** tab to obtain the service IP addresses of all HSFabric or HSBroker instances. You can select one or more normal instances for connection.
    3. To obtain the port numbers, choose **Cluster** > **Services** > **HetuEngine**. Click **Configurations** then **All Configurations**.

       Search for **gateway.port** to obtain the HSFabric port number. The default port number is **29902** in security mode and **29903** in normal mode.

       Search for **server.port** to obtain the HSBroker port number. The default port number is **29860** in security mode and **29861** in normal mode.
  - If the connection fails, disable the proxy and try again.
  - The **tenant** parameter is optional. If it is not configured, a random tenant is used.

2. **Connect Config**: Select the **jdbc_param.properties** file prepared in **Step 2.4**.
3. **User name**: Enter the username for downloading the credential.

Figure 9-21 Configuring the user name



Step 7 Click **Test DSN** to test the connection. If the connection is successful and both **Catalog** and **Schema** contain content, the connection is successful. Click **Next**.

Figure 9-22 Testing the connection

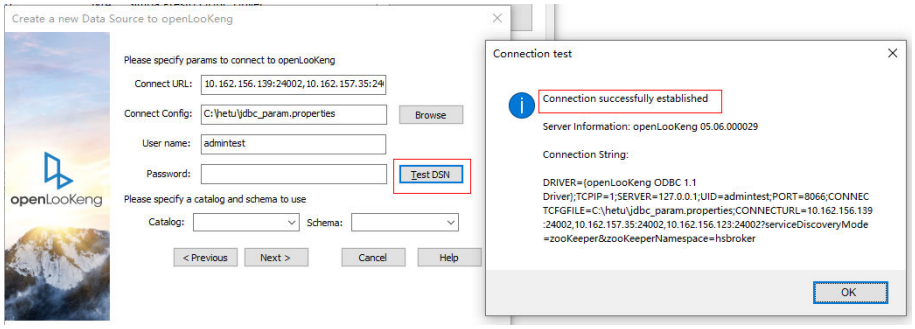
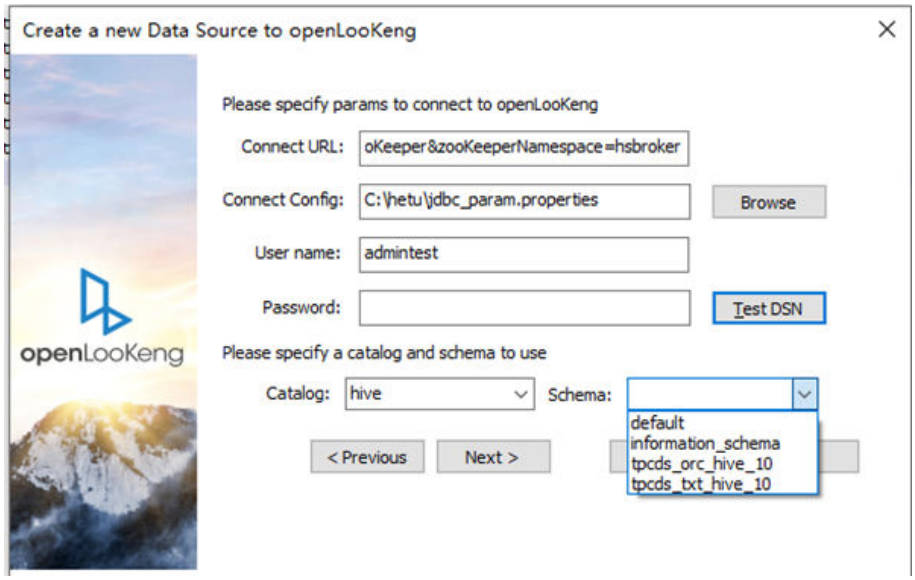
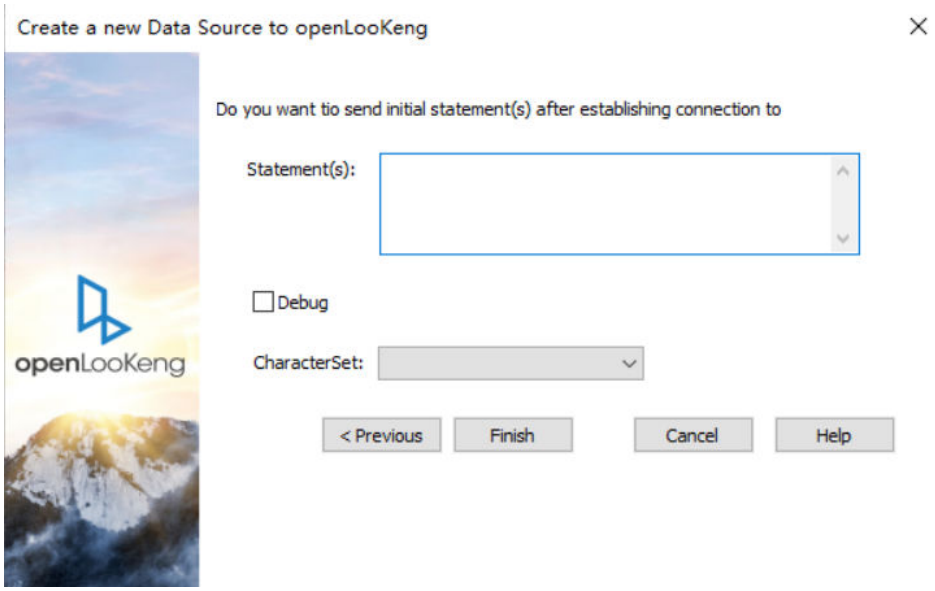


Figure 9-23 Viewing the content



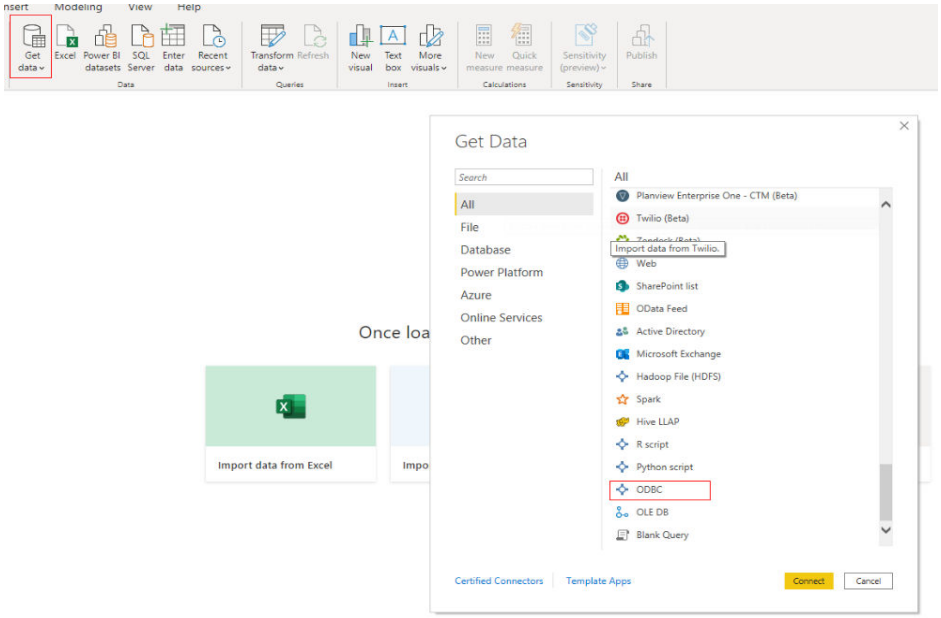
Step 8 Click **Finish**.

Figure 9-24 Completing the connection



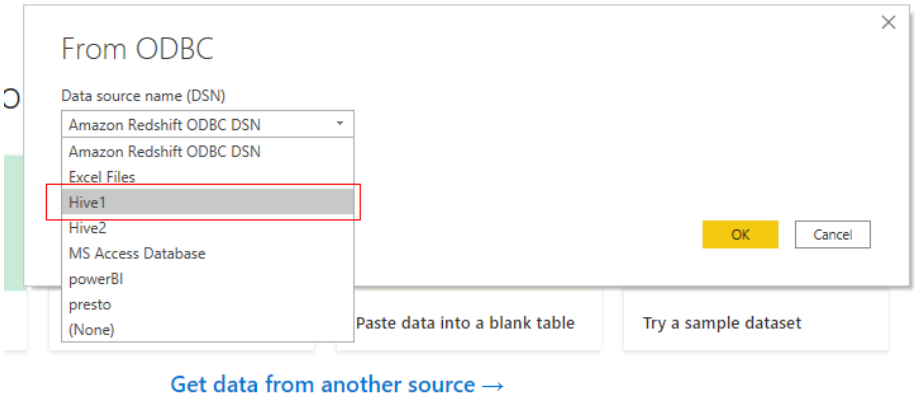
Step 9 To use Power BI for interconnection, choose **Get data** > **All** > **ODBC** > **Connect**.

Figure 9-25 Selecting ODBC



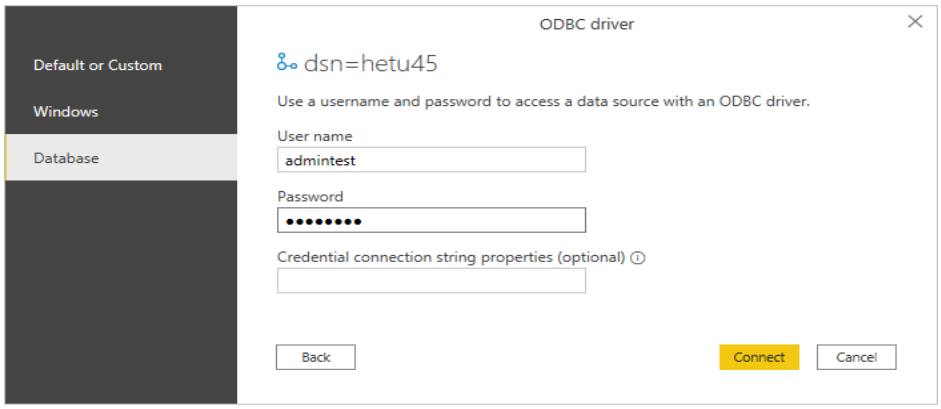
Step 10 Select the data source to be added and click **OK**.

Figure 9-26 Adding a data source



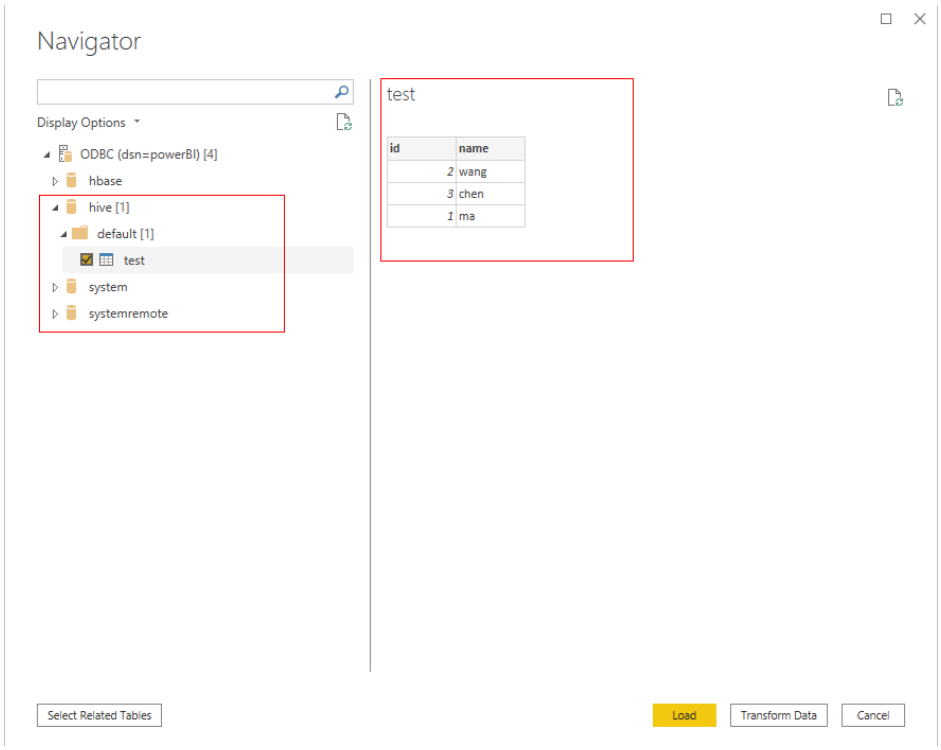
Step 11 Enter **User name** and **Password** of the user who downloads the credential, and click **Connect**.

Figure 9-27 Entering the database username and password



Step 12 After the connection is successful, all table information is displayed, as shown in **Figure 9-28**.

Figure 9-28 Successful connection



----End

9.12.4 Using Yonghong BI to Access HetuEngine

Use Yonghong Desktop 9.1 as an example to describe how to access HetuEngine.

Prerequisites

- Yonghong Desktop has been installed.
- The JDBC JAR file has been obtained. For details, see **Step 1**.
- A human-machine user, for example, **hetu_user**, has been created in the cluster. For details, see **Creating a HetuEngine User**. For clusters with Ranger

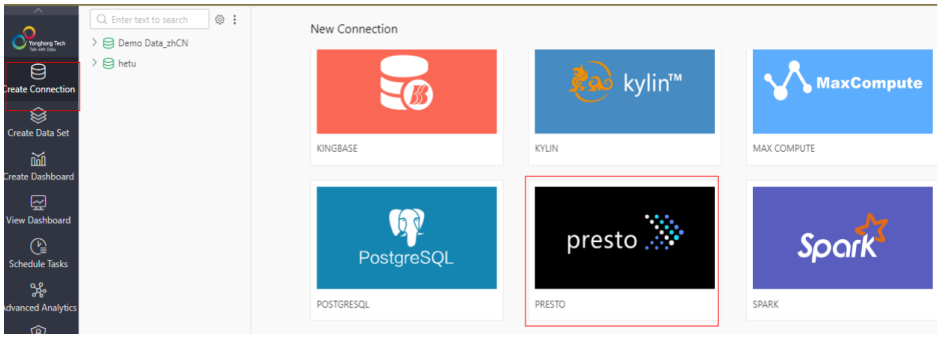
authentication enabled, the Ranger permission must be added to user **hetu_user** based on service requirements. For details, see **Adding a Ranger Access Permission Policy for HetuEngine**.

- A compute instance has been created and is running properly. For details, see **Creating a HetuEngine Compute Instance**.

Procedure

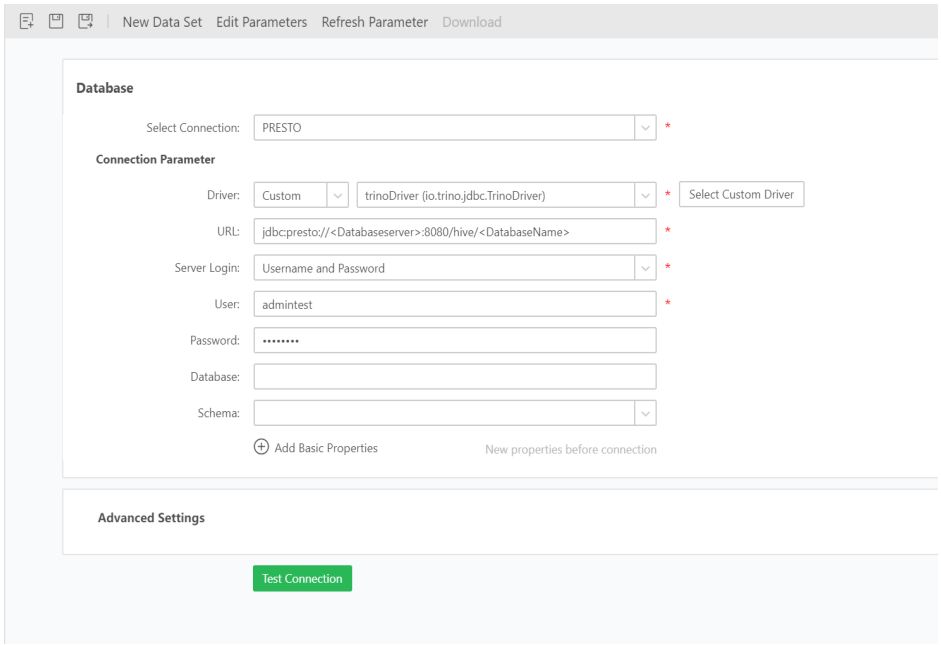
Step 1 Open Yonghong Desktop and choose **Create Connection** > **presto**.

Figure 9-29 Opening presto



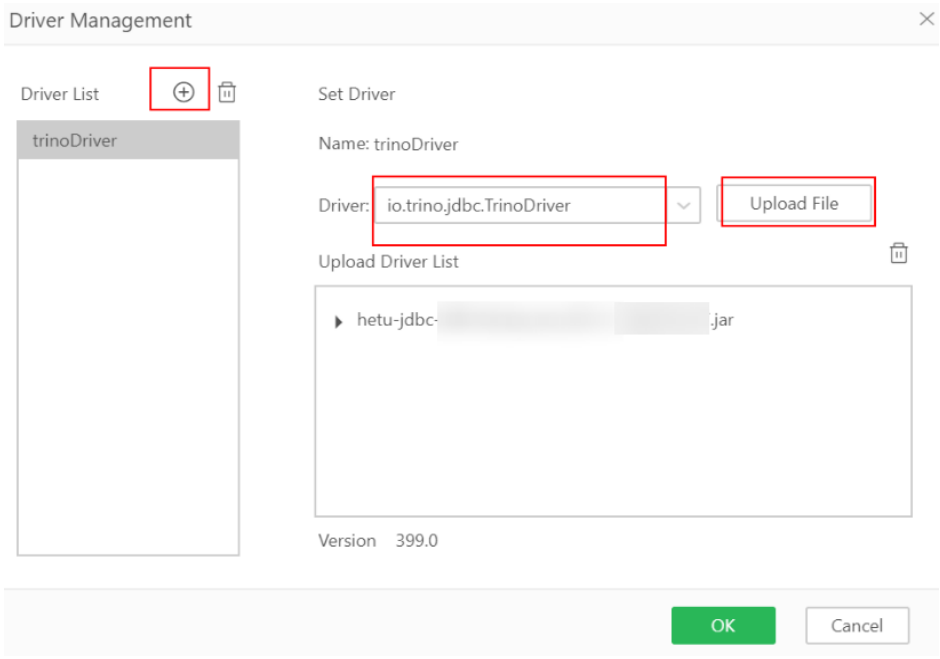
Step 2 On the data source configuration page, set parameters by referring to **Figure 9-30**. **User** and **Password** are the username and password of the created human-machine user. After the configuration is complete, click **Test Connection**.

Figure 9-30 Configuring the data source



- **Driver**: Choose **Custom** > **Select Custom Driver**. Click , edit the driver name, click **Upload File** to upload the obtained JDBC JAR file, and click **OK**.

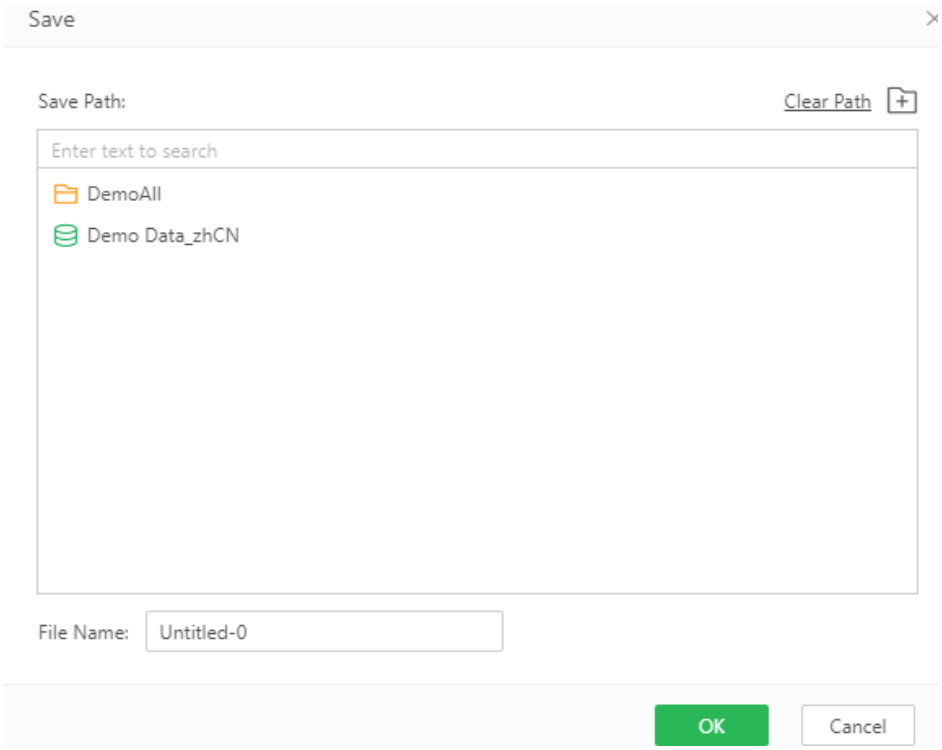
Figure 9-31 Driver management settings



- **URL**: Enter the URL either in the HSFabric or HSBroker mode. For details, see **Table 9-55**.
- **Server Login**: Select **Username and Password** and enter the username and password.

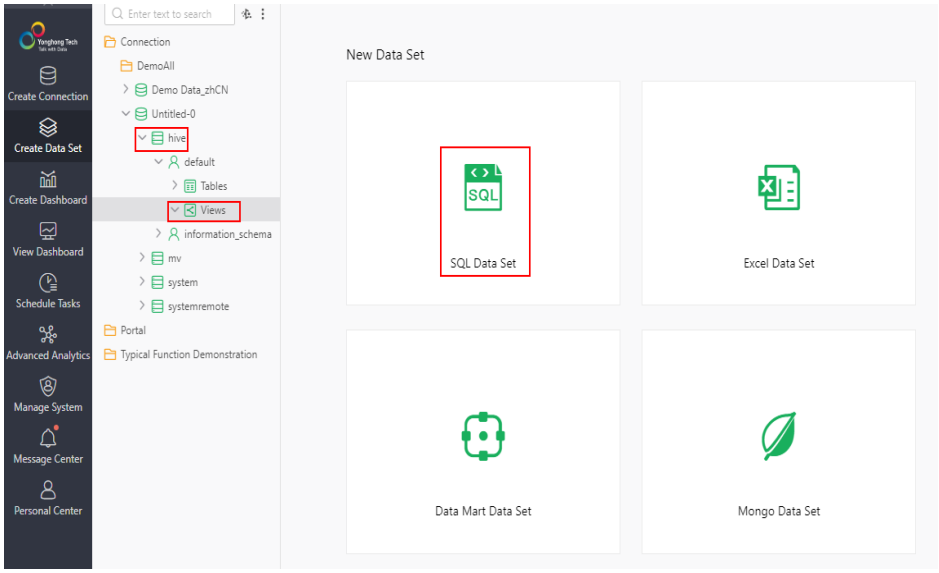
Step 3 Click **New Data Set**. On the page that is displayed, modify the save path and change the file name by referring to **Figure 9-32**, and click **OK**.

Figure 9-32 Modifying the save path and changing the file name



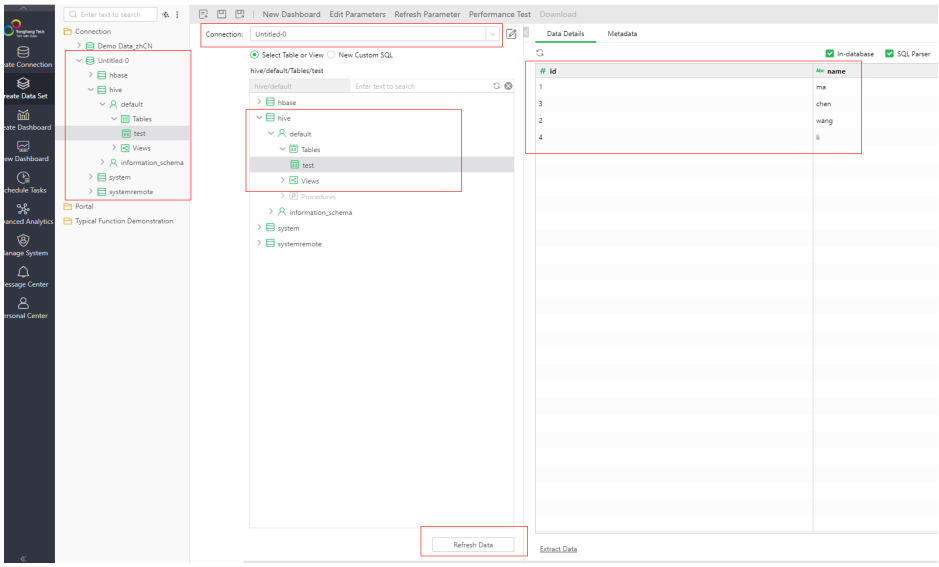
Step 4 Select the file name of the data set created in **Step 3** under **DemoAll**. The default file name **Untitled-0** is used as an example. Choose **Untitled-0** > **hive** > **default** > **Views** and select **SQL Data Set** under **New Data Set** in the right pane.

Figure 9-33 Selecting the SQL data set



Step 5 In the **Connection** area, select the new data set created in **Step 3**. All table information is displayed. Select a table, for example, **test**, and click **Refresh Data**. All table information is displayed in the **Data Details** area on the right.

Figure 9-34 Viewing table information



----End

9.13 Developing and Applying Functions and UDFs

9.13.1 HetuEngine Function Plugin Development and Application

You can customize functions to extend SQL statements to meet personalized requirements. These functions are called UDFs.

This section describes how to develop and apply HetuEngine function plugins.

NOTE

The development must be based on JDK 17.0.4 or later.

Developing Function Plugins

This sample implements two function plugins described in the following table.

Table 9-56 HetuEngine function plugins

Parameter	Description	Type
add_two	Adds **2** to the input integer and returns the result.	ScalarFunction
avg_double	Aggregates and calculates the average value of a specified column. The field type of the column is **double**.	AggregationFunction

Step 1 Create a Maven project. Set **groupId** to **com.test.functions** and **artifactId** to **myfunctions**. The two values can be customized based on the site requirements.

Step 2 Modify the **pom.xml** file as follows:

```
<project xmlns="http://maven.apache.org/POM/4.0.0" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:schemaLocation="http://maven.apache.org/POM/4.0.0 http://maven.apache.org/xsd/maven-4.0.0.xsd">
    <modelVersion>4.0.0</modelVersion>
    <groupId>com.test.functions</groupId>
    <artifactId>myfunctions</artifactId>
    <version>0.0.1-SNAPSHOT</version>
    <packaging>trino-plugin</packaging>
   <properties>
      <project.build.targetJdk>17</project.build.targetJdk>
      <dep.guava.version>31.1-jre</dep.guava.version>
       <dep.hetu.version>399-h0.cbu.mrs.321.r13</dep.hetu.version>
   </properties>

    <dependencies>
        <dependency>
            <groupId>com.google.guava</groupId>
            <artifactId>guava</artifactId>
            <version>${dep.guava.version}</version>
        </dependency>

        <dependency>
            <groupId>io.trino</groupId>
            <artifactId>trino-spi</artifactId>
            <version>${dep.hetu.version}</version>
            <scope>provided</scope>
```

```
        </dependency>

    </dependencies>

    <build>
        <plugins>
            <plugin>
                <groupId>org.apache.maven.plugins</groupId>
                <artifactId>maven-assembly-plugin</artifactId>
                <version>3.3.0</version>
                <configuration>
                    <encoding>UTF-8</encoding>
                </configuration>
            </plugin>
            <plugin>
                <groupId>io.trino</groupId>
                <artifactId>trino-maven-plugin</artifactId>
                <version>11</version>
                <extensions>true</extensions>
            </plugin>
        </plugins>
    </build>
</project>
```

Step 3 Create the implementation class of the function plugin.

1. Create the function plugin implementation class **com.test.functions.scalar.MyFunction**. The content is as follows:

```
package com.test.functions.scalar;
import io.trino.spi.function.ScalarFunction;
import io.trino.spi.function.SqlNullable;
import io.trino.spi.function.SqlType;
import io.trino.spi.type.StandardTypes;
import jdk.jfr.Description;
public class MyFunction {
    private MyFunction() {
    }
    @Description("Add two")
    @ScalarFunction("add_two")
    @SqlType(StandardTypes.INTEGER)
    public static long add2(@SqlNullable @SqlType(StandardTypes.INTEGER) Long i) {
        return i + 2;
    }
}
```

2. Create the function plugin implementation class **com.test.function.aggregation.MyAverageAggregationFunction**. The content is as follows:

```
package com.test.functions.aggregation;

import static io.trino.spi.type.DoubleType.DOUBLE;

import io.trino.spi.block.BlockBuilder;
import io.trino.spi.function.AggregationFunction;
import io.trino.spi.function.AggregationState;
import io.trino.spi.function.CombineFunction;
import io.trino.spi.function.InputFunction;
import io.trino.spi.function.OutputFunction;
import io.trino.spi.function.SqlType;
import io.trino.spi.type.StandardTypes;

@AggregationFunction("avg_double")
public class MyAverageAggregationFunction
{
    private MyAverageAggregationFunction() {}

    @InputFunction
    public static void input(
        @AggregationState LongAndDoubleState state,
```

```
        @SqlType(StandardTypes.DOUBLE) double value)
    {
        state.setLong(state.getLong() + 1);
        state.setDouble(state.getDouble() + value);
    }

    @CombineFunction
    public static void combine(
        @AggregationState LongAndDoubleState state,
        @AggregationState LongAndDoubleState otherState)
    {
        state.setLong(state.getLong() + otherState.getLong());
        state.setDouble(state.getDouble() + otherState.getDouble());
    }

    @OutputFunction(StandardTypes.DOUBLE)
    public static void output(@AggregationState LongAndDoubleState state, BlockBuilder out)
    {
        long count = state.getLong();
        if (count == 0) {
            out.appendNull();
        }
        else {
            double value = state.getDouble();
            DOUBLE.writeDouble(out, value / count);
        }
    }
}
```

Step 4 Create the **com.test.functions.aggregation.LongAndDoubleState** API on which AverageAggregation depends.

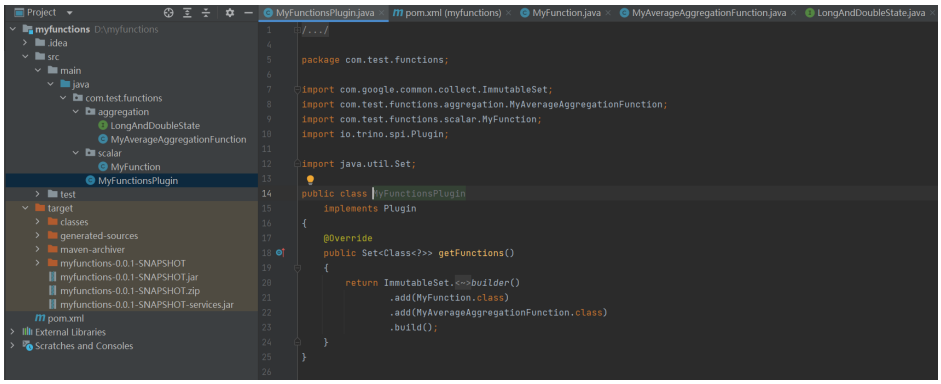
```
package com.test.functions.aggregation;

import io.trino.spi.function.AccumulatorState;

public interface LongAndDoubleState
    extends AccumulatorState
{
    long getLong();

    void setLong(long value);

    double getDouble();

    void setDouble(double value);
}
```

Step 5 Create the function plugin registration class **com.test.functions.MyFunctionsPlugin**. The content is as follows:

```
package com.test.functions;

import com.google.common.collect.ImmutableSet;
import com.test.functions.aggregation.MyAverageAggregationFunction;
import com.test.functions.scalar.MyFunction;

import io.trino.spi.Plugin;

import java.util.Set;

public class MyFunctionsPlugin
    implements Plugin
{
    @Override
    public Set<Class<?>> getFunctions() {
        return ImmutableSet.<Class<?>>builder()
            .add(MyFunction.class)
            .add(MyAverageAggregationFunction.class)
            .build();
```

```
    }
}
```

Step 6 Pack the Maven project and obtain the **myfunctions-0.0.1-SNAPSHOT** directory in the **target** directory. The following figure shows the overall structure of the project:



----End

Deploying Function Plugins

Before the deployment, ensure that:

- The HetuEngine service is normal.
- The HDFS and HetuEngine client have been installed in a directory on the cluster node, for example, **/opt/client**.
- A HetuEngine user has been created. For details about how to create a user, see **Creating a HetuEngine User**.

Step 1 Upload the **myfunctions-0.0.1-SNAPSHOT** directory obtained in packing the Maven project to any directory on the node where the client is installed.

Step 2 Upload the **myfunctions-0.0.1-SNAPSHOT** directory to HDFS.

1. Log in to the node where the client is installed and perform security authentication.

   cd /opt/client

   source bigdata_env

   kinit *HetuEngine user*

   Enter the password as prompted and change the password upon the first authentication.

2. Create the following paths in HDFS. If the paths already exist, skip this step.

   hdfs dfs -mkdir -p /user/hetuserver/udf/data/externalFunctionsPlugin

3. Upload the **myfunctions-0.0.1-SNAPSHOT** directory to HDFS.

   hdfs dfs -put myfunctions-0.0.1-SNAPSHOT /user/hetuserver/udf/data/externalFunctionsPlugin

4. Change the directory owner and owner group.

   hdfs dfs -chown -R hetuserver:hadoop /user/hetuserver/udf/data

Step 3 Restart the HetuEngine compute instance.

----End

Verifying Function Plugins

Step 1 Log in to the node where the client is installed and perform security authentication.

cd /opt/client

source bigdata_env

kinit *HetuEngine user*

hetu-cli

Step 2 Select columns that have numeric values (int or double type) in a table from the verification environment. In this example, table **hive.default.test1** is used. Run the following command to verify the function plugins:

1. Query a table.

   select * from hive.default.test1;

   ```
   select * from hive.default.test1;
   name  |  price
   --------|-------
   apple   |  17.8
   orange |  25.0
   (2 rows)
   ```

2. Return the average value.

   select avg_double(price) from hive.default.test1;

   ```
   select avg_double(price) from hive.default.test1;
   _col0
   -------
    21.4
   (1 row)
   ```

3. Return the value of the input integer plus 2.

   select add_two(4);

   ```
   select add_two(4);
   _col0
   -------
      6
   (1 row)
   ```

----End

9.13.2 Hive UDF Development and Application

You can customize functions to extend SQL statements to meet personalized requirements. These functions are called UDFs.

This section describes how to develop and apply Hive UDFs.

NOTE

The development must be based on JDK 17.0.4 or later.

Developing Hive UDFs

This sample implements one Hive UDF described in the following table.

Table 9-57 Hive UDF

Parameter	Description
AutoAddOne	Adds **1** to the input value and returns the result.

NOTE

- A common Hive UDF must be inherited from **org.apache.hadoop.hive.ql.exec.UDF**.
- A common Hive UDF must implement at least one **evaluate()**. The **evaluate** function supports overloading.
- Currently, only the following data types are supported:
  - boolean, byte, short, int, long, float, and double
  - Boolean, Byte, Short, Int, Long, Float, and Double
  - List and Map

  UDFs, UDAFs, and UDTFs currently do not support complex data types other than the preceding ones.
- Currently, Hive UDFs supports only less than or equal to five input parameters. UDFs with more than five input parameters will fail to be registered.
- If the input parameter of a Hive UDF is **null**, the call returns **null** directly without parsing the Hive UDF logic. As a result, the UDF execution result may be inconsistent with the Hive execution result.
- To add the **hive-exec-3.1.1** dependency package to the Maven project, you can obtain the package from the Hive installation directory.
- (Optional) If the Hive UDF depends on a configuration file, you are advised to save the configuration file as a resource file in the **resources** directory so that it can be packed into the Hive UDF function package.

Step 1 Create a Maven project. Set **groupId** to **com.test.udf** and **artifactId** to **udf-test**. The two values can be customized based on the site requirements.

Step 2 Modify the **pom.xml** file as follows:

```
<project xmlns="http://maven.apache.org/POM/4.0.0" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:schemaLocation="http://maven.apache.org/POM/4.0.0 http://maven.apache.org/xsd/maven-4.0.0.xsd">
    <modelVersion>4.0.0</modelVersion>
    <groupId>com.test.udf</groupId>
    <artifactId>udf-test</artifactId>
    <version>0.0.1-SNAPSHOT</version>

    <dependencies>
      <dependency>
        <groupId>org.apache.hive</groupId>
        <artifactId>hive-exec</artifactId>
        <version>3.1.1</version>
      </dependency>
    </dependencies>

    <build>
      <plugins>
        <plugin>
```

```
            <artifactId>maven-shade-plugin</artifactId>
            <executions>
               <execution>
                  <phase>package</phase>
                  <goals>
                     <goal>shade</goal>
                  </goals>
               </execution>
            </executions>
         </plugin>
         <plugin>
            <artifactId>maven-resources-plugin</artifactId>
            <executions>
               <execution>
                  <id>copy-resources</id>
                  <phase>package</phase>
                  <goals>
                     <goal>copy-resources</goal>
                  </goals>
                  <configuration>
                     <outputDirectory>${project.build.directory}/</outputDirectory>
                     <resources>
                        <resource>
                           <directory>src/main/resources/</directory>
                           <filtering>false</filtering>
                        </resource>
                     </resources>
                  </configuration>
               </execution>
            </executions>
         </plugin>
      </plugins>
   </build>
</project>
```

Step 3 Create the implementation class of the Hive UDF.

```
import org.apache.hadoop.hive.ql.exec.UDF;

/**
 * AutoAddOne
 *
 * @since 2020-08-24
 */
public class AutoAddOne extends UDF {
    public int evaluate(int data) {
        return data + 1;
    }
}
```

Step 4 Package the Maven project. The **udf-test-0.0.1-SNAPSHOT.jar** file in the **target** directory is the Hive UDF function package.

NOTE

You need to pack all dependencies into a JAR package.

----End

Configuring Hive UDFs

In configuration file **udf.properties**, add registration information in the "Function_name Class_path" format to each line.

The following provides an example of registering four Hive UDFs in configuration file **udf.properties**:

```
booleanudf io.hetu.core.hive.dynamicfunctions.examples.udf.BooleanUDF
shortudf io.hetu.core.hive.dynamicfunctions.examples.udf.ShortUDF
```

```
byteudf io.hetu.core.hive.dynamicfunctions.examples.udf.ByteUDF
intudf io.hetu.core.hive.dynamicfunctions.examples.udf.IntUDF
```

NOTE

- If the added Hive UDF registration information is incorrect, for example, the format is incorrect or the class path does not exist, the system ignores the incorrect registration information and prints the corresponding logs.
- If duplicate Hive UDFs are registered, the system will only register once and ignore the duplicate registrations.
- If the Hive UDF to be registered is the same as that already registered in the system, the system throws an exception and cannot be started properly. To solve this problem, you need to delete the Hive UDF registration information.

Deploying Hive UDFs

To use an existing Hive UDF in HetuEngine, you need to upload the UDF function package, **udf.properties** file, and configuration file on which the UDF depends to the specified HDFS directory, for example, **/user/hetuserver/udf/**, and restart the HetuEngine compute instance.

Step 1 Create the **/user/hetuserver/udf/data/externalFunctions** directory, save the **udf.properties** file in the **/user/hetuserver/udf** directory, save the UDF function package in the **/user/hetuserver/udf/data/externalFunctions** directory, and save the configuration files on which the UDF depends in the **/user/hetuserver/udf/data** directory.

- Upload the files on the HDFS page:
  a. Log in to FusionInsight Manager using the HetuEngine username and choose **Cluster** > **Services** > **HDFS**.
  b. In the **Basic Information** area on the **Dashboard** page, click the link next to **NameNode WebUI**.
  c. Choose **Utilities** > **Browse the file system** and click  to create the **/user/hetuserver/udf/data/externalFunctions** directory.
  d. Go to **/user/hetuserver/udf** and click  to upload the **udf.properties** file.
  e. Go to the **/user/hetuserver/udf/data/** directory and click  to upload the configuration file on which the UDF depends.
  f. Go to the **/user/hetuserver/udf/data/externalFunctions** directory and click  to upload the UDF function package.
- Use the HDFS CLI to upload the files.
  a. Log in to the node where the HDFS service client is located and switch to the client installation directory, for example, **/opt/client**.
     cd /opt/client
  b. Run the following command to configure environment variables:
     source bigdata_env

c. If the cluster is in security mode, run the following command to authenticate the user. In normal mode, skip user authentication.

kinit *HetuEngine username*

Enter the password as prompted.

d. Run the following commands to create directories and upload the prepared UDF function package, **udf.properties** file, and configuration file on which the UDF depends to the target directories:

hdfs dfs -mkdir /user/hetuserver/udf/data/externalFunctions

hdfs dfs -put ./*Configuration files on which the UDF depends* **/user/hetuserver/udf/data**

hdfs dfs -put ./udf.properties /user/hetuserver/udf

hdfs dfs -put ./*UDF function package* **/user/hetuserver/udf/data/externalFunctions**

Step 2 Restart the HetuEngine compute instance.

----End

Using Hive UDFs

Use a client to access a Hive UDF:

1. Log in to the HetuEngine client. For details, see **Using the HetuEngine Client**.
2. Run the following command to use a Hive UDF:

select AutoAddOne(1);

```
select AutoAddOne(1);
_col0
-------
    2
(1 row)
```

9.13.3 HetuEngine UDF Development and Application

You can customize functions to extend SQL statements to meet personalized requirements. These functions are called UDFs.

This section describes how to develop and apply HetuEngine UDFs.

NOTE

The development must be based on JDK 17.0.4 or later.

Developing HetuEngine UDFs

This sample implements one HetuEngine UDF described in the following table.

Table 9-58 HetuEngine UDF

Parameter	Description
AddTwo	Adds **2** to the input value and returns the result.

Step 1 Create a Maven project. Set **groupId** to **com.test.udf** and **artifactId** to **udf-test**. The two values can be customized based on the site requirements.

Step 2 Modify the **pom.xml** file as follows:

```
<project xmlns="http://maven.apache.org/POM/4.0.0" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:schemaLocation="http://maven.apache.org/POM/4.0.0 http://maven.apache.org/xsd/maven-4.0.0.xsd">
    <modelVersion>4.0.0</modelVersion>
    <groupId>com.test.udf</groupId>
    <artifactId>udf-test</artifactId>
    <version>0.0.1-SNAPSHOT</version>

    <build>
      <plugins>
        <plugin>
          <artifactId>maven-shade-plugin</artifactId>
          <executions>
            <execution>
              <phase>package</phase>
              <goals>
                <goal>shade</goal>
              </goals>
            </execution>
          </executions>
        </plugin>
        <plugin>
          <artifactId>maven-resources-plugin</artifactId>
          <executions>
            <execution>
              <id>copy-resources</id>
              <phase>package</phase>
              <goals>
                <goal>copy-resources</goal>
              </goals>
              <configuration>
                <outputDirectory>${project.build.directory}/</outputDirectory>
                <resources>
                  <resource>
                    <directory>src/main/resources/</directory>
                    <filtering>false</filtering>
                  </resource>
                </resources>
              </configuration>
            </execution>
          </executions>
        </plugin>
      </plugins>
    </build>
</project>
```

Step 3 Create the implementation class of the HetuEngine UDF.

```
package com.xxxbigdata..hetuengine.functions;

public class AddTwo {
   public Integer evaluate(Integer num) {
      return num + 2;
   }
}
```

Step 4 Package the Maven project. The **udf-test-0.0.1-SNAPSHOT.jar** file in the **target** directory is the HetuEngine UDF function package.

NOTE

- A common HetuEngine UDF must implement at least one **evaluate()**. The **evaluate** function supports overloading.
- Currently, HetuEngine UDFs supports only less than or equal to five input parameters. HetuEngine UDFs with more than five input parameters will fail to be registered.
- You need to pack all dependencies into a JAR package.
- (Optional) If the HetuEngine UDF depends on a configuration file, you are advised to save the configuration file as a resource file in the **resources** directory so that it can be packed into the HetuEngine UDF function package.

----End

Deploying HetuEngine UDFs

To use the HetuEngine UDF in HetuEngine, you need to upload the corresponding UDF function package to a specified HDFS directory, for example, **/udf/hetuserver**. The directory can be customized based on the site requirements.

Create the **/udf/hetuserver** directory and save the UDF function package to it.

- Upload the files on the HDFS page:
  a. Log in to FusionInsight Manager using the HetuEngine username and choose **Cluster** > **Services** > **HDFS**.
  b. In the **Basic Information** area on the **Dashboard** page, click the link next to **NameNode WebUI**.
  c. Choose **Utilities** > **Browse the file system** and click  to create the **/udf/hetuserver** directory.
  d. Go to the **/udf/hetuserver** directory and click  to upload UDF function package.
- Use the HDFS CLI to upload the files.
  a. Log in to the node where the HDFS service client is located and switch to the client installation directory, for example, **/opt/client**.
     cd /opt/client
  b. Run the following command to configure environment variables:
     source bigdata_env
  c. If the cluster is in security mode, run the following command to authenticate the user. In normal mode, skip user authentication.
     kinit*HetuEngineusername*
     Enter the password as prompted.
  d. Run the following commands to create a directory and upload the prepared UDF function package to the target directory:
     hdfs dfs -mkdir -p /udf/hetuserver
     hdfs dfs -put ./*UDF function package* **/udf/hetuserver**.
  e. Run the following command to change the permission of the UDF function package:
     hdfs dfs -chmod 644 /udf/hetuserver/*UDF function package*

NOTICE

- When uploading a UDF JAR file to a user-defined HDFS directory, ensure that the user has the read permission on the JAR file. You are advised to use **chmod 644** to set the permission. In addition, if you want the UDF JAR file to be deleted during the HetuEngine service uninstallation, you can create a user-defined directory in the **/user/hetuserver/** directory.
- Currently, HetuEngine supports the UDF JAR file to be stored only in **hdfs://** *Resource URI* in HDFS.
- If the JAR file is re-uploaded due to function modification or addition, HetuEngine caches the classloader for 5 minutes by default. The JAR file does not take effect immediately, instead, it is updated and reloaded 5 minutes later.

Using HetuEngine UDFs

Use a client to access a HetuEngine UDF.

1. Log in to the HetuEngine client. For details, see **Using the HetuEngine Client**.
2. Create a HetuEngine UDF.

```
CREATE FUNCTION example.namespace01.add_two (
 num integer
)
RETURNS integer
LANGUAGE JAVA
DETERMINISTIC
SYMBOL "com.xxx.bigdata.hetuengine.functions.AddTwo"
URI "hdfs://hacluster/udf/hetuserver/udf-test-0.0.1-SNAPSHOT.jar";
```

3. Use the HetuEngine UDF.

```
select example.namespace01.add_two(2);
_col0
-------
    4
(1 row)
```

NOTE

Overloading is used to distinguish functions with the same name in the implementation classes. Therefore, you need to specify different function names when creating a HetuEngine UDF.

9.14 HetuEngine Logs

Log Description

Log paths:

The HetuEngine logs are stored in **/var/log/Bigdata/hetuengine/** and **/var/log/Bigdata/audit/hetuengine/**.

Log archiving rules:

Log archiving rules use the FixedWindowRollingPolicy policy. The maximum size of a single file and the maximum number of log archive files can be configured. The rules are as follows:

- When the size of a single file exceeds the default maximum value, a new compressed archive file is generated. The naming rule of the compressed archive log file is as follows: *<Original log name>.[ID]*.log.gz.
- When the number of log archive files reaches the maximum value, the earliest log file is deleted.

By default, the maximum size of an audit log file is 30 MB, and the maximum number of log archive files is 20.

By default, the maximum size of a run log file is 100 MB, and the maximum number of log archive files is 20.

To change the maximum size of a single run log file or audit log file or change the maximum number of log archive files of an instance, perform the following operations:

Step 1 Log in to Manager.

Step 2 Choose **Cluster** > **Services** > **HetuEngine** > **Configurations** > **All Configurations**.

Step 3 In the parameter list of log levels, search for **logback.xml** to view the current run log and audit log configurations of HSBroker, HSConsole, HSFabric, and QAS.

Step 4 Select the configuration item to be modified and modify it.

Step 5 Click **Save**, and then click **OK**. The configuration automatically takes effect after about 30 seconds.

----End

Table 9-59 HetuEngine log list

Log Category	Log File	Description
Installation, startup, and stop log	prestart.log	Preprocessing script log before startup
	start.log	Startup log
	stop.log	Stop log
	postinstall.log	Installation log
Run log	*Instance name*.log	Run log
	*Instance name*_wsf.log	Interface parameter verification log
	hdfs://hacluster/hetuserverhistory/*Tenant*/*Coordinator or worker*/*application_ID*/*container_ID*/*yyyyMMdd*/server.log	Run log of the HetuEngine compute instance
Status check log	service_check.log	Health check log
	service_getstate.log	Status check log

Log Category	Log File	Description
	availability-check.log	HetuEngine status check log
	haCheck.log	Log generated when the QAS checks the HA status
Audit log	*Instance name*-audit.log	Audit log
	hsbroker-audit.log	Audit log of HSBroker operations
	hsconsole-audit.log	Audit log of HSConsole operations
	hsfabric-audit.log	Audit log of HetuEngine operations performed across domains
	hdfs://hacluster/hetuserverhistory/*Tenant*/coordinator/*application_ID*/*container_ID*/*yyyyMMdd*/hetuserver-engine-audit.log	Audit log of the HetuEngine compute instance
queryInfo log	hdfs://hacluster/hetuserverhistory/*Tenant*/*Coordinator*/*application_ID*/*container_ID*/*yyyyMMdd*/queryinfo.log	queryInfo log of HetuEngine compute instances, which records SQL running statistics.
Clean log	cleanup.log	Script cleanup log
Initialization log	hetupg.log	Metadata initialization log
	ranger-trino-plugin-enable.log	Operation log of integrating Ranger plug-ins to the HetuEngine kernel
Client log	qas_client.log	ZooKeeper client log of the QAS instance
Stack information log	threadDump-<*DATE*>.log	Log printed when instances are restarted or stopped
Other	hetu-updateKrb5.log	Log generated when the Hive data source configuration is automatically updated after the Hive cluster domain is changed.

Log Category	Log File	Description
	hetu_utils.log	Log generated when the preprocessing script calls the tool class to upload files to the HDFS during startup.

Log Level

Table 9-60 describes the log levels provided by HetuEngine. The priorities of log levels are OFF, ERROR, WARN, INFO, and DEBUG in descending order. Logs whose levels are higher than or equal to the specified level are printed. The number of printed logs decreases as the specified log level increases.

Table 9-60 Log levels

Level	Description
OFF	Logs of this level record no logs.
ERROR	Logs of this level record error information about the current event processing.
WARN	Logs of this level record exception information about the current event processing.
INFO	Logs of this level record normal running status information about the system and events.
DEBUG	Logs of this level record the system information and system debugging information.

To change the run log or audit log level of an instance, perform the following steps:

Step 1 Log in to FusionInsight Manager.

Step 2 Choose **Cluster** > **Services** > **HetuEngine** > **Configurations** > **All Configurations**.

Step 3 In the parameter list of log levels, search for **logback.xml** to view the current run log and audit log levels of HSBroker, HSConsole, and HSFabric.

Step 4 Select a desired log level.

Step 5 Click **Save**, and then click **OK**. The configuration automatically takes effect after about 30 seconds.

----End

To change the HetuEngine Coordinator/Worker log level, perform the following steps:

Step 1 Log in to FusionInsight Manager.

Step 2 Choose **Cluster** > **Services** > **HetuEngine** > **Configurations** > **All Configurations**.

Step 3 In the parameter list of log levels, search for **log.properties** to view the current log levels.

Step 4 Select a desired log level.

Step 5 Click **Save**, and then click **OK**. Wait until the operation is successful.

Step 6 Choose **Cluster** > **Services** > **HetuEngine** > **Instance**, click the HSBroker instance in the role list, and choose **More** > **Restart Instance**.

Step 7 After the HSBroker instance is restarted, choose **Cluster** > **Services** > **HetuEngine**. On the overview page, click the link next to **HSConsole WebUI** to go to the compute instance page.

Step 8 Select the compute instances to be restarted and click **Stop**. After all instances are stopped, click **Start** to restart the compute instances.

----End

9.15 HetuEngine Performance Tuning

9.15.1 Adjusting the YARN Service Configuration

Scenario

HetuEngine depends on the resource allocation and control capabilities provided by Yarn. You need to adjust the Yarn service configuration based on the actual service and cluster server configuration to achieve the optimal performance.

Procedure

Step 1 Log in to FusionInsight Manager.

Step 2 Choose **Cluster** > **Services** > **Yarn** > **Configurations** > **All Configurations** and set Yarn service parameters by referring to **Table 9-61**.

Table 9-61 Yarn configuration parameters

Parameter	Description	Default Value	Recommended Value
yarn.nodemanager.resource.memory-mb	Total physical memory on the node that can be used by Yarn. The default value is 16,384 MB. If the node has permanent processes of other services, reduce this value to reserve sufficient resources for the processes.	16384	To achieve the optimal performance, set this parameter to 90% of the minimum physical memory of the node in the cluster.
yarn.nodemanager.resource.cpu-vcores	Number of CPU cores that can be allocated to a container.	8	To achieve the optimal performance, set this parameter to the minimum number of vCores of the node in the cluster.
yarn.scheduler.maximum-allocation-mb	Maximum memory requested by each container of ResourceManager. The unit is MB. If much memory is requested, the memory that is set by the parameter is allocated.	65536	To achieve the optimal performance, set this parameter to 90% of the minimum physical memory of the node in the cluster.
yarn.scheduler.maximum-allocation-vcores	Maximum value requested by each container of ResourceManager, represented by the number of virtual CPU cores. Requests where the requested values are greater than this value are invalid and the values will be overwritten by this parameter.	32	To achieve the optimal performance, set this parameter to the minimum number of vCores of the node in the cluster.

Step 3 Click **Save**.

Step 4 Choose **Cluster** > **Services** > **Yarn** > **More** > **Restart Service** to restart the Yarn service for the parameters to take effect.

----End

9.15.2 Adjusting Cluster Node Resource Configurations

Scenario

The default memory size and disk overflow path of HetuEngine are not the best. You need to adjust node resources in the cluster based on the actual service and server configuration of the cluster to achieve the optimal performance.

Procedure

Step 1 Log in to FusionInsight Manager.

Step 2 Choose **Cluster** > **Services** > **HetuEngine** > **Configurations** > **All Configurations** and adjust the cluster node resource parameters by referring to **Table 9-62**.

Table 9-62 Parameters for configuring cluster node resources

Parameter	Default Value	Recommended Value	Description	Parameter File
yarn.hetuserver.engine.coordinator.memory	5120	At least 2 GB less than that of **yarn.scheduler.maximum-allocation-mb**	Memory size used by a Coordinator node	application.properties
yarn.hetuserver.engine.coordinator.number-of-containers	2	2	Number of Coordinator nodes	application.properties
yarn.hetuserver.engine.coordinator.number-of-cpus	1	At least two vCores less than **yarn.scheduler.maximum-allocation-vcores**	CPU vCores used by a Coordinator node	application.properties
yarn.hetuserver.engine.worker.memory	10240	At least 2 GB less than that of **yarn.scheduler.maximum-allocation-mb**	Memory size used by a worker node	application.properties
yarn.hetuserver.engine.worker.number-of-containers	2	Adjusted based on application requirements	Number of worker nodes	application.properties
yarn.hetuserver.engine.worker.number-of-cpus	1	At least two vCores less than **yarn.scheduler.maximum-allocation-vcores**	CPU vCores used by a Worker node	application.properties

Parameter	Default Value	Recommended Value	Description	Parameter File
Xmx size in the **extraJavaOptions** parameter	8 GB	*Memory size used by a worker node x 0.8*	Maximum available memory of the worker JVM process	worker.jvm.config
query.max-memory-per-node	5 GB	Worker JVM x 0.7	Maximum available memory of a Query node	worker.config.properties
query.max-total-memory-per-node	5 GB	Worker JVM x 0.7	Maximum available memory of a Query + System node	worker.config.properties
memory.heap-headroom-per-node	3 GB	Worker JVM x 0.3	Maximum available memory of a system heap node	worker.config.properties
Xmx size in the **extraJavaOptions** parameter	4 GB	*Memory size used by a Coordinator node x 0.8*	Maximum available memory of the Coordinator JVM process	coordinator.jvm.config
query.max-memory-per-node	3 GB	Coordinator JVM x 0.7	Maximum memory that can be used for node query	coordinator.config.properties
query.max-total-memory-per-node	3 GB	Coordinator JVM x 0.7	Maximum available memory of a Query + System node	coordinator.config.properties
memory.heap-headroom-per-node	1 GB	Coordinator JVM x 0.3	Maximum available memory of a system heap node	coordinator.config.properties
query.max-memory	7 GB	Sum(query.max-memory-per-node) x 0.7	Maximum available memory of a Query cluster	worker.config.properties/ coordinator.config.properties

Parameter	Default Value	Recommended Value	Description	Parameter File
spiller-spill-path	CONTAINER_ROOT_PATH/tmp/hetuserver/hetuserver-sqlengine/	One or more independent SSDs	Disk output file path	worker.config.properties/coordinator.config.properties
max-spill-per-node	10 GB	Sum(Available space of each node) x 50%	Available disk space for storing output files of all queries on a node	worker.config.properties/coordinator.config.properties
query-max-spill-per-node	10 GB	80% of the available disk space on a node	Available disk space for storing output files of a query on a node	worker.config.properties/coordinator.config.properties

Step 3 Click **Save**.

Step 4 Choose **Cluster** > **Services** > **HetuEngine** > **More** > **Restart Service** to restart the HetuEngine service for the parameters to take effect.

----End

9.15.3 Optimizing INSERT Statements

Scenario

You can add custom configurations based on the number of partition columns in the query result to achieve optimal writing performance when using HetuEngine to write data to a Hive data source partition table.

Procedure

Step 1 Log in to FusionInsight Manager as a HetuEngine administrator and choose **Cluster** > **Services** > **HetuEngine**. The **HetuEngine** service page is displayed.

Step 2 In the **Basic Information** area on the **Dashboard** page, click the link next to **HSConsole WebUI**.

Step 3 On HSConsole, click **Data Source**. Locate the row that contains the target Hive data source, click **Edit** in the **Operation** column, and add custom configurations. You can adjust custom parameters by referring to **Table 9-63**.

Table 9-63 Performance optimization parameters of the INSERT statement

Parameter	Description
hive.max-partitions-per-writers	The value must be greater than or equal to the product of the values generated by the **Count(distinct)** method for all partition columns of the Hive data source partition table to which data is to be written.
task.writer-count	1

NOTE

The following is an example of the **Count(distinct)** method:

The **t2** table contains the **col1**, **col2**, and **col3** columns. The query result is as follows:

col1 col2 col3

A 100 5

C 103 4

B 101 3

E 110 4

D 100 5

- If **col3** is a partition column and its **Count(distinct)** value is **3**, you are advised to set **hive.max-partitions-per-writers** to a value no less than **3**.
- If the result table has multiple partition columns, for example, **col2** and **col3**, and the **Count(distinct)** values of **col2** and **col3** are **4** and **3**, respectively, you are advised to set **hive.max-partitions-per-writers** to a value no less than **12**.

Step 4 Click **OK**.

----End

9.15.4 Adjusting Metadata Cache

Scenario

When HetuEngine accesses the Hive data source, it needs to access the Hive metastore to obtain the metadata information. HetuEngine provides the metadata cache function. When the database or table of the Hive data source is accessed for the first time, the metadata information (database name, table name, table field, partition information, and permission information) of the database or table is cached, the Hive metastore does not need to be accessed again during subsequent access. If the table data of the Hive data source does not change frequently, the query performance can be improved to some extent.

Procedure

Step 1 Log in to FusionInsight Manager as a HetuEngine administrator and choose **Cluster** > **Services** > **HetuEngine**.

Step 2 On the **Dashboard** tab page that is displayed, find the **Basic Information** area, and click the link next to **HSConsole WebUI**.

Step 3 On HSConsole, click **Data Source**. Locate the row that contains the target Hive data source, click **Edit** in the **Operation** column, and add custom configurations according to **Table 9-64**.

Table 9-64 Metadata cache parameters

Parameter	Description	Default Value
hive.metastore-cache-ttl	Cache duration of the metadata of the co-deployed Hive data source.	0s
hive.metastore-cache-maximum-size	Maximum cache size of the metadata of the co-deployed Hive data source.	10000
hive.metastore-refresh-interval	Interval for refreshing the metadata of the co-deployed Hive data source.	1s
hive.per-transaction-metastore-cache-maximum-size	Maximum cache size of the metadata for each transaction of the co-deployed Hive data source.	1000

Step 4 Click **OK**.

----End

9.15.5 Enabling Dynamic Filtering

Scenario

HetuEngine provides the dynamic filtering function, which significantly improves the performance in join scenarios.

This section describes how to enable dynamic filtering.

Procedure

Step 1 Log in to FusionInsight Manager as a user who can access the HetuEngine web UI and choose **Cluster** > **Services** > **HetuEngine**. The **HetuEngine** service page is displayed.

Step 2 In the **Basic Information** area on the **Dashboard** tab page, click the link next to **HSConsole WebUI**. The HSConsole page is displayed.

Step 3 In the **Compute Instance** page, locate the row that contains the tenant to which the target instance belongs and click **Configure** in the **Operation** column.

Step 4 In the **Custom Configuration** area, click **Add** to add the following parameters:

Table 9-65 Dynamic filtering parameters

Parameter	Value	ConFile	Parameter Description
enable-dynamic-filtering	true	**coordinator.config.properties** and **worker.config.properties**	Whether to enable the dynamic filtering function. The default value is **false**.

Step 5 Set **Start Now** to **Yes** and click **OK**.

----End

9.15.6 Adjusting the Execution of Adaptive Queries

Scenario

Typically, SQL statements of large tasks (for example, scanning large amounts of data from an entire table) occupy a large number of resources, which affects the load of other tasks in case that resources are insufficient. This deteriorates user experience and increases O&M costs. To resolve this issue, HetuEngine provides the adaptive query execution function to allow adaptive scheduling and execution of queries.

This section describes how to enable adaptive query execution.

Procedure

Step 1 Log in to FusionInsight Manager as a HetuEngine administrator and choose **Cluster** > **Services** > **HetuEngine**.

Step 2 On the **Dashboard** tab page that is displayed, find the **Basic Information** area, and click the link next to **HSConsole WebUI**.

Step 3 On the page that is displayed, click **Data Source**, locate the row containing the Hive data source to be modified, and click **Edit** in the **Operation** column.

Step 4 Add **hive.strict-mode-restrictions** to the custom parameters and set it to **NONE** to enable the adaptive query execution function. For details, see **Step 6.7**.

Step 5 Click **OK**.

----End

9.15.7 Adjusting Timeout for Hive Metadata Loading

Scenario

A large partitioned table contains too many partitions. As a result, the task times out. In addition, a large number of partitions may take more time to load and synchronize with the metadata storage cache. To achieve better performance in larger-scale storage, you are advised to adjust the maximum timeout interval for loading the metadata cache and the maximum waiting time for loading the metadata connection pool accordingly.

Procedure

Step 1 Log in to FusionInsight Manager as a HetuEngine administrator and choose **Cluster** > **Services** > **HetuEngine**.

Step 2 On the **Dashboard** tab page that is displayed, find the **Basic Information** area, and click the link next to **HSConsole WebUI**.

Step 3 Click **Data Source**, locate the row that contains the Hive data source, click **Edit** in the **Operation** column, and add the following custom parameters:

Table 9-66 Metadata timeout parameters

Parameter	Default Value	Description
hive.metastore-timeout	10s	• Specifies the maximum timeout interval (in seconds or minutes) for caching metadata loaded by the Hive data source in co-deployment scenarios. • For operations in a large partition table, the value can be 60s or greater. Set this parameter based on the data volume.
hive.metastore.connection.pool.maxWaitMillis	1000	• Specifies the maximum waiting time of the connection pool (in milliseconds) for loading metadata to the Hive data source in co-deployment scenarios. • If the connection pool is frequently accessed and the number of connections in the connection pool is small, the value can be 100000 or larger. Set this parameter based on the service volume.

Step 4 Click **OK**.

----End

9.15.8 Tuning Hudi Data Source Performance

HetuEngine can access data sources such as Hive and Hudi at a high speed. Hudi data source optimization includes Hudi table design optimization and cluster environment optimization.

Hudi Table Tuning

You can optimize table and data structures by referring to the following suggestions:

- Partition tables by the fields frequently used as filter conditions.
- If there mostly are equivalent queries with primary keys or primary key subsets, use bucket indexes to create tables and use query fields as bucketing keys.

- When querying a MOR table, periodically compact data to improve query performance. For details, see **Compaction**.

Cluster Environment Optimization

You can adjust the YARN configuration, cluster node resource configurations, metadata cache, and dynamic filter policies to optimize the system.

- For details about how to adjust the YARN configuration, see **Adjusting the YARN Service Configuration**.
- To adjust cluster node resource configurations, see **Adjusting Cluster Node Resource Configurations**.
- To adjust the metadata cache configuration, see **Adjusting Metadata Cache**.
- To adjust the dynamic filter policy, see **Enabling Dynamic Filtering**.

Example

A user stores device order information in a Hudi MOR table. The user can query the order details by order number. The number of orders per day is stable, and there are small peak hours during holidays.

- The order number is unique. In more than 80% queries, the order number is used for equivalent queries. The SQL statement is similar to **select * from table where order_id = 'id1';**.
- You can use day as the partition key since the number of orders per day is stable.
- Historical partition updates are not frequent, and main data is updated in new partitions.

Optimization suggestions

1. Use bucket indexes to create tables with Spark-SQL. The index key is the order ID, and the partition key is the date.
2. Compact logs periodically to improve query performance.

The following are example SQL statements:

```
set hoodie.compact.inline=true;
set hoodie.schedule.compact.only.inline=true;
set hoodie.run.compact.only.inline=false;
create table hudi_mor (order_id int, comb int, col1 string, col2 string, dt int)
using hudi
partitioned by(dt)
options(type='mor', primaryKey='order_id', preCombineField='comb',
hoodie.index.type = 'BUCKET',
hoodie.bucket.index.num.buckets=100,
hoodie.bucket.index.hash.field = 'order_id')
```

9.16 HetuEngine FAQ

9.16.1 How Do I Perform Operations After the Domain Name Is Changed?

Question

After the domain name is changed, the installed client configuration and data source configuration become invalid, and the created cluster is unavailable. When data sources in different domains are interconnected, HetuEngine automatically combines the **krb5.conf** file. After the domain name is changed, the domain name for Kerberos authentication changes. As a result, the information about the interconnected data source becomes invalid.

Answer

- You need to reinstall the cluster client.
- Delete the old data source information on HSConsole by referring to **Managing Configured Data Sources**.
- Configure the data source information on HSConsole again by referring to **Configuring Data Sources**.

9.16.2 What Do I Do If Starting a Cluster on the Client Times Out?

Question

If the cluster startup on the client takes a long time, the waiting times out and the waiting page exits.

Answer

If the cluster startup times out, the waiting page automatically exits. You can log in to the cluster again until the cluster is successfully started.

Additionally, you can also view the cluster running status on the HSConsole page. When the cluster is in the running state, log in to the cluster again. If the cluster fails to be started, you can locate the fault based on the startup logs.

For details, see **Log Description**.

9.16.3 How Do I Handle Data Source Loss?

Question

Why is the data source lost when I log in to the client to check the data source connected to the HSConsole page?

Answer

The possible cause of data source loss is that the DBService active/standby switchover occurs or the database connection usage exceeds the threshold.

You can log in to FusionInsight Manager to view the alarm information.

Clear the DBService alarm based on the alarm guide.

9.16.4 How Do I Handle HetuEngine Alarms?

Question

Log in to FusionInsight Manager and HetuEngine alarms are generated for the cluster.

Answer

Log in to FusionInsight Manager, go to the O&M page, and view alarm details. You can click the drop-down button of an alarm to view the alarm details. For most alarms, you can locate and handle them based on the alarm causes in the alarm details. You can also view the online help information about an alarm by using the alarm help function. If the alarm is not automatically cleared, you can manually clear it after troubleshooting.

1. Log in to FusionInsight Manager.
2. Choose **O&M** > **Alarm** > **Alarms**.
3. View alarm details in the alarm list.
4. Locate the row that contains the alarm and click **View Help** in the **Operation** column to obtain more help information.
5. Locate the fault based on the possible causes provided in the online help and clear the HetuEngine alarms based on the handling procedure provided in the online help.

9.16.5 How Do I Do If an Error Is Reported Indicating that Python Does Not Exist When a Compute Instance Fails to Start?

Question

HetuEngine compute instances fail to start, and the following error information is displayed in the **stderr.txt** file in a coordinator container:

```
/usr/bin/env: 'python': No such file or directory
```

Answer

The startup of HetuEngine compute instances depends on the Python file. Ensure that the Python file exists in the **/usr/bin/** directory on each node.

Step 1 Log in to FusionInsight Manager, choose **Hosts**, and view and record the service IP addresses of all hosts.

Step 2 Log in to the node recorded in **Step 1** as user **root** and run the following commands on all nodes to add the python3 soft link to the **/usr/bin/** directory:

cd /usr/bin

ln -s python3 python

Step 3 Restart the HetuEngine compute instance.

----End

9.16.6 How Do I Do If a Compute Instance Fails 30 Seconds After It Is Started?

Question

A HetuEngine compute instance enters the faulty state about 30 seconds after it is started.

Answer

When starting a compute instance, HetuEngine sends a command to Yarn to start the corresponding application. If HetuEngine does not receive a response from Yarn within 30 seconds, HetuEngine ends the request due to timeout.

If the response message for Yarn to start the application cannot be received within 30 seconds due to machine performance or network environment problems, you can prolong the timeout period.

Step 1 Log in to FusionInsight Manager.

Step 2 Choose **Cluster** > **Services** > **HetuEngine** and click **Configurations** then **All Configurations**.

Step 3 Search for the **application.customized.properties** parameter, add the custom parameter **yarn.application.start.timeout**, set the timeout interval as required (enter only digits without the unit second), and save the configuration.

Step 4 Click the **Instance** tab, select all HSBroker instances, click **More**, and select **Restart Instance** to restart the HSBroker instances as prompted.

----End

9.16.7 What Do I Do If Data Fails to Be Written to a Table Because the Namespace of the Table Is Different from That of the /tmp Directory in the Federation Scenario?

Question

In the federation scenario, when data is written in a table(for example, **insert**), error information similar to the following is displayed:

```
Error moving data files from hdfs://nsfed/tmp/hetuengine/presto-hetutest/.9f23b71e-234d-768a-8b93f-cdee9297f25f.crc to final location hdfs://nsfed/user/hive/warehouse/hetutb/20230928_022345_00209_ajke4@default@HetuEngine_234d-768a-8b93f-cdee92dqeqef
```

Answer

In the federation scenario, **/tmp** and **/user** are mounted to different NameServices. However, the path prefix is **hdfs://nsfed**, and NameService is not explicitly used. As a result, the file fails to be moved. Use either of the following methods to solve the problem:

- Explicitly specify NameService in **location** when creating a table. The following is an example:

```
hetuengine:default> create table hetutb(id integer, name string) location 'hdfs://ns1/user/hetutb';
CREATE TABLE
hetuengine:default> insert into hetutb select 123,'kate';
INSERT: 1 row

Query 20230927_025023_00546_u8kdr@default@HetuEngine, FINISHED, 3 nodes
Splits: 42 total, 42 done (100.00%)
0.46 [0 rows, 0B] [0 rows/s, 0B/s]
```

- Add **hive.temporary-staging-directory-path=/user/tmp/hetuengine/presto-${USER}** to the Hive data source configuration.
  a. Log in to FusionInsight Manager as a HetuEngine administrator and choose **Cluster** > **Services** > **HetuEngine**. The **HetuEngine** service page is displayed.
  b. In the **Basic Information** area on the **Dashboard** page, click the link next to **HSConsole WebUI**. The **HSConsole** page is displayed.
  c. Click **Data Source**. Locate the row that contains the data source where Hive table creation is queried, and click **Edit** in the **Operation** column.
  d. Add a custom configuration. Set the parameter name to **hive.temporary-staging-directory-path** and the value to **/user/tmp/hetuengine/presto-${USER}**.
  e. Confirm that the information is correct and click **OK**. Wait for about 1 minute and run the query statement again.

9.16.8 How Do I Configure HetuEngine SQL Inspection?

There are numerous SQL engines in the current big data field, which bring diversity to the solutions but also expose some issues such as varying quality of SQL input statements, difficult SQL problem localization, and excessive resource consumption by large SQL statements.

Poor quality SQL can have unforeseeable impacts on data analysis platforms, affecting system performance or platform stability.

Function Description

MRS allows you to configure inspection rules for mainstream SQL engines (Hive, Spark, HetuEngine, and ClickHouse). MRS can identify typical large SQL queries and low-quality SQL statements and intercepts them before execution or block them during execution. Users do not need to change how they submit SQL statements or change SQL syntax. Service modifications are not required and inspection is easy to implement.

- You can configure SQL inspection rules on the UI that also allows you to query and modify the rules.
- During query response and execution, each SQL engine proactively inspects SQL statements based on the rules.
- Administrators can select to display hints on, intercept, or block SQL statements. The system logs SQL inspection events in real time for SQL audit. O&M engineers can analyze the logs, evaluate SQL statement quality on the live network, detect target statements, and take effective measures.

SQL inspection rules are classified into the following types:

- Static interception: The system displays hints on or intercepts SQL statements based on SQL syntax rules.
- Dynamic interception: The system displays hints on or intercepts SQL statements based on rules of data table statistics and metadata information.
- Runtime Blocking: The system blocks SQL statements based on system states (such as CPU, memory, and I/O) during the runtime of the SQL statements.

SQL requests that meet the static and dynamic interception rules can be intercepted, and the system gives hints for processing the statements properly. If a SQL request meets the blocking rule, the system blocks the SQL task.

10 Using HDFS

10.1 Using Hadoop from Scratch

You can use Hadoop to submit wordcount jobs. Wordcount is the most classic Hadoop job and is used to count the number of words in massive text.

Procedure

Step 1 Prepare the wordcount program.

Multiple open source Hadoop sample programs are provided, including wordcount. You can download the Hadoop sample program from **https://dist.apache.org/repos/dist/release/hadoop/common/**.

For example, choose **hadoop-***x.x.x*. On the page that is displayed, click **hadoop-***x.x.x***.tar.gz** to download it. Then, decompress it to obtain **hadoop-mapreduce-examples-***x.x.x***.jar** (the Hadoop sample program) from **hadoop-***x.x.x***\share\hadoop\mapreduce**. The **hadoop-mapreduce-examples-***x.x.x***.jar** package contains the wordcount program.

NOTE

hadoop-*x.x.x* indicates the Hadoop version. Choose a version based on your requirements.

Step 2 Prepare data files.

There is no format requirement for data files. Prepare one or more **.txt** files. The following are examples of the **.txt** file:

```
qwsdfhoedfrffrofhuncckgktpmhutopmma
jjpsffjfjorgjgtyiuyjmhombmbogohoyhm
jhheyeombdhuaqqiquyebchdhmamdhdemmj
doeyhjwedcrfvtgbmojiyhhqssddddddfkf
kjhhjkehdeiyrudjhfhfhffooqweopuyyyy
```

Step 3 Upload data to OBS.

1. Log in to OBS Console.
2. Click **Parallel File System** and choose **Create Parallel File System** to create a file system named **wordcount01**.

wordcount01 is only an example. The file system name must be globally unique. Otherwise, the parallel file system fails to be created.

3. In the OBS file system list, click **wordcount01** and choose **Files** > **Create Folder** to create the **program** and **input** folders.
   - **program**: stores user programs.
   - **input**: stores user data files.
4. Go to the **program** folder, choose **Upload File** > **add file**, select the program package downloaded in **Step 1** from the local host, and click **Upload**.
5. Go to the **input** folder and upload the data file prepared in **Step 2** to the **input** folder.

Step 4 Log in to the MRS console. In the navigation pane on the left, click **Clusters** and choose **Active Clusters**. Click the cluster name. The cluster must contain Hadoop components.

Step 5 Submit the wordcount job.

In the cluster list, click the name of the desired cluster. Click **Jobs** then **Create**. The **Create Job** dialog box is displayed.

- Set **Type** to **MapReduce**.
- Set **Name** to **mr_01**.
- Set the path of the executable program to the address of the program stored on the OBS, for example, **obs://wordcount01/program/hadoop-mapreduce-examples-*x.x.x*.jar**.
- Enter **wordcount obs://wordcount01/input/ obs://wordcount01/output/** in the **Parameter** pane.

  NOTE

  - Replace the OBS file system name in **obs://wordcount01/input/** with the actual name of the file system created in the environment.
  - Replace the OBS file system name in **obs://wordcount01/output/** with the actual name of the file system created in the environment. Enter a directory that does not exist in the **output** directory.
- **Service Parameter** can be left blank.

A job can be submitted only when the cluster is in the **Running** state.

After a job is submitted successfully, it is in the **Accepted** state by default. You do not need to manually execute the job.

Step 6 View the job execution result.

1. Go to the **Jobs** tab page and check whether the job is successfully executed.

   It takes some time to run the job. After the job is complete, refresh the job list

   Once a job has succeeded or failed, you cannot execute it again. However, you can add or copy a job, and set job parameters to submit a job again.
2. Log in to the OBS console, go to the OBS path, and view the job output information.

   You can view output files in the **output** directory created in **Step 5**. You need to download the file to the local host and open it in text format.

----End

10.2 Configuring Memory Management

Scenario

In HDFS, each file object needs to register corresponding information in the NameNode and occupies certain storage space. As the number of files increases, if the original memory space cannot store the corresponding information, you need to change the memory size.

Configuration Description

Navigation path for setting parameters:

Go to the **All Configurations** page of HDFS by referring to **Modifying Cluster Service Configuration Parameters**.

Table 10-1 Parameter description

Parameter	Description	Default Value
GC_PROFILE	The NameNode memory size depends on the size of FsImage, which can be calculated based on the following formula: FsImage size = Number of files x 900 bytes. You can estimate the memory size of the NameNode of HDFS based on the calculation result. The value range of this parameter is as follows: • **high**: 4 GB • **medium**: 2 GB • **low**: 256 MB • **custom**: The memory size can be set according to the data size in GC_OPTS.	custom

Parameter	Description	Default Value
GC_OPTS	JVM parameter used for garbage collection (GC). This parameter is valid only when **GC_PROFILE** is set to **custom**. Ensure that the **GC_OPT** parameter is set correctly. Otherwise, the process will fail to be started. **NOTICE** Exercise caution when you modify the configuration. If the configuration is incorrect, the services are unavailable.	-Xms2G -Xmx4G -XX:NewSize=128M -XX:MaxNewSize=256M -XX:MetaspaceSize=128M -XX:MaxMetaspaceSize=128M -XX:+UseConcMarkSweepGC -XX:+CMSParallelRemarkEnabled -XX:CMSInitiatingOccupancyFraction=65 -XX:+PrintGCDetails -Dsun.rmi.dgc.client.gcInterval=0x7FFFFFFFFFFFFE -Dsun.rmi.dgc.server.gcInterval=0x7FFFFFFFFFFFFE -XX:-OmitStackTraceInFastThrow -XX:+PrintGCDateStamps -XX:+UseGCLogFileRotation -XX:NumberOfGCLogFiles=10 -XX:GCLogFileSize=1M -Djdk.tls.ephemeralDHKeySize=2048

10.3 Creating an HDFS Role

Scenario

This section describes how to create and configure an HDFS role on FusionInsight Manager. The HDFS role is granted the rights to read, write, and execute HDFS directories or files.

A user has the complete permission on the created HDFS directories or files, that is, the user can directly read data from and write data to as well as authorize others to access the HDFS directories or files.

NOTE

- An HDFS role can be created only in security mode.
- If the current component uses Ranger for permission control, HDFS policies must be configured based on Ranger for permission management. For details, see **Adding a Ranger Access Permission Policy for HDFS**.

Prerequisites

The MRS cluster administrator has understood service requirements.

Procedure

Step 1 Log in to FusionInsight Manager, and choose **System** > **Permission** > **Role**.

Step 2 On the displayed page, click **Create Role** and fill in **Role Name** and **Description**.

Step 3 Configure the resource permission. For details, see **Table 10-2**.

File System: HDFS directory and file permission

Common HDFS directories are as follows:

- **flume**: Flume data storage directory
- **hbase**: HBase data storage directory
- **mr-history**: MapReduce task information storage directory
- **tmp**: temporary data storage directory
- **user**: user data storage directory

Table 10-2 Setting a role

Task	Operation
Setting the HDFS administrator permission	In the **Configure Resource Permission** area, choose *Name of the desired cluster* > HDFS, and select **Cluster Admin Operations**. **NOTE** The setting takes effect after the HDFS service is restarted.
Setting the permission for users to check and recover HDFS	1. In the **Configure Resource Permission** area, choose *Name of the desired cluster* > HDFS > **File System**. 2. Locate the save path of specified directories or files on HDFS. 3. In the **Permission** column of the specified directories or files, select **Read** and **Execute**.
Setting the permission for users to read directories or files of other users	1. In the **Configure Resource Permission** area, choose *Name of the desired cluster* > HDFS > **File System**. 2. Locate the save path of specified directories or files on HDFS. 3. In the **Permission** column of the specified directories or files, select **Read** and **Execute**.
Setting the permission for users to write data to files of other users	1. In the **Configure Resource Permission** area, choose *Name of the desired cluster* > HDFS > **File System**. 2. Locate the save path of specified files on HDFS. 3. In the **Permission** column of the specified files, select **Write** and **Execute**.

Task	Operation
Setting the permission for users to create or delete sub-files or sub-directories in the directory of other users	1. In the **Configure Resource Permission** area, choose *Name of the desired cluster* > HDFS > **File System**. 2. Locate the path where the specified directory is saved in the HDFS. 3. In the **Permission** column of the specified directories, select **Write** and **Execute**.
Setting the permission for users to execute directories or files of other users	1. In the **Configure Resource Permission** area, choose *Name of the desired cluster* > HDFS > **File System**. 2. Locate the save path of specified directories or files on HDFS. 3. In the **Permission** column of the specified directories or files, select **Execute**.
Setting the permission for allowing subdirectories to inherit all permissions of their parent directories	1. In the **Configure Resource Permission** area, choose *Name of the desired cluster* > HDFS > **File System**. 2. Locate the save path of specified directories or files on HDFS. 3. In the **Permission** column of the specified directories or files, select **Recursive**.

Step 4 Click **OK**, and return to the **Role** page.

----End

10.4 Using the HDFS Client

Scenario

This section describes how to use the HDFS client in an O&M scenario or service scenario.

Prerequisites

- The client has been installed.

  For example, the installation directory is **/opt/client**. The client directory in the following operations is only an example. Change it based on the actual installation directory onsite.
- Service component users have been created by the MRS cluster administrator. In security mode, machine-machine users need to download the keytab file. A human-machine user needs to change the password upon the first login. (This operation is not required in normal mode.)

Using the HDFS Client

Step 1 Log in to the node where the client is installed as the client installation user.

Step 2 Run the following command to go to the client installation directory:

cd /opt/client

Step 3 Run the following command to configure environment variables:

source bigdata_env

Step 4 If Kerberos authentication is enabled for the cluster (the cluster is in security mode), run the following command to authenticate the user. If Kerberos authentication is disabled for the cluster (the cluster is in normal mode), user authentication is not required. In this case, skip this step.

kinit *Component service user*

Step 5 Run the HDFS Shell command. Example:

hdfs dfs -ls /

----End

Common HDFS Client Commands

The following table lists common HDFS client commands.

Table 10-3 Common HDFS client commands

Command	Description	Example
hdfs dfs -mkdir *Folder name*	Used to create a folder.	**hdfs dfs -mkdir /tmp/mydir**
hdfs dfs -ls *Folder name*	Used to view a folder.	**hdfs dfs -ls /tmp**
hdfs dfs -put *Local file on the client node Specified HDFS path*	Used to upload a local file to a specified HDFS path.	**hdfs dfs -put /opt/test.txt /tmp** Upload the **/opt/test.txt** file on the client node to the **/tmp** directory of HDFS.
hdfs dfs -get *Specified file on HDFS Specified path on the client node*	Used to download the HDFS file to the specified local path.	**hdfs dfs -get /tmp/test.txt /opt/** Download the **/tmp/test.txt** file on HDFS to the **/opt** path on the client node.
hdfs dfs -rm -r -f *Specified folder on HDFS*	Used to delete a folder.	**hdfs dfs -rm -r -f /tmp/mydir**

Command	Description	Example
hdfs dfs -chmod *Permission parameter File directory*	Used to configure the HDFS directory permission for a user.	**hdfs dfs -chmod 700 /tmp/test**
hdfs dfsadmin -clearDeadNode	Used to delete expired DataNodes.	**hdfs dfsadmin -clearDeadNode**

Client-related FAQs

1. What do I do when the HDFS client exits abnormally and error message "java.lang.OutOfMemoryError" is displayed after the HDFS client command is running?

   This problem occurs because the memory required for running the HDFS client exceeds the preset upper limit (128 MB by default). You can change the memory upper limit of the client by modifying **CLIENT_GC_OPTS** in *<Client installation path>***/HDFS/component_env**. For example, if you want to set the upper limit to 1 GB, run the following command:

   ```
   CLIENT_GC_OPTS="-Xmx1G"
   ```

   After the modification, run the following command to make the modification take effect:

   source <*Client installation path*>**/bigdata_env**

2. How do I set the log level when the HDFS client is running?

   By default, the logs generated during the running of the HDFS client are printed to the console. The default log level is INFO. To enable the DEBUG log level for fault locating, run the following command to export an environment variable:

   export HADOOP_ROOT_LOGGER=DEBUG,console

   Then run the HDFS Shell command to generate the DEBUG logs.

   If you want to print INFO logs again, run the following command:

   export HADOOP_ROOT_LOGGER=INFO,console

3. How do I delete HDFS files permanently?

   HDFS provides a recycle bin mechanism. Typically, after an HDFS file is deleted, the file is moved to the recycle bin of HDFS. If the file is no longer needed and the storage space needs to be released, clear the corresponding recycle bin directory, for example, **hdfs://hacluster/user/xxx/.Trash/Current/***xxx*.

10.5 Running the DistCp Command

Scenario

DistCp is a tool used to perform large-amount data replication between clusters or in a cluster. It uses MapReduce tasks to implement distributed copy of a large amount of data.

Prerequisites

- The Yarn client or a client that contains Yarn has been installed. For example, the installation directory is **/opt/client**.
- Service users of each component are created by the MRS cluster administrator based on service requirements. In security mode, machine-machine users need to download the keytab file. A human-machine user must change the password upon the first login. (Not involved in normal mode)
- To copy data between clusters, you need to enable the inter-cluster data copy function on both clusters.

Procedure

Step 1 Log in to the node where the client is installed.

Step 2 Run the following command to go to the client installation directory:

cd /opt/client

Step 3 Run the following command to configure environment variables:

source bigdata_env

Step 4 If the cluster is in security mode, the user group to which the user executing the DistCp command belongs must be **supergroup** and the user run the following command to perform user authentication. In normal mode, user authentication is not required.

kinit *Component service user*

Step 5 Run the DistCp command. The following provides an example:

hadoop distcp hdfs://hacluster/source hdfs://hacluster/target

----End

Common Usage of DistCp

1. The following is an example of the commonest usage of DistCp:
   ```
   hadoop distcp -numListstatusThreads 40 -update -delete -prbugpaxtq hdfs:///cluster1/source hdfs://cluster2/target
   ```

NOTE

In the preceding command:

- **-numListstatusThreads** specifies the number of threads for creating the list of 40 copied files.
- **-update -delete** specifies that files at the source location and the target location are synchronized, and that files with excessive target locations are deleted. If you need to copy files incrementally, delete **-delete**.
- If **-prbugpaxtq** and **-update** are used, it indicates that the status information of the copied file is also updated.
- **hdfs://cluster1/source** indicates the source location, and **hdfs://cluster2/target** indicates the target location.

2. The following is an example of data copy between clusters:

```
hadoop distcp hdfs://cluster1/foo/bar hdfs://cluster2/bar/foo
```

NOTE

The network between cluster1 and cluster2 must be reachable, and the two clusters must use the same HDFS version or compatible HDFS versions.

3. The following are multiple examples of data copy in a source directory:

```
hadoop distcp hdfs://cluster1/foo/a \
hdfs://cluster1/foo/b \
hdfs://cluster2/bar/foo
```

The preceding command is used to copy the folders a and b of cluster1 to the **/bar/foo** directory of cluster2. The effect is equivalent to that of the following commands:

```
hadoop distcp -f hdfs://cluster1/srclist \
hdfs://cluster2/bar/foo
```

The content of **srclist** is as follows. Before running the DistCp command, upload the **srclist** file to HDFS.

```
hdfs://cluster1/foo/a
hdfs://cluster1/foo/b
```

4. **-update** indicates that a to-be-copied file does not exist in the target location, or the content of the copied file in the target location is updated; and **-overwrite** is used to overwrite existing files in the target location.

The following is an example of the difference between no option and any one of the two options (either **update** or **overwrite**) that is added:

Assume that the structure of a file at the source location is as follows:

```
hdfs://cluster1/source/first/1
hdfs://cluster1/source/first/2
hdfs://cluster1/source/second/10
hdfs://cluster1/source/second/20
```

Commands without options are as follows:

```
hadoop distcp hdfs://cluster1/source/first  hdfs://cluster1/source/second  hdfs://cluster2/target
```

By default, the preceding command creates the **first** and **second** folders at the target location. Therefore, the copy results are as follows:

```
hdfs://cluster2/target/first/1
hdfs://cluster2/target/first/2
hdfs://cluster2/target/second/10
hdfs://cluster2/target/second/20
```

The command with any one of the two options (for example, **update**) is as follows:

```
hadoop distcp -update hdfs://cluster1/source/first  hdfs://cluster1/source/second  hdfs://cluster2/target
```

The preceding command copies only the content at the source location to the target location. Therefore, the copy results are as follows:

```
hdfs://cluster2/target/1
hdfs://cluster2/target/2
hdfs://cluster2/target/10
hdfs://cluster2/target/20
```

NOTE

- If files with the same name exist in multiple source locations, the DistCp command fails.
- If neither **update** nor **overwrite** is used and the file to be copied already exists in the target location, the file will be skipped.
- When **update** is used, if the file to be copied already exists in the target location but the file content is different, the file content in the target location is updated.
- When **overwrite** is used, if the file to be copied already exists in the target location, the file in the target location is still overwritten.

5. The following table describes other command options:

Table 10-4 Other command options

Option	Description
-p[rbugpcaxtq]	When **-update** is also used, the status information of a copied file is updated even if the content of the copied file is not updated. **r**: number of copies **b**: size of a block **u**: user to which the files belong **g**: user group to which the user belongs **p**: permission **c**: check and type **a**: access control **t**: timestamp **q**: quota information
-i	Failures ignored during copying
-log <logdir>	Path of the specified log
-v	Additional information in the specified log
-m <num_maps>	Maximum number of concurrent copy tasks that can be executed at the same time
-numListstatusThreads	Number of threads for constituting the list of copied files. This option increases the running speed of DistCp.
-overwrite	File at the target location that is to be overwritten

Option	Description
-update	A file at the target location is updated if the size and check of a file at the source location are different from those of the file at the target location.
-append	When **-update** is also used, the content of the file at the source location is added to the file at the target location.
-f <urilist_uri>	Content of the **<urilist_uri>** file is used as the file list to be copied.
-filters	A local file is specified whose content contains multiple regular expressions. If the file to be copied matches a regular expression, the file is not copied.
-async	The **distcp** command is run asynchronously.
-atomic {-tmp <tmp_dir>}	An atomic copy can be performed. You can add a temporary directory during copying.
-bandwidth	The transmission bandwidth of each copy task. Unit: MB/s.
-delete	The files that exist in the target location is deleted but do not exist in the source location. This option is usually used with **-update**, and indicates that files at the source location are synchronized with those at the target location and the redundant files at the target location are deleted.
-diff <oldSnapshot> <newSnapshot>	The differences between the old and new versions are copied to a file in the old version at the target location.
-skipcrccheck	Whether to skip the cyclic redundancy check (CRC) between the source file and the target file.
-strategy {dynamic| uniformsize}	The policy for copying a task. The default policy is **uniformsize**, that is, each copy task copies the same number of bytes.

Copying Data in an Encryption Area

By default, when DistCp is executed, the checksum provided by the file system is compared to verify that the data is copied to the target. When data is copied from a common directory to an encryption area, from an encryption area to a common directory, or between different directories in an encryption area, the checksum verification fails because the data block content is different.

In this case, you can specify the **-skipcrccheck** and **-update** flags to avoid verifying the checksum. If you use **-skipcrccheck**, DistCp performs file size comparison to check file integrity immediately after each file is copied.

The following is an example command:

```
hadoop distcp -skipcrccheck -update /encryptedpath /commonpath
```

NOTE

If you use DistCp to copy data from a cluster where transparent encryption is disabled to a cluster where transparent encryption is enabled, the operation will fail. You need to ensure that KMS transparent encryption is enabled for both clusters.

Copying Data in the Original Encryption Area

To retain data in the HDFS encryption area, HDFS introduces a new virtual path prefixed with **/.reserved/raw/**. This prefix allows cluster administrators to directly access basic data blocks in the file system and copy data without accessing the encryption key. This way, decrypting and re-encrypting data are avoided. Source data is the same as the replicated data. If the replicated data is encrypted using the new EDEK, an exception may occur.

The following is an example command:

```
hadoop distcp -px /.reserved/raw/encrptedpath /.reserved/raw/backpath
```

NOTE

- The encryption attributes (such as EDEK) are stored in the extended attribute **-px**. To decrypt the file, you need to retain only the extended attributes marked with **-px** when you copy the encrypted data to the **/.reserved/raw/** directory.
- The current version does not support cross-cluster copy using the preceding method.
- If you run the preceding command to copy files, ensure that the two directories are encrypted using the same EZK.

FAQs of DistCp

1. When you run the DistCp command, if the content of some copied files is large, you are advised to change the timeout period of MapReduce that executes the copy task. It can be implemented by specifying the **mapreduce.task.timeout** in the DistCp command. For example, run the following command to change the timeout to 30 minutes:
   ```
   hadoop distcp -Dmapreduce.task.timeout=1800000 hdfs://cluster1/source hdfs://cluster2/target
   ```
   Or, you can also use **filters** to exclude the large files out of the copy process. The command example is as follows:
   ```
   hadoop distcp -filters /opt/client/filterfile hdfs://cluster1/source hdfs://cluster2/target
   ```
   In the preceding command, *filterfile* indicates a local file, which contains multiple expressions used to match the path of a file that is not copied. The following is an example:
   ```
   .*excludeFile1.*
   .*excludeFile2.*
   ```
2. If the DistCp command unexpectedly quits, the error message "java.lang.OutOfMemoryError" is displayed.

   This is because the memory required for running the copy command exceeds the preset memory limit (default value: 128 MB). You can change the memory upper limit of the client by modifying **CLIENT_GC_OPTS** in *<Client installation path>***/HDFS/component_env**. For example, if you want to set the memory upper limit to 1 GB, refer to the following configuration:
   ```
   CLIENT_GC_OPTS="-Xmx1G"
   ```

After the modification, run the following command to make the modification take effect:

source {*Client installation path*}**/bigdata_env**

3. When the dynamic policy is used to run the DistCp command, the command exits unexpectedly and the error message "Too many chunks created with splitRatio" is displayed.

   The cause of this problem is that the value of **distcp.dynamic.max.chunks.tolerable** (default value: 20,000) is less than the value of **distcp.dynamic.split.ratio** (default value: 2) multiplied by the number of Maps. This problem occurs when the number of Maps exceeds 10,000. You can use the **-m** parameter to reduce the number of Maps to less than 10,000.

   ```
   hadoop distcp -strategy dynamic -m 9500 hdfs://cluster1/source hdfs://cluster2/target
   ```

   Alternatively, you can use the **-D** parameter to set **distcp.dynamic.max.chunks.tolerable** to a large value.

   ```
   hadoop distcp -Ddistcp.dynamic.max.chunks.tolerable=30000 -strategy dynamic hdfs://cluster1/source hdfs://cluster2/target
   ```

10.6 Overview of HDFS File System Directories

This section describes the directory structure in HDFS, as shown in the following table.

Table 10-5 Directory structure of the HDFS file system

Path	Type	Function	Whether the Directory Can Be Deleted	Deletion Consequence
/tmp/logs/	Fixed directory	Stores container log files.	Yes	Container log files cannot be viewed.
/tmp/carbon/	Fixed directory	Stores the abnormal data in this directory if abnormal CarbonData data exists during data import.	Yes	Error data is lost.
/tmp/Loader-${*Job name*}_${*MR job ID*}	Temporary directory	Stores the region information about Loader HBase bulkload jobs. The data is automatically deleted after the job running is completed.	No	Failed to run the Loader HBase Bulkload job.

Path	Type	Function	Whether the Directory Can Be Deleted	Deletion Consequence
/tmp/hadoop-omm/yarn/system/rmstore	Fixed directory	Stores the ResourceManager running information.	Yes	Status information is lost after ResourceManager is restarted.
/tmp/archived	Fixed directory	Archives the MR task logs on HDFS.	Yes	MR task logs are lost.
/tmp/hadoop-yarn/staging	Fixed directory	Stores the run logs, summary information, and configuration attributes of ApplicationMaster running jobs.	No	Services are running improperly.
/tmp/hadoop-yarn/staging/history/done_intermediate	Fixed directory	Stores temporary files in the **/tmp/hadoop-yarn/staging** directory after all tasks are executed.	No	MR task logs are lost.
/tmp/hadoop-yarn/staging/history/done	Fixed directory	The periodic scanning thread periodically moves the **done_intermediate** log file to the **done** directory.	No	MR task logs are lost.
/tmp/mr-history	Fixed directory	Stores the historical record files that are pre-loaded.	No	Historical MR task log data is lost.
/tmp/solr	Temporary directory	Stores the Solr temporary index data.	No	Failed to perform HDFS index tasks of Solr in batches.
/tmp/hive-scratch	Fixed directory	Stores temporary data (such as session information) generated during Hive running.	No	Failed to run the current task.

Path	Type	Function	Whether the Directory Can Be Deleted	Deletion Consequence
/user/{user}/.sparkStaging	Fixed directory	Stores temporary files of the SparkJDBCServer application.	No	Failed to start the executor.
/user/spark/jars	Fixed directory	Stores the dependency packages for running the Spark executor.	No	Failed to start the executor.
/user/loader	Fixed directory	Stores dirty data of Loader jobs and data of HBase jobs.	No	Failed to execute the HBase job. Or dirty data is lost.
/user/loader/etl_dirty_data_dir				
/user/loader/etl_hbase_putlist_tmp				
/user/loader/etl_hbase_tmp				
/user/oozie	Fixed directory	Stores dependent libraries required for Oozie running, which needs to be manually uploaded.	No	Failed to schedule Oozie.
/user/mapred/hadoop-mapreduce-*3.1.1*.tar.gz	Fixed files	Stores JAR files used by the distributed MR cache.	No	The MR distributed cache function is unavailable.
/user/solr	Fixed directory	Stores Solr historical data.	No	Historical Solr data is lost.
/user/hive	Fixed directory	Stores Hive-related data by default, including the depended Spark lib package and default table data storage path.	No	User data is lost.
/user/omm-bulkload	Temporary directory	Stores HBase batch import tools temporarily.	No	Failed to import HBase tasks in batches.

Path	Type	Function	Whether the Directory Can Be Deleted	Deletion Consequence
/user/hbase	Temporary directory	Stores HBase batch import tools temporarily.	No	Failed to import HBase tasks in batches.
/sparkJobHistory	Fixed directory	Stores Spark eventlog data.	No	The History Server service is unavailable, and the task fails to be executed.
/flume	Fixed directory	Stores data collected by Flume from HDFS.	No	Flume runs improperly.
/mr-history/tmp	Fixed directory	Stores logs generated by MapReduce jobs.	Yes	Log information is lost.
/mr-history/done	Fixed directory	Stores logs managed by MR JobHistory Server.	Yes	Log information is lost.
/tenant	Created when a tenant is added.	Directory of a tenant in the HDFS. By default, the system automatically creates a folder in the **/tenant** directory based on the tenant name. For example, the default HDFS storage directory for **ta1** is **tenant/ta1**. When a tenant is created for the first time, the system creates the **/tenant** directory in the HDFS root directory. You can customize the storage path.	No	The tenant account is unavailable.
/solr	Fixed directory	Stores Solr data.	No	Solr runs improperly.
/apps{1~5}/	Fixed directory	Stores the Hive package used by WebHCat.	No	Failed to run the WebHCat tasks.

Path	Type	Function	Whether the Directory Can Be Deleted	Deletion Consequence
/hbase	Fixed directory	Stores HBase data.	No	HBase user data is lost.
/hbaseFileStream	Fixed directory	Stores HFS files.	No	The HFS file is lost and cannot be restored.

10.7 Changing the DataNode Storage Directory

Scenario

If the storage directory defined by the HDFS DataNode is incorrect or the HDFS storage plan changes, the MRS cluster administrator needs to modify the DataNode storage directory on FusionInsight Manager to ensure smooth HDFS running. Changing the ZooKeeper storage directory includes the following scenarios:

- Change the storage directory of the DataNode role. In this way, the storage directories of all DataNode instances are changed.
- Change the storage directory of a single DataNode instance. In this way, only the storage directory of this instance is changed, and the storage directories of other instances remain the same.

Impact on the System

- The HDFS service needs to be stopped and restarted during the process of changing the storage directory of the DataNode role, and the cluster cannot provide services before it is completely started.
- The DataNode instance needs to stopped and restarted during the process of changing the storage directory of the instance, and the instance at this node cannot provide services before it is started.
- The directory for storing service parameter configurations must also be updated.

Prerequisites

- New disks have been prepared and installed on each data node, and the disks are formatted.
- New directories have been planned for storing data in the original directories.
- The HDFS client has been installed.

- The service user **hdfs** is available.
- When changing the storage directory of a single DataNode instance, ensure that the number of active DataNode instances is greater than the value of **dfs.replication**.

Procedure

Check the environment.

Step 1 Log in to the server where the HDFS client is installed as user **root**, and run the following command to configure environment variables:

source *Installation directory of the HDFS client*/**bigdata_env**

Step 2 If the cluster is in security mode, run the following command to authenticate the user:

kinit hdfs

Step 3 Run the following command on the HDFS client to check whether all directories and files in the HDFS root directory are normal:

hdfs fsck /

Check the fsck command output.

- If the following information is displayed, no file is lost or damaged. Go to **Step 4**.
  ```
  The filesystem under path '/' is HEALTHY
  ```
- If other information is displayed, some files are lost or damaged. Go to **Step 5**.

Step 4 Log in to FusionInsight Manager, choose **Cluster** > **Services**, and check whether **Running Status** of HDFS is **Normal**.

- If yes, go to **Step 6**.
- If no, the HDFS status is unhealthy. Go to **Step 5**.

Step 5 Rectify the HDFS fault.. The task is complete.

Step 6 Determine whether to change the storage directory of the DataNode role or that of a single DataNode instance:

- To change the storage directory of the DataNode role, go to **Step 7**.
- To change the storage directory of a single DataNode instance, go to **Step 12**.

Changing the storage directory of the DataNode role

Step 7 Choose **Cluster** > **Services** > **HDFS** and click **Stop Service** to stop the HDFS service.

Step 8 Log in to each data node where the HDFS service is installed as user **root** and perform the following operations:

1. Create a target directory (**data1** and **data2** are original directories in the cluster).

   For example, to create a target directory **${BIGDATA_DATA_HOME}/hadoop/data3/dn**, run the following command:

   mkdir -p ${BIGDATA_DATA_HOME}/hadoop/data3/dn

2. Mount the target directory to the new disk. For example, mount **${BIGDATA_DATA_HOME}/hadoop/data3** to the new disk.
3. Modify permissions on the new directory.

   For example, to create a target directory **${BIGDATA_DATA_HOME}/hadoop/data3/dn**, run the following commands:

   chmod 700 ${BIGDATA_DATA_HOME}/hadoop/data3/dn -R and **chown omm:wheel ${BIGDATA_DATA_HOME}/hadoop/data3/dn -R**
4. Copy the data to the target directory.

   For example, if the old directory is **${BIGDATA_DATA_HOME}/hadoop/data1/dn** and the target directory is **${BIGDATA_DATA_HOME}/hadoop/data3/dn**, run the following command:

   cp -af ${BIGDATA_DATA_HOME}/hadoop/data1/dn/* ${BIGDATA_DATA_HOME}/hadoop/data3/dn

Step 9 On FusionInsight Manager, choose **Cluster** > **Services** > **HDFS** and click **Configurations** then **All Configurations** to access the HDFS service configuration page.

Change the value of **dfs.datanode.data.dir** from the default value **%{@auto.detect.datapart.dn}** to the new target directory, for example, **${BIGDATA_DATA_HOME}/hadoop/data3/dn**.

For example, the original data storage directories are **/srv/BigData/hadoop/data1**, **/srv/BigData/hadoop/data2**. To migrate data from the **/srv/BigData/hadoop/data1** directory to the newly created **/srv/BigData/hadoop/data3** directory, replace the whole parameter with **/srv/BigData/hadoop/data2, /srv/BigData/hadoop/data3**. Separate multiple storage directories with commas (,). In this example, changed directories are **/srv/BigData/hadoop/data2**, **/srv/BigData/hadoop/data3**.

Step 10 Click **Save**. On the **Cluster** > **Services** page, start each stopped service in the cluster.

Step 11 After the HDFS is started, run the following command on the HDFS client to check whether all directories and files in the HDFS root directory are correctly copied:

hdfs fsck /

Check the fsck command output.

- If the following information is displayed, no file is lost or damaged, and data replication is successful. No further action is required.
  ```
  The filesystem under path '/' is HEALTHY
  ```
- If other information is displayed, some files are lost or damaged. In this case, check whether **8.4** is correct and run the **hdfs fsck** *Name of the damaged file* **-delete** command.

Changing the storage directory of a single DataNode instance

Step 12 Choose **Cluster** > **Services** > **HDFS** and click **Instance**. Select the DataNode whose storage directory needs to be modified, click **More**, and select **Stop Instance**.

Step 13 Log in to the DataNode node as user **root**, and perform the following operations:

1. Create a target directory.

For example, to create a target directory **${BIGDATA_DATA_HOME}/hadoop/data3/dn**, run the following command:

mkdir -p ${BIGDATA_DATA_HOME}/hadoop/data3/dn

2. Mount the target directory to the new disk.

   For example, mount **${BIGDATA_DATA_HOME}/hadoop/data3** to the new disk.

3. Modify permissions on the new directory.

   For example, to create a target directory **${BIGDATA_DATA_HOME}/hadoop/data3/dn**, run the following commands:

   chmod 700 ${BIGDATA_DATA_HOME}/hadoop/data3/dn -R and **chown omm:wheel ${BIGDATA_DATA_HOME}/hadoop/data3/dn -R**

4. Copy the data to the target directory.

   For example, if the old directory is **${BIGDATA_DATA_HOME}/hadoop/data1/dn** and the target directory is **${BIGDATA_DATA_HOME}/hadoop/data3/dn**, run the following command:

   cp -af ${BIGDATA_DATA_HOME}/hadoop/data1/dn/* ${BIGDATA_DATA_HOME}/hadoop/data3/dn

Step 14 On FusionInsight Manager, choose **Cluster** > **Services** > **HDFS** and click **Instance**. Click the specified DataNode instance and go to the **Configurations** tab page.

Change the value of **dfs.datanode.data.dir** from the default value **%{@auto.detect.datapart.dn}** to the new target directory, for example, **${BIGDATA_DATA_HOME}/hadoop/data3/dn**.

For example, the original data storage directories are **/srv/BigData/hadoop/data1,/srv/BigData/hadoop/data2**. To migrate data from the **/srv/BigData/hadoop/data1** directory to the newly created **/srv/BigData/hadoop/data3** directory, replace the whole parameter with **/srv/BigData/hadoop/data2,/srv/BigData/hadoop/data3**.

Step 15 Click **Save**, and then click **OK**.

Operation succeeded is displayed. click **Finish**.

Step 16 Choose **More** > **Restart Instance** to restart the DataNode instance.

----End

10.8 Configuring HDFS Directory Permission

Scenario

The permission for some HDFS directories is **777** or **750** by default, which brings potential security risks. You are advised to modify the permission for the HDFS directories after the HDFS is installed to increase user security.

Procedure

Log in to the HDFS client as the administrator and run the following command to modify the permission for the **/user** directory.

The permission is set to **1777**, that is, **1** is added to the original permission. This indicates that only the user who creates the directory can delete it.

hdfs dfs -chmod 1777 */user*

To ensure security of the system file, you are advised to harden the security for non-temporary directories. The following directories are examples:

- /user:777
- /mr-history:777
- /mr-history/tmp:777
- /mr-history/done:777
- /user/mapred:755

10.9 Configuring NFS

Scenario

Before deploying a cluster, you can deploy a Network File System (NFS) server based on requirements to store NameNode metadata to enhance data reliability.

If the NFS server has been deployed and NFS services are configured, you can follow operations in this section to configure NFS on the cluster. These operations are optional.

Procedure

Step 1 On the NFS server, check the permission on the NFS shared directory to ensure that the server can access NameNodes in the MRS cluster.

Step 2 Log in to the active NameNode as user **root**.

Step 3 Run the following commands to create a directory and assign it write permissions:

mkdir ${BIGDATA_DATA_HOME}/namenode-nfs

chown omm:wheel ${BIGDATA_DATA_HOME}/namenode-nfs

chmod 750 ${BIGDATA_DATA_HOME}/namenode-nfs

Step 4 Run the following command to mount the NFS to the active NameNode:

mount -t nfs -o rsize=8192,wsize=8192,soft,nolock,timeo=3,intr *IP address of the NFS server*:*Shared directory* **${BIGDATA_DATA_HOME}/namenode-nfs**

For example, if the IP address of the NFS server is **192.168.0.11** and the shared directory is **/opt/Hadoop/NameNode**, run the following command:

mount -t nfs -o rsize=8192,wsize=8192,soft,nolock,timeo=3,intr 192.168.0.11:/opt/Hadoop/NameNode ${BIGDATA_DATA_HOME}/namenode-nfs

Step 5 Perform **Step 2** to **Step 4** on the standby NameNode.

NOTE

The names of the shared directories (for example, **/opt/Hadoop/NameNode**) created on the NFS server by the active and standby NameNodes must be different.

Step 6 Log in to FusionInsight Manager and choose **Cluster** > **Services** > **HDFS**. Click **Configurations** then **All Configurations**.

Step 7 In the search box, search for **dfs.namenode.name.dir**, add **${BIGDATA_DATA_HOME}/namenode-nfs** to **Value**, and click **Save**. Separate paths with commas (,).

Step 8 Click **OK**. On the **Dashboard** tab page, choose **More** > **Restart Service** to restart the service.

----End

10.10 Planning HDFS Capacity

In HDFS, DataNode stores user files and directories as blocks, and file objects are generated on the NameNode to map each file, directory, and block on the DataNode.

The file objects on the NameNode require certain memory capacity. The memory consumption linearly increases as more file objects generated. The number of file objects on the NameNode increases and the objects consume more memory when the files and directories stored on the DataNode increase. In this case, the existing hardware may not meet the service requirement and the cluster is difficult to be scaled out.

Capacity planning of the HDFS that stores a large number of files is to plan the capacity specifications of the NameNode and DataNode and to set parameters according to the capacity plans.

Capacity Specifications

- NameNode capacity specifications

  Each file object on the NameNode corresponds to a file, directory, or block on the DataNode.

  A file uses at least one block. The default size of a block is **134,217,728**, that is, 128 MB, which can be set in the **dfs.blocksize** parameter. By default, a file whose size is less than 128 MB occupies only one block. If the file size is greater than 128 MB, the number of occupied blocks is the file size divided by 128 MB (Number of occupied blocks = File size/128). The directories do not occupy any blocks.

  Based on **dfs.blocksize**, the number of file objects on the NameNode is calculated as follows:

  Table 10-6 Number of NameNode file objects

Size of a File	Number of File Objects
< 128 MB	1 (File) + 1 (Block) = 2

Size of a File	Number of File Objects
> 128 MB (for example, 128 GB)	1 (File) + 1,024 (128 GB/128 MB = 1,024 blocks) = 1,025

The maximum number of file objects supported by the active and standby NameNodes is 300,000,000 (equivalent to 150,000,000 small files). **dfs.namenode.max.objects** specifies the number of file objects that can be generated in the system. The default value is **0**, which indicates that the number of generated file objects is not limited.

- DataNode capacity specifications

  In HDFS, blocks are stored on the DataNode as copies. The default number of copies is **3**, which can be set in the **dfs.replication** parameter.

  The number of blocks stored on all DataNode role instances in the cluster can be calculated based on the following formula: Number of HDFS blocks x 3 Average number of saved blocks = Number of HDFS blocks x 3/Number of DataNodes

Table 10-7 DataNode specifications

Item	Specifications
Maximum number of blocks supported by a DataNode instance	5,000,000
Maximum number of blocks supported by a disk on a DataNode instance	500,000
Minimum number of disks required when the number of blocks supported by a DataNode instance reaches the maximum	10

Table 10-8 Number of DataNodes

Number of HDFS Blocks	Minimum Number of DataNode Roles
10,000,000	10,000,000 *3/5,000,000 = 6
50,000,000	50,000,000 *3/5,000,000 = 30
100,000,000	100,000,000 *3/5,000,000 = 60

Setting Memory Parameters

- Configuration rules of the NameNode JVM parameter

  Default value of the NameNode JVM parameter **GC_OPTS**:

  -Xms2G -Xmx4G -XX:NewSize=128M -XX:MaxNewSize=256M -XX:MetaspaceSize=128M -XX:MaxMetaspaceSize=128M -

XX:+UseConcMarkSweepGC -XX:+CMSParallelRemarkEnabled -XX:CMSInitiatingOccupancyFraction=65 -XX:+PrintGCDetails -Dsun.rmi.dgc.client.gcInterval=0x7FFFFFFFFFFFFE -Dsun.rmi.dgc.server.gcInterval=0x7FFFFFFFFFFFFE -XX:-OmitStackTraceInFastThrow -XX:+PrintGCDateStamps -XX:+UseGCLogFileRotation -XX:NumberOfGCLogFiles=10 -XX:GCLogFileSize=1M -Djdk.tls.ephemeralDHKeySize=3072 -Djdk.tls.rejectClientInitiatedRenegotiation=true -Djava.io.tmpdir=${Bigdata_tmp_dir}

The number of NameNode files is proportional to the used memory size of the NameNode. When file objects change, you need to change **-Xms2G -Xmx4G -XX:NewSize=128M --XX:MaxNewSize=256M** in the default value. The following table lists the reference values.

Table 10-9 NameNode JVM configuration

Number of File Objects	Reference Value
10,000,000	-Xms6G -Xmx6G -XX:NewSize=512M -XX:MaxNewSize=512M
20,000,000	-Xms12G -Xmx12G -XX:NewSize=1G -XX:MaxNewSize=1G
50,000,000	-Xms32G -Xmx32G -XX:NewSize=3G -XX:MaxNewSize=3G
100,000,000	-Xms64G -Xmx64G -XX:NewSize=6G -XX:MaxNewSize=6G
200,000,000	-Xms96G -Xmx96G -XX:NewSize=9G -XX:MaxNewSize=9G
300,000,000	-Xms164G -Xmx164G -XX:NewSize=12G -XX:MaxNewSize=12G

- Configuration rules of the DataNode JVM parameter

  Default value of the DataNode JVM parameter **GC_OPTS**:

  -Xms2G -Xmx4G -XX:NewSize=128M -XX:MaxNewSize=256M -XX:MetaspaceSize=128M -XX:MaxMetaspaceSize=128M -XX:+UseConcMarkSweepGC -XX:+CMSParallelRemarkEnabled -XX:CMSInitiatingOccupancyFraction=65 -XX:+PrintGCDetails -Dsun.rmi.dgc.client.gcInterval=0x7FFFFFFFFFFFFE -Dsun.rmi.dgc.server.gcInterval=0x7FFFFFFFFFFFFE -XX:-OmitStackTraceInFastThrow -XX:+PrintGCDateStamps -XX:+UseGCLogFileRotation -XX:NumberOfGCLogFiles=10 -XX:GCLogFileSize=1M -Djdk.tls.ephemeralDHKeySize=3072 -Djdk.tls.rejectClientInitiatedRenegotiation=true -Djava.io.tmpdir=${Bigdata_tmp_dir}

  The average number of blocks stored in each DataNode instance in the cluster is: Number of HDFS blocks x 3/Number of DataNodes. If the average number of blocks changes, you need to change **-Xms2G -Xmx4G -**

XX:NewSize=128M -XX:MaxNewSize=256M in the default value. The following table lists the reference values.

Table 10-10 DataNode JVM configuration

Average Number of Blocks in a DataNode Instance	Reference Value
2,000,000	-Xms6G -Xmx6G -XX:NewSize=512M -XX:MaxNewSize=512M
5,000,000	-Xms12G -Xmx12G -XX:NewSize=1G -XX:MaxNewSize=1G

Xmx specifies memory which corresponds to the threshold of the number of DataNode blocks, and each GB memory supports a maximum of 500,000 DataNode blocks. Set the memory as required.

Viewing the HDFS Capacity Status

- NameNode information

  Log in to FusionInsight Manager, choose **Cluster** > **Services** > **HDFS**, click **NameNode(Active)**, and click **Overview** to view information like the number of file objects, files, directories, and blocks in HDFS in **Summary** area.

- DataNode information

  Log in to FusionInsight Manager, choose **Cluster** > **Services** > **HDFS**, click **NameNode(Active)**, and click **DataNodes** to view the number of blocks on all DataNodes that report alarms.

- Alarm information

  Check whether the alarms whose IDs are 14007, 14008, and 14009 are generated and change the alarm thresholds as required.

10.11 Configuring ulimit for HBase and HDFS

Symptom

When an HDFS file is opened and the number of handles is limited, the following error occurs:

```
IOException (Too many open files)
```

Procedure

You can contact the cluster administrator to increase the number of handles for each user. This is a configuration on the OS instead of that for HBase or HDFS. It is recommended that the cluster administrator set the number of handles based on the service volume of HBase and HDFS and the permissions of each user. If a user needs to frequently perform many operations on the HDFS with heavy service volume, set a large number of handles for the user to avoid the preceding error.

Step 1 Log in to operating systems of all nodes or clients in the cluster as user **root** and go to the **/etc/security** directory.

Step 2 Run the following command to edit the **limits.conf** file:

vi limits.conf

Added the following contents:

```
hdfs -       nofile  32768
hbase -      nofile  32768
```

hdfs and **hbase** indicate the OS user names used in services.

NOTE

- Only user **root** has the permission to edit the **limits.conf** file.
- If the modification does not take effect, check whether there are other **nofile** values for the OS user in the **/etc/security/limits.d** directory. Such values may overwrite the value configured in **/etc/security/limits.conf**.
- If a user needs to perform operations on HBase, it is recommended that the handle count of the user be set to more than 10,000. If a user needs to perform operations on HDFS, it is recommended that the handle count be set based on the service volume. (A small value is not recommended.) If a user needs to perform operations on HBase and HDFS, it is recommended that the handle count be set to a large value, for example, 32,768.

Step 3 You can run the following command to view the maximum number of handles of a user:

su - *user_name*

ulimit -n

The command output displays the maximum number of handles of the user. The following is an example.

```
8194
```

----End

10.12 Configuring HDFS DataNode Data Balancing

Scenario

In the HDFS cluster, unbalanced disk usage among DataNodes may occur, for example, when new DataNodes are added to the cluster. Unbalanced disk usage may result in multiple problems. For example, MapReduce applications cannot make full use of local computing advantages, network bandwidth usage between data nodes cannot be optimal, or node disks cannot be used. Therefore, the MRS cluster administrator needs to periodically check and maintain DataNode data balance.

HDFS provides a capacity balancing program Balancer. By running Balancer, you can balance the HDFS cluster and ensure that the difference between the disk usage of each DataNode and that of the HDFS cluster does not exceed the threshold. DataNode disk usage before and after balancing is shown in **Figure 10-1** and **Figure 10-2**, respectively.

Figure 10-1 DataNode disk usage before balancing

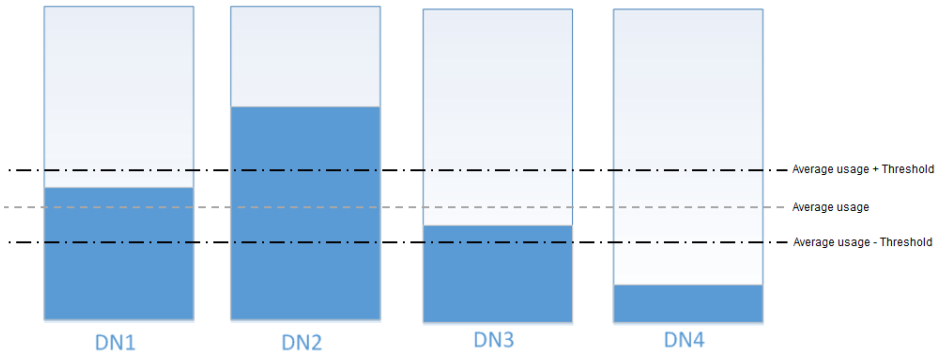
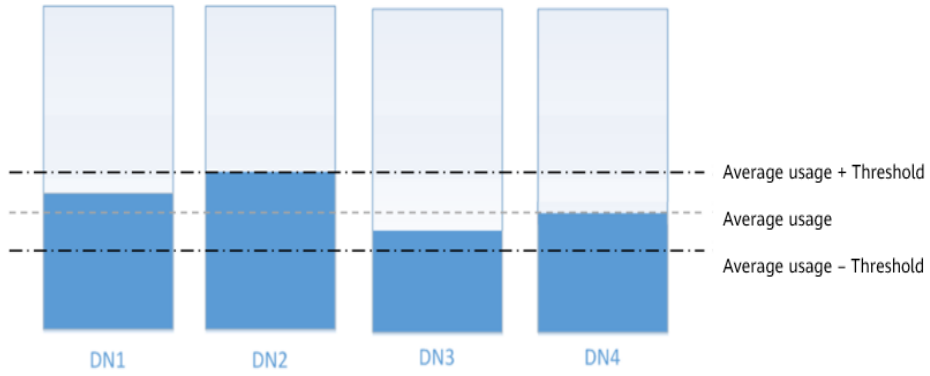


Figure 10-2 DataNode disk usage after balancing



The time of the balancing operation is affected by the following two factors:

1. Total amount of data to be migrated:

   The data volume of each DataNode must be greater than (Average usage - Threshold) x Average data volume and less than (Average usage + Threshold) x Average data volume. If the actual data volume is less than the minimum value or greater than the maximum value, imbalance occurs. The system sets the largest deviation volume on all DataNodes as the total data volume to be migrated.

2. Balancer migration is performed in sequence in iteration mode. The amount of data to be migrated in each iteration does not exceed 10 GB, and the usage of each iteration is recalculated.

Therefore, for a cluster, you can estimate the time consumed by each iteration (by observing the time consumed by each iteration recorded in balancer logs) and divide the total data volume by 10 GB to estimate the task execution time.

The balancer can be started or stopped at any time.

Impact on the System

- The balance operation occupies network bandwidth resources of DataNodes. Perform the operation during maintenance based on service requirements.
- The balance operation may affect the running services if the bandwidth traffic (the default bandwidth control is 20 MB/s) is reset or the data volume is increased.

Prerequisites

The client has been installed.

Procedure

Step 1 Log in to the node where the client is installed as a client installation user. Run the following command to switch to the client installation directory, for example, **/opt/client**:

cd /opt/client

NOTE

If the cluster is in normal mode, run the **su - omm** command to switch to user **omm**.

Step 2 Run the following command to configure environment variables:

source bigdata_env

Step 3 If the cluster is in security mode, run the following command to authenticate the HDFS identity:

kinit hdfs

Step 4 Determine whether to adjust the bandwidth control.

- If yes, go to **Step 5**.
- If no, go to **Step 6**.

Step 5 Run the following command to change the maximum bandwidth of Balancer, and then go to **Step 6**.

hdfs dfsadmin -setBalancerBandwidth *<bandwidth in bytes per second>*

<bandwidth in bytes per second> indicates the bandwidth control value, in bytes. For example, to set the bandwidth control to 20 MB/s (the corresponding value is 20971520), run the following command:

hdfs dfsadmin -setBalancerBandwidth 20971520

NOTE

- The default bandwidth control is 20 MB/s. This value is applicable to the scenario where the current cluster uses the 10GE network and services are being executed. If the service idle time window is insufficient for balance maintenance, you can increase the value of this parameter to shorten the balance time, for example, to 209715200 (200 MB/s).
- The value of this parameter depends on the networking. If the cluster load is high, you can change the value to 209715200 (200 MB/s). If the cluster is idle, you can change the value to 1073741824 (1 GB/s).
- If the bandwidth of the DataNodes cannot reach the specified maximum bandwidth, modify the HDFS parameter **dfs.datanode.balance.max.concurrent.moves** on FusionInsight Manager, and change the number of threads for balancing on each DataNode to **32** and restart the HDFS service.

Step 6 Run the following command to start the balance task:

bash /opt/client/HDFS/hadoop/sbin/start-balancer.sh -threshold *<threshold of balancer>*

-threshold specifies the deviation value of the DataNode disk usage, which is used for determining whether the HDFS data is balanced. When the difference between the disk usage of each DataNode and the average disk usage of the entire HDFS cluster is less than this threshold, the system considers that the HDFS cluster has been balanced and ends the balance task.

For example, to set deviation rate to 5%, run the following command:

bash /opt/client/HDFS/hadoop/sbin/start-balancer.sh -threshold 5

NOTE

- The preceding command executes the task in the background. You can query related logs in the **hadoop-root-balancer-***Host name***.out** log file in the **/opt/client/HDFS/hadoop/logs** directory of the host.
- To stop the balance task, run the following command:

  bash /opt/client/HDFS/hadoop/sbin/stop-balancer.sh
- If only data on some nodes needs to be balanced, you can add the **-include** parameter in the script to specify the nodes to be migrated. You can run commands to view the usage of different parameters.
- **/opt/client** is the client installation directory. If the directory is inconsistent, replace it.
- If the command fails to be executed and the error information **Failed to APPEND_FILE /system/balancer.id** is displayed in the log, run the following command to forcibly delete **/system/balancer.id** and run the **start-balancer.sh** script again:

  hdfs dfs -rm -f /system/balancer.id

Step 7 After you run the script in **Step 6**, the **hadoop-root-balancer-***Host name***.out** log file is generated in **/opt/client/HDFS/hadoop/logs**, the client installation directory. You can view the following information in the log:

- Time Stamp
- Bytes Already Moved
- Bytes Left To Move
- Bytes Being Moved

If message "Balance took *xxx* seconds" is displayed in the log, the balancing operation is complete.

----End

Related Tasks

Enable automatic execution of the balance task

Step 1 Log in to FusionInsight Manager.

Step 2 Choose **Cluster** > **Services** > **HDFS**. Click **Configurations** then **All Configurations**, search for the following parameters, and change the parameter values.

- **dfs.balancer.auto.enable** indicates whether to enable automatic balance task execution. The default value **false** indicates that automatic balance task execution is disabled. The value **true** indicates that automatic execution is enabled.
- **dfs.balancer.auto.cron.expression** indicates the task execution time. The default value **0 1 * * 6** indicates that the task is executed at 01:00 every Saturday. This parameter is valid only when the automatic execution is enabled.

Table 10-11 describes the expression for modifying this parameter. * indicates consecutive time segments.

Table 10-11 Parameters in the execution expression

Column	Description
1	Minute. The value ranges from 0 to 59.
2	Hour. The value ranges from 0 to 23.
3	Date. The value ranges from 1 to 31.
4	Month. The value ranges from 1 to 12.
5	Week. The value ranges from 0 to 6. **0** indicates Sunday.

- **dfs.balancer.auto.stop.cron.expression** indicates the task ending time. The default value is empty, indicating that the running balance task is not automatically stopped. For example, **0 5 * * 6** indicates that the balance task is stopped at 05:00 every Saturday. This parameter is valid only when the automatic execution is enabled.

  Table 10-11 describes the expression for modifying this parameter. * indicates consecutive time segments.

Step 3 Running parameters of the balance task that is automatically executed are shown in Table 10-12.

Table 10-12 Running parameters of the automatic balancer

Parameter	Parameter description	Default Value
dfs.balancer.auto.threshold	Specifies the balancing threshold of the disk capacity percentage. This parameter is valid only when **dfs.balancer.auto.enable** is set to **true**.	10
dfs.balancer.auto.exclude.datanodes	Specifies the list of DataNodes on which automatic disk balancing is not required. This parameter is valid only when **dfs.balancer.auto.enable** is set to **true**.	The value is left blank by default.
dfs.balancer.auto.bandwidthPerSec	Specifies the maximum bandwidth (MB/s) of each DataNode for load balancing.	20

Parameter	Parameter description	Default Value
dfs.balancer.auto.maxIdleIterations	Specifies the maximum number of consecutive idle iterations of Balancer. An idle iteration is an iteration without moving blocks. When the number of consecutive idle iterations reaches the maximum number, the balance task ends. The value **-1** indicates infinity.	5
dfs.balancer.auto.maxDataNodesNum	Controls the number of DataNodes that perform automatic balance tasks. Assume that the value of this parameter is *N*. If *N* is greater than 0, data is balanced between *N* DataNodes with the highest percentage of remaining space and *N* DataNodes with the lowest percentage of remaining space. If *N* is 0, data is balanced among all DataNodes in the cluster.	5

Step 4 Click **Save** to make configurations take effect. You do not need to restart the HDFS service.

Go to the **/var/log/Bigdata/hdfs/nn/hadoop-omm-balancer-***Host name***.log** file to view the task execution logs saved in the active NameNode.

----End

10.13 Configuring Replica Replacement Policy for Heterogeneous Capacity Among DataNodes

Scenario

By default, NameNode randomly selects a DataNode to write files. If the disk capacity of some DataNodes in a cluster is inconsistent (the total disk capacity of some nodes is large and of some nodes is small), the nodes with small disk capacity will be fully written. To resolve this problem, change the default disk selection policy for data written to DataNode to the available space block policy. This policy increases the probability of writing data blocks to the node with large available disk space. This ensures that the node usage is balanced when disk capacity of DataNodes is inconsistent.

Impact on the System

The disk selection policy is changed to **org.apache.hadoop.hdfs.server.blockmanagement.AvailableSpaceBlockPlacem**

entPolicy. It is proven that the HDFS file write performance optimizes by 3% after the modification.

NOTE

The default replica storage policy of the NameNode is as follows:

1. First replica: stored on the node where the client resides.
2. Second replica: stored on DataNodes of the remote rack.
3. Third replica: stored on different nodes of the same rack for the node where the client resides.

If there are more replicas, randomly store them on other DataNodes.

The replica selection mechanism (**org.apache.hadoop.hdfs.server.blockmanagement.AvailableSpaceBlockPlacementPolicy**) is as follows:

1. First replica: stored on the DataNode where the client resides (the same as the default storage policy).
2. Second replica:
   - When selecting a storage node, select two data nodes that meet the requirements.
   - Compare the disk usages of the two DataNodes. If the difference is smaller than 5%, store the replicas to the first node.
   - If the difference exceeds 5%, there is a 60% probability (specified by **dfs.namenode.available-space-block-placement-policy.balanced-space-preference-fraction** and default value is **0.6**) that the replica is written to the node whose disk space usage is low.
3. As for the storage of the third replica and subsequent replicas, refer to that of the second replica.

Prerequisites

The total disk capacity deviation of DataNodes in the cluster cannot exceed 100%.

Procedure

Step 1 Go to the **All Configurations** page of HDFS by referring to **Modifying Cluster Service Configuration Parameters**.

Step 2 Modify the disk selection policy parameters when HDFS writes data. Search for the **dfs.block.replicator.classname** parameter and change its value to **org.apache.hadoop.hdfs.server.blockmanagement.AvailableSpaceBlockPlacementPolicy**.

Step 3 Save the modified configuration. Restart the expired service or instance for the configuration to take effect.

----End

10.14 Configuring the Number of Files in a Single HDFS Directory

Scenario

Generally, multiple services are deployed in a cluster, and the storage of most services depends on the HDFS file system. Different components such as Spark

and Yarn or clients are constantly writing files to the same HDFS directory when the cluster is running. However, the number of files in a single directory in HDFS is limited. Users must plan to prevent excessive files in a single directory and task failure.

You can set the number of files in a single directory using the **dfs.namenode.fs-limits.max-directory-items** parameter in HDFS.

Procedure

Step 1 Go to the **All Configurations** page of HDFS by referring to **Modifying Cluster Service Configuration Parameters**.

Step 2 Search for the configuration item **dfs.namenode.fs-limits.max-directory-items**.

Table 10-13 Parameter description

Parameter	Description	Default Value
dfs.namenode.fs-limits.max-directory-items	Maximum number of items in a directory Value range: 1 to 6,400,000	1048576

Step 3 Set the maximum number of files that can be stored in a single HDFS directory. Save the modified configuration. Restart the expired service or instance for the configuration to take effect.

NOTE

Plan data storage in advance based on time and service type categories to prevent excessive files in a single directory. You are advised to use the default value, which is about 1 million pieces of data in a single directory.

----End

10.15 Configuring the Recycle Bin Mechanism

Scenario

On HDFS, deleted files are moved to the recycle bin (trash can) so that the data deleted by mistake can be restored.

You can set the time threshold for storing files in the recycle bin. Once the file storage duration exceeds the threshold, it is permanently deleted from the recycle bin. If the recycle bin is cleared, all files in the recycle bin are permanently deleted.

Configuration Description

If a file is deleted from HDFS, the file is saved in the trash space rather than cleared immediately. After the aging time is due, the deleted file becomes an aging file and will be cleared based on the system mechanism or manually cleared by users.

Parameter portal:

Go to the **All Configurations** page of HDFS and enter a parameter name in the search box by referring to **Modifying Cluster Service Configuration Parameters**.

Table 10-14 Parameter description

Parameter	Description	Default Value
fs.trash.interval	Trash collection time, in minutes. If data in the trash station exceeds the time, the data will be deleted. Value range: 1440 to 259200	1440
fs.trash.checkpoint.interval	Interval between trash checkpoints, in minutes. The value must be less than or equal to the value of **fs.trash.interval**. The checkpoint program creates a checkpoint every time it runs and removes the checkpoint created **fs.trash.interval** minutes ago. For example, the system checks whether aging files exist every 10 minutes and deletes aging files if any. Files that are not aging are stored in the checkpoint list waiting for the next check. If this parameter is set to 0, the system does not check aging files and all aging files are saved in the system. Value range: 0 to *fs.trash.interval* **NOTE** It is not recommended to set this parameter to 0 because aging files will use up the disk space of the cluster.	60

10.16 Setting Permissions on Files and Directories

Scenario

HDFS allows users to modify the default permissions of files and directories. The default mask provided by the HDFS for creating file and directory permissions is **022**. If you have special requirements for the default permissions, you can set configuration items to change the default permissions.

Configuration Description

Parameter portal:

Go to the **All Configurations** page of HDFS and enter a parameter name in the search box by referring to **Modifying Cluster Service Configuration Parameters**.

Table 10-15 Parameter description

Parameter	Description	Default Value
fs.permissions.umask-mode	This **umask** value (user mask) is used when the user creates files and directories in the HDFS on the clients. This parameter is similar to the file permission mask on Linux. The parameter value can be in octal or in symbolic, for example, **022** (octal, the same as **u=rwx,g=r-x,o=r-x** in symbolic), or **u=rwx,g=rwx,o=** (symbolic, the same as **007** in octal). **NOTE** The octal mask is opposite to the actual permission value. You are advised to use the symbol notation to make the description clearer.	022

10.17 Setting the Maximum Lifetime and Renewal Interval of a Token

Scenario

In security mode, users can flexibly set the maximum token lifetime and token renewal interval in HDFS based on cluster requirements.

Configuration Description

Navigation path for setting parameters:

Go to the **All Configurations** page of HDFS and enter a parameter name in the search box by referring to **Modifying Cluster Service Configuration Parameters**.

Table 10-16 Parameter description

Parameter	Description	Default Value
dfs.namenode.delegation.token.max-lifetime	This parameter is a server parameter. It specifies the maximum lifetime of a token. Unit: milliseconds. Value range: 10,000 to 10,000,000,000,000	604,800,000
dfs.namenode.delegation.token.renew-interval	This parameter is a server parameter. It specifies the maximum lifetime to renew a token. Unit: milliseconds. Value range: 10,000 to 10,000,000,000,000	86,400,000

10.18 Configuring the Damaged Disk Volume

Scenario

In the open source version, if multiple data storage volumes are configured for a DataNode, the DataNode stops providing services by default if one of the volumes is damaged. You can change the value of **dfs.datanode.failed.volumes.tolerated** to specify the number of damaged disk volumes that are allowed. If the number of damaged volumes does not exceed the threshold, DataNode continues to provide services.

Configuration Description

Navigation path for setting parameters:

Go to the **All Configurations** page of HDFS and enter a parameter name in the search box by referring to **Modifying Cluster Service Configuration Parameters**.

Table 10-17 Parameter description

Parameter	Description	Default Value
dfs.datanode.failed.volumes.tolerated	Specifies the number of damaged volumes that are allowed before the DataNode stops providing services. By default, there must be at least one valid volume. The value **-1** indicates that the minimum value of a valid volume is **1**. The value greater than or equal to **0** indicates the number of damaged volumes that are allowed.	–1

10.19 Configuring Encrypted Channels

Scenario

Encrypted channel is an encryption protocol of remote procedure call (RPC) in HDFS. When a user invokes RPC, the user's login name will be transmitted to RPC through RPC head. Then RPC uses Simple Authentication and Security Layer (SASL) to determine an authorization protocol (Kerberos and DIGEST-MD5) to complete RPC authorization. When you deploy a security cluster, use a secure encrypted channel and configure the following parameters:

Configuration Description

Go to the **All Configurations** page of HDFS and enter a parameter name in the search box by referring to **Modifying Cluster Service Configuration Parameters**.

Table 10-18 Parameter description

Parameter	Description	Default Value
hadoop.rpc.protection	**NOTICE** • The setting takes effect only after the service is restarted. Rolling restart is not supported. • After the setting, you need to download the client configuration again. Otherwise, the HDFS cannot provide the read and write services. Whether the RPC channels of each module in Hadoop are encrypted. The channels include: • RPC channels for clients to access HDFS • RPC channels between modules in HDFS, for example, RPC channels between DataNode and NameNode • RPC channels for clients to access Yarn • RPC channels between NodeManager and ResourceManager • RPC channels for Spark to access Yarn and HDFS • RPC channels for MapReduce to access Yarn and HDFS • RPC channels for HBase to access HDFS **NOTE** You can set this parameter on the HDFS component configuration page. The parameter setting takes effect globally, that is, the setting of whether the RPC channel is encrypted takes effect on all modules in Hadoop. There are three encryption modes. • **authentication**: This is the default value in normal mode. In this mode, data is directly transmitted without encryption after being authenticated. This mode ensures performance but has security risks. • **integrity**: Data is transmitted without encryption or authentication. To ensure data security, exercise caution when using this mode. • **privacy**: This is the default value in security mode, indicating that data is transmitted after authentication and encryption. This mode reduces the performance.	• Security mode: privacy • Normal mode: authentication

10.20 Reducing the Probability of Abnormal Client Application Operation When the Network Is Not Stable

Scenario

Clients probably encounter running errors when the network is not stable. Users can adjust the following parameter values to improve the running efficiency.

Configuration Description

Go to the **All Configurations** page of HDFS and enter a parameter name in the search box by referring to **Modifying Cluster Service Configuration Parameters**.

Table 10-19 Parameter description

Parameter	Description	Default Value
ha.health-monitor.rpc-timeout.ms	Timeout interval during the NameNode health check performed by ZKFC. Increasing this value can prevent dual active NameNodes and reduce the probability of application running exceptions on clients. Unit: millisecond. Value range: 30,000 to 3,600,000	180,000
ipc.client.connect.max.retries.on.timeouts	Number of retry times when the socket connection between a server and a client times out. Value range: 1 to 256	45
ipc.client.connect.timeout	Timeout interval of the socket connection between a client and a server. Increasing the value of this parameter increases the timeout interval for setting up a connection. Unit: millisecond. Value range: 1 to 3,600,000	20,000

10.21 Configuring the NameNode Blacklist

Scenario

In the existing default DFSclient failover proxy provider, if a NameNode in a process is faulty, all HDFS client instances in the same process attempt to connect to the NameNode again. As a result, the application waits for a long time and timeout occurs.

When clients in the same JVM process connect to the NameNode that cannot be accessed, the system is overloaded. The NameNode blacklist is equipped with the MRS cluster to avoid this problem.

In the new Blacklisting DFSClient failover provider, the faulty NameNode is recorded in a list. The DFSClient then uses the information to prevent the client from connecting to such NameNodes again. This function is called NameNode blacklisting.

For example, there is a cluster with the following configurations:

namenode: nn1, nn2

dfs.client.failover.connection.retries: 20

Processes in a single JVM: 10 clients

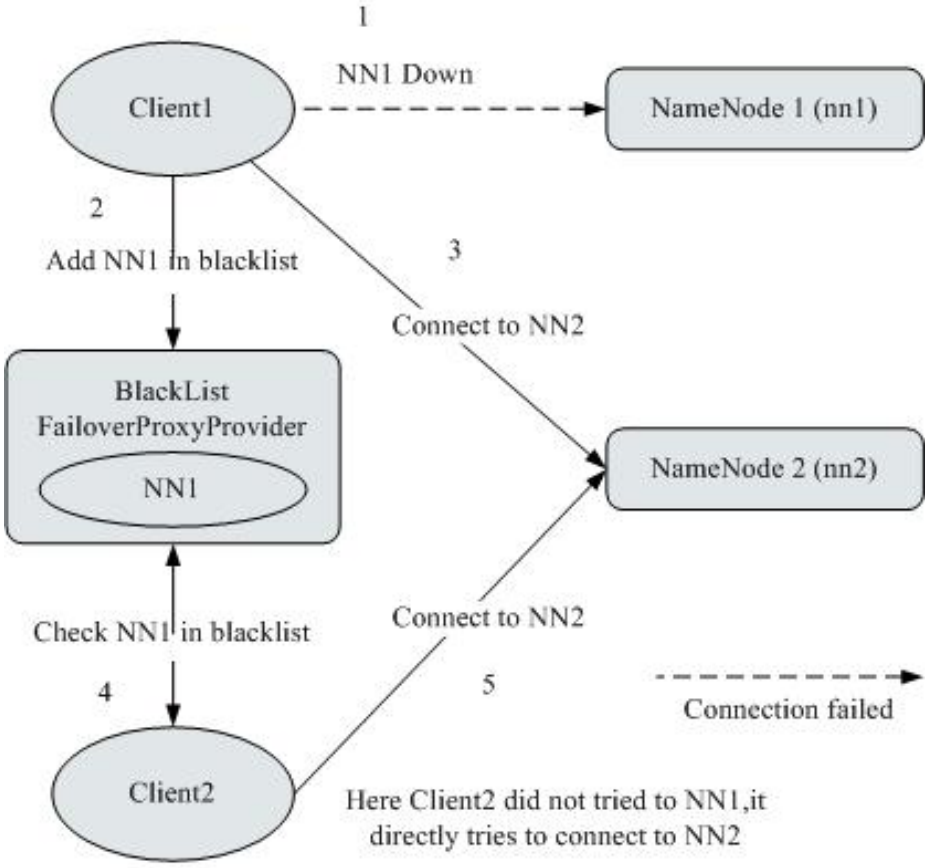
In the preceding cluster, if the active **nn1** cannot be accessed, client1 will retry the connection for 20 times. Then, a failover occurs, and client1 will connect to **nn2**. In the same way, other clients also connect to **nn2** when the failover occurs after retrying the connection to **nn1** for 20 times. Such process prolongs the fault recovery of NameNode.

In this case, the NameNode blacklisting adds **nn1** to the blacklist when client1 attempts to connect to the active **nn1** which is already faulty. Therefore, other clients will avoid trying to connect to **nn1** but choose **nn2** directly.

NOTE

If, at any time, all NameNodes are added to the blacklist, the content in the blacklist will be cleared, and the client attempts to connect to the NameNodes based on the initial NameNode list. If any fault occurs again, the NameNode is still added to the blacklist.

Figure 10-3 NameNode blacklisting working principle



Configuration Description

Go to the **All Configurations** page of HDFS and enter a parameter name in the search box by referring to **Modifying Cluster Service Configuration Parameters**.

Table 10-20 NameNode blacklisting parameters

Parameter	Description	Default Value
dfs.client.failover.proxy.provider.*[nameservice ID]*	Client Failover proxy provider class which creates the NameNode proxy using the authenticated protocol. Set this parameter to **org.apache.hadoop.hdfs.server.namenode.ha.BlackListingFailoverProxyProvider**. You can configure the observer NameNode to process read requests.	org.apache.hadoop.hdfs.server.namenode.ha.AdaptiveFailoverProxyProvider

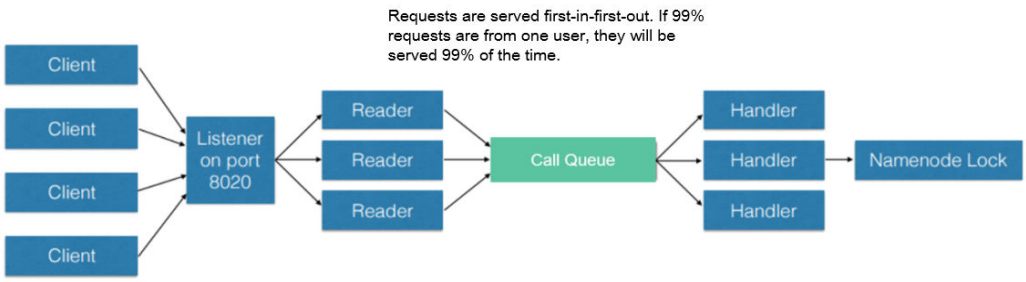
10.22 Optimizing HDFS NameNode RPC QoS

Scenarios

Several finished Hadoop clusters are faulty because the NameNode is overloaded and unresponsive.

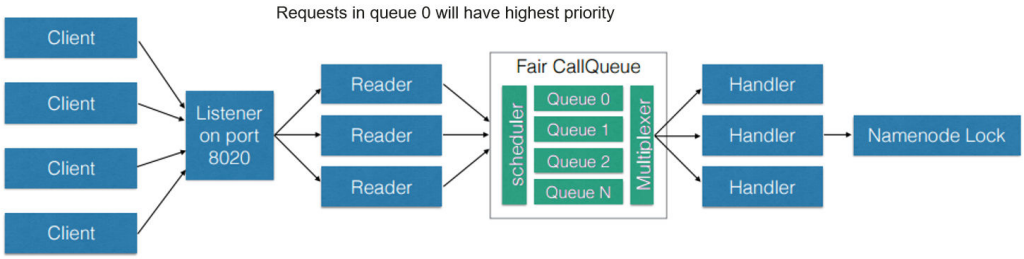
Such problem is caused by the initial design of Hadoop: In Hadoop, the NameNode functions as an independent part and in its namespace coordinates various HDFS operations, including obtaining the data block location, listing directories, and creating files. The NameNode receives HDFS operations, regards them as RPC calls, and places them in the FIFO call queue for read threads to process. Requests in FIFO call queue are served first-in first-out. However, users who perform more I/O operations are served more time than those performing fewer I/O operations. In this case, the FIFO is unfair and causes the delay.

Figure 10-4 NameNode request processing based on the FIFO call queue



The unfair problem and delaying mentioned before can be improved by replacing the FIFO queue with a new type of queue called FairCallQueue. In this way, FAIR queues assign incoming RPC calls to multiple queues based on the scale of the caller's call. The scheduling module tracks the latest calls and assigns a higher priority to users with a smaller number of calls.

Figure 10-5 NameNode request processing based on FAIRCallQueue



Configuration Description

- FairCallQueue ensures quality of service (QoS) by internally adjusting the order in which RPCs are invoked.

  This queue consists of the following parts:

a. DecayRpcScheduler: used to provide priority values from 0 to N (the value 0 indicates the highest priority).
b. Multi-level queues (located in the FairCallQueue): used to ensure that queues are invoked in order of priority.
c. Multi-channel converters (provided with Weighted Round Robin Multiplexer): used to provide logic control for queue selection.

After the FairCallQueue is configured, the control module determines the sub-queue to which the received invoking is allocated. The current scheduling module is DecayRpcScheduler, which only continuously tracks the priority numbers of various calls and periodically reduces these numbers.

Go to the **All Configurations** page of HDFS and enter a parameter name in the search box by referring to **Modifying Cluster Service Configuration Parameters**.

Table 10-21 FairCallQueue parameters

Parameter	Description	Default Value
ipc.*<port>*.callqueue.impl	Specifies the queue implementation class. You need to run the **org.apache.hadoop.ipc.FairCallQueue** command to enable the QoS feature.	java.util.concurrent.LinkedBlockingQueue

- RPC BackOff

  Backoff is one of the FairCallQueue functions. It requires the client to retry operations (such as creating, deleting, and opening a file) after a period of time. When the backoff occurs, the RCP server throws RetriableException. The FairCallQueue performs backoff in either of the following cases:

  – The queue is full, that is, there are many client calls in the queue.
  – The queue response time is longer than the threshold time (specified by the **ipc.<port>.decay-scheduler.backoff.responsetime.thresholds** parameter).

Table 10-22 RPC Backoff configuration

Parameter	Description	Default Value
ipc.*<port>*.backoff.enable	Specifies whether to enable the backoff. When the current application contains a large number of user callings, the RPC request is blocked if the connection limit of the operating system is not reached. Alternatively, when the RPC or NameNode is heavily loaded, some explicit exceptions can be thrown back to the client based on certain policies. The client can understand these exceptions and perform exponential rollback, which is another implementation of the RetryInvocationHandler class.	false
ipc.*<port>*.decay-scheduler.backoff.responsetime.enable	Indicate whether to enable the backoff based on the average queue response time.	false
ipc.*<port>*.decay-scheduler.backoff.responsetime.thresholds	Configure the response time threshold for each queue. The response time threshold must match the number of priorities (the value of **ipc.<port> .faircallqueue.priority-levels**). Unit: millisecond	10000,20000,30000,40000

NOTE

- **<port>** indicates the RPC port configured on the NameNode.
- The backoff function based on the response time takes effect only when **ipc.<port> .backoff.enable** is set to **true**.

10.23 Optimizing HDFS DataNode RPC QoS

Scenario

When the speed at which the client writes data to the HDFS is greater than the disk bandwidth of the DataNode, the disk bandwidth is fully occupied. As a result, the DataNode does not respond. The client can back off only by canceling or restoring the channel, which results in write failures and unnecessary channel recovery operations.

Configuration

The new configuration parameter **dfs.pipeline.ecn** is introduced. When this configuration is enabled, the DataNode sends a signal from the write channel when the write channel is overloaded. The client may perform backoff based on the blocking signal to prevent the system from being overloaded. This configuration parameter is introduced to make the channel more stable and reduce unnecessary cancellation or recovery operations. After receiving the signal, the client backs off for a period of time (5,000 ms), and then adjusts the backoff time based on the related filter (the maximum backoff time is 50,000 ms).

Go to the **All Configurations** page of HDFS and enter a parameter name in the search box by referring to **Modifying Cluster Service Configuration Parameters**.

Table 10-23 DN ECN configuration

Parameter	Description	Default Value
dfs.pipeline.ecn	After configuration, the DataNode can send blocking notifications to the client.	false

10.24 Configuring Reserved Percentage of Disk Usage on DataNodes

Scenario

When the Yarn local directory and DataNode directory are on the same disk, the disk with larger capacity can run more tasks. Therefore, more intermediate data is stored in the Yarn local directory.

Currently, you can set **dfs.datanode.du.reserved** to configure the absolute value of the reserved disk space on DataNodes. A small value cannot meet the requirements of a disk with large capacity. However, configuring a large value for a disk with same capacity wastes a lot of disk space.

To avoid this problem, a new parameter **dfs.datanode.du.reserved.percentage** is introduced to configure the reserved percentage of the disk space.

NOTE

- If **dfs.datanode.du.reserved.percentage** and **dfs.datanode.du.reserved** are configured at the same time, the larger value of the reserved disk space calculated using the two parameters is used as the reserved space of the data nodes.
- You are advised to set **dfs.datanode.du.reserved** or **dfs.datanode.du.reserved.percentage** based on the actual disk space.

Configuration Description

Go to the **All Configurations** page of HDFS and enter a parameter name in the search box by referring to **Modifying Cluster Service Configuration Parameters**.

Table 10-24 Parameter description

Parameter	Description	Default Value
dfs.datanode.du.reserved.percentage	Indicates the percentage of the reserved disk space on DataNodes. The DataNode permanently reserves the disk space calculated using this percentage. The value is an integer ranging from 0 to 100.	10

10.25 Configuring HDFS NodeLabel

Scenario

You need to configure the nodes for storing HDFS file data blocks based on data features. You can configure a label expression to an HDFS directory or file and assign one or more labels to a DataNode so that file data blocks can be stored on specified DataNodes.

If the label-based data block placement policy is used for selecting DataNodes to store the specified files, the DataNode range is specified based on the label expression. Then proper nodes are selected from the specified range.

NOTE

After cross-AZ HA is enabled for a single cluster, the HDFS NodeLabel function cannot be configured.

- Scenario 1: DataNodes partitioning scenario

  Scenario description:

  When different application data is required to run on different nodes for separate management, label expressions can be used to achieve separation of different services, storing specified services on corresponding nodes.

  By configuring the NodeLabel feature, you can perform the following operations:

- Store data in **/HBase** to DN1, DN2, DN3, and DN4.
- Store data in **/Spark** to DN5, DN6, DN7, and DN8.

Figure 10-6 DataNode partitioning scenario

NOTE

- Run the **hdfs nodelabel -setLabelExpression -expression 'LabelA[fallback=NONE]' -path /Hbase** command to set an expression for the **Hbase** directory. As shown in **Figure 10-6**, the data block replicas of files in the **/Hbase** directory are placed on the nodes labeled with the **LabelA**, that is, DN1, DN2, DN3, and DN4. Similarly, run the **hdfs nodelabel -setLabelExpression -expression 'LabelB[fallback=NONE]' -path /Spark** command to set an expression for the Spark directory. Data block replicas of files in the **/Spark** directory can be placed only on nodes labeled with **LabelB**, that is, DN5, DN6, DN7, and DN8.
- For details about how to set labels for a data node, see **Configuration Description**.
- If multiple racks are available in one cluster, it is recommended that DataNodes of these racks should be available under each label, to ensure reliability of data block placement.

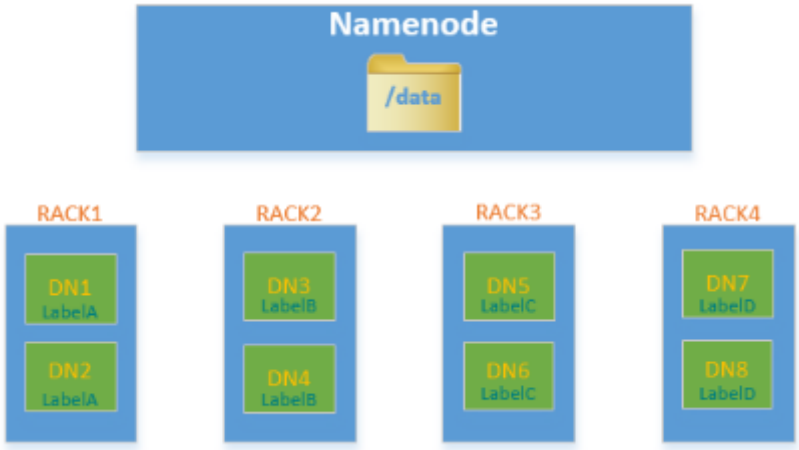
- Scenario 2: Specifying replica location when there are multiple racks

  Scenario description:

  In a heterogeneous cluster, customers need to allocate certain nodes with high availability to store important commercial data. Label expressions can be used to specify replica location so that the replica can be placed on a high reliable node.

  Data blocks in the **/data** directory have three replicas by default. In this case, at least one replica is stored on a node of RACK1 or RACK2 (nodes of RACK1 and RACK2 are high reliable), and the other two are stored separately on the nodes of RACK3 and RACK4.

Figure 10-7 Scenario example



NOTE

Run the **hdfs nodelabel -setLabelExpression -expression 'LabelA|| LabelB[fallback=NONE],LabelC,LabelD' -path /data** command to set an expression for the **/data** directory.

When data is to be written to the **/data** directory, at least one data block replica is stored on a node labeled with the LabelA or LabelB, and the other two data block replicas are stored separately on the nodes labeled with the LabelC and LabelD.

Configuration Description

- DataNode label configuration

  Go to the **All Configurations** page of HDFS and enter a parameter name in the search box by referring to **Modifying Cluster Service Configuration Parameters**.

  Table 10-25 Parameter description

Parameter	Description	Default Value
dfs.block.replicator.classname	Used to configure the DataNode policy of HDFS. To enable the NodeLabel function, set this parameter to **org.apache.hadoop.hdfs.server.blockmanagement.BlockPlacementPolicyWithNodeLabel**.	org.apache.hadoop.hdfs.server.blockmanagement.AvailableSpaceBlockPlacementPolicy

Parameter	Description	Default Value
host2tags	Used to configure a mapping between a DataNode host and a label. The host name can be configured with an IP address extension expression (for example, **192.168.1.[1-128]** or **192.168.[2-3].[1-128]**) or a regular expression (for example, **/datanode-[123]/** or **/datanode-\d{2}/**) starting and ending with a slash (/). The label configuration name cannot contain the following characters: = / \ **Note**: The IP address must be a service IP address.	-

NOTE

- The **host2tags** configuration item is described as follows:

  Assume there are 20 DataNodes which range from dn-1 to dn-20 in a cluster and the IP addresses of clusters range from 10.1.120.1 to 10.1.120.20. The value of **host2tags** can be represented in either of the following methods:

  Regular expression of the host name

  /dn-\d/ = label-1 indicates that the labels corresponding to dn-1 to dn-9 are label-1, that is, dn-1 = label-1, dn-2 = label-1, ..., dn-9 = label-1.

  /dn-((1[0-9]$)|(20$))/ = label-2 indicates that the labels corresponding to dn-10 to dn-20 are label-2, that is, dn-10 = label-2, dn-11 = label-2, ...dn-20 = label-2.

  IP address range expression

  10.1.120.[1-9] = label-1 indicates that the labels corresponding to 10.1.120.1 to 10.1.120.9 are label-1, that is, 10.1.120.1 = label-1, 10.1.120.2 = label-1, ..., and 10.1.120.9 = label-1.

  10.1.120.[10-20] = label-2 indicates that the labels corresponding to 10.1.120.10 to 10.1.120.20 are label-2, that is, 10.1.120.10 = label-2, 10.1.120.11 = label-2, ..., and 10.1.120.20 = label-2.

- Label-based data block placement policies are applicable to capacity expansion and reduction scenarios.

  A newly added DataNode will be assigned a label if the IP address of the DataNode is within the IP address range in the **host2tags** configuration item or the host name of the DataNode matches the host name regular expression in the **host2tags** configuration item.

  For example, the value of **host2tags** is **10.1.120.[1-9] = label-1**, but the current cluster has only three DataNodes: 10.1.120.1 to 10.1.120.3. If DataNode 10.1.120.4 is added for capacity expansion, the DataNode is labeled as label-1. If the 10.1.120.3 DataNode is deleted or out of the service, no data block will be allocated to the node.

- Set label expressions for directories or files.
  - On the HDFS parameter configuration page, configure **path2expression** to configure the mapping between HDFS directories and labels. If the configured HDFS directory does not exist, the configuration can succeed. When a directory with the same name as the HDFS directory is created manually, the configured label mapping relationship will be inherited by the directory within 30 minutes. After a labeled directory is deleted, a

new directory with the same name as the deleted one will inherit its mapping within 30 minutes.

- For details about configuring items using commands, see the **hdfs nodelabel -setLabelExpression** command.
- To set label expressions using the Java API, invoke the **setLabelExpression(String src, String labelExpression)** method using the instantiated object NodeLabelFileSystem. *src* indicates a directory or file path on HDFS, and **labelExpression** indicates the label expression.

- After the NodeLabel is enabled, you can run the **hdfs nodelabel -listNodeLabels** command to view the label information of each DataNode.

Block Replica Location Selection

Nodelabel supports different placement policies for replicas. The expression **label-1,label-2,label-3** indicates that three replicas are respectively placed in DataNodes containing label-1, label-2, and label-3. Different replica policies are separated by commas (,).

If you want to place two replicas in DataNode with label-1, set the expression as follows: **label-1[replica=2],label-2,label-3**. In this case, if the default number of replicas is 3, two nodes with label-1 and one node with label-2 are selected. If the default number of replicas is 4, two nodes with label-1, one node with label-2, and one node with label-3 are selected. Note that the number of replicas is the same as that of each replica policy from left to right. However, the number of replicas sometimes exceeds the expressions. If the default number of replicas is 5, the extra replica is placed on the last node, that is, the node labeled with label-3.

When the ACLs function is enabled and the user does not have the permission to access the labels used in the expression, the DataNode with the label is not selected for the replica.

Deletion of Redundant Block Replicas

If the number of block replicas exceeds the value of **dfs.replication** (number of file replicas specified by the user), HDFS will delete redundant block replicas to ensure cluster resource usage.

The deletion rules are as follows:

- Preferentially delete replicas that do not meet any expression.

  For example: The default number of file replicas is **3**.

  The label expression of **/test** is **LA[replica=1],LB[replica=1],LC[replica=1]**.

  The file replicas of **/test** are distributed on four nodes (D1 to D4), corresponding to labels (LA to LD).

  ```
  D1:LA
  D2:LB
  D3:LC
  D4:LD
  ```

  Then, block replicas on node D4 will be deleted.

- If all replicas meet the expressions, delete the redundant replicas which are beyond the number specified by the expression.

  For example: The default number of file replicas is **3**.

The label expression of **/test** is **LA[replica=1],LB[replica=1],LC[replica=1]**.

The file replicas of **/test** are distributed on the following four nodes, corresponding to the following labels.

```
D1:LA
D2:LA
D3:LB
D4:LC
```

Then, block replicas on node D1 or D2 will be deleted.

- If a file owner or group of a file owner cannot access a label, preferentially delete the replica from the DataNode mapped to the label.

Example of label-based block placement policy

Assume that there are six DataNodes, namely, dn-1, dn-2, dn-3, dn-4, dn-5, and dn-6 in a cluster and the corresponding IP address range is 10.1.120.[1-6]. Six directories must be configured with label expressions. The default number of block replicas is **3**.

- The following provides three expressions of the DataNode label in **host2labels** file. The three expressions have the same function.
  - Regular expression of the host name

    ```
    /dn-[1456]/ = label-1,label-2
    /dn-[26]/ = label-1,label-3
    /dn-[3456]/ = label-1,label-4
    /dn-5/ = label-5
    ```

  - IP address range expression

    ```
    10.1.120.[1-6] = label-1
    10.1.120.1 = label-2
    10.1.120.2 = label-3
    10.1.120.[3-6] = label-4
    10.1.120.[4-6] = label-2
    10.1.120.5 = label-5
    10.1.120.6 = label-3
    ```

  - Common host name expression

    ```
    /dn-1/ = label-1, label-2
    /dn-2/ = label-1, label-3
    /dn-3/ = label-1, label-4
    /dn-4/ = label-1, label-2, label-4
    /dn-5/ = label-1, label-2, label-4, label-5
    /dn-6/ = label-1, label-2, label-3, label-4
    ```

- The label expressions of the directories are set as follows:

  ```
  /dir1 = label-1
  /dir2 = label-1 && label-3
  /dir3 = label-2 || label-4[replica=2]
  /dir4 = (label-2 || label-3) && label-4
  /dir5 = !label-1
  /sdir2.txt = label-1 && label-3[replica=3,fallback=NONE]
  /dir6 = label-4[replica=2],label-2
  ```

  NOTE

  For details about the label expression configuration, see the **hdfs nodelabel -setLabelExpression** command.

  The file data block storage locations are as follows:

  - Data blocks of files in the **/dir1** directory can be stored on any of the following nodes: dn-1, dn-2, dn-3, dn-4, dn-5, and dn-6.
  - Data blocks of files in the **/dir2** directory can be stored on the dn-2 and dn-6 nodes. The default number of block replicas is **3**. The expression

matches only two DataNodes. The third replica will be stored on one of the remaining nodes in the cluster.

- Data blocks of files in the **/dir3** directory can be stored on any three of the following nodes: dn-1, dn-3, dn-4, dn-5, and dn-6.
- Data blocks of files in the **/dir4** directory can be stored on the dn-4, dn-5, and dn-6 nodes.
- Data blocks of files in the **/dir5** directory do not match any DataNode and will be stored on any three nodes in the cluster, which is the same as the default block selection policy.
- For the data blocks of the **/sdir2.txt** file, two replicas are stored on the dn-2 and dn-6 nodes. The left one is not stored in the node because **fallback=NONE** is enabled.
- Data blocks of the files in the **/dir6** directory are stored on the two nodes with label-4 selected from dn-3, dn-4, dn-5, and dn-6 and another node with label-2. If the specified number of file replicas in the **/dir6** directory is more than 3, the extra replicas will be stored on a node with label-2.

Restrictions

In configuration files, **key** and **value** are separated by equation signs (=), colons (:), and whitespace. Therefore, the host name of the **key** cannot contain these characters because these characters may be considered as separators.

10.26 Configuring HDFS Mover

Scenario

Mover is a new data migration tool whose working mode is similar to that of the HDFS Balancer. Mover can redistribute data in the cluster based on the configured data storage policy.

Use Mover to periodically check whether the specified HDFS file or directory in the HDFS file system meets the preset storage policy. If not, migrate data to make them meet the policy.

Configuration Description

Go to the **All Configurations** page of HDFS and enter a parameter name in the search box by referring to **Modifying Cluster Service Configuration Parameters**.

Table 10-26 Parameter description

Parameter	Description	Default Value
dfs.mover.auto.enable	Specifies whether to enable the data replica migration function. This function supports multiple modes. The default value is **false**, indicating that this function is disabled.	false

Parameter	Description	Default Value
dfs.mover.auto.cron.expression	Specifies the CRON expression for HDFS automatic data migration, and is used to control the start time of data migration. This parameter is valid only when **dfs.mover.auto.enable** is set to **true**. The default value is **0 * * * ***, indicating that the task is executed on the hour. For details about CRON expression, see **Table 10-27**.	0 * * * *
dfs.mover.auto.hdfsfiles_or_dirs	Specifies HDFS file and directory lists that implement automatic replica migration in specified clusters. Multiple values are separated by space. This parameter is valid only when **dfs.mover.auto.enable** is set to **true**.	-

Table 10-27 CRON expressions

Column	Description
1	Minute. The value ranges from 0 to 59.
2	Hour. The value ranges from 0 to 23.
3	Date. The value ranges from 1 to 31.
4	Month. The value ranges from 1 to 12.
5	Week. The value ranges from 0 to 6. **0** indicates Sunday.

Use Restrictions

Run the command on the HDFS client to enable the mover function. The command format is as follows:

hdfs mover -p *<Full path or directory path of an HDFS file >*

NOTE

Users running this command on the client must have the **supergroup** permission. You can use the system user **hdfs** of the HDFS service. For details about the initial password,contact the system administrator to obtain. Alternatively, you can create a user with the **supergroup** permission in the cluster and then run the command.

10.27 Using HDFS AZ Mover

Scenario

AZ Mover is a copy migration tool used to move copies to meet the new AZ policies set on the directory. It can be used to migrate copies from one AZ policy

to another. AZ Mover instructs NameNode to move copies based on a new AZ policy. If the NameNode refuses to delete the old copies, the new policy may not be met. For example, the copies are marked as outdated.

Restrictions

- Changing the policy name to **LOCAL_AZ** is the same as that to **ONE_AZ** because the client location cannot be determined when the uploaded file is written.
- Mover cannot determine the AZ status. As a result, the copy may be moved to the abnormal AZ and depends on NameNode for further processing.
- Mover depends on whether the number of DataNodes in each AZ meets the minimum requirement. If the AZ Mover is executed in an AZ with a small number of DataNodes, the result may be different from the expected result.
- Mover only meets the AZ-level policies and does not guarantee to meet the basic block placement policy (BPP).
- Mover does not support the change of replication factors. If the number of copies in the new AZ is different from that in the old AZ, an exception occurs.

Procedure

Step 1 Run the following command to go to the client installation directory. For example, if the client installation directory is **/opt/client**, run the following command:

cd /opt/client

Step 2 Run the following command to configure environment variables:

source bigdata_env

Step 3 If the cluster is in security mode, the user must have the read permission on the source directory or file and the write permission on the destination directory, and run the following command to authenticate the user: In normal mode, skip user authentication.

kinit *Component service user*

Step 4 Create a directory and set an AZ policy.

Run the following command to create a directory.

hdfs dfs -mkdir <*path*>

Run the following command to set the AZ policy (**azexpression** indicates the AZ policy):

hdfs dfsadmin -setAZExpression *<path> <azexpression>*

NOTE

If **<azexpression>** contains a vertical bar (|), add double quotation marks ("") to the AZ expression. The following is an example:

hdfs dfsadmin -setAZExpression /az "REP[3]:AZ1[1][*],AZ2||AZ3[1]"

Run the following command to view the AZ policy:

hdfs dfsadmin -getAZExpression <*path*>

Step 5 Upload files to the directory.

hdfs dfs -put <*localfile*> <*hdfs-path*>

Step 6 Delete the old policy from the directory and set a new policy.

Run the following command to clear the old policy:

hdfs dfsadmin -clearAZExpression <*path*>

Run the following command to configure a new policy:

hdfs dfsadmin -setAZExpression <*path*> <*azexpression*>

Step 7 Run the **azmover** command to make the copy distribution meet the new AZ policy.

hdfs azmover -p /targetDirecotry

----End

10.28 Configuring HDFS DiskBalancer

Scenario

DiskBalancer is an online disk balancer that balances disk data on running DataNodes based on various indicators. It works in the similar way of the HDFS Balancer. The difference is that HDFS Balancer balances data between DataNodes, while HDFS DiskBalancer balances data among disks on a single DataNode.

Data among disks may be unevenly distributed if a large number of files have been deleted from a cluster running for a long time, or disk capacity expansion is performed on a node in the cluster. Uneven data distribution may deteriorate the concurrent read/write performance of the HDFS, or cause service failure due to inappropriate HDFS write policies. In this case, the data density among disks on a node needs to be balanced to prevent heterogeneous small disks from becoming the performance bottleneck of the node.

Configuration Description

Go to the **All Configurations** page of HDFS and enter a parameter name in the search box by referring to **Modifying Cluster Service Configuration Parameters**.

Table 10-28 Parameter description

Parameter	Description	Default Value
dfs.disk.balancer.auto.enabled	Indicates whether to enable the HDFS DiskBalancer function. The default value is **false**, indicating that this function is disabled.	false

Parameter	Description	Default Value
dfs.disk.balancer.auto.cron.expression	CRON expression of the HDFS disk balancing operation, which is used to control the start time of the balancing operation. This parameter is valid only when **dfs.disk.balancer.auto.enabled** is set to **true**. The default value is **0 1 * * 6**, indicating that tasks are executed at 01:00 every Saturday. For details about cron expression, see **Table 10-29**. The default value indicates that the DiskBalancer check is executed at 01:00 every Saturday.	0 1 * * 6
dfs.disk.balancer.max.disk.throughputInMBperSec	Specifies the maximum disk bandwidth that can be used for disk data balancing. The unit is MB/s, and the default value is **10**. Set this parameter based on the actual disk conditions of the cluster.	10
dfs.disk.balancer.max.disk.errors	Specifies the maximum number of errors that are allowed in a specified movement process. If the value exceeds this threshold, the movement fails.	5
dfs.disk.balancer.block.tolerance.percent	Specifies the difference threshold between the data storage capacity and optimal status of each disk during data balancing among disks. For example, the ideal data storage capacity of each disk is 1 TB, and this parameter is set to **10**. When the data storage capacity of the target disk reaches 900 GB, the storage status of the disk is considered as perfect. Value range: 1 to 100.	10
dfs.disk.balancer.plan.threshold.percent	Specifies the data density difference that is allowed between two disks during disk data balancing. If the absolute value of the data density difference between any two disks exceeds the threshold, data balancing is required. Value range: 1 to 100.	10
dfs.disk.balancer.top.nodes.number	Specifies the top *N* nodes whose disk data needs to be balanced in the cluster.	5

To use this function, set **dfs.disk.balancer.auto.enabled** to **true** and configure a proper CRON expression. Set other parameters based on the cluster status.

Table 10-29 CRON expressions

Column	Description
1	Minute. The value ranges from 0 to 59.
2	Hour. The value ranges from 0 to 23.
3	Date. The value ranges from 1 to 31.
4	Month. The value ranges from 1 to 12.
5	Week. The value ranges from 0 to 6. **0** indicates Sunday.

Use Restrictions

1. Data can only be moved between disks of the same type. For example, data can only be moved between SSDs or between DISKs.
2. Enabling this function occupies disk I/O resources and network bandwidth resources of involved nodes. Enable this function in off-peak hours.
3. The DataNodes specified by the **dfs.disk.balancer.top.nodes.number** parameter are frequently calculated. Therefore, set the parameter to a small value.
4. Commands for using the DiskBalancer function on the HDFS client are as follows:

   Table 10-30 DiskBalancer commands

Syntax	Description
hdfs diskbalancer -report -top <N>	Set *N* to an integer greater than 0. This command can be used to query the top *N* nodes that require disk data balancing in the cluster.
hdfs diskbalancer -plan <Hostname|IP Address>	This command can be used to generate a JSON file based on the DataNode. The file contains information about the source disk, target disk, and blocks to be moved. In addition, this command can be used to specify other parameters such as the network bandwidth.
hdfs diskbalancer -query <Hostname:$dfs.datanode.ipc.port>	The default port number of the cluster is 9867. This command is used to query the running status of the DiskBalancer task on the current node.

Syntax	Description
hdfs diskbalancer -execute <planfile>	In this command, **planfile** indicates the JSON file generated in the second command. Use the absolute path.
hdfs diskbalancer -cancel <planfile>	This command is used to cancel the running planfile. Use the absolute path.

NOTE

- Users running this command on the client must have the **supergroup** permission. You can use the system user **hdfs** of the HDFS service. For details about the initial password, contact the system administrator to obtain. Alternatively, you can create a user with the **supergroup** permission in the cluster and then run the command.
- Only formats and usage of commands are provided in **Table 10-30**. For more parameters to be configured for each command, run the **hdfs diskbalancer -help <command>** command to view detailed information.
- When you troubleshoot performance problems during the cluster O&M, check whether the HDFS disk balancing occurs in the event information of the cluster. If yes, check whether DiskBalancer is enabled in the cluster.
- After the automatic DiskBalancer function is enabled, the ongoing task stops only after the current data balancing is complete. The task cannot be canceled during the balancing.
- You can manually specify certain nodes for data balancing on the client.

10.29 Configuring the Observer NameNode to Process Read Requests

Scenario

In an HDFS cluster configured with HA, the active NameNode processes all client requests, and the standby NameNode reserves the latest metadata and block location information. However, in this architecture, the active NameNode is the bottleneck of client request processing. This bottleneck is more obvious in clusters with a large number of requests.

To address this issue, a new NameNode is introduced: an observer NameNode. Similar to the standby NameNode, the observer NameNode also reserves the latest metadata information and block location information. In addition, the observer NameNode can process read requests from clients in the same way as the active NameNode. In typical HDFS clusters with many read requests, the observer NameNode can be used to process read requests, reducing the active NameNode load and improving the cluster capability of processing requests.

Impact on the System

- The active NameNode load can be reduced and the capability of HDFS cluster processing requests can be improved, which is especially obvious for large clusters.

- The client application configuration needs to be updated.

Prerequisites

- The HDFS cluster has been installed, the active and standby NameNodes are running properly, and the HDFS service is normal.
- The **${BIGDATA_DATA_HOME}/namenode** partition has been created on the node where the observer NameNode is to be installed.

Procedure

The following steps describe how to configure the observer NameNode of a hacluster and enable it to process read requests. If there are multiple pairs of NameServices in the cluster and they are all in use, perform the following steps to configure the observer NameNode for each pair.

Step 1 Log in to FusionInsight Manager.

Step 2 Choose **Cluster** > **Services** > **HDFS** > **Manage NameService**.

Step 3 Click **Add** next to **hacluster**.

Step 4 On the **Add NameNode** page, set **NameNode type** to **Observer** and click **Next**.

Step 5 On the **Assign Role** page, select the planned host, add the observer NameNode, and click **Next**.

NOTE

A maximum of five observer NameNodes can be added to each pair of NameServices.

Step 6 On the configuration page, configure the storage directory and port number of the NameNode as planned and click **Next**.

Step 7 Confirm the information, click **Submit**, and wait until the installation of the observer NameNode is complete.

Step 8 Restart the upper-layer components that depend on HDFS, update the client application configuration, and restart the client application.

----End

10.30 Performing Concurrent Operations on HDFS Files

Scenario

Performing this operation can concurrently modify file and directory permissions and access control tools in a cluster.

Impact on the System

Performing concurrent file modification operations in a cluster has adverse impacts on the cluster performance. Therefore, you are advised to do so when the cluster is idle.

Prerequisites

- The HDFS client or clients including HDFS has been installed. For example, the installation directory is **/opt/client**.
- Service component users have been created by the MRS cluster administrator. In security mode, machine-machine users need to download the keytab file. A human-machine user needs to change the password upon the first login. (This operation is not required in normal mode.)

Procedure

Step 1 Log in to the node where the client is installed as the client installation user.

Step 2 Run the following command to go to the client installation directory:

cd /opt/client

Step 3 Run the following command to configure environment variables:

source bigdata_env

Step 4 If the cluster is in security mode, the user executing the DistCp command must belong to the **supergroup** group and run the following command to perform user authentication. In normal mode, user authentication is not required.

kinit *Component service user*

Step 5 Increase the JVM size of the client to prevent out of memory (OOM). (32 GB is recommended for 100 million files.)

NOTE

The HDFS client exits abnormally and the error message "java.lang.OutOfMemoryError" is displayed after the HDFS client command is executed.

This problem occurs because the memory required for running the HDFS client exceeds the preset upper limit (128 MB by default). You can change the memory upper limit of the client by modifying **CLIENT_GC_OPTS** in *<Client installation path>***/HDFS/component_env**. For example, if you want to set the upper limit to 1 GB, run the following command:

CLIENT_GC_OPTS="-Xmx1G"

After the modification, run the following command to make the modification take effect:

source <*Client installation path*>/**/bigdata_env**

Step 6 Run the concurrent commands shown in the following table.

Command	Description	Function
hdfs quickcmds [-t threadsNumber] [-p principal] [-k keytab] -setrep <rep> <path> ...	**threadsNumber** indicates the number of concurrent threads. The default value is the number of vCPUs of the local host. **principal** indicates the Kerberos user. **keytab** indicates the Keytab file. **rep** indicates the number of replicas. **path** indicates the HDFS directory.	Used to concurrently set the number of copies of all files in a directory.
hdfs quickcmds [-t threadsNumber] [-p principal] [-k keytab] -chown [owner][:[group]] <path> ...	**threadsNumber** indicates the number of concurrent threads. The default value is the number of vCPUs of the local host. **principal** indicates the Kerberos user. **keytab** indicates the Keytab file. **owner** indicates the owner. **group** indicates the group to which the user belongs. **path** indicates the HDFS directory.	Used to concurrently set the owner group of all files in the directory.
hdfs quickcmds [-t threadsNumber] [-p principal] [-k keytab] -chmod <mode> <path> ...	**threadsNumber** indicates the number of concurrent threads. The default value is the number of vCPUs of the local host. **principal** indicates the Kerberos user. **keytab** indicates the Keytab file. **mode** indicates the permission (for example, 754). **path** indicates the HDFS directory.	Used to concurrently set permissions for all files in a directory.
hdfs quickcmds [-t threadsNumber] [-p principal] [-k keytab] -setfacl [{-b|-k} {-m|-x <acl_spec>} <path> ...]|[--set <acl_spec> <path> ...]	**threadsNumber** indicates the number of concurrent threads. The default value is the number of vCPUs of the local host. **principal** indicates the Kerberos user. **keytab** indicates the Keytab file. **acl_spec** indicates the ACL list separated by commas (,). **path** indicates the HDFS directory.	Used to concurrently set ACL information for all files in a directory.

----End

10.31 Introduction to HDFS Logs

Log Description

Log path: The default path of HDFS logs is **/var/log/Bigdata/hdfs/***Role name*.

- NameNode: **/var/log/Bigdata/hdfs/nn** (run logs) and **/var/log/Bigdata/audit/hdfs/nn** (audit logs)
- DataNode: **/var/log/Bigdata/hdfs/dn** (run logs) and **/var/log/Bigdata/audit/hdfs/dn** (audit logs)
- ZKFC: **/var/log/Bigdata/hdfs/zkfc** (run logs) and **/var/log/Bigdata/audit/hdfs/zkfc** (audit logs)
- JournalNode: **/var/log/Bigdata/hdfs/jn** (run logs) and **/var/log/Bigdata/audit/hdfs/jn** (audit logs)
- Router: **/var/log/Bigdata/hdfs/router** (run logs) and **/var/log/Bigdata/audit/hdfs/router** (audit logs)
- HttpFS: **/var/log/Bigdata/hdfs/httpfs** (run logs) and **/var/log/Bigdata/audit/hdfs/httpfs** (audit logs)

Log archive rule: The automatic HDFS log compression function is enabled. By default, when the size of logs exceeds 100 MB, logs are automatically compressed into a log file named in the following format: *<Original log file name>-<yyyy-mm-dd_hh-mm-ss.[ID]>***.log.zip**. A maximum of 100 latest compressed files are reserved. The number of compressed files can be configured on Manager.

Table 10-31 HDFS log list

Type	Name	Description
Run log	hadoop-<SSH_USER>-<process_name>-<hostname>.log	HDFS system log, which records most of the logs generated when the HDFS system is running.
	hadoop-<SSH_USER>-<process_name>-<hostname>.out	Log that records the HDFS running environment information.
	hadoop.log	Log that records the operation of the Hadoop client.

Type	Name	Description
	hdfs-period-check.log	Log that records scripts that are executed periodically, including automatic balancing, data migration, and JournalNode data synchronization detection.
	<process_name>-<SSH_USER>-<DATE>-<PID>-gc.log	Garbage collection log file
	postinstallDetail.log	Work log before the HDFS service startup and after the installation.
	hdfs-service-check.log	Log that records whether the HDFS service starts successfully.
	hdfs-set-storage-policy.log	Log that records the HDFS data storage policies.
	cleanupDetail.log	Log that records the cleanup logs about the uninstallation of the HDFS service.
	prestartDetail.log	Log that records cluster operations before the HDFS service startup.
	hdfs-recover-fsimage.log	Recovery log of the NameNode metadata.
	datanode-disk-check.log	Log that records the disk status check during the cluster installation and use.
	hdfs-availability-check.log	Log that check whether the HDFS service is available.
	hdfs-backup-fsimage.log	Backup log of the NameNode metadata.
	startDetail.log	Detailed log that records the HDFS service startup.

Type	Name	Description
	hdfs-blockplacement.log	Log that records the placement policy of HDFS blocks.
	upgradeDetail.log	Upgrade logs.
	hdfs-clean-acls-java.log	Log that records the clearing of deleted roles' ACL information by HDFS.
	hdfs-haCheck.log	Run log that checks whether the NameNode in active or standby state has obtained scripts.
	<process_name>-jvmpause.log	Log that records JVM pauses during process running.
	hadoop-<SSH_USER>-balancer-<hostname>.log	Run log of HDFS automatic balancing.
	hadoop-<SSH_USER>-balancer-<hostname>.out	Log that records information of the environment where HDFS executes automatic balancing.
	hdfs-switch-namenode.log	Run log that records the HDFS active/standby switchover.
	hdfs-router-admin.log	Run log of the mount table management operation
	threadDump-<DATE>.log	Instance process stack log
Tomcat logs	hadoop-omm-host1.out, httpfs-catalina.<DATE>.log, httpfs-host-manager.<DATE>.log, httpfs-localhost.<DATE>.log, httpfs-manager.<DATE>.log, localhost_access_web_log.log	Tomcat run log
Audit log	hdfs-audit-<process_name>.log ranger-plugin-audit.log	Audit log that records the HDFS operations (such as creating, deleting, modifying and querying files).

Type	Name	Description
	SecurityAuth.audit	HDFS security audit log.

Log Level

Table 10-32 lists the log levels supported by HDFS. The log levels include FATAL, ERROR, WARN, INFO, and DEBUG. Logs of which the levels are higher than or equal to the set level will be printed by programs. The higher the log level is set, the fewer the logs are recorded.

Table 10-32 Log levels

Level	Description
FATAL	Indicates the critical error information about system running.
ERROR	Indicates the error information about system running.
WARN	Indicates that the current event processing exists exceptions.
INFO	Indicates that the system and events are running properly.
DEBUG	Indicates the system and system debugging information.

To modify log levels, perform the following operations:

Step 1 Go to the **All Configurations** page of HDFS by referring to **Modifying Cluster Service Configuration Parameters**.

Step 2 On the left menu bar, select the log menu of the target role.

Step 3 Select a desired log level.

Step 4 Save the configuration. In the displayed dialog box, click **OK** to make the configurations take effect.

NOTE

The configurations take effect immediately without restarting the service.

----End

Log Formats

The following table lists the HDFS log formats.

Table 10-33 Log formats

Type	Format	Example
Run log	*<yyyy-MM-dd HH:mm:ss,SSS>*|*<Log level>*|*<Name of the thread that generates the log>*|*<Message in the log>*|*<Location where the log event occurs>*	2015-01-26 18:43:42,840 | INFO | IPC Server handler 40 on 8020 | Rolling edit logs | org.apache.hadoop.hdfs.server.namenode.FSEditLog.rollEditLog(FSEditLog.java:1096)
Audit log	*<yyyy-MM-dd HH:mm:ss,SSS>*|*<Log level>*|*<Name of the thread that generates the log>*|*<Message in the log>*|*<Location where the log event occurs>*	2015-01-26 18:44:42,607 | INFO | IPC Server handler 32 on 8020 | allowed=true ugi=hbase (auth:SIMPLE) ip=/10.177.112.145 cmd=getfileinfo src=/hbase/WALs/hghoulaslx410,16020,1421743096083/hghoulaslx410%2C16020%2C1421743096083.1422268722795 dst=null perm=null | org.apache.hadoop.hdfs.server.namenode.FSNamesystem$DefaultAuditLogger.logAuditMessage(FSNamesystem.java:7950)

10.32 HDFS Performance Tuning

10.32.1 Improving Write Performance

Scenario

Improve the HDFS write performance by modifying the HDFS attributes.

Procedure

Navigation path for setting parameters:

On FusionInsight Manager, choose **Cluster** > **Services** > **HDFS** and click **Configurations** then **All Configurations**. Enter a parameter name in the search box.

Table 10-34 Parameters for improving HDFS write performance

Parameter	Description	Default Value
dfs.datanode.drop.cache.behind.reads	Specifies whether to enable a DataNode to automatically clear all data in the cache after the data in the cache is transferred to the client. • **true**: The cached data is discarded. This parameter needs to be configured on the DataNode. You are advised to set it to **true** if data is repeatedly read only a few times, so that the cache can be used by other operations. • **false**: You are advised to set it to **false** if data is read repeatedly for many times to improve the read speed. **NOTE** This parameter is optional for improving write performance. You can configure it as needed.	false
dfs.client-write-packet-size	Specifies the size of the client write packet. When the HDFS client writes data to the DataNode, the data will be accumulated until a packet is generated. Then, the packet is transmitted over the network. This parameter specifies the size (unit: byte) of the data packet to be transmitted, which can be specified by each job. In the 10-Gigabit network, you can increase the value of this parameter to enhance the transmission throughput.	262144

10.32.2 Improving Read Performance Using Client Metadata Cache

Scenario

Improve the HDFS read performance by using the client to cache the metadata for block locations.

NOTE

This function is recommended only for reading files that are not modified frequently. Because the data modification done on the server side by some other client is invisible to the cache client, which may cause the metadata obtained from the cache to be outdated.

Procedure

Navigation path for setting parameters:

On FusionInsight Manager, choose **Cluster** > **Services** > **HDFS**, click **Configurations** then **All Configurations**, and enter the parameter name in the search box.

Table 10-35 Parameter configuration

Parameter	Description	Default Value
dfs.client.metadata.cache.enabled	Enables or disables the client to cache the metadata for block locations. Set this parameter to **true** and use it along with the **dfs.client.metadata.cache.pattern** parameter to enable the cache.	false
dfs.client.metadata.cache.pattern	Indicates the regular expression pattern of the path of the file to be cached. Only the metadata for block locations of these files is cached until the metadata expires. This parameter is valid only when **dfs.client.metadata.cache.enabled** is set to **true**. Example: **/test.*** indicates that all files whose paths start with **/test** are read. **NOTE** • To ensure consistency, configure a specific mode to cache only files that are not frequently modified by other clients. • The regular expression pattern verifies only the path of the URI, but not the schema and authority in the case of the Fully Qualified path.	-
dfs.client.metadata.cache.expiry.sec	Indicates the duration for caching metadata. The cache entry becomes invalid after its caching time exceeds this duration. Even metadata that is frequently used during the caching process can become invalid. Time suffixes **s**/**m**/**h** can be used to indicate second, minute, and hour, respectively. **NOTE** If this parameter is set to **0s**, the cache function is disabled.	60s
dfs.client.metadata.cache.max.entries	Indicates the maximum number of non-expired data items that can be cached at a time.	65536

NOTE

Call *DFSClient#clearLocatedBlockCache()* to completely clear the client cache before it expires.

The sample usage is as follows:

```
FileSystem fs = FileSystem.get(conf);
DistributedFileSystem dfs = (DistributedFileSystem) fs;
DFSClient dfsClient = dfs.getClient();
dfsClient.clearLocatedBlockCache();
```

10.32.3 Improving the Connection Between the Client and NameNode Using Current Active Cache

Scenario

When HDFS is deployed in high availability (HA) mode with multiple NameNode instances, the HDFS client needs to connect to each NameNode in sequence to determine which is the active NameNode and use it for client operations.

Once the active NameNode is identified, its details can be cached and shared to all clients running on the client host. In this way, each new client first tries to load the details of the active Name Node from the cache and save the RPC call to the standby NameNode, which can help a lot in abnormal scenarios, for example, when the standby NameNode cannot be connected for a long time.

When a fault occurs and the other NameNode is switched to the active state, the cached details are updated to the information about the current active NameNode.

Procedure

Navigation path for setting parameters:

On FusionInsight Manager, choose **Cluster** > **Services** > **HDFS**, click **Configurations** then **All Configurations**, and enter the parameter name in the search box.

Table 10-36 Configuration parameters

Parameter	Description	Default Value
dfs.client.failover.proxy.provider.[nameservice ID]	Client Failover proxy provider class which creates the NameNode proxy using the authenticated protocol. If this parameter is set to **org.apache.hadoop.hdfs.server.namenode.ha.BlackListingFailoverProxyProvider**, you can use the NameNode blacklist feature on the HDFS client. If this parameter is set to **org.apache.hadoop.hdfs.server.namenode.ha.ObserverReadProxyProvider**, you can configure the observer NameNode to process read requests.	org.apache.hadoop.hdfs.server.namenode.ha.AdaptiveFailoverProxyProvider

Parameter	Description	Default Value
dfs.client.failover.activeinfo.share.flag	Specifies whether to enable the cache function and share the detailed information about the current active NameNode with other clients. Set it to **true** to enable the cache function.	false
dfs.client.failover.activeinfo.share.path	Specifies the local directory for storing the shared files created by all clients in the host. If a cache area is to be shared by different users, the directory must have required permissions (for example, creating, reading, and writing cache files in the specified directory).	/tmp
dfs.client.failover.activeinfo.share.io.timeout.sec	(Optional) Used to control timeout. The cache file is locked when it is being read or written, and if the file cannot be locked within the specified time, the attempt to read or update the caches will be abandoned. The unit is second.	5

NOTE

The cache files created by the HDFS client are reused by other clients, and thus these files will not be deleted from the local system. If this function is disabled, you may need to manually clear the data.

10.33 FAQ

10.33.1 NameNode Startup Is Slow

Question

The NameNode startup is slow when it is restarted immediately after a large number of files (for example, 1 million files) are deleted.

Answer

It takes time for the DataNode to delete the corresponding blocks after files are deleted. When the NameNode is restarted immediately, it checks the block information reported by all DataNodes. If a deleted block is found, the NameNode generates the corresponding INFO log information, as shown below:

```
2015-06-10 19:25:50,215 | INFO  | IPC Server handler 36 on 25000 | BLOCK* processReport: blk_1075861877_2121067 on node 10.91.8.218:9866 size 10249 does not belong to any file | org.apache.hadoop.hdfs.server.blockmanagement.BlockManager.processReport(BlockManager.java:1854)
```

A log is generated for each deleted block. A file may contain one or more blocks. Therefore, after startup, the NameNode spends a large amount of time printing

logs when a large number of files are deleted. As a result, the NameNode startup becomes slow.

To address this issue, the following operations can be performed to speed up the startup:

1. After a large number of files are deleted, wait until the DataNode deletes the corresponding blocks and then restart the NameNode.

   You can run the ***hdfs dfsadmin -report*** command to check the disk space and check whether the files have been deleted.

2. If a large number of the preceding logs are generated, you can change the NameNode log level to **ERROR** so that the NameNode stops printing such logs.

   After the NameNode is restarted, change the log level back to **INFO**. You do not need to restart the service after changing the log level.

10.33.2 DataNode Is Normal but Cannot Report Data Blocks

Question

The DataNode is normal, but cannot report data blocks. As a result, the existing data blocks cannot be used.

Answer

This error may occur when the number of data blocks in a data directory exceeds four times the upper limit (4 x 1 MB). And the DataNode generates the following error logs:

```
2015-11-05 10:26:32,936 | ERROR | DataNode:[[[DISK]file:/srv/BigData/hadoop/data1/dn/]] heartbeating to
vm-210/10.91.8.210:8020 | Exception in BPOfferService for Block pool
BP-805114975-10.91.8.210-1446519981645
(Datanode Uuid bcada350-0231-413b-bac0-8c65e906c1bb) service to vm-210/10.91.8.210:8020 |
BPServiceActor.java:824
java.lang.IllegalStateException:com.google.protobuf.InvalidProtocolBufferException:Protocol message was
too large.May
be malicious.Use CodedInputStream.setSizeLimit() to increase the size limit. at
org.apache.hadoop.hdfs.protocol.BlockListAsLongs$BufferDecoder$1.next(BlockListAsLongs.java:369)
at org.apache.hadoop.hdfs.protocol.BlockListAsLongs$BufferDecoder$1.next(BlockListAsLongs.java:347) at
org.apache.hadoop.hdfs.
protocol.BlockListAsLongs$BufferDecoder.getBlockListAsLongs(BlockListAsLongs.java:325) at
org.apache.hadoop.hdfs.protocolPB.DatanodeProtocolClientSideTranslatorPB.
blockReport(DatanodeProtocolClientSideTranslatorPB.java:190) at
org.apache.hadoop.hdfs.server.datanode.BPServiceActor.blockReport(BPServiceActor.java:473)
at org.apache.hadoop.hdfs.server.datanode.BPServiceActor.offerService(BPServiceActor.java:685) at
org.apache.hadoop.hdfs.server.datanode.BPServiceActor.run(BPServiceActor.java:822)
at java.lang.Thread.run(Thread.java:745) Caused
by:com.google.protobuf.InvalidProtocolBufferException:Protocol message was too large.May be
malicious.Use CodedInputStream.setSizeLimit()
to increase the size limit. at
com.google.protobuf.InvalidProtocolBufferException.sizeLimitExceeded(InvalidProtocolBufferException.java:1
10) at com.google.protobuf.CodedInputStream.refillBuffer(CodedInputStream.java:755)
at com.google.protobuf.CodedInputStream.readRawByte(CodedInputStream.java:769) at
com.google.protobuf.CodedInputStream.readRawVarint64(CodedInputStream.java:462) at
com.google.protobuf.
CodedInputStream.readSInt64(CodedInputStream.java:363) at
org.apache.hadoop.hdfs.protocol.BlockListAsLongs$BufferDecoder$1.next(BlockListAsLongs.java:363)
```

The number of data blocks in the data directory is displayed as **Metric**. You can monitor its value through **http://<datanode-ip>:<http-port>/jmx**. If the value is

greater than four times the upper limit (4 x 1 MB), you are advised to configure multiple drives and restart HDFS.

Recovery procedure:

1. Configure multiple data directories on the DataNode.

   For example, configure multiple directories on the DataNode where only the **/data1/datadir** directory is configured:

   ```
   <property> <name>dfs.datanode.data.dir</name> <value>/data1/datadir</value> </property>
   ```

   Configure as follows:

   ```
   <property> <name>dfs.datanode.data.dir</name> <value>/data1/datadir/,/data2/datadir,/data3/datadir</value> </property>
   ```

   NOTE

   You are advised to configure multiple data directories on multiple disks. Otherwise, performance may be affected.

2. Restart the HDFS.
3. Perform the following operation to move the data to the new data directory:

   mv */data1/datadir/current/finalized/subdir1 /data2/datadir/current/finalized/subdir1*

4. Restart the HDFS.

10.33.3 HDFS WebUI Cannot Properly Update Information About Damaged Data

Question

1. When errors occur in the **dfs.datanode.data.dir** directory of DataNode due to the permission or disk damage, HDFS WebUI does not display information about damaged data.
2. After errors are restored, HDFS WebUI does not timely remove related information about damaged data.

Answer

1. DataNode checks whether the disk is normal only when errors occur in file operations. Therefore, only when a data damage is detected and the error is reported to NameNode, NameNode displays information about the damaged data on HDFS WebUI.
2. After errors are fixed, you need to restart DataNode. During restarting DataNode, all data states are checked and damaged data information is uploaded to NameNode. Therefore, after errors are fixed, damaged data information is not displayed on the HDFS WebUI only by restarting DataNode.

10.33.4 Why Do DistCp Commands Fail to Run in a Security Cluster and Exceptions Are Thrown?

Question

DistCp commands fail to run in a security cluster and exceptions are thrown.

The following client exception is reported:

```
Invalid arguments:Unexpected end of file from server
```

The following server exception is reported:

```
javax.net.ssl.SSLException:Unrecognized SSL message, plaintext connection?
```

Answer

When a user uses **webhdfs://** in a DistCp command, the preceding exceptions are thrown because the cluster uses HTTPS, that is, the **dfs.http.policy** value in the **hdfs-site.xml** file configured in *Client installation directory*/**HDFS/hadoop/etc/hadoop** is **HTTPS_ONLY**. To avoid this exception, replace **webhdfs://** with **swebhdfs://**.

Example:

./hadoop distcp swebhdfs://IP:PORT/testfile hdfs://IP:PORT/testfile1

10.33.5 How Do I Rectify the Faulty If DataNode Fails to Be Started When the Number of Disks Defined in dfs.datanode.data.dir Equals the Value of dfs.datanode.failed.volumes.tolerated?

Symptom

When the number of disks defined in **dfs.datanode.data.dir** equals the value of **dfs.datanode.failed.volumes.tolerated**, DataNode fails to be started.

Answer

By default, if a single disk is faulty, the HDFS DataNode process is stopped. As a result, NameNode schedules extra copies for each block stored in DataNode, causing block replication on normal disks.

To prevent this problem, you can configure a DataNodes tolerance value for the **dfs.data.dir** fault. Log in to FusionInsight Manager, choose **Cluster** > **Services** > **HDFS**. On the displayed page, click **Configurations** > **All Configurations**, and search for **dfs.datanode.failed.volumes.tolerated**. For example, if this parameter is set to **3**, DataNode fails to be started when four or more directories are faulty.

To prevent DataNode faults, the value of **dfs.datanode.failed.volumes.tolerated** must be less than the number of configured volumes. You can also set **dfs.datanode.failed.volumes.tolerated** to **-1**, which is equivalent to **n-1** (**n** indicates the number of volumes). This way, DataNode will be started normally.

10.33.6 Failed to Calculate the Capacity of a DataNode when Multiple data.dir Directories Are Configured in a Disk Partition

Question

The capacity of a DataNode fails to calculate when multiple data.dir directories are configured in a disk partition.

Answer

Currently, the capacity is calculated based on disks, which is similar to the ***df*** command in Linux. Ideally, users do not configure multiple data.dir directories in a disk partition. Otherwise, all data will be written to the same disk, greatly deteriorating the performance.

You are advised to configure them as below.

For example, if a node contains the following disks:

```
host-4:~ # df -h
Filesystem      Size  Used  Avail  Use%  Mounted on
/dev/sda1       352G  11G    324G  4%     /
udev            190G  252K  190G  1%     /dev
tmpfs           190G  72K    190G  1%     /dev/shm
/dev/sdb1       2.7T  74G    2.5T   3%    /data1
/dev/sdc1       2.7T  75G    2.5T   3%    /data2
/dev/sdd1       2.7T  73G    2.5T   3%    /da
```

Recommended configuration:

```
<property>
<name>dfs.datanode.data.dir</name>
<value>/data1/datadir/,/data2/datadir,/data3/datadir</value>
</property>
```

Unrecommended configuration:

```
<property>
<name>dfs.datanode.data.dir</name>
<value>/data1/datadir1/,/data2/datadir1,/data3/datadir1,/data1/datadir2,data1/datadir3,/data2/datadir2,/
data2/datadir3,/data3/datadir2,/data3/datadir3</value>
</property>
```

10.33.7 Standby NameNode Fails to Be Restarted When the System Is Powered off During Metadata (Namespace) Storage

Question

When the standby NameNode is powered off during metadata (namespace) storage, it fails to be started and the following error information is displayed.

```
2015-12-04 11:49:12,121 | ERROR | main | Failed to load image from FS
ImageFile(file=/srv/BigData/namenode/current/fsimage_0000000000000096
080,
cpktTxId=0000000000000096080) | FSImage.java:685
java.io.IOException: Invalid MD5 file /srv/BigData/namenode/current/f
simage_0000000000000096080.md5:
the content "                                  does not match the expecte
d pattern.
at org.apache.hadoop.hdfs.util.MD5FileUtils.readStoredMd5(MD5FileUtil
s.java:92)
at org.apache.hadoop.hdfs.util.MD5FileUtils.readStoredMd5ForFile(MD5F
ileUtils.java:109)
at org.apache.hadoop.hdfs.server.namenode.FSImage.loadFSImage(FSImage
.java:975)
at org.apache.hadoop.hdfs.server.namenode.FSImage.loadFSImageFile(FSI
mage.java:744)
at org.apache.hadoop.hdfs.server.namenode.FSImage.loadFSImage(FSImage
.java:682)
at org.apache.hadoop.hdfs.server.namenode.FSImage.recoverTransitionRe
ad(FSImage.java:300)
at org.apache.hadoop.hdfs.server.namenode.FSNamesystem.loadFSImage(FS
Namesystem.java:968)
at org.apache.hadoop.hdfs.server.namenode.FSNamesystem.loadFromDisk(F
SNamesystem.java:675)
at org.apache.hadoop.hdfs.server.namenode.NameNode.loadNamesystem(Nam
eNode.java:625)
at org.apache.hadoop.hdfs.server.namenode.NameNode.initialize(NameNod
e.java:685)
at org.apache.hadoop.hdfs.server.namenode.NameNode.<init>(NameNode.ja
va:889)
at org.apache.hadoop.hdfs.server.namenode.NameNode.<init>(NameNode.ja
va:872)
at org.apache.hadoop.hdfs.server.namenode.NameNode.createNameNode(Nam
eNode.java:1580)
at org.apache.hadoop.hdfs.server.namenode.NameNode.main(NameNode.java
:1654)
```

Answer

When the standby NameNode is powered off during metadata (namespace) storage, it fails to be started and the MD5 file is damaged. Remove the damaged fsimage and start the standby NameNode to rectify the fault. After the rectification, the standby NameNode loads the previous fsimage and reproduces all edits.

Recovery procedure:

1. Run the following command to remove the damaged fsimage:

   rm -rf ${BIGDATA_DATA_HOME}/namenode/current/fsimage_0000000000000096

2. Start the standby NameNode.

10.33.8 What Should I Do If Data in the Cache Is Lost When the System Is Powered Off During Small File Storage?

Symptom

The system is powered off when it is saving small files. As a result, the data in the cache is lost.

Answer

Blocks in the cache were not written to the disk immediately due to the power failure. To synchronously write the cached blocks to the disk, set **dfs.datanode.synconclose** to **true** in *Client installation path*/**HDFS/hadoop/etc/hadoop/hdfs-site.xml**.

By default, **dfs.datanode.synconclose** is set to **false**. Although the performance is high, data stored in the cache will be lost after a power failure. You can set **dfs.datanode.synconclose** to **true** to solve this problem. However, the performance will be greatly affected. Set this parameter based on the application scenario.

10.33.9 Why Does Array Border-crossing Occur During FileInputFormat Split?

Question

When HDFS calls the FileInputFormat getSplit method, the ArrayIndexOutOfBoundsException: 0 appears in the following log:

```
java.lang.ArrayIndexOutOfBoundsException: 0
at org.apache.hadoop.mapred.FileInputFormat.identifyHosts(FileInputFormat.java:708)
at org.apache.hadoop.mapred.FileInputFormat.getSplitHostsAndCachedHosts(FileInputFormat.java:675)
at org.apache.hadoop.mapred.FileInputFormat.getSplits(FileInputFormat.java:359)
at org.apache.spark.rdd.HadoopRDD.getPartitions(HadoopRDD.scala:210)
at org.apache.spark.rdd.RDD$$anonfun$partitions$2.apply(RDD.scala:239)
at org.apache.spark.rdd.RDD$$anonfun$partitions$2.apply(RDD.scala:237)
at scala.Option.getOrElse(Option.scala:120)
at org.apache.spark.rdd.RDD.partitions(RDD.scala:237)
at org.apache.spark.rdd.MapPartitionsRDD.getPartitions(MapPartitionsRDD.scala:35)
```

Answer

The elements of each block correspondent frame are as below: /default/rack0/:,/default/rack0/datanodeip:port.

The problem is due to a block damage or loss, making the block correspondent machine ip and port become null. Use **hdfs fsck** to check the file blocks health state when this problem occurs, and remove damaged block or restore the missing block to re-computing the task.

10.33.10 Why Is the Storage Type of File Copies DISK When the Tiered Storage Policy Is LAZY_PERSIST?

Question

When the storage policy of the file is set to **LAZY_PERSIST**, the storage type of the first replica should be **RAM_DISK**, and the storage type of other replicas should be **DISK**.

But why is the storage type of all copies shown as **DISK** actually?

Answer

When a user writes into a file whose storage policy is **LAZY_PERSIST**, three replicas are written one by one. The first replica is preferentially written into the

DataNode where the client is located. The storage type of all replicas is **DISK** in the following scenarios:

- If the DataNode where the client is located does not have the RAM disk, the first replica is written into the disk of the DataNode where the client is located, and other replicas are written into the disks of other nodes.
- If the DataNode where the client is located has the RAM disk, but the value of **dfs.datanode.max.locked.memory** is not set or is set to a value less than **dfs.blocksize**, the first replica is written into the disk of the DataNode where the client is located, and other replicas are written into the disks of other nodes. (To check the parameter value, log in to FusionInsight Manager and choose **Cluster** > **Services** > **HDFS**. On the displayed page, click **Configurations** > **All Configurations**, and search the parameter.)

10.33.11 How Do I Handle the Problem that HDFS Client Is Irresponsive When the NameNode Is Overloaded for a Long Time?

Symptom

When the NameNode node is overloaded (100% of the CPU is occupied), the NameNode is irresponsive. The HDFS clients that are connected to the overloaded NameNode fail to respond. However, the HDFS clients that are newly connected to the NameNode will be switched to a backup NameNode and run properly.

Answer

When the preceding error occurs, the default configuration was used (as described in **Table 10-37**): the keep alive mechanism is enabled for the RPC connection between the HDFS client and the NameNode. The keep alive mechanism keeps the HDFS client waiting for server's responses and prevents the connection from being out timed, causing the irresponsive HDFS client.

Perform the following operations on the irresponsive HDFS client:

- Leave the HDFS client waiting. Once the CPU usage of the node where NameNode locates drops, the NameNode will obtain CPU resources and the HDFS client will receive a response.
- If you do not want to leave the HDFS client running, restart the application where the HDFS client locates to reconnect the HDFS client to another idle NameNode.

Solution:

To avoid this problem, add the following configurations to *Client installation path*/**HDFS/hadoop/etc/hadoop/core-site.xml**.

Table 10-37 Description

Parameter	Description	Default Value
ipc.client.ping	If this parameter is **true**, the HDFS client will wait for the response from the server and periodically send the ping message to avoid disconnection caused by tcp timeout. If this parameter is **false**, the HDFS client will set the value of **ipc.ping.interval** as the timeout time. If no response is received within that time, timeout occurs. To avoid the irresponsiveness of HDFS when the NameNode is overloaded for a long time, set this parameter to **false**.	true
ipc.ping.interval	If **ipc.client.ping** is **true**, this parameter indicates the interval between sending the ping messages. If **ipc.client.ping** is **false**, this parameter indicates the connection timeout interval. To avoid the irresponsiveness of HDFS when the NameNode is overloaded for a long time, you are advised to set this parameter to a large value, for example 900000 (ms) to avoid timeout when the server is busy.	60000

10.33.12 Can I Delete or Modify the Data Storage Directory in DataNode?

Question

- In DataNode, the storage directory of data blocks is specified by **dfs.datanode.data.dir.** Can I modify **dfs.datanode.data.dir** to modify the data storage directory?
- Can I modify files under the data storage directory?

Answer

During the system installation, you need to configure the **dfs.datanode.data.dir** parameter to specify one or more root directories.

- During the system installation, you need to configure the dfs.datanode.data.dir parameter to specify one or more root directories.
- Exercise caution when modifying dfs.datanode.data.dir. You can configure this parameter to add a new data root directory.
- Do not modify or delete data blocks in the storage directory. Otherwise, the data blocks will lose.

NOTE

Similarly, do not delete the storage directory, or modify or delete data blocks under the directory using the following parameters:

- dfs.namenode.edits.dir
- dfs.namenode.name.dir
- dfs.journalnode.edits.dir

10.33.13 Blocks Miss on the NameNode UI After the Successful Rollback

Question

Why are some blocks missing on the NameNode UI after the rollback is successful?

Answer

This problem occurs because blocks with new IDs or genstamps may exist on the DataNode. The block files in the DataNode may have different generation flags and lengths from those in the rollback images of the NameNode. Therefore, the NameNode rejects these blocks in the DataNode and marks the files as damaged.

Scenarios:

1. Before an upgrade:

   Client A writes some data to file X. (Assume A bytes are written.)

2. During an upgrade:

   Client A still writes data to file X. (The data in the file is A + B bytes.)

3. After an upgrade:

   Client A completes the file writing. The final data is A + B bytes.

4. Rollback started:

   The status will be rolled back to the status before the upgrade. That is, file X in NameNode will have A bytes, but block files in DataNode will have A + B bytes.

Recovery procedure:

1. Obtain the list of damaged files from NameNode web UI or run the following command to obtain:

   hdfs fsck <filepath> -list-corruptfileblocks

2. Run the following command to delete unnecessary files:

   hdfs fsck <corrupt file path> - delete

   NOTE

   Deleting a file is a high-risk operation. Ensure that the files are no longer needed before performing this operation.

3. For the required files, run the **fsck** command to obtain the block list and block sequence.

- In the block sequence table provided, use the block ID to search for the data directory in the DataNode and download the corresponding block from the DataNode.
- Write all such block files in appending mode based on the sequence to construct the original file.

  Example:

  File 1--> blk_1, blk_2, blk_3

  Create a file by combining the contents of all three block files from the same sequence.
- Delete the old file from HDFS and rewrite the new file.

10.33.14 Why Is "java.net.SocketException: No buffer space available" Reported When Data Is Written to HDFS

Question

Why is an "java.net.SocketException: No buffer space available" exception reported when data is written to HDFS?

This problem occurs when files are written to the HDFS. Check the error logs of the client and DataNode.

The client logs are as follows:

Figure 10-8 Client logs

```
2017-07-05 21:58:06,459 INFO  [htable-pool3-t1] ipc.AbstractRpcClient: RPC Server Kerberos principal name for service=ClientService is hbase/hadoop.hadoop123.com@HADOOP12
2017-07-05 21:58:06,893 WARN  [main] mapreduce.LoadIncrementalHFiles: Skipping non-directory hdfs://hacluster/HBaseTest/bulkload_output/_SUCCESS
2017-07-05 21:59:13,211 WARN  [main] hdfs.BlockReaderFactory: I/O error constructing remote block reader.
java.net.SocketException: No buffer space available
        at sun.nio.ch.Net.connect0(Native Method)
        at sun.nio.ch.Net.connect(Net.java:454)
        at sun.nio.ch.Net.connect(Net.java:446)
        at sun.nio.ch.SocketChannelImpl.connect(SocketChannelImpl.java:648)
        at org.apache.hadoop.net.SocketIOWithTimeout.connect(SocketIOWithTimeout.java:192)
        at org.apache.hadoop.net.NetUtils.connect(NetUtils.java:531)
        at org.apache.hadoop.hdfs.DFSClient.newConnectedPeer(DFSClient.java:3345)
        at org.apache.hadoop.hdfs.BlockReaderFactory.nextTcpPeer(BlockReaderFactory.java:789)
        at org.apache.hadoop.hdfs.BlockReaderFactory.getRemoteBlockReaderFromTcp(BlockReaderFactory.java:706)
        at org.apache.hadoop.hdfs.BlockReaderFactory.build(BlockReaderFactory.java:369)
        at org.apache.hadoop.hdfs.DFSInputStream.getBlockReader(DFSInputStream.java:713)
        at org.apache.hadoop.hdfs.DFSInputStream.blockSeekTo(DFSInputStream.java:663)
        at org.apache.hadoop.hdfs.DFSInputStream.readWithStrategy(DFSInputStream.java:919)
        at org.apache.hadoop.hdfs.DFSInputStream.read(DFSInputStream.java:973)
        at java.io.DataInputStream.readFully(DataInputStream.java:195)
        at org.apache.hadoop.hbase.io.hfile.FixedFileTrailer.readFromStream(FixedFileTrailer.java:391)
        at org.apache.hadoop.hbase.io.hfile.HFile.isHFileFormat(HFile.java:578)
        at org.apache.hadoop.hbase.io.hfile.HFile.isHFileFormat(HFile.java:560)
        at org.apache.hadoop.hbase.mapreduce.LoadIncrementalHFiles.visitBulkHFiles(LoadIncrementalHFiles.java:229)
        at org.apache.hadoop.hbase.mapreduce.LoadIncrementalHFiles.discoverLoadQueue(LoadIncrementalHFiles.java:281)
        at org.apache.hadoop.hbase.mapreduce.LoadIncrementalHFiles.prepareHFileQueue(LoadIncrementalHFiles.java:452)
        at org.apache.hadoop.hbase.mapreduce.LoadIncrementalHFiles.doBulkLoad(LoadIncrementalHFiles.java:365)
        at org.apache.hadoop.hbase.mapreduce.LoadIncrementalHFiles.doBulkLoad(LoadIncrementalHFiles.java:331)
        at org.apache.hadoop.hbase.mapreduce.LoadIncrementalHFiles.run(LoadIncrementalHFiles.java:1107)
        at org.apache.hadoop.util.ToolRunner.run(ToolRunner.java:70)
        at org.apache.hadoop.hbase.mapreduce.LoadIncrementalHFiles.main(LoadIncrementalHFiles.java:1114)
2017-07-05 21:59:13,215 WARN  [main] hdfs.DFSClient: Failed to connect to /192.168.152.128:25009 for block BP-1989348819-192.168.199.5-1497961637591:blk_1107301222_335745
ffer space available
java.net.SocketException: No buffer space available
        at sun.nio.ch.Net.connect0(Native Method)
        at sun.nio.ch.Net.connect(Net.java:454)
        at sun.nio.ch.Net.connect(Net.java:446)
        at sun.nio.ch.SocketChannelImpl.connect(SocketChannelImpl.java:648)
        at org.apache.hadoop.net.SocketIOWithTimeout.connect(SocketIOWithTimeout.java:192)
        at org.apache.hadoop.net.NetUtils.connect(NetUtils.java:531)
        at org.apache.hadoop.hdfs.DFSClient.newConnectedPeer(DFSClient.java:3345)
```

DataNode logs are as follows:

```
2017-07-24 20:43:39,269 | ERROR | DataXceiver for client DFSClient_NONMAPREDUCE_996005058_86
 at /192.168.164.155:40214 [Receiving block
BP-1287143557-192.168.199.6-1500707719940:blk_1074269754_528941 with io weight 10] |
DataNode{data=FSDataset{dirpath='[/srv/BigData/hadoop/data1/dn/current, /srv/BigData/hadoop/
data2/dn/current, /srv/BigData/hadoop/data3/dn/current, /srv/BigData/hadoop/data4/dn/current, /srv/
BigData/hadoop/data5/dn/current, /srv/BigData/hadoop/data6/dn/current, /srv/BigData/hadoop/data7/dn/
current]'}, localName='192-168-164-155:9866', datanodeUuid='a013e29c-4e72-400c-bc7b-bbbf0799604c',
xmitsInProgress=0}:Exception transfering block
BP-1287143557-192.168.199.6-1500707719940:blk_1074269754_528941 to mirror 192.168.202.99:9866:
java.net.SocketException: No buffer space available | DataXceiver.java:870
```

```
2017-07-24 20:43:39,269 | INFO | DataXceiver for client DFSClient_NONMAPREDUCE_996005058_86
 at /192.168.164.155:40214 [Receiving block
BP-1287143557-192.168.199.6-1500707719940:blk_1074269754_528941 with io weight 10] | opWriteBlock
BP-1287143557-192.168.199.6-1500707719940:blk_1074269754_528941 received exception
java.net.SocketException: No buffer space available | DataXceiver.java:933
2017-07-24 20:43:39,270 | ERROR | DataXceiver for client DFSClient_NONMAPREDUCE_996005058_86
 at /192.168.164.155:40214 [Receiving block
BP-1287143557-192.168.199.6-1500707719940:blk_1074269754_528941 with io weight 10] |
192-168-164-155:9866:DataXceiver error processing WRITE_BLOCK operation src: /192.168.164.155:40214
dst: /192.168.164.155:9866 | DataXceiver.java:304 java.net.SocketException: No buffer space available
 at sun.nio.ch.Net.connect0(Native Method)
 at sun.nio.ch.Net.connect(Net.java:454)
 at sun.nio.ch.Net.connect(Net.java:446)
 at sun.nio.ch.SocketChannelImpl.connect(SocketChannelImpl.java:648)
 at org.apache.hadoop.net.SocketIOWithTimeout.connect(SocketIOWithTimeout.java:192)
 at org.apache.hadoop.net.NetUtils.connect(NetUtils.java:531)
 at org.apache.hadoop.net.NetUtils.connect(NetUtils.java:495)
 at org.apache.hadoop.hdfs.server.datanode.DataXceiver.writeBlock(DataXceiver.java:800)
 at org.apache.hadoop.hdfs.protocol.datatransfer.Receiver.opWriteBlock(Receiver.java:138)
 at org.apache.hadoop.hdfs.protocol.datatransfer.Receiver.processOp(Receiver.java:74)
 at org.apache.hadoop.hdfs.server.datanode.DataXceiver.run(DataXceiver.java:265)
 at java.lang.Thread.run(Thread.java:748)
```

Answer

The preceding problem may be caused by network memory exhaustion.

You can increase the threshold of the network device based on the actual scenario.

Example:

```
[root@xxxxx ~]# cat /proc/sys/net/ipv4/neigh/default/gc_thresh*
128
512
1024
[root@xxxxx ~]# echo 512 > /proc/sys/net/ipv4/neigh/default/gc_thresh1
[root@xxxxx ~]# echo 2048 > /proc/sys/net/ipv4/neigh/default/gc_thresh2
[root@xxxxx ~]# echo 4096 > /proc/sys/net/ipv4/neigh/default/gc_thresh3
[root@xxxxx ~]# cat /proc/sys/net/ipv4/neigh/default/gc_thresh*
512
2048
4096
```

You can also add the following parameters to the **/etc/sysctl.conf** file. The configuration takes effect even if the host is restarted.

```
net.ipv4.neigh.default.gc_thresh1 = 512
net.ipv4.neigh.default.gc_thresh2 = 2048
net.ipv4.neigh.default.gc_thresh3 = 4096
```

10.33.15 Why are There Two Standby NameNodes After the active NameNode Is Restarted?

Question

Why are there two standby NameNodes after the active NameNode is restarted?

When this problem occurs, check the ZooKeeper and ZooKeeper FC logs. You can find that the sessions used for the communication between the ZooKeeper server and client (ZKFC) are inconsistent. The session ID of the ZooKeeper server is **0x164cb2b3e4b36ae4**, and the session ID of the ZooKeeper FC is **0x144cb2b3e4b36ae4**. Such inconsistency means that the data interaction between the ZooKeeper server and ZKFC fails.

Content of the ZooKeeper log is as follows:

```
2015-04-15 21:24:54,257 | INFO | CommitProcessor:22 | Established session 0x164cb2b3e4b36ae4 with negotiated timeout 45000 for client /192.168.0.117:44586 | org.apache.zookeeper.server.ZooKeeperServer.finishSessionInit(ZooKeeperServer.java:623)
2015-04-15 21:24:54,261 | INFO | NIOServerCxn.Factory:192-168-0-114/192.168.0.114:2181 | Successfully authenticated client: authenticationID=hdfs/hadoop@<System domain name>; authorizationID=hdfs/hadoop@<System domain name>. | org.apache.zookeeper.server.auth.SaslServerCallbackHandler.handleAuthorizeCallback(SaslServerCallbackHandler.java:118)
2015-04-15 21:24:54,261 | INFO | NIOServerCxn.Factory:192-168-0-114/192.168.0.114:2181 | Setting authorizedID: hdfs/hadoop@<System domain name> | org.apache.zookeeper.server.auth.SaslServerCallbackHandler.handleAuthorizeCallback(SaslServerCallbackHandler.java:134)
2015-04-15 21:24:54,261 | INFO | NIOServerCxn.Factory:192-168-0-114/192.168.0.114:2181 | adding SASL authorization for authorizationID: hdfs/hadoop@<System domain name> | org.apache.zookeeper.server.ZooKeeperServer.processSasl(ZooKeeperServer.java:1009)
2015-04-15 21:24:54,262 | INFO | ProcessThread(sid:22 cport:-1): | Got user-level KeeperException when processing sessionid:0x164cb2b3e4b36ae4 type:create cxid:0x3 zxid:0x20009fafc txntype:-1 reqpath:n/a Error Path:/hadoop-ha/hacluster/ActiveStandbyElectorLock Error:KeeperErrorCode = NodeExists for /hadoop-ha/hacluster/ActiveStandbyElectorLock | org.apache.zookeeper.server.PrepRequestProcessor.pRequest(PrepRequestProcessor.java:648)
```

Content of the ZKFC log is as follows:

```
2015-04-15 21:24:54,237 | INFO | main-SendThread(192-168-0-114:2181) | Socket connection established to 192-168-0-114/192.168.0.114:2181, initiating session | org.apache.zookeeper.ClientCnxn$SendThread.primeConnection(ClientCnxn.java:854)
2015-04-15 21:24:54,257 | INFO | main-SendThread(192-168-0-114:2181) | Session establishment complete on server 192-168-0-114/192.168.0.114:2181, sessionid = 0x144cb2b3e4b36ae4 , negotiated timeout = 45000 | org.apache.zookeeper.ClientCnxn$SendThread.onConnected(ClientCnxn.java:1259)
2015-04-15 21:24:54,260 | INFO | main-EventThread | EventThread shut down | org.apache.zookeeper.ClientCnxn$EventThread.run(ClientCnxn.java:512)
2015-04-15 21:24:54,262 | INFO | main-EventThread | Session connected. | org.apache.hadoop.ha.ActiveStandbyElector.processWatchEvent(ActiveStandbyElector.java:547)
2015-04-15 21:24:54,264 | INFO | main-EventThread | Successfully authenticated to ZooKeeper using SASL. | org.apache.hadoop.ha.ActiveStandbyElector.processWatchEvent(ActiveStandbyElector.java:573)
```

Answer

- Cause Analysis

  After the active NameNode restarts, the temporary node **/hadoop-ha/hacluster/ActiveStandbyElectorLock** created on ZooKeeper is deleted. After the standby NameNode receives that information that the **/hadoop-ha/hacluster/ActiveStandbyElectorLock** node is deleted, the standby NameNode creates the /**hadoop-ha/hacluster/ActiveStandbyElectorLock** node in ZooKeeper in order to switch to the active NameNode. However, when the standby NameNode connects with ZooKeeper through the client ZKFC, the session ID of ZKFC differs from that of ZooKeeper due to network issues, overload CPU, or overload clusters. In this case, the watcher of the standby NameNode fails to detect that the temporary node has been successfully created, and fails to consider the standby NameNode as the active NameNode. After the original active NameNode restarts, it detects that the **/hadoop-ha/hacluster/ActiveStandbyElectorLock** already exists and becomes the standby NameNode. Therefore, both NameNodes are standby NameNodes.

- Solution

  You are advised to restart two ZKFCs of HDFS on FusionInsight Manager.

10.33.16 When Does a Balance Process in HDFS, Shut Down and Fail to be Executed Again?

Question

After I start a Balance process in HDFS, the process is shut down abnormally. If I attempt to execute the Balance process again, it fails again.

Answer

After a Balance process is executed in HDFS, another Balance process can be executed only after the **/system/balancer.id** file is automatically released.

However, if a Balance process is shut down abnormally, the **/system/balancer.id** has not been released when the Balance is executed again, which triggers the **append /system/balancer.id** operation.

- If the time spent on releasing the **/system/balancer.id** file exceeds the soft-limit lease period 60 seconds, executing the Balance process again triggers the append operation, which preempts the lease. The last block is in construction or under recovery status, which triggers the block recovery operation. The **/system/balancer.id** file cannot be closed until the block recovery completes. Therefore, the append operation fails.

  After the **append /system/balancer.id** operation fails, the exception message **RecoveryInProgressException** is displayed.

  ```
  org.apache.hadoop.ipc.RemoteException(org.apache.hadoop.protocol.RecoveryInProgressException): Failed to APPEND_FILE /system/balancer.id for DFSClient because lease recovery is in progress. Try again later.
  ```

- If the time spent on releasing the **/system/balancer.id** file is within 60 seconds, the original client continues to own the lease and the exception AlreadyBeingCreatedException occurs and null is returned to the client. The following exception message is displayed on the client:

  ```
  java.io.IOException: Cannot create any NameNode Connectors.. Exiting...
  ```

Either of the following methods can be used to solve the problem:

- Execute the Balance process again after the hard-limit lease period expires for 1 hour, when the original client has released the lease.
- Delete the **/system/balancer.id** file before executing the Balance process again.

10.33.17 "This page can't be displayed" Is Displayed When Internet Explorer Fails to Access the Native HDFS UI

Question

Occasionally, nternet Explorer 9, Explorer 10, or Explorer 11 fails to access the native HDFS UI.

Symptom

Internet Explorer 9, Explorer 10, or Explorer 11 fails to access the native HDFS UI, as shown in the following figure.

Cause

Some Internet Explorer 9, Explorer 10, or Explorer 11versions fail to handle SSL handshake issues, causing access failure.

Solution

Refresh the page.

10.33.18 NameNode Fails to Be Restarted Due to EditLog Discontinuity

Question

If a JournalNode server is powered off, the data directory disk is fully occupied, and the network is abnormal, the EditLog sequence number on the JournalNode is inconsecutive. In this case, the NameNode restart may fail.

Symptom

The NameNode fails to be restarted. The following error information is reported in the NameNode run logs:

```
2019-11-08 16:30:28,399 | ERROR | main | Failed to start namenode. | NameNode.java:1732
java.io.IOException: There appears to be a gap in the edit log.  We expected txid 13698019, but got txid 13698088.
        at org.apache.hadoop.hdfs.server.namenode.MetaRecoveryContext.editLogLoaderPrompt(MetaRecoveryContext.java:94)
        at org.apache.hadoop.hdfs.server.namenode.FSEditLogLoader.loadEditRecords(FSEditLogLoader.java:278)
        at org.apache.hadoop.hdfs.server.namenode.FSEditLogLoader.loadFSEdits(FSEditLogLoader.java:188)
        at org.apache.hadoop.hdfs.server.namenode.FSImage.loadEdits(FSImage.java:924)
        at org.apache.hadoop.hdfs.server.namenode.FSImage.loadFSImage(FSImage.java:771)
        at org.apache.hadoop.hdfs.server.namenode.FSImage.recoverTransitionRead(FSImage.java:331)
        at org.apache.hadoop.hdfs.server.namenode.FSNamesystem.loadFSImage(FSNamesystem.java:1108)
        at org.apache.hadoop.hdfs.server.namenode.FSNamesystem.loadFromDisk(FSNamesystem.java:727)
        at org.apache.hadoop.hdfs.server.namenode.NameNode.loadNamesystem(NameNode.java:638)
        at org.apache.hadoop.hdfs.server.namenode.NameNode.initialize(NameNode.java:700)
        at org.apache.hadoop.hdfs.server.namenode.NameNode.<init>(NameNode.java:943)
        at org.apache.hadoop.hdfs.server.namenode.NameNode.<init>(NameNode.java:916)
        at org.apache.hadoop.hdfs.server.namenode.NameNode.createNameNode(NameNode.java:1655)
        at org.apache.hadoop.hdfs.server.namenode.NameNode.main(NameNode.java:1725)
```

Solution

1. Find the active NameNode before the restart, go to its data directory (you can obtain the directory, such as **/srv/BigData/namenode/current** by checking the configuration item **dfs.namenode.name.dir**), and obtain the sequence number of the latest FsImage file, as shown in the following figure:

```
-rw-------. 1 omm wheel     574 Oct  2 01:12 edits_0000000000013259401-00000000000
-rw-------. 1 omm wheel     575 Oct  2 01:13 edits_0000000000013259409-00000000000
-rw-------. 1 omm wheel      42 Oct  2 01:13 edits_0000000000013259417-00000000000
-rw-------. 1 omm wheel 1048576 Nov  8 16:01 edits_inprogress_0000000000013698088
-rw-------. 1 omm wheel  314803 Nov  8 15:53 fsimage_0000000000013698018
-rw-------. 1 omm wheel      62 Nov  8 15:53 fsimage_0000000000013698018.md5
-rw-------. 1 omm wheel  314803 Nov  8 15:56 fsimage_0000000000013698050
-rw-------. 1 omm wheel      62 Nov  8 15:56 fsimage_0000000000013698050.md5
-rw-------. 1 omm wheel  314803 Nov  8 15:59 fsimage_0000000000013698066
-rw-------. 1 omm wheel      62 Nov  8 15:59 fsimage_0000000000013698066.md5
-rw-------. 1 omm wheel       9 Oct  2 01:13 seen_txid
-rw-------. 1 omm wheel     187 Nov  8 15:59 VERSION
```

2. Check the data directory of each JournalNode (you can obtain the directory such as**/srv/BigData/journalnode/hacluster/current** by checking the value of the configuration item **dfs.journalnode.edits.dir**), and check whether the sequence number starting from that obtained in step 1 is consecutive in edits files. That is, you need to check whether the last sequence number of the previous edits file is consecutive with the first sequence number of the next edits file. (As shown in the following figure, edits_0000000000013259231-0000000000013259237 and edits_0000000000013259239-0000000000013259246 are not consecutive.)

```
-rw-------. 1 omm wheel     575 Oct  2 00:43 edits_0000000000013259159-0000000000013259166
-rw-------. 1 omm wheel     576 Oct  2 00:43 edits_0000000000013259167-0000000000013259174
-rw-------. 1 omm wheel     575 Oct  2 00:45 edits_0000000000013259175-0000000000013259182
-rw-------. 1 omm wheel     575 Oct  2 00:45 edits_0000000000013259183-0000000000013259190
-rw-------. 1 omm wheel     576 Oct  2 00:47 edits_0000000000013259191-0000000000013259198
-rw-------. 1 omm wheel     575 Oct  2 00:48 edits_0000000000013259199-0000000000013259206
-rw-------. 1 omm wheel     575 Oct  2 00:49 edits_0000000000013259207-0000000000013259214
-rw-------. 1 omm wheel     575 Oct  2 00:50 edits_0000000000013259215-0000000000013259222
-rw-------. 1 omm wheel     573 Oct  2 00:51 edits_0000000000013259223-0000000000013259230
-rw-------. 1 omm wheel     571 Oct  2 00:52 edits_0000000000013259231-0000000000013259237
-rw-------. 1 omm wheel     576 Oct  2 00:53 edits_0000000000013259239-0000000000013259246
-rw-------. 1 omm wheel     575 Oct  2 00:54 edits_0000000000013259247-0000000000013259254
-rw-------. 1 omm wheel     576 Oct  2 00:55 edits_0000000000013259255-0000000000013259262
-rw-------. 1 omm wheel      42 Oct  2 00:56 edits_0000000000013259263-0000000000013259264
-rw-------. 1 omm wheel    1107 Oct  2 00:57 edits_0000000000013259265-0000000000013259278
-rw-------. 1 omm wheel      42 Oct  2 00:58 edits_0000000000013259279-0000000000013259280
-rw-------. 1 omm wheel    1109 Oct  2 00:59 edits_0000000000013259281-0000000000013259294
-rw-------. 1 omm wheel      42 Oct  2 01:00 edits_0000000000013259295-0000000000013259296
-rw-------. 1 omm wheel    1299 Oct  2 01:01 edits_0000000000013259297-0000000000013259312
-rw-------. 1 omm wheel     260 Oct  2 01:02 edits_0000000000013259313-0000000000013259316
-rw-------. 1 omm wheel     984 Oct  2 01:03 edits_0000000000013259317-0000000000013259328
-rw-------. 1 omm wheel     572 Oct  2 01:04 edits_0000000000013259329-0000000000013259336
-rw-------. 1 omm wheel     575 Oct  2 01:05 edits_0000000000013259337-0000000000013259344
```

3. If the edits files are not consecutive, check whether the edits files with the related sequence number exist in the data directories of other JournalNodes or NameNode. If the edits files can be found, copy a consecutive segment to the JournalNode.
4. In this way, all inconsecutive edits files are restored.
5. Restart the NameNode and check whether the restart is successful. If the fault persists, contact technical support.

11 Using Hive

11.1 Using Hive from Scratch

Hive is a data warehouse framework built on Hadoop. It maps structured data files to a database table and provides SQL-like functions to analyze and process data. It also allows you to quickly perform simple MapReduce statistics using SQL-like statements without the need of developing a specific MapReduce application. It is suitable for statistical analysis of data warehouses.

Background

Suppose a user develops an application to manage users who use service A in an enterprise. The procedure of operating service A on the Hive client is as follows:

Operations on common tables:

- Create the **user_info** table.
- Add users' educational backgrounds and professional titles to the table.
- Query user names and addresses by user ID.
- Delete the user information table after service A ends.

Table 11-1 User information

ID	Name	Gender	Age	Address
12005000201	A	Male	19	City A
12005000202	B	Female	23	City B
12005000203	C	Male	26	City C
12005000204	D	Male	18	City D
12005000205	E	Female	21	City E
12005000206	F	Male	32	City F
12005000207	G	Female	29	City G

ID	Name	Gender	Age	Address
12005000208	H	Female	30	City H
12005000209	I	Male	26	City I
12005000210	J	Female	25	City J

Procedure

Step 1 Download the client configuration file.

1. Log in to FusionInsight Manager and click **Download Client** in the upper right corner of the home page.
2. Select **Configuration Files Only** for **Select Client Type**, select a platform type, select **Server** for downloading the client file, and click **OK** to generate the client configuration file. The generated file is saved in the **/tmp/FusionInsight-Client/** directory on the active management node by default.

Step 2 Log in to the active management node of Manager.

1. Log in to any node where Manager is deployed as user **root**.
2. Run the following command to identify the active and standby nodes:

   sh ${BIGDATA_HOME}/om-server/om/sbin/status-oms.sh

   In the command output, the value of **HAActive** for the active management node is **active**, and that for the standby management node is **standby**. In the following example, **node-master1** is the active management node, and **node-master2** is the standby management node.

   ```
   HAMode
   double
   NodeName            HostName        HAVersion       StartTime           HAActive
   HAAllResOK          HARunPhase
   192-168-0-30        node-master1    V100R001C01     2020-05-01 23:43:02 active
   normal              Actived
   192-168-0-24        node-master2    V100R001C01     2020-05-01 07:14:02 standby
   normal              Deactived
   ```

3. Log in to the primary management node as user **root** and run the following command to switch to user **omm**:

   sudo su - omm

Step 3 Run the following command to go to the client installation directory:

cd /opt/client

The cluster client has been installed in advance. The following client installation directory is used as an example. Change it based on the site requirements.

Step 4 Run the following command to update the client configuration for the active management node.

sh refreshConfig.sh /opt/client *Full path of the client configuration file package*

For example, run the following command:

sh refreshConfig.sh /opt/client /tmp/FusionInsight-Client/FusionInsight_Cluster_1_Services_Client.tar

If the following information is displayed, the configurations have been updated successfully.

```
ReFresh components client config is complete.
Succeed to refresh components client config.
```

Step 5 Use the client on a Master node.

1. On the active management node, for example, **192-168-0-30**, run the following command to switch to the client directory, for example, **/opt/client**.

   cd /opt/client

2. Run the following command to configure environment variables:

   source bigdata_env

3. If Kerberos authentication is enabled for the current cluster, run the following command to authenticate the current user:

   kinit *MRS cluster user*

   Example: user **kinit hiveuser**

   The current user must have the permission to create Hive tables. If Kerberos authentication is disabled, skip this step.

4. Run the following command to log in to the Hive client CLI:

   beeline

   NOTE

   Hive allows you to add extension identifiers to JDBC connection strings. These extension identifiers are printed in HiveServer audit logs to distinguish SQL sources. You can concatenate the following to a URL:

   ```
   auditAddition=xxx
   ```

   xxx is the custom identifier. The identifier can contain a maximum of 256 bytes and only letters, digits, underscores (_), commas (,), and colons (:) are allowed.

   For details about how to set the extension identifier using code, see the *Hive Development Guide*. The client connection can be set in either of the following ways:

   - Modify the *Client installation directory*/**Hive/component_env** file, add **\;auditAddition=***xxx* to the end of the **CLIENT_HIVE_URI** parameter, and run the **source bigdata_env** command again to apply the changes.
   - When using a specified JDBC URL to connect to the Hive client, add **;auditAddition=***xxx* at the end of the URL. The following is an example:

Step 6 Run the Hive client command to implement service A.

Operations on internal tables:

1. Create the **user_info** user information table according to **Table 11-1** and add data to it.

   create table user_info(id string,name string,gender string,age int,addr string);

   insert into table user_info(id,name,gender,age,addr) values("12005000201","A","Male",19,"City A");

2. Add users' educational backgrounds and professional titles to the **user_info** table.

   For example, to add educational background and title information about user 12005000201, run the following command:

alter table user_info add columns(education string,technical string);

3. Query user names and addresses by user ID.

   For example, to query the name and address of user 12005000201, run the following command:

   select name,addr from user_info where id='12005000201';

4. Delete the user information table.

   drop table user_info;

Operations on external partition tables:

Create an external partition table and import data.

1. Create a path for storing external table data.

   hdfs dfs -mkdir /hive/

   hdfs dfs -mkdir /hive/user_info

2. Create a table.

   create external table user_info(id string,name string,gender string,age int,addr string) partitioned by(year string) row format delimited fields terminated by ' ' lines terminated by '\n' stored as textfile location '/hive/user_info';

   NOTE

   fields terminated indicates delimiters, for example, spaces.

   lines terminated indicates line breaks, for example, **\n**.

   /hive/user_info indicates the path of the data file.

3. Import data.

   a. Execute the insert statement to insert data.

      insert into user_info partition(year="2018") values ("12005000201","A","Male",19,"City A");

   b. Run the **load data** command to import file data.

      i. Create a file based on the data in **Table 11-1**. For example, the file name is **txt.log**. Fields are separated by space, and the line feed characters are used as the line breaks.

      ii. Upload the file to HDFS.

      hdfs dfs -put txt.log /tmp

      iii. Load data to the table.

      load data inpath '/tmp/txt.log' into table user_info partition (year='2011');

4. Query the imported data.

   select * from user_info;

5. Delete the user information table.

   drop table user_info;

6. Run the following command to exit:

   !q

----End

11.2 Configuring Hive Parameters

Navigation Path

Go to the Hive configurations page by referring to **Modifying Cluster Service Configuration Parameters**.

Parameter Description

Table 11-2 Hive parameter description

Parameter	Description	Default Value
hive.auto.convert.join	Whether Hive converts common **join** to **mapjoin** based on the input file size. **NOTE** When Hive is used to query a join table, whatever the table size is (if the data in the join table is less than 24 MB, it is a small one), set this parameter to **false**. If this parameter is set to **true**, new **mapjoin** cannot be generated when you query a join table.	Possible values are as follows: • true • false The default value is **true**.
hive.default.fileformat	Indicates the default file format used by Hive.	RCFile
hive.exec.reducers.max	Indicates the maximum number of reducers in a MapReduce job submitted by Hive.	999
hive.server2.thrift.max.worker.threads	Indicates the maximum number of threads that can be started in the HiveServer internal thread pool.	1,000
hive.server2.thrift.min.worker.threads	Indicates the number of threads started during initialization in the HiveServer internal thread pool.	5
hive.hbase.delete.mode.enabled	Indicates whether to enable the function of deleting HBase records from Hive. If this function is enabled, you can use **remove table xx where xxx** to delete HBase records from Hive.	true

Parameter	Description	Default Value
hive.metastore.server.min.threads	Indicates the number of threads started by MetaStore for processing connections. If the number of threads is more than the set value, MetaStore always maintains a number of threads that is not lower than the set value, that is, the number of resident threads in the MetaStore thread pool is always higher than the set value.	200
hive.server2.enable.doAs	Indicates whether to simulate client users during sessions between HiveServer2 and other services (such as Yarn and HDFS). If you change the configuration item from **false** to **true**, users with only the column permission lose the permissions to access corresponding tables.	true

11.3 Hive SQL

Hive SQL supports all features in Hive-3.1.0.

Table 11-3 describes the extended Hive statements provided by .

Table 11-3 Extended Hive statements

Extended Syntax	Syntax Description	Syntax Example	Example Description
CREATE [TEMPORARY] [EXTERNAL] TABLE [IF NOT EXISTS] [db_name.]table_name (col_name data_type [COMMENT col_comment], ...) [ROW FORMAT row_format] [STORED AS file_format] | STORED BY 'storage.handler.class.name' [WITH SERDEPROPERTIES (...)] ..... [TBLPROPERTIES ("groupId"=" group1 ","locatorId"="locator1")] ...;	The statement is used to create a Hive table and specify locators on which table data files locate. For details, see **Using HDFS Colocation to Store Hive Tables**.	CREATE TABLE tab1 (id INT, name STRING) row format delimited fields terminated by '\t' stored as RCFILE TBLPROPERTIES(" groupId"=" group1 ","locatorId"="locator1");	The statement is used to create table **tab1** and specify locator1 on which the table data of **tab1** locates.

Extended Syntax	Syntax Description	Syntax Example	Example Description
CREATE [TEMPORARY] [EXTERNAL] TABLE [IF NOT EXISTS] [db_name.]table_name (col_name data_type [COMMENT col_comment], ...) [ROW FORMAT row_format] [STORED AS file_format] | STORED BY 'storage.handler.class.name' [WITH SERDEPROPERTIES (...)] ... [TBLPROPERTIES ('**column.encode.columns**'='col_name1,col_name2'| '**column.encode.indices**'='col_id1,col_id2', **'column.encode.classname'**='encode_classname')]...;	The statement is used to create a hive table and specify the table encryption column and encryption algorithm. For details, see **Using the Hive Column Encryption Function**.	create table encode_test(id INT, name STRING, phone STRING, address STRING) ROW FORMAT SERDE 'org.apache.hadoop.hive.serde2.lazy.LazySimpleSerDe' WITH SERDEPROPERTIES ('column.encode.indices'='2,3', 'column.encode.classname'='org.apache.hadoop.hive.serde2.SMS4Rewriter') STORED AS TEXTFILE;	The statement is used to create table **encode_test** and specify that column 2 and column 3 will be encrypted using the **org.apache.hadoop.hive.serde2.SMS4Rewriter** encryption algorithm class during data insertion.
REMOVE TABLE *hbase_tablename* [WHERE where_condition];	The statement is used to delete data that meets criteria from the Hive on HBase table. For details, see **Deleting Single-Row Records from Hive on HBase**.	remove table hbase_table1 where id = 1;	The statement is used to delete data that meets the criterion of "id = 1" from the table.

Extended Syntax	Syntax Description	Syntax Example	Example Description
CREATE [TEMPORARY] [EXTERNAL] TABLE [IF NOT EXISTS] [db_name.]table_name (col_name data_type [COMMENT col_comment], ...) [ROW FORMAT row_format] **STORED AS inputformat 'org.apache.hadoop.hive.contrib.fileformat.SpecifiedDelimiterInputFormat'** outputformat 'org.apache.hadoop.hive.ql.io.HiveIgnoreKeyTextOutputFormat';	The statement is used to create a hive table and specify that the table supports customized row delimiters. For details, see **Customizing Row Separators**.	create table blu(time string, num string, msg string) row format delimited fields terminated by ',' **stored as inputformat 'org.apache.hadoop.hive.contrib.fileformat.SpecifiedDelimiterInputFormat'** outputformat 'org.apache.hadoop.hive.ql.io.HiveIgnoreKeyTextOutputFormat';	The statement is used to create table **blu** and set **inputformat** to **SpecifiedDelimiterInputFormat** so that the query row delimiter can be specified during the query.

11.4 Permission Management

11.4.1 Hive Permission

Hive is a data warehouse framework built on Hadoop. It provides basic data analysis services using the Hive query language (HQL), a language like the structured query language (SQL).

MRS supports users, user groups, and roles. Permissions must be assigned to roles and then roles are bound to users or user groups. Users can obtain permissions only by binding a role or joining a group that is bound with a role.

NOTE

- Hive permissions in security mode need to be managed whereas those in normal mode do not.
- If the current component uses Ranger for permission control, you need to configure permission management policies based on Ranger. For details, see **Adding a Ranger Access Permission Policy for Hive**.

Hive Permission Model

To use the Hive component, users must have permissions on Hive databases and tables (including external tables and views). In MRS, the complete Hive permission

model is composed of Hive metadata permission and HDFS file permission. The Hive permission model also includes the permission to use databases or tables.

- Hive metadata permission

  Similar to traditional relational databases, the Hive database of MRS supports the **CREATE** and **SELECT** permission, and the Hive tables and columns support the **SELECT**, **INSERT**, and **DELETE** permissions. Hive also supports the permissions of **OWNERSHIP** and **Hive Admin Privilege**.

- Hive data file permission, also known as HDFS file permission

  Hive database and table files are stored in the HDFS. The created databases or tables are saved in the **/user/hive/warehouse** directory of the HDFS by default. The system automatically creates subdirectories named after database names and database table names. To access a database or a table, the corresponding file permissions (read, write, and execute) on the HDFS are required.

To perform various operations on Hive databases or tables, you need to associate the metadata permission with the HDFS file permission. For example, to query Hive data tables, you need to associate the metadata permission **SELECT** and the HDFS file permissions **Read** and **Write**.

To use the role management function of Manager GUI to manage the permissions of Hive databases and tables, you only need to configure the metadata permission, and the system will automatically associate and configure the HDFS file permission. In this way, operations on the interface are simplified, and the efficiency is improved.

Hive Users

MRS provides users and roles to use Hive, such as creating tables, inserting data into tables, and querying tables. Hive defines the **USER** class, corresponding to user instances. Hive defines the **GROUP** class, corresponding to role instances.

You can use Manager to set permissions for Hive users. This method only supports permission setting in roles. A user or user group can obtain the permissions only after a role is bound to the user or user group. Hive users can be granted Hive administrator permissions and permissions to access databases, tables, and columns.

Support for Cascading Authorization.

Hive tables in a cluster with Ranger authentication enabled support cascading authorization, which significantly improves the authentication usability. You only need to authorize for service tables once on the Ranger page, and the background automatically associates the permissions of the data storage source in a fine-grained manner without detecting the storage path of the tables and without requiring secondary authorization. For details, see **Hive Tables Supporting Cascading Authorization**.

Hive Usage Scenarios and Related Permissions

Creating a database with Hive requires users to join in the **hive** group, without granting a role. Users have all permissions on the databases or tables created by themselves in Hive or HDFS. They can create tables, select, delete, insert, or

update data, and grant permissions to other users to allow them to access the tables and corresponding HDFS directories and files.

A user can access the tables or database only with permissions. The permission required by users varies according to Hive usage scenarios.

Table 11-4 Hive usage scenarios

Typical Scenario	Permission
Using Hive tables, columns, or databases	Permissions required in different scenarios are as follows: ● To create tables, the **CREATE** permission is required. ● To query data, the **SELECT** permission is required. ● To insert data, the **INSERT** permission is required. ● To delete data, the **DELETE** permission is required.
Associating and using other components	In addition to Hive permissions, permissions of other components are required in some scenarios, for example: ● Yarn permissions are required when some HQL statements, such as **insert**, **count**, **distinct**, **group by**, **order by**, **sort by**, and **join**, are run. You are advised to grant Yarn permissions to the role of each Hive user. ● HBase permission is required when Hive over HBase is used, for example, querying HBase table data in Hive.

In some special Hive usage scenarios, you need to configure other types of permission.

Table 11-5 Hive authorization precautions

Scenario	Permission
Creating Hive databases, tables, and external tables, or adding partitions to created Hive tables or external tables when data files specified by Hive users are saved to other HDFS directories except **/user/hive/warehouse**	The directory must already exist, the Hive user must be the owner of the directory, and the Hive user must have the read, write, and execute permissions on the directory. The user must have the **read** and **write** permissions of all the upper-layer directories of the directory. After an administrator grants the Hive permission to the role, the HDFS permission is automatically granted.
Using **load** to load data from all the files or specified files in a specified directory to Hive tables as a Hive user	• The data source is a Linux local disk, the specified directory exists, and the system user **omm** has read and execute permission of the directory and all its upper-layer directories. The specified file exists, and user **omm** has read permission of the file and has the read and execute permission of all the upper-layer directories of the file. • The data source is HDFS, the specified directory exists, and the Hive user is the owner of the directory and has read, write, and execute permission on the directory and its subdirectories, and has read and write permission on all its upper-layer directories. The specified file exists, and the Hive user is the owner of the file and has read, write, and execute permission, and has read and execute permission on the file and all its upper-layer directories. **NOTE** When **load** is used to import data to a Linux local disk, files must be loaded to the HiveServer on which the command is run and the permission must be modified. You are advised to run the command on a client. The HiveSever to which the client is connected can be found. For example, if the Hive client displays **0: jdbc:hive2://10.172.0.43:21066/>**, the IP address of the connected HiveServer is 10.172.0.43.
Creating or deleting functions or modifying any database	The **Hive Admin Privilege** is required.

Scenario	Permission
Performing operations on all databases and tables in Hive	The user must be added to the **supergroup** user group and granted **Hive Admin Privilege**.

11.4.2 Creating a Hive Role

Scenario

Create and configure a Hive role on Manager as an MRS cluster administrator. The Hive role can be granted the permissions of the Hive administrator and the permissions to operate Hive table data.

Creating a database with Hive requires users to join in the **hive** group, without granting a role. Users have all permissions on the databases or tables created by themselves in Hive or HDFS. They can create tables, select, delete, insert, or update data, and grant permissions to other users to allow them to access the tables and corresponding HDFS directories and files. The created databases or tables are saved in the **/user/hive/warehouse** directory of the HDFS by default.

NOTE

- A Hive role can be created only in security mode.
- If the current component uses Ranger for permission control, you need to configure permission management policies based on Ranger. For details, see **Adding a Ranger Access Permission Policy for Hive**.

Prerequisites

- The MRS cluster administrator has understood service requirements.
- Log in to FusionInsight Manager.
- The Hive client has been installed.

Procedure

Step 1 Log in to FusionInsight Manager.

Step 2 Choose **System** > **Permission** > **Role**.

Step 3 Click **Create Role**, and set **Role Name** and **Description**.

Step 4 Set **Configure Resource Permission**. For details, see **Table 11-6**.

- Grant the read and execution permissions for the HDFS directory.
  - Click *Name of the desired cluster* and select **HDFS** for **Service Name**. On the displayed page, click **File System**, choose **hdfs://hacluster/** > **user**, locate the row where **hive** is located, and select **Read** and **Execute** in the **Permission** column.
  - Click *Name of the desired cluster* and select **HDFS** for **Service Name**. On the displayed page, click **File System**, choose **hdfs://hacluster/** > **user** >

hive, locate the row where **warehouse** is located, and select **Read** and **Execute** in the **Permission** column.

- Click *Name of the desired cluster* and select **HDFS** for **Service Name**. On the displayed page, click **File System**, choose **hdfs://hacluster/** > **tmp**, locate the row where **hive-scratch** is located, and select **Read** and **Execute** in the **Permission** column.

- **Hive Admin Privilege**: Hive administrator permission.
- **Hive Read Write Privileges**: Hive data table management permission, which is the operation permission to set and manage the data of created tables.

NOTE

- Hive role management supports the administrator permissions and the permission of accessing databases, tables, and views.
- The permissions of the Hive administrator do not include the permission to manage HDFS.
- If there are too many tables in the database or too many files in tables, the permission granting may last a while. For example, if a table contains 10,000 files, the permission granting lasts about 2 minutes.

Table 11-6 Setting a role

Task	Role Authorization
Setting the Hive administrator permission	In the **Configure Resource Permission** table, choose *Name of the desired cluster* > **Hive** and select **Hive Admin Privilege**. **NOTE** After being bound to the Hive administrator role, perform the following operations during each maintenance operation: 1. Log in to the node where the Hive client is installed as the client installation user. 2. Run the following command to configure environment variables: For example, if the Hive client installation directory is **/opt/hiveclient**, run **source /opt/hiveclient/bigdata_env**. 3. Run the following command to authenticate the user: **kinit** *Hive service user* 4. Run the following command to log in to the client tool: **beeline** 5. Run the following command to update the administrator permissions of the Hive user: **set role admin;**

Task	Role Authorization
Setting the permission to query a table of another user in the default database	1. In the **Configure Resource Permission** table, choose *Name of the desired cluster* > **Hive** > **Hive Read Write Privileges**. 2. Click the name of the specified database in the database list. Tables in the database are displayed. 3. In the **Rights** column of the specified table, choose **Select**.
Setting the permission to query a table of another user in the default database	1. In the **Configure Resource Permission** table, choose *Name of the desired cluster* > **Hive** > **Hive Read Write Privileges**. 2. Click the name of the specified database in the database list. Tables in the database are displayed. 3. In the **Permission** column of the specified table, select **INSERT**.
Setting the permission to import data to a table of another user in the default database	1. In the **Configure Resource Permission** table, choose *Name of the desired cluster* > **Hive** > **Hive Read Write Privileges**. 2. Click the name of the specified database in the database list. Tables in the database are displayed. 3. In the **Permission** column of the specified indexes, select **DELETE** and **INSERT**.
Setting the permission to submit HQL commands to Yarn for execution	The HQL commands used by some services are converted into MapReduce tasks and submitted to Yarn for execution. You need to set the Yarn permissions. For example, the HQL statements to be run use statements, such as **insert**, **count**, **distinct**, **group by**, **order by**, **sort by**, or **join**. 1. In the **Permission** table, choose *Name of the desired cluster* > **Yarn** > **Scheduling Queue** > **root**. 2. In the **Permission** column of the **default** queue, select **Submit**.

Step 5 Click **OK**, and return to the **Role** page.

----End

11.4.3 Configuring Permissions for Hive Tables, Columns, or Databases

Scenario

You can configure related permissions if you need to access tables or databases created by other users. Hive supports column-based permission control. If a user needs to access some columns in tables created by other users, the user must be granted the permission for columns. The following describes how to grant table, column, and database permissions to users by using the role management function of MRS Manager.

NOTE

- You can configure permissions for Hive tables, columns, or databases only in security mode.
- If the current component uses Ranger for permission control, you need to configure permission management policies based on Ranger. For details, see **Adding a Ranger Access Permission Policy for Hive**.

Prerequisites

- You have obtained a user account with the administrator permissions, such as **admin**.
- You have created a role, for example, **hrole**, on Manager by referring to instructions in **Creating a Hive Role**. You do not need to set the Hive permission but need to set the permission to submit the HQL command to Yarn for execution.
- You have created two Hive human-machine users, such as **huser1** and **huser2**, on Manager and added them to the **hive** group. **huser2** has been bound to **hrole**. The **hdb** database has created by user **huser1** and the **htable** table has been created in the database.

Procedure

- Granting Table Permissions

  Users have complete permission on the tables created by themselves in Hive and the HDFS. To access the tables created by others, they need to be granted the permission. After the Hive metadata permission is granted, the HDFS permission is automatically granted. The procedure for granting a role the permission of querying, inserting, and deleting **htable** data is as follows:

  a. On FusionInsight Manager, choose **System** > **Permission** > **Role**.

  b. Locate the row that contains **hrole**, and click **Modify**.

  c. Choose *Name of the desired cluster* > **Hive** > **Hive Read Write Privileges**.

  d. Click the name of the specified database **hdb** in the database list. Table **htable** in the database is displayed.

e. In the **Permission** column of the **htable** table, select **SELECT**, **INSERT**, and **DELETE**.

f. Click **OK**.

NOTE

In role management, the procedure for granting a role the permission of querying, inserting, and deleting Hive external table data is the same. After the metadata permission is granted, the HDFS permission is automatically granted.

- Granting Column Permissions

  Users have all permissions for the tables created by themselves in Hive and HDFS. Users do not have the permission to access the tables created by others. If a user needs to access some columns in tables created by other users, the user must be granted the permission for columns. After the Hive metadata permission is granted, the HDFS permission is automatically granted. The procedure for granting a role the permission of querying and inserting data in **hcol** of **htable** is as follows:

  a. On FusionInsight Manager, choose **System** > **Permission** > **Role**.

  b. Locate the row that contains **hrole**, and click **Modify**.

  c. Choose *Name of the desired cluster* > **Hive** > **Hive Read Write Privileges**.

  d. In the database list, click the specified database **hdb** to display the **htable** table in the database. Click the **htable** table to display the **hcol** column in the table.

  e. In the **Permission** column of the **hcol** column, select **SELECT** and **INSERT**.

  f. Click **OK**.

NOTE

In role management, after the metadata permission is granted, the HDFS permission is automatically granted. Therefore, after the column permission is granted, the HDFS ACL permission for all files of the table is automatically granted.

- Granting Database Permissions

  Users have complete permission on the databases created by themselves in Hive and the HDFS. To access the databases created by others, they need to be granted the permission. After the Hive metadata permission is granted, the HDFS permission is automatically granted. The procedure for granting a role the permission of querying data and creating tables in database **hdb** is as follows. Other types of database operation permission are not supported.

  a. On FusionInsight Manager, choose **System** > **Permission** > **Role**.

  b. Locate the row that contains **hrole**, and click **Modify**.

  c. Choose *Name of the desired cluster* > **Hive** > **Hive Read Write Privileges**.

  d. In the **Permission** column of the **hdb** database, select **SELECT** and **CREATE**.

  e. Click **OK**.

NOTE

- Any permission for a table in the database is automatically associated with the HDFS permission for the database directory to facilitate permission management. When any permission for a table is canceled, the system does not automatically cancel the HDFS permission for the database directory to ensure performance. In this case, users can only log in to the database and view table names.
- When the query permission on a database is added to or deleted from a role, the query permission on tables in the database is automatically added to or deleted from the role.
- If the number of partitions in the database exceeds one million and all partitions are in the table directory, to accelerate granting permissions to the database, log in to FusionInsight Manager, click **Cluster** and choose **Services** > **Hive** . On the page that is displayed, click **Configurations** and then **All Configurations**. In the navigation pane on the left, choose **MetaStore(Role)** > **Customization**, add the **hive-ext.skip.grant.partition** parameter, and set it to **true**. After this parameter is added, partition scanning is skipped when permissions are granted to the database. You need to restart the MetaStore instance for the modification to take effect.

Concepts

Table 11-7 Scenarios of using Hive tables, columns, or databases

Scenario	Required Permission
DESCRIBE TABLE	SELECT
SHOW PARTITIONS	SELECT
ANALYZE TABLE	SELECT and INSERT
SHOW COLUMNS	SELECT
SHOW TABLE STATUS	SELECT
SHOW TABLE PROPERTIES	SELECT
SELECT	SELECT
EXPLAIN	SELECT
CREATE VIEW	SELECT, Grant Of Select, and CREATE
SHOW CREATE TABLE	SELECT and Grant Of Select
CREATE TABLE	CREATE
ALTER TABLE ADD PARTITION	INSERT
INSERT	INSERT
INSERT OVERWRITE	INSERT and DELETE
LOAD	INSERT and DELETE
ALTER TABLE DROP PARTITION	DELETE
CREATE FUNCTION	Hive Admin Privilege
DROP FUNCTION	Hive Admin Privilege

Scenario	Required Permission
ALTER DATABASE	Hive Admin Privilege

11.4.4 Configuring Permissions to Use Other Components for Hive

Scenario

Hive may need to be associated with other components. For example, Yarn permissions are required in the scenario of using HQL statements to trigger MapReduce jobs, and HBase permissions are required in the Hive over HBase scenario. The following describes the operations in the two scenarios.

NOTE

- In security mode, Yarn and HBase permission management is enabled by default. Therefore, Yarn and HBase permissions need to be configured by default.
- In common mode, Yarn and HBase permission management is disabled by default. That is, any user has permissions. Therefore, YARN and HBase permissions does not need to be configured by default. If a user enables the permission management by modifying the Yarn or HBase configurations, the Yarn and HBase permissions then need to be configured.
- If the current component uses Ranger for permission control, you need to configure permission management policies based on Ranger. For details, see **Adding a Ranger Access Permission Policy for Hive**.

Prerequisites

- The Hive client has been installed. For example, the installation directory is **/opt/client**.
- You have obtained a user account with the administrator permissions, such as **admin**.

Procedure

Association with Yarn

Yarn permissions are required when HQL statements, such as **insert**, **count**, **distinct**, **group by**, **order by**, **sort by**, and **join**, are used to trigger MapReduce jobs. The following uses the procedure for assigning a role the permissions to run the **count** statements in the **thc** table as an example.

Step 1 Create a role on FusionInsight Manager.

Step 2 In the **Configure Resource Permission** table, choose *Name of the desired cluster* > **Yarn** > **Scheduler Queue** > **root**.

Step 3 In the **Permission** column of the **default** queue, select **Submit** and click **OK**.

Step 4 In the **Configure Resource Permission** table, choose *Name of the desired cluster* > **Hive** > **Hive Read Write Privileges** > **default**. Select **SELECT** for table **thc**, and click **OK**.

----End

Hive over HBase Authorization

After the permissions are assigned, you can use HQL statements that are similar to SQL statements to access HBase tables from Hive. The following uses the procedure for assigning a user the rights to query HBase tables as an example.

Step 1 On the role management page of FusionInsight Manager, create an HBase role, for example, **hive_hbase_create**, and grant the permission to create HBase tables.

In the **Configure Resource Permission** table, choose *Name of the desired cluster* > **HBase** > **HBase Scope** > **global**. Select **Create** of the namespace **default**, and click **OK**.

Step 2 On FusionInsight Manager, create a human-machine user, for example, **hbase_creates_user**, add the user to the **hive** group, and bind the **hive_hbase_create** role to the user so that the user can create Hive and HBase tables.

Step 3 If the current component uses Ranger for permission control, grant the create permission for **hive_hbase_create** or **hbase_creates_user**. For details, see **Adding a Ranger Access Permission Policy for Hive**.

Step 4 Log in to the node where the client is installed as the client installation user.

Step 5 Run the following command to configure environment variables:

source /opt/client/bigdata_env

Step 6 Run the following command to authenticate the user:

kinit hbase_creates_user

Step 7 Run the following command to go to the shell environment of the Hive client:

beeline

Step 8 Run the following command to create a table in Hive and HBase, for example, the **thh** table.

CREATE TABLE thh(id int, name string, country string) STORED BY 'org.apache.hadoop.hive.hbase.HBaseStorageHandler' WITH SERDEPROPERTIES("hbase.columns.mapping" = "cf1:id,cf1:name,:key") TBLPROPERTIES ("hbase.table.name" = "thh");

The created Hive table and the HBase table are stored in the Hive database **default** and the HBase namespace **default**, respectively.

Step 9 On the role management page of FusionInsight Manager, create a role, for example, **hive_hbase_select**, and assign the role the permission to query the Hive table **thh** and the HBase table **thh**.

1. In the **Configure Resource Permission** table, choose *Name of the desired cluster* > **HBase** > **HBase Scope** > **global** > **default**. Select **read** of the **thh** table, and click **OK** to grant the table query permission to the HBase role.

2. Edit the role. In the **Configure Resource Permission** table, choose *Name of the desired cluster* > **HBase** > **HBase Scope** > **global** > **hbase**, select **Execute** for **hbase:meta**, and click **OK**.
3. Edit the role. In the **Configure Resource Permission** table, choose *Name of the desired cluster* > **Hive** > **Hive Read Write Privileges** > **default**. Select **SELECT** for the **thh** table, and click **OK**.

Step 10 On FusionInsight Manager, create a human-machine user, for example, **hbase_select_user**, add the user to the **hive** group, and bind the **hive_hbase_select** role to the user so that the user can query Hive and HBase tables.

Step 11 Run the following command to configure environment variables:

source /opt/client/bigdata_env

Step 12 Run the following command to authenticate users:

kinit hbase_select_user

Step 13 Run the following command to go to the shell environment of the Hive client:

beeline

Step 14 Run the following command to use an HQL statement to query HBase table data:

select * from thh;

----End

11.5 Using a Hive Client

Scenario

This section guides users to use a Hive client in an O&M or service scenario.

Prerequisites

- The client has been installed. For example, the client is installed in the **/opt/hadoopclient** directory. The client directory in the following operations is only an example. Change it to the actual installation directory.
- Service component users have been created by the MRS cluster administrator. In security mode, machine-machine users need to download the keytab file. A human-machine user must change the password upon the first login.

Using the Hive Client

Step 1 Log in to the node where the client is installed as the client installation user.

Step 2 Run the following command to go to the client installation directory:

cd /opt/hadoopclient

Step 3 Run the following command to configure environment variables:

source bigdata_env

Step 4 Log in to the Hive client based on the cluster authentication mode.

- In security mode, run the following command to complete user authentication and log in to the Hive client:

  kinit *Component service user*

  beeline

- In common mode, run the following command to log in to the Hive client. If no component service user is specified, the current OS user is used to log in to the Hive client.

  beeline -n *component service user*

Step 5 Run the following command to execute the HCatalog client command:

hcat -e *"cmd"*

cmd must be a Hive DDL statement, for example, **hcat -e "show tables"**.

NOTE

- To use the HCatalog client, choose **More** > **Download Client** on the service page to download the clients of all services. This restriction does not apply to the beeline client.
- Due to permission model incompatibility, tables created using the HCatalog client cannot be accessed on the HiveServer client. However, the tables can be accessed on the WebHCat client.
- If you use the HCatalog client in Normal mode, the system performs DDL commands using the current user who has logged in to the operating system.
- Exit the beeline client by running the **!q** command instead of by pressing **Ctrl + C**. Otherwise, the temporary files generated by the connection cannot be deleted and a large number of junk files will be generated as a result.
- If multiple statements need to be entered during the use of beeline clients, separate the statements from each other using semicolons (**;**) and set the value of **entireLineAsCommand** to **false**.

  Setting method: If beeline has not been started, run the **beeline --entireLineAsCommand=false** command. If the beeline has been started, run the **!set entireLineAsCommand false** command.

  After the setting, if a statement contains semicolons (**;**) that do not indicate the end of the statement, escape characters must be added, for example, **select concat_ws('\;', collect_set(col1)) from tbl**.

----End

Common Hive Client Commands

The following table lists common Hive Beeline commands.

Table 11-8 Common Hive Beeline commands

Command	Description
set <key>=<value>	Sets the value of a specific configuration variable (key). **NOTE** If the variable name is incorrectly spelled, the Beeline does not display an error.

Command	Description
set	Prints the list of configuration variables overwritten by users or Hive.
set -v	Prints all configuration variables of Hadoop and Hive.
add FILE[S] <filepath> <filepath>* add JAR[S] <filepath> <filepath>* add ARCHIVE[S] <filepath> <filepath>*	Adds one or more files, JAR files, or ARCHIVE files to the resource list of the distributed cache.
add FILE[S] <ivyurl> <ivyurl>* add JAR[S] <ivyurl> <ivyurl>* add ARCHIVE[S] <ivyurl> <ivyurl>*	Adds one or more files, JAR files, or ARCHIVE files to the resource list of the distributed cache using the lvy URL in the **ivy://goup:module:version?query_string** format.
list FILE[S] list JAR[S] list ARCHIVE[S]	Lists the resources that have been added to the distributed cache.
list FILE[S] <filepath>* list JAR[S] <filepath>* list ARCHIVE[S] <filepath>*	Checks whether given resources have been added to the distributed cache.
delete FILE[S] <filepath>* delete JAR[S] <filepath>* delete ARCHIVE[S] <filepath>*	Deletes resources from the distributed cache.
delete FILE[S] <ivyurl> <ivyurl>* delete JAR[S] <ivyurl> <ivyurl>* delete ARCHIVE[S] <ivyurl> <ivyurl>*	Delete the resource added using **<ivyurl>** from the distributed cache.
reload	Enable HiveServer2 to discover the change of the JAR file **hive.reloadable.aux.jars.path** in the specified path. (You do not need to restart HiveServer2.) Change actions include adding, deleting, or updating JAR files.
dfs <dfs command>	Runs the **dfs** command.

Command	Description
<query string>	Executes the Hive query and prints the result to the standard output.

11.6 Using HDFS Colocation to Store Hive Tables

Scenario

HDFS Colocation is the data location control function provided by HDFS. The HDFS Colocation API stores associated data or data on which associated operations are performed on the same storage node. Hive supports the HDFS Colocation function. When Hive tables are created, after the locator information is set for table files, data files of related tables are stored on the same storage node when data is inserted into tables using the insert statement (other data import modes are not supported). This ensures convenient and efficient data computing among associated tables. The supported table formats are only TextFile and RCFile.

Procedure

Step 1 Log in to the node where the client is installed as a client installation user.

Step 2 Run the following command to switch to the client installation directory, for example, **/opt/client**:

cd /opt/client

Step 3 Run the following command to configure environment variables:

source bigdata_env

Step 4 If the cluster is in security mode, run the following command to authenticate the user:

kinit *MRS username*

Step 5 Create the *groupid* through the HDFS API.

hdfs colocationadmin -createGroup -groupId *<groupid>* -locatorIds *<locatorid1>*,*<locatorid2>*,*<locatorid3>*

NOTE

In the preceding command, *<groupid>* indicates the name of the created group. The group created in this example contains three locators. You can define the number of locators as required.

For details about group ID creation and HDFS Colocation, see HDFS description.

Step 6 Run the following command to log in to the Hive client:

beeline

Step 7 Enable Hive to use colocation.

Assume that **table_name1** and **table_name2** are associated with each other. Run the following statements to create them:

CREATE TABLE ***<[db_name.]table_name1>[(col_name data_type , ...)]*** **[ROW FORMAT** ***<row_format>*****] [STORED AS** ***<file_format>*****] TBLPROPERTIES("groupId="** ***<group>*** **","locatorId="*****<locator1>*****");**

CREATE TABLE ***<[db_name.]table_name2> [(col_name data_type , ...)]*** **[ROW FORMAT** ***<row_format>*****] [STORED AS** ***<file_format>*****] TBLPROPERTIES("groupId="** ***<group>*** **","locatorId="*****<locator1>*****");**

After data is inserted into **table_name1** and **table_name2** using the insert statement, data files of **table_name1** and **table_name2** are distributed to the same storage position in the HDFS, facilitating associated operations among the two tables.

----End

11.7 Using the Hive Column Encryption Function

Scenario

Hive supports encryption of one or multiple columns in a table. When creating a Hive table, you can specify the column to be encrypted and encryption algorithm. When data is inserted into the table using the insert statement, the related columns are encrypted. Column encryption can be performed in HDFS tables of only the TextFile and SequenceFile file formats. The Hive column encryption does not support views and the Hive over HBase scenario.

Hive supports two column encryption algorithms, which can be specified during table creation:

- AES (the encryption class is org.apache.hadoop.hive.serde2.AESRewriter)
- SMS4 (the encryption class is org.apache.hadoop.hive.serde2.SMS4Rewriter)

NOTE

- In national cryptographic cluster scenarios, Hive column encryption supports only table creation using the SMS4 algorithm.
- When you import data from a common Hive table into a Hive column encryption table, you are advised to delete the original data from the common Hive table as long as doing this does not affect other services. Retaining an unencrypted table poses security risks.

Procedure

Step 1 Specify the column to be encrypted and encryption algorithm when creating a table.

create table***<[db_name.]table_name> (<col_name1> <data_type> ,<col_name2> <data_type>,<col_name3> <data_type>,<col_name4> <data_type>)*** **ROW FORMAT SERDE 'org.apache.hadoop.hive.serde2.lazy.LazySimpleSerDe' WITH SERDEPROPERTIES ('column.encode.columns'='*****<col_name2>,<col_name3>*****', 'column.encode.classname'='org.apache.hadoop.hive.serde2.AESRewriter')STORED AS TEXTFILE;**

Alternatively, use the following statement:

create table ***<[db_name.]table_name> (<col_name1> <data_type> ,<col_name2> <data_type>,<col_name3> <data_type>,<col_name4> <data_type>)*** **ROW FORMAT SERDE 'org.apache.hadoop.hive.serde2.lazy.LazySimpleSerDe' WITH SERDEPROPERTIES ('column.encode.indices'='1,2', 'column.encode.classname'='org.apache.hadoop.hive.serde2.SMS4Rewriter') STORED AS TEXTFILE;**

NOTE

- The numbers used to specify encryption columns start from 0. 0 indicates column 1, 1 indicates column 2, and so on.
- When creating a table with encrypted columns, ensure that the directory where the table resides is empty.

Step 2 Insert data into the table using the insert statement.

Assume that the test table exists and contains data.

insert into table ***<table_name>*** **select** ***<col_list>*** **from test;**

----End

11.8 Customizing Row Separators

Scenario

In most cases, a carriage return character is used as the row delimiter in Hive tables stored in text files, that is, the carriage return character is used as the terminator of a row during queries. However, some data files are delimited by special characters, and not a carriage return character.

MRS Hive allows you to use different characters or character combinations to delimit rows of Hive text data. When creating a table, set **inputformat** to **SpecifiedDelimiterInputFormat**, and set the following parameter before search each time. Then the table data is queried by the specified delimiter.

set hive.textinput.record.delimiter='';

NOTE

The Hue component of the current version does not support the configuration of multiple separators when files are imported to a Hive table.

Procedure

Step 1 Specify **inputFormat** and **outputFormat** when creating a table.

CREATE [TEMPORARY] [EXTERNAL] TABLE [IF NOT EXISTS] *[db_name.]table_name* **[(***col_name data_type* **[COMMENT** *col_comment***], ...)] [ROW FORMAT** *row_format***] STORED AS inputformat 'org.apache.hadoop.hive.contrib.fileformat.SpecifiedDelimiterInputFormat' outputformat 'org.apache.hadoop.hive.ql.io.HiveIgnoreKeyTextOutputFormat'**

Step 2 Specify the delimiter before search.

set hive.textinput.record.delimiter='!@!'

Hive will use '!@!' as the row delimiter.

----End

11.9 Configuring Hive on HBase in Across Clusters with Mutual Trust Enabled

For mutually trusted Hive and HBase clusters with Kerberos authentication enabled, you can access the HBase cluster and synchronize its key configurations to HiveServer of the Hive cluster.

Prerequisites

The mutual trust relationship has been configured between the two security clusters with Kerberos authentication enabled.

Procedure for Configuring Hive on HBase Across Clusters

Step 1 Download the HBase configuration file and decompress it.

1. Log in to FusionInsight Manager of the target HBase cluster, click **Cluster** and choose **Services** > **HBase**.
2. Choose **More** > **Download Client**.
3. Download the HBase configuration file and choose **Configuration Files only** for **Select Client Type**.

Step 2 Log in to FusionInsight Manager of the source Hive cluster.

Step 3 Click **Cluster**, choose **Services** > **Hive**, click **Configurations** and then **All Configurations**. On the displayed page, add the following parameters to the **hive-site.xml** configuration file of the HiveServer role.

Search for the following parameters in the **hbase-site.xml** configuration file of the downloaded HBase client and add them to HiveServer:

- hbase.security.authentication
- hbase.security.authorization
- hbase.zookeeper.property.clientPort
- hbase.zookeeper.quorum (The domain name needs to be converted into an IP address.)
- hbase.regionserver.kerberos.principal
- hbase.master.kerberos.principal

Step 4 Save the configurations and restart Hive.

----End

11.10 Deleting Single-Row Records from Hive on HBase

Scenario

Due to the limitations of underlying storage systems, Hive does not support the ability to delete a single piece of table data. In Hive on HBase, MRS Hive supports the ability to delete a single piece of HBase table data. Using a specific syntax, Hive can delete one or more pieces of data from an HBase table.

Table 11-9 Permissions required for deleting single-row records from the Hive on HBase table

Cluster Authentication Mode	Required Permission
Security mode	SELECT, INSERT, and DELETE
Common mode	None

Procedure

Step 1 To delete some data from an HBase table, run the following HQL statement:

remove table *<table_name>* **where** *<expression>*;

In the preceding information, *<expression>* specifies the filter condition of the data to be deleted. *<table_name>* indicates the Hive on HBase table from which data is to be deleted.

----End

11.11 Configuring HTTPS/HTTP-based REST APIs

Scenario

WebHCat provides external REST APIs for Hive. By default, the open-source community version uses the HTTP protocol.

MRS Hive supports the HTTPS protocol that is more secure, and enables switchover between the HTTP protocol and the HTTPS protocol.

NOTE

The security mode supports HTTPS and HTTP, and the common mode supports only HTTP.

Procedure

Step 1 Log in to FusionInsight Manager. For details. Click **Cluster**, choose **Services** > **Hive**, click **Configurations**, and then **All Configurations**.

Step 2 Choose **WebHCat(Role)** > **Security**. On the page that is displayed, select **HTTPS** or **HTTP**. After the modification, restart the Hive service to use the corresponding protocol.

----End

11.12 Enabling or Disabling the Transform Function

Scenario

The Transform function is not allowed by Hive of the open source version.

MRS Hive supports the configuration of the Transform function. The function is disabled by default, which is the same as that of the open-source community version.

Users can modify configurations of the Transform function to enable the function. However, security risks exist when the Transform function is enabled.

NOTE

The Transform function can be disabled only in security mode.

Procedure

Step 1 Log in to FusionInsight Manager, click **Cluster**, choose **Services** > **Hive**, click **Configurations**, and then **All Configurations**.

Step 2 Enter the parameter name in the search box, search for **hive.security.transform.disallow**, change the parameter value to **true** or **false**, and restart all HiveServer instances.

NOTE

- If this parameter is set to **true**, the Transform function is disabled, which is the same as that in the open-source community version.
- If this parameter is set to **false**, the Transform function is enabled, which poses security risks.

----End

11.13 Access Control of a Dynamic Table View on Hive

Scenario

This section describes how to create a view on Hive when MRS is configured in security mode, authorize access permissions to different users, and specify that different users access different data.

In the view, Hive can obtain the built-in function **current_user()** of the users who submit tasks on the client and filter the users. This way, authorized users can only access specific data in the view.

NOTE

- In normal mode, the **current_user()** function cannot distinguish users who submit tasks on the client. Therefore, the access control function takes effect only for Hive in security mode.
- If the **current_user()** function is used in the actual service logic, the possible risks must be fully evaluated during the conversion between the security mode and normal mode.

Example

- If the **current_user()** function is not used, different views need to be created for different users to access different data.
  - Authorize the view **v1** permission to user **hiveuser1**. The user **hiveuser1** can access data with **type** set to **hiveuser1** in **table1**.

    create view v1 as select * from table1 where type='hiveuser1'
  - Authorize the view **v2** permission to user **hiveuser2**. The user **hiveuser2** can access data with **type** set to **hiveuser2** in **table1**.

    create view v2 as select * from table1 where type='hiveuser2'
- If the **current_user** function is used, only one view needs to be created.

  Authorize the view **v** permission to users **hiveuser1** and **hiveuser2**. When user **hiveuser1** queries view **v**, the **current_user()** function is automatically converted to **hiveuser1**. When user **hiveuser2** queries view **v**, the **current_user()** function is automatically converted to **hiveuser2**.

  create view v as select * from table1 where type=current_user()

11.14 Specifying Whether the ADMIN Permissions Is Required for Creating Temporary Functions

Scenario

You must have **ADMIN** permission when creating temporary functions on Hive of the open source community version.

MRS Hive supports the configuration of the function for creating temporary functions with **ADMIN** permission. The function is disabled by default, which is the same as that of the open-source community version.

You can modify configurations of this function. After the function is enabled, you can create temporary functions without **ADMIN** permission. If this parameter is set to **false**, security risks exist.

NOTE

The security mode supports the configuration of whether the ADMIN permission is required for creating temporary functions, but the common mode does not support this function.

Procedure

Step 1 Log in to FusionInsight Manager, click **Cluster**, choose **Services** > **Hive**, click **Configurations**, and then **All Configurations**.

Step 2 Enter the parameter name in the search box, search for **hive.security.temporary.function.need.admin**, change the parameter value to **true** or **false**, and restart all HiveServer instances.

NOTE

- If this parameter is set to **true**, the ADMIN permission is required for creating temporary functions, which is the same as that in the open source community.
- If this parameter is set to **false**, the ADMIN permission is not required for creating temporary functions.

----End

11.15 Using Hive to Read Data in a Relational Database

Scenario

Hive allows users to create external tables to associate with other relational databases. External tables read data from associated relational databases and support Join operations with other tables in Hive.

Currently, the following relational databases can use Hive to read data:

- DB2
- Oracle

Prerequisites

The Hive client has been installed.

Procedure

Step 1 Log in to the node where the Hive client is installed as the Hive client installation user .

Step 2 Run the following command to go to the client installation directory:

cd *Client installation directory*

For example, if the client installation directory is **/opt/client**, run the following command:

cd /opt/client

Step 3 Run the following command to configure environment variables:

source bigdata_env

Step 4 Check whether the cluster authentication mode is Security.

- If yes, run the following command to authenticate the user:

  kinit *Hive service user*
- If no, go to **Step 5**.

Step 5 Run the following command to upload the driver JAR package of the relational database to be associated to an HDFS directory.

hdfs dfs -put *directory where the JAR package is located HDFS directory to which the JAR is uploaded*

For example, to upload the Oracle driver JAR package in **/opt** to the **/tmp** directory in HDFS, run the following command:

hdfs dfs -put /opt/ojdbc6.jar /tmp

Step 6 Create an external table on the Hive client to associate with the relational database, as shown in the following example.

NOTE

If the security mode is used, the user who creates the table must have the **ADMIN** permission. The **ADD JAR** path is subject to the actual path.

```
-- Example of associating with an Oracle Linux 6 database
-- In security mode, set the admin permission.
set role admin;
-- Upload the driver JAR package of the relational database to be associated. The driver JAR packages vary according to databases.
ADD JAR hdfs:///tmp/ojdbc6.jar;

CREATE EXTERNAL TABLE ora_test
-- The Hive table must have one more column than the database return result. This column is used for paging query.
(id STRING,rownum string)
STORED BY 'com.qubitproducts.hive.storage.jdbc.JdbcStorageHandler'
TBLPROPERTIES (
-- Relational database table type
"qubit.sql.database.type" = "ORACLE",
-- Connect to the URL of the relational database through JDBC. (The URL formats vary according to databases.)
"qubit.sql.jdbc.url" = "jdbc:oracle:thin:@//10.163.0.1:1521/mydb",
-- Relational database driver class type
"qubit.sql.jdbc.driver" = "oracle.jdbc.OracleDriver",
-- SQL statement queried in the relational database. The result is returned to the Hive table.
"qubit.sql.query" = "select name from aaa",
-- (Optional) Match the Hive table columns to the relational database table columns.
"qubit.sql.column.mapping" = "id=name",
-- Relational database user
"qubit.sql.dbcp.username" = "test",
-- Relational database password. Commands carrying authentication passwords pose security risks. Disable historical command recording before running such commands to prevent information leakage.
"qubit.sql.dbcp.password" = "xxx");
```

----End

11.16 Supporting Traditional Relational Database Syntax in Hive

Overview

Hive supports the following types of traditional relational database syntax:

- Grouping
- EXCEPT and INTERSECT

Grouping

Syntax description:

- Grouping takes effect only when the Group by statement contains ROLLUP or CUBE.
- The result set generated by CUBE contains all the combinations of values in the selected columns.
- The result set generated by ROLLUP contains the combinations of a certain layer structure in the selected columns.
- Grouping: If a row is added by using the CUBE or ROLLUP operator, the output value of the added row is 1. If the row is not added by using the CUBE or ROLLUP operator, the output value of the added row is 0.

For example, the **table_test** table exists in Hive and the table structure is as follows:

```
+----------------+-------------------+--+
| table_test.id  | table_test.value  |
+----------------+-------------------+--+
| 1              | 10                |
| 1              | 15                |
| 2              | 20                |
| 2              | 5                 |
| 2              | 13                |
+----------------+-------------------+--+
```

Run the following statement:

select id,grouping(id),sum(value) from table_test group by id with rollup;

The result is as follows:

```
+-------+-----------------+------+--+
|  id   | groupingresult  | sum  |
+-------+-----------------+------+--+
| 1     | 0               | 25   |
| NULL  | 1               | 63   |
| 2     | 0               | 38   |
+-------+-----------------+------+--+
```

EXCEPT and INTERSECT

Syntax description:

- EXCEPT returns the difference of two result sets (that is, non-duplicated values return only one query).
- INTERSECT returns the intersection of two result sets (that is, non-duplicated values return by both queries).

For example, two tables **test_table1** and **test_table2** exist in Hive.

The table structure of **test_table1** is as follows:

```
+-----------------+--+
| test_table1.id  |
+-----------------+--+
| 1               |
| 2               |
| 3               |
| 4               |
+-----------------+--+
```

The table structure of **test_table2** is as follows:

```
+-----------------+--+
| test_table2.id  |
+-----------------+--+
| 2               |
| 3               |
| 4               |
| 5               |
+-----------------+--+
```

- Run the following EXCEPT statement:

  select id from test_table1 except select id from test_table2;

  The result is as follows:

  ```
  +--------------+--+
  | _alias_0.id  |
  +--------------+--+
  | 1            |
  +--------------+--+
  ```

- Run the following INTERSECT statement:

  select id from test_table1 intersect select id from test_table2;

  The result is as follows:

  ```
  +--------------+--+
  | _alias_0.id  |
  +--------------+--+
  | 2            |
  | 3            |
  | 4            |
  +--------------+--+
  ```

11.17 Creating User-Defined Hive Functions

When the built-in functions of Hive cannot meet requirements, you can compile user-defined functions (UDFs) and use them in queries.

According to implementation methods, UDFs are classified as follows:

- Common UDFs: used to perform operations on a single data row and export a single data row.
- User-defined aggregating functions (UDAFs): used to input multiple data rows and export a single data row.
- User-defined table-generating functions (UDTFs): used to perform operations on a single data row and export multiple data rows.

According to use methods, UDFs are classified as follows:

- Temporary functions: used only in the current session and must be recreated after a session restarts.
- Permanent functions: used in multiple sessions. You do not need to create them every time a session restarts.

NOTE

You need to properly control the memory and thread usage of variables in UDFs. Improper control may cause memory overflow or high CPU usage.

The following uses AddDoublesUDF as an example to describe how to compile and use UDFs.

Function

AddDoublesUDF is used to add two or more floating point numbers. In this example, you can learn how to write and use UDFs.

NOTE

- A common UDF must be inherited from **org.apache.hadoop.hive.ql.exec.UDF**.
- A common UDF must implement at least one **evaluate()**. The evaluate function supports overloading.
- To develop a UDF, add the **hive-exec-*.jar** dependency package to the project. You can obtain the package from the Hive service installation directory, for example, **${BIGDATA_HOME}/components/FusionInsight_HD_*/Hive/disaster/plugin/lib/**.

Sample Code

The following is a UDF code example:

xxx indicates the name of the organization that develops the program.

```
package com.xxx.bigdata.hive.example.udf;
import org.apache.hadoop.hive.ql.exec.UDF;

public class AddDoublesUDF extends UDF {
 public Double evaluate(Double... a) {
    Double total = 0.0;
    // Processing logic
    for (int i = 0; i < a.length; i++)
      if (a[i] != null)
        total += a[i];
    return total;
  }
}
```

How to Use

Step 1 Packing programs as **AddDoublesUDF.jar** on the client node, and upload the package to a specified directory in HDFS, for example, **/user/hive_examples_jars**.

Both the user who creates the function and the user who uses the function must have the read permission on the file.

The following are example statements:

hdfs dfs -put ./hive_examples_jars /user/hive_examples_jars

hdfs dfs -chmod 777 /user/hive_examples_jars

Step 2 Check the cluster authentication mode.

- In security mode, log in to the beeline client as a user with the Hive management permission and run the following commands:

  kinit *Hive service user*

  beeline

  set role admin;

- In common mode, run the following command:

  beeline -n *Hive service user*

Step 3 Define the function in HiveServer. Run the following SQL statement to create a permanent function:

CREATE FUNCTION *addDoubles* **AS 'com.***xxx***.bigdata.hive.example.udf.AddDoublesUDF' using jar 'hdfs://hacluster/user/hive_examples_jars/AddDoublesUDF.jar';**

addDoubles is the alias of the function, which is used in **SELECT** queries. *xxx* is typically the name of the organization that develops the program.

Run the following statement to create a temporary function:

CREATE TEMPORARY FUNCTION addDoubles AS 'com.*xxx***.bigdata.hive.example.udf.AddDoublesUDF' using jar 'hdfs://hacluster/user/hive_examples_jars/AddDoublesUDF.jar';**

- *addDoubles* indicates the function alias that is used for SELECT query.
- **TEMPORARY** indicates that the function is used only in the current session with the HiveServer.

Step 4 Run the following SQL statement to use the function on the HiveServer:

SELECT addDoubles(1,2,3);

NOTE

If an [Error 10011] error is displayed when you log in to the client again, run the **reload function;** command and then use this function.

Step 5 Run the following SQL statement to delete the function from the HiveServer:

DROP FUNCTION addDoubles;

----End

Extended Applications

None

11.18 Enhancing beeline Reliability

Scenario

- When the beeline client is disconnected due to network exceptions during the execution of a batch processing task, tasks submitted before beeline is disconnected can be properly executed in Hive. When you start the batch processing task again, the submitted tasks are not executed and tasks that are not executed are executed in sequence.
- When the HiveServer service breaks down due to some reasons during the execution of a batch processing task, Hive enables that the tasks that have been successfully executed are not executed again when the same batch processing task is started again. The execution starts from the task that has not been executed from the time when HiveServer2 breaks down.

Example

1. Beeline is reconnected after being disconnection.

   Example:

   beeline -e "${*SQL*}" --hivevar batchid=*xxxxx*

2. Beeline kills the running tasks.

   Example:

   beeline -e "" --hivevar batchid=*xxxxx* --hivevar kill=true

3. Log in to the beeline client and start the mechanism of reconnection after disconnection.

   Log in to the beeline client and run the **set hivevar:batchid=***xxxx* command.

   NOTE

   Instructions:

   - *xxxx* indicates the batch ID of tasks submitted in the same batch using the beeline client. Batch IDs can be used to identify the task submission batch. If the batch ID is not contained when a task is submitted, this feature is not enabled. The value of *xxxx* is specified during task execution. In the following example, the value of *xxxx* is **012345678901**.

     beeline -f hdfs://hacluster/user/hive/table.sql --hivevar batchid=012345678901

   - If the running SQL script depends on the data timeliness, you are advised not to enable the breakpoint reconnection mechanism. You can use a new batch ID to submit tasks. During reexecution of the scripts, some SQL statements have been executed and are not executed again. As a result, expired data is obtained.
   - If some built-in time functions are used in the SQL script, it is recommended that you do not enable the breakpoint reconnection mechanism or the use of a new batch ID for each execution. The reason is the same as above.
   - A SQL script contains one or more subtasks. If the logic for deleting and creating temporary tables exist in the SQL script, it is recommended that the logic for deleting temporary tables be placed at the end of the script. If the subtasks executed after the temporary table deletion task fail to be executed and the temporary table is used in the subtasks before the temporary table deletion task, when the SQL script is executed using the same batch ID for the next time, the compilation of the subtasks (excluding the task for creating the temporary table because the creation has been completed and is not executed again, and only compilation is allowed) executed before the temporary table deletion task fails because the temporary has been deleted. In this case, you are advised to use a new batch ID to execute the script.

   Parameter description:

   - **zk.cleanup.finished.job.interval**: indicates the interval for executing the cleanup task. The default interval is 60 seconds.
   - **zk.cleanup.finished.job.outdated.threshold**: indicates the threshold of the node validity period. A node is generated for tasks in the same batch. The threshold is calculated from the end time of the execution of the current batch task. If the time exceeds 60 minutes, the node is deleted.
   - **batch.job.max.retry.count**: indicates the maximum number of retry times of a batch task. If the number of retry times of a batch task exceeds the value of this parameter, the task execution record is deleted. The task will be executed from the first task when the task is started next time. The default value is **10**.
   - **beeline.reconnect.zk.path**: indicates the root node for storing task execution progress. The default value for the Hive service is **/beeline**.

11.19 Viewing Table Structures Using the show create Statement as Users with the select Permission

Scenario

This function is supported on Hive and Spark.

With this function enabled, if the select permission is granted to a user during Hive table creation, the user can run the **show create table** command to view the table structure.

Procedure

Step 1 Log in to FusionInsight Manager, click **Cluster**, choose **Services** > **Hive**, click **Configurations**, and then **All Configurations**.

Step 2 Choose **HiveServer(Role)** > **Customization**, add a customized parameter to the **hive-site.xml** parameter file, set **Name** to **hive.allow.show.create.table.in.select.nogrant**, and set **Value** to **true**. Restart all Hive instances after the modification.

Step 3 Determine whether to enable this function on the Spark client.

- If yes, download and install the Spark client again.
- If no, no further action is required.

----End

11.20 Writing a Directory into Hive with the Old Data Removed to the Recycle Bin

Scenario

This function applies to Hive.

After this function is enabled, run the following command to write a directory into Hive: **insert overwrite directory "***/path1***" ...**. After the operation is successfully performed, the old data is removed to the recycle bin, and the directory cannot be an existing database path in the Hive metastore.

Step 1 Log in to FusionInsight Manager, click **Cluster**, choose **Services** > **Hive**, click **Configurations**, and then **All Configurations**.

Step 2 Choose **HiveServer(Role)** > **Customization**, add a customized parameter to the **hive-site.xml** parameter file, set **Name** to **hive.overwrite.directory.move.trash**, and set **Value** to **true**. Restart all Hive instances after the modification.

----End

11.21 Inserting Data to a Directory That Does Not Exist

Scenario

This function applies to Hive.

With this function enabled, run the **insert overwrite directory** */path1/path2/path3*... command to write a subdirectory. The permission of the */path1/path2* directory is 700, and the owner is the current user. If the */path3* directory does not exist, it is automatically created and data is written successfully.

This function is supported when **hive.server2.enable.doAs** is set to **true** in earlier versions. This version supports the function when **hive.server2.enable.doAs** is set to **false**.

NOTE

The parameter adjustment of this function is the same as that of the custom parameters added in **Writing a Directory into Hive with the Old Data Removed to the Recycle Bin**.

Procedure

Step 1 Log in to FusionInsight Manager, click **Cluster**, choose **Services** > **Hive**, click **Configurations**, and then **All Configurations**.

Step 2 Choose **HiveServer(Role)** > **Customization**, add a customized parameter to the **hive-site.xml** parameter file, set **Name** to **hive.overwrite.directory.move.trash**, and set **Value** to **true**. Restart all Hive instances after the modification.

----End

11.22 Creating Databases and Creating Tables in the Default Database Only as the Hive Administrator

Scenario

This function is supported on Hive and Spark.

After this function is enabled, only the Hive administrator can create databases and tables in the default database. Other users can use the databases only after being authorized by the Hive administrator.

NOTE

- After this function is enabled, common users are not allowed to create a database or create a table in the default database. Based on the actual application scenario, determine whether to enable this function.
- Permissions of common users are restricted. In the scenario where common users have been used to perform operations, such as database creation, table script migration, and metadata recreation in an earlier version of database, the users can perform such operations on the database in the condition that this function is disabled temporarily after the database is migrated or after the cluster is upgraded.

Procedure

Step 1 Log in to FusionInsight Manager, click **Cluster**, choose **Services** > **Hive**, click **Configurations**, and then **All Configurations**.

Step 2 Choose **HiveServer(Role)** > **Customization**, add a customized parameter to the **hive-site.xml** parameter file, set **Name** to **hive.allow.only.admin.create**, and set **Value** to **true**. Restart all Hive instances after the modification.

Step 3 Determine whether to enable this function on the Spark client.

- If yes, go to **Step 4**.
- If no, no further action is required.

Step 4 Choose **SparkResource** > **Customization**, add a customized parameter to the **hive-site.xml** parameter file, and set **Name** to **hive.allow.only.admin.create** and **Value** to **true**. Then, choose **JDBCServer** > **Customization** and repeat the preceding operations to add the customized parameter. Restart all Spark instances after the modification.

Step 5 Download and install the Spark client again.

----End

11.23 Disabling of Specifying the location Keyword When Creating an Internal Hive Table

Scenario

This function applies to Hive and Spark.

After this function is enabled, the **location** keyword cannot be specified when a Hive internal table is created. Specifically, after a table is created, the table path following the location keyword is created in the default **\warehouse** directory and cannot be specified to another directory. If the location is specified when the internal table is created, the creation fails.

NOTE

After this function is enabled, the location keyword cannot be specified during the creation of a Hive internal table. The table creation statement is restricted. If a table that has been created in the database is not stored in the default directory **/warehouse**, the **location** keyword can still be specified when the database creation, table script migration, or metadata recreation operation is performed by disabling this function temporarily.

Procedure

Step 1 Log in to FusionInsight Manager, click **Cluster**, choose **Services** > **Hive**, click **Configurations**, and then **All Configurations**.

Step 2 Choose **HiveServer(Role)** > **Customization**, add a customized parameter to the **hive-site.xml** parameter file, set **Name** to **hive.internaltable.notallowlocation**, and set **Value** to **true**. Restart all Hive instances after the modification.

Step 3 Determine whether to enable this function on the Spark client.

- If yes, download and install the Spark client again.
- If no, no further action is required.

----End

11.24 Enabling the Function of Creating a Foreign Table in a Directory That Can Only Be Read

Scenario

This function applies to Hive and Spark.

After this function is enabled, the user or user group that has the read and execute permissions on a directory can create foreign tables in the directory without checking whether the current user is the owner of the directory. In addition, the directory of a foreign table cannot be stored in the default directory **\warehouse**. In addition, do not change the permission of the directory during foreign table authorization.

NOTE

After this function is enabled, the function of the foreign table changes greatly. Based on the actual application scenario, determine whether to enable this function.

Procedure

Step 1 Log in to FusionInsight Manager, click **Cluster**, choose **Services** > **Hive**, click **Configurations**, and then **All Configurations**.

Step 2 Choose **HiveServer(Role)** > **Customization**, add a customized parameter to the **hive-site.xml** parameter file, set **Name** to **hive.restrict.create.grant.external.table**, and set **Value** to **true**.

Step 3 Choose **MetaStore(Role)** > **Customization**, add a customized parameter to the **hivemetastore-site.xml** parameter file, set **Name** to **hive.restrict.create.grant.external.table**, and set **Value** to **true**. Restart all Hive instances after the modification.

Step 4 Determine whether to enable this function on the Spark client.

- If yes, download and install the Spark client again.
- If no, no further action is required.

----End

11.25 Authorizing Over 32 Roles in Hive

Scenario

This function applies to Hive.

The number of OS user groups is limited, and the number of roles that can be created in Hive cannot exceed 32. After this function is enabled, more than 32 roles can be created in Hive.

NOTE

- After this function is enabled and the table or database is authorized, roles that have the same permission on the table or database will be combined using vertical bars (|). When the ACL permission is queried, the combined result is displayed, which is different from that before the function is enabled. This operation is irreversible. Determine whether to make adjustment based on the actual application scenario.
- If the current component uses Ranger for permission control, you need to configure related policies based on Ranger for permission management. For details, see **Adding a Ranger Access Permission Policy for Hive**.
- After this function is enabled, a maximum of 512 roles (including **owner**) are supported by default. The number is controlled by the user-defined parameter **hive.supports.roles.max** of MetaStore. You can change the value based on the actual application scenario.

Procedure

Step 1 Log in to FusionInsight Manager, click **Cluster**, choose **Services** > **Hive**, click **Configurations**, and then **All Configurations**.

Step 2 Choose **MetaStore(Role)** > **Customization**, add a custom parameter to the **hivemetastore-site.xml** parameter file, and set **Name** to **hive.supports.over.32.roles** and **Value** to **true**. Restart all MetaStore instances after the modification.

----End

11.26 Restricting the Maximum Number of Maps for Hive Tasks

Scenario

- This function applies to Hive.
- This function is used to limit the maximum number of maps for Hive tasks on the server to avoid performance deterioration caused by overload of the HiveSever service.

Procedure

Step 1 Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Hive** > **Configurations** > **All Configurations**.

Step 2 Choose **MetaStore(Role)** > **Customization**, add a customized parameter to the **hivemetastore-site.xml** parameter file, set **Name** to **hive.mapreduce.per.task.max.splits**, and set the parameter to a large value. Restart all Hive instances after the modification.

----End

11.27 HiveServer Lease Isolation

Scenario

- This function applies to Hive.
- This function can be enabled to specify specific users to access HiveServer services on specific nodes, achieving HiveServer resource isolation.

Procedure

This section describes how to set lease isolation for user **hiveuser** for existing HiveServer instances.

Step 1 Log in to FusionInsight Manager.

Step 2 Choose **Cluster** > **Services** > **Hive** and click **HiveServer**.

Step 3 In the HiveServer list, select the HiveServer for which lease isolation is configured and choose **HiveServer** > **Instance Configurations** > **All Configurations**.

Step 4 In the upper right corner of the **All Configurations** page, search for **hive.server2.zookeeper.namespace** and specify its value, for example, **hiveserver2_zk**.

Step 5 Click **Save**. In the dialog box that is displayed, click **OK**.

Step 6 Choose **Cluster** > **Services** > **Hive**. Click **More** and select **Restart Service**. In the dialog box displayed, enter the password to restart the service.

Step 7 Run the **beeline -u** command to log in to the client and run the following command:

beeline -u "jdbc:hive2:// *10.5.159.13* **:2181/;serviceDiscoveryMode=zooKeeper;zooKeeperNamespace=** *hiveserver2_zk* **;sasl.qop=auth-conf;auth=KERBEROS;principal=hive/hadoop.** *<System domain name>* **@** *<System domain name>* **"**

Replace **10.5.159.13** with the IP address of any ZooKeeper instance. To query the IP address, choose **Cluster** > **Services** > **ZooKeeper** and click **Instance**.

hiveserver2_zk following **zooKeeperNamespace=** is set to the value of **hive.server2.zookeeper.namespace** in **Step 4**.

As a result, only the HiveServer whose lease isolation is configured can be logged in.

NOTE

- After this function is enabled, you must run the preceding command during login to access the HiveServer for which lease isolation is configured. If you run the **beeline** command to log in to the client, only the HiveServer that is not isolated by the lease is accessed.
- You can log in to FusionInsight Manager, choose **System** > **Permission** > **Domain and Mutual Trust**, and view the value of **Local Domain**, which is the current system domain name. **hive/hadoop.**<*system domain name*> is the username. All letters in the system domain name contained in the username are lowercase letters.

----End

11.28 Hive Supports Isolation of Metastore instances Based on Components

Scenario

This function restricts components in a cluster to connect to specified Hive Metastore instances. By default, components can connect to all Metastore instances.

Currently, only HetuEngine, Hive, Loader, Metadata, Spark, and Flink can connect to Metastore in a cluster. The Metastore instances can be allocated in a unified manner.

NOTE

- This function only limits the Metastore instances accessed by component servers. Metadata is not isolated.
- Currently, Flink tasks can only connect to Metastore instances through the client.
- When spark-sql is used to execute tasks, the client is directly connected to Metastore. The client needs to be updated for the isolation to take effect.
- This function supports only isolation in the same cluster. If HetuEngine is deployed in different clusters, unified isolation configuration is not supported. You need to modify the HetuEngine configuration to connect to the specified Metastore instance.
- You are advised to configure at least two Metastore instances for each component to ensure availability during isolation configuration.

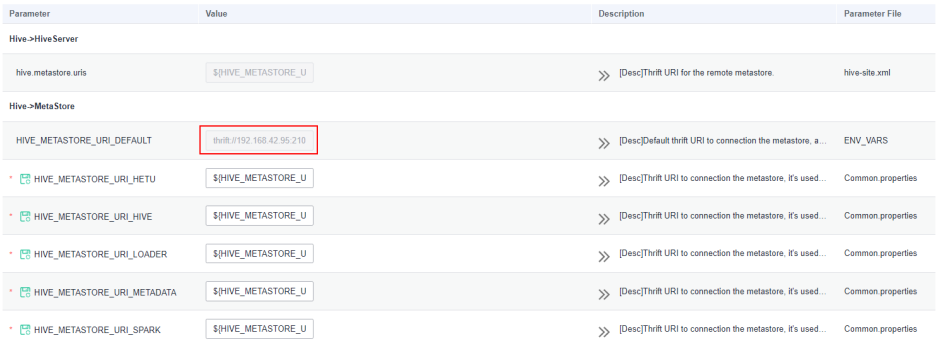
Prerequisites

The Hive service has been installed in the cluster and is running properly.

Procedure

Step 1 Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Hive**. On the displayed page, click the **Configurations** tab and then **All Configurations**, and search for the **HIVE_METASTORE_URI** parameter.

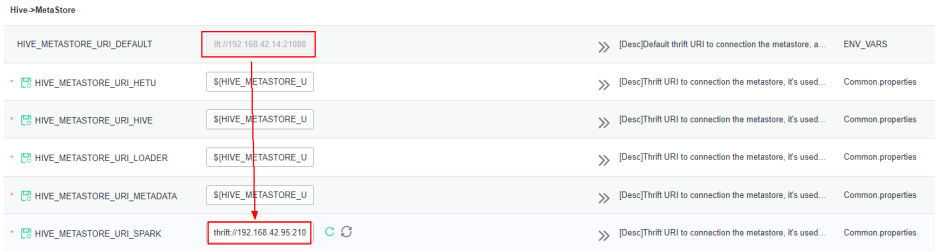
Step 2 Set the value of **HIVE_METASTORE_URI_DEFAULT** to the URI connection string of all Metastore instances.



Step 3 Connect a component to a specified Metastore instance. Copy the value in **Step 2**, modify the configuration items based on the component name, save the modification, and restart the component.

The following example shows how Spark connects only to two Metastore instances of Hive.

1. Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Hive**. On the displayed page, click the **Configurations** tab and then **All Configurations**, and search for the **HIVE_METASTORE_URI** parameter.
2. Copy the default configuration of **HIVE_METASTORE_URI_DEFAULT** to the URI configuration item of Spark. If Spark needs to connect only to two Metastore instances, retain two nodes as required. Click **Save**.



3. Choose **Cluster** > **Services** > **Spark**. Click **Instance**, select the instances whose configuration has expired, click **More**, and select **Restart Instance**. In the dialog box that is displayed, enter the password and click **OK** to restart the instances.

----End

11.29 Switching the Hive Execution Engine to Tez

Scenario

Hive can use the Tez engine to process data computing tasks. Before executing a task, you can manually switch the execution engine to Tez.

Prerequisites

The TimelineServer role of the Yarn service has been installed in the cluster and is running properly.

Switching the Execution Engine on the Client to Tez

Step 1 Install and log in to the Hive client. For details, see **Using a Hive Client**.

Step 2 Run the following command to switch the engine:

set hive.execution.engine=tez;

NOTE

- To specify a running Yarn queue, run the **set tez.queue.name=default** command on the client.

Step 3 Submit and execute the Tez tasks.

Step 4 Log in to FusionInsight Manager. Choose **Cluster** > **Services** > **Tez** > **TezUI** *(host name)* to view the task execution status on the TezUI page.

----End

Switching the Default Execution Engine of Hive to Tez

Step 1 Log in to FusionInsight Manager. Choose **Cluster** > *Name of the desired cluster* > **Services** > **Hive** > **Configurations** > **All Configurations** > **HiveServer(Role)**, and search for **hive.execution.engine**.

Step 2 Set **hive.execution.engine** to **tez**.

Step 3 Click **Save**. In the displayed confirmation dialog box, click **OK**.

Step 4 Choose **Dashboard** > **More** > **Restart Service** to restart the Hive service. Enter the password to restart the service.

Step 5 Install and log in to the Hive client. For details, see **Using a Hive Client**.

Step 6 Submit and execute the Tez tasks.

Step 7 Log in to FusionInsight Manager and choose **Cluster** > *Name of the desired cluster* > **Services** > **Tez** > **TezUI** *(host name)*. On the displayed TezUI page, view the task execution status.

----End

11.30 Hive Supporting Reading Hudi Tables

Hive External Tables Corresponding to Hudi Tables

A Hudi source table corresponds to a copy of HDFS data. The Hudi table data can be mapped to a Hive external table through the Spark component, Flink component, or Hudi client. Based on the external table, Hive can easily perform real-time query, read-optimized view query, and incremental view query.

NOTE

- Different view queries are provided for different types of Hudi source tables:
  - When the Hudi source table is a Copy-On-Write (COW) table, it can be mapped to a Hive external table. The table supports real-time query and incremental view query.
  - When the Hudi source table is a Merge-On-Read (MOR) table, it can be mapped to two Hive external tables (RO table and RT table). The RO table supports read-optimized view query, and the RT table supports real-time view query and incremental view query.
- Hive external tables cannot be added, deleted, or modified (including **insert**, **update**, **delete**, **load**, **merge**, **alter** and **msck**). Only the query operation (**select**) is supported.
- Granting table permissions: The update, alter, write, and all permissions cannot be modified.
- Backup and restoration: The RO and RT tables are mapped from the same Hudi source table. When one table is backed up, the other table is also backed up. The same applies to restoration. Therefore, only one table needs to be backed up.
- Component versions:
  - Hive: FusionInsight_HD_8.1.0.1; Hive kernel version 3.1.0
  - Spark: FusionInsight_Spark_8.1.0.1; Hudi kernel version 0.11.0

Creating Hive External Tables Corresponding to Hudi Tables

Generally, Hudi table data is synchronized to Hive external tables when the data is imported to the lake. In this case, you can directly query the corresponding Hive external tables in Beeline. If the data is not synchronized to the Hive external tables, you can use the Hudi client tool **run_hive_sync_tool.sh** to synchronize data manually.

Querying Hive External Tables Corresponding to Hudi Tables

Prerequisites

Before using Hive to perform incremental query on Hudi tables, you need to set another three parameters in **Table 11-10**. The three parameters are table-level parameters. Each Hudi source table corresponds to three parameters, where **hudisourcetablename** indicates the name of the Hudi source table (not the name of the Hive external table).

Table 11-10 Parameter description

Parameter	Default Value	Description
hoodie. hudisourcetable-name.consume.mode	None	Query mode of the Hudi table. • Incremental query: Set it to **INCREMENTAL**. • Non-incremental query: Do not set this parameter or set it to **SNAPSHOT**.

Parameter	Default Value	Description
hoodie. hudisourcetable-name.consume.start.timestamp	None	Start time of the incremental query on the Hudi table. ● Incremental query: start time of the incremental query. ● Non-incremental query: Do not set this parameter.
hoodie. hudisourcetable-name.consume.max.commits	None	The incremental query on the Hudi table is based on the number of commits after **hoodie.hudisourcetable-name.consume.start.timestamp**. ● Incremental query: number of commits. For example, if this parameter is set to **3**, data after three commits from the specified start time is queried. If this parameter is set to **-1**, all data committed after the specified start time is queried. ● Non-incremental query: Do not set this parameter.

Querying a Hudi COW Table

For example, the name of a Hudi source table of the COW type is **hudicow**, and the name of the mapped Hive external table is **hudicow**.

- Real-time view query on the COW table:

  Select * from hudicow;

- Incremental query on the COW table: Set three incremental query parameters based on the name of the Hudi source table. The **where** clause of the incremental query statements must contain **`_hoodie_commit_time`>'***xxx*'**, where *xxx* indicates the value of **hoodie.hudisourcetablename.consume.start.timestamp**.

  set hoodie.hudicow.consume.mode= INCREMENTAL;

  set hoodie.hudicow.consume.max.commits=3;

  set hoodie.hudicow.consume.start.timestamp= 20200427114546;

  select count(*) from hudicow where `_hoodie_commit_time`>'20200427114546';

Querying a Hudi MOR Table

For example, the name of a Hudi source table of the MOR type is **hudimor**, and the two mapped Hive external tables are **hudimor_ro** (RO table) and **hudimor_rt** (RT table).

- Read-optimized view query on the RO table:

  Select * from hudicow_ro;

- Real-time view query on the RT table:

  Select * from hudicow_rt;

- Incremental query on the RT table: Set three incremental query parameters based on the name of the Hudi source table. The **where** clause of the incremental query statements must contain **`_hoodie_commit_time`>'***xxx*'**, where *xxx* indicates the value of **hoodie.hudisourcetablename.consume.start.timestamp**.

  set hoodie.hudimor.consume.mode=INCREMENTAL;

  set hoodie.hudimor.consume.max.commits=-1;

  set hoodie.hudimor.consume.start.timestamp=20210207144611;

  select * from hudimor_rt where `_hoodie_commit_time`>'20210207144611';

  NOTE

  set hoodie.hudisourcetablename.consume.mode=INCREMENTAL; is used only for the incremental query on the table. To switch to another query mode, run **set hoodie.hudisourcetablename.consume.mode=SNAPSHOT;**.

Querying Hive External Tables Corresponding to Hudi Schema Evolution Tables

If the Hudi table is a schema evolution table (some fields in the table have been modified), you need to set **set hive.exec.schema.evolution** to **true** when Hive queries the table.

The following uses the query of the real-time view of a COW table as an example. To query other views, you need to add this parameter.

- Real-time view query on the COW table:

  set hive.exec.schema.evolution=true;

  select * from *hudicow***;**

11.31 Hive Supporting Cold and Hot Storage of Partitioned Metadata

Cold and Hot Storage of Partitioned Metadata

- The metadata that have not been used for a long time is moved to a backup table to reduce the pressure on metadata databases. This process is called partitioned data freezing. The partitions in which data is moved are cold partitions, partitions that are not frozen are hot partitions. A table with a cold partition is a frozen table. Moving the frozen data back to the original metadata table is called partitioned data unfreezing.
- When a partition is changed from a hot partition to a cold partition, only metadata is identified. The partition path and data file content on the HDFS service side do not change.

Freezing a Partition

The user who creates the table can freeze one or more partitions based on filter criteria. The format is **freeze partitions** *Database name Table name* **where** *Filter criteria*.

Example:

```
freeze partitions testdb.test where year <= 2021;
freeze partitions testdb.test where year<=2021 and month <= 5;
freeze partitions testdb.test where year<=2021 and month <= 5 and day <= 27;
```

Unfreezing a Partition

The user who creates the table can unfreeze one or more partitions based on filter criteria. The format is **unfreeze partitions** *Database name Table name* **where** *Filter criteria*. Example:

```
unfreeze partitions testdb.test where year <= 2021;
unfreeze partitions testdb.test where year<=2021 and month <= 5;
unfreeze partitions testdb.test where year<=2021 and month <= 5 and day <= 27;
```

Querying Tables with Frozen Data

- Querying all frozen tables in the current database

  show frozen tables;
- Querying all frozen tables in the **dbname** database

  show frozen tables in dbname;

Querying Frozen Partitions of a Frozen Table

Querying frozen partitions

show frozen partitions table;

NOTE

- By default, only partitions of the int, string, varchar, date, or timestamp type can be frozen in the metadata database.
- For external metadata databases, only the Postgres database is supported, and only partitions of the int, string, varchar, or timestamp type can be frozen.
- You need to unfreeze data to restore the metadata of a frozen table using MSCK. If a frozen table has been backed up, you can run **msck repair** to restore the table, and you can only run this command to unfreeze the table.
- You need to unfreeze data before renaming a frozen partition. Otherwise, a message indicating that the partition does not exist is displayed.
- When a table that contains frozen data is deleted, the frozen data is also deleted.
- When a partition that contains frozen data is deleted, information about the frozen partition and HDFS service data is not deleted.
- When you run the **select** command to query data, the criteria for filtering the data in cold partitions is automatically added. The query result does not contain the data in cold partitions.
- When you run the **show partitions table** command to query the partitioned data in the table, the query result does not contain the data in cold partitions. You can run the **show frozen partitions table** command to query frozen partitions.

11.32 Hive Supporting ZSTD Compression Formats

Zstandard (ZSTD) is an open-source lossless data compression algorithm. Its compression performance and compression ratio are better than those of other compression algorithms supported by Hadoop. Hive with this feature supports tables in ZSTD compression formats. The ZSTD compression formats supported by Hive include ORC, RCFile, TextFile, JsonFile, Parquet, Sequence, and CSV.

You can create a table in ZSTD compression format as follows:

- To create a table in ORC format, specify **TBLPROPERTIES("orc.compress"="zstd")**.

  create table tab_1(...) stored as orc TBLPROPERTIES("orc.compress"="zstd");
- To create a table in Parquet format, specify **TBLPROPERTIES("parquet.compression"="zstd")**.

  create table tab_2(...) stored as parquet TBLPROPERTIES("parquet.compression"="zstd");
- To create a table in other formats or common formats, run the following commands to set the **compress.codec** parameters to **org.apache.hadoop.io.compress.ZStandardCode**.

  set hive.exec.compress.output=true;

  set mapreduce.map.output.compress=true;

  set mapreduce.map.output.compress.codec=org.apache.hadoop.io.compress.ZStandardCodec;

  set mapreduce.output.fileoutputformat.compress=true;

  set mapreduce.output.fileoutputformat.compress.codec=org.apache.hadoop.io.compress.ZStandardCodec;

  set hive.exec.compress.intermediate=true;

  create table tab_3(...) stored as textfile;

NOTE

- The SQL operations on a table compressed using ZSTD are the same as those on a common compressed table. Addition, deletion, query, and aggregation are supported.
- To default the compression format of Parquet tables to ZSTD, run the following command on the Hive Beeline client:

  set hive.parquet.default.compression.codec=zstd;

  This command is applied to the current session only.

11.33 Locating Abnormal Hive Files

Scenario

- Data files stored in Hive are abnormal due to misoperations or disk damage, thereby causing task execution failures or incorrect data results.

- Common non-text data files can be located using the specified tool.

Procedure

1. Log in to the node where the Hive service is installed as user **omm** and run the following command to go to the Hive installation directory:

   cd ${BIGDATA_HOME}/FusionInsight_HD_*/install/FusionInsight-Hive-*/hive-*/bin

2. Run the following tool to locate abnormal Hive files:

   sh hive_parser_file.sh [--help] <filetype> <command> <input-file|input-directory>

   Table 11-11 describes the related parameters.

   Note: You can run only one command at a time.

   Table 11-11 Parameter description

Parameter	Description	Remarks
filetype	Specifies the format of the data file to be parsed. Currently, only the ORC, RC (RCFile), and Parquet formats are supported.	Currently, data files in the RC format can only be viewed.
-c	Prints the column information in the current metadata.	The column information includes the class name, file format, and sequence number.
-d	Prints data in a data file. You can limit the data volume using the **limit** parameter.	The data is the content of the specified data file. Note that only one value can be specified for the **limit** parameter at a time.
-t	Prints the time zone to which the data is written.	The time zone is the zone to which the file is written.
-h	Prints the help information.	Help information.
-m	Prints information about various storage formats.	The information varies based on the storage format. For example, if the file format is ORC, information such as strip and block size will be printed.
-a	Prints detailed information.	The detailed information, including the preceding parameters, is displayed.

Parameter	Description	Remarks
input-file	Specifies the data files to be input.	If the input directory contains a file of the supported formats, the file will be parsed. Otherwise, this operation is omitted. You can specify a local file or an HDFS/OBS file or directory.
input-directory	Specifies the directory where the input data file is located. This parameter is used when there are multiple subfiles.	

3. Example:

   sh hive_parser_file.sh orc -d limit=100 hdfs://hacluster/user/hive/warehouse/orc_test

   If the file name does not contain a prefix similar to **hdfs://hacluster**, the local file is read by default.

11.34 Using the ZSTD_JNI Compression Algorithm to Compress Hive ORC Tables

Scenario

ZSTD_JNI is a native implementation of the ZSTD compression algorithm. Compared with ZSTD, ZSTD_JNI has higher compression read/write efficiency and compression ratio, and allows you to specify the compression level as well as the compression mode for data columns in a specific format.

Currently, only ORC tables can be compressed using ZSTD_JNI. By contrast, ZSTD enables you to compress tables in the full storage format. Therefore, you are advised to use this feature only when you have high requirements on data compression.

Example

Step 1 Log in to the node where the client is installed as the Hive client installation user.

Step 2 Run the following command to switch to the client installation directory, for example, **/opt/client**:

cd /opt/client

Step 3 Run the following command to configure environment variables:

source bigdata_env

Step 4 Check whether the cluster authentication mode is in security mode.

- If yes, run the following command to perform user authentication and then go to **Step 5**.

  kinit *Hive service user*

- If no, go to **Step 5**.

Step 5 Run the following command to log in to the Hive client:

beeline

Step 6 Create a table in ZSTD_JNI compression format as follows:

- Run the following example command to set the **orc.compress** parameter to **ZSTD_JNI** when using this compression algorithm to create an ORC table:

  create table tab_1(...) stored as orc TBLPROPERTIES("orc.compress"="ZSTD_JNI");

- The compression level of ZSTD_JNI ranges from 1 to 19. A larger value indicates a higher compression ratio but a slower read/write speed. A smaller value indicates a lower compression ratio but a faster compression speed compared with read/write speed and the other way around. The default value is **6**. You can set the compression level through the **orc.global.compress.level** parameter, as shown in the follows.

  create table tab_1(...) stored as orc TBLPROPERTIES("orc.compress"="ZSTD_JNI", 'orc.global.compress.level'='3');

- This compression algorithm allows you to compress service data and columns in a specific data format. Currently, data in the following formats is supported: JSON data columns, Base64 data columns, timestamp data columns, and UUID data columns. You can achieve this function by setting the **orc.column.compress** parameter during table creation.

  The following example code shows how to use ZSTD_JNI to compress data in the JSON, Base64, timestamp, and UUID formats.

  create table test_orc_zstd_jni(f1 int, f2 string, f3 string, f4 string, f5 string) stored as orc

  TBLPROPERTIES('orc.compress'='ZSTD_JNI', 'orc.column.compress'='[{"type":"cjson","columns":"f2"}, {"type":"base64","columns":"f3"},{"type ":"gorilla","columns":{"format": "yyyy-MM-dd HH:mm:ss.SSS", "columns": "f4"}}, {"type":"uuid","columns":"f5"}]');

  You can insert data in the corresponding format based on the site requirements to further compress the data.

----End

11.35 Load Balancing for Hive MetaStore Client Connection

Scenario

The client connection of Hive MetaStore supports load balancing. That is, heavy load of a single MetaStore node during heavy service traffic can be avoided by connecting to the node with the least connections based on the connection number recorded in ZooKeeper. Enabling this function does not affect the original connection mode.

Procedure

Step 1 Log in to FusionInsight Manager, click **Cluster**, choose **Services** > **Hive**, click **Configurations**, and then **All Configurations**.

Step 2 Search for the **hive.metastore-ext.balance.connection.enable** parameter and set its value to **true**.

Step 3 Click **Save**.

Step 4 Click **Instance**, select all instances, choose **More** > **Restart Instance**, enter the password, and click **OK** to restart all Hive instances.

Step 5 For other components that connect to MetaStore, add the **hive.metastore-ext.balance.connection.enable** parameter and set its value to **true**.

The following uses Spark as an example:

1. Log in to FusionInsight Manager, choose **Cluster** > **Services** > **Spark**, and click **Configurations**.
2. Click **Customization**, add a custom parameter **hive.metastore-ext.balance.connection.enable** to all **hive-site.xml** parameter files, set its value to **true**, and click **Save**.
3. Click **Instance**, select all configuration-expired instances, choose **More** > **Restart Instance**, enter the password, and click **OK** to restart them.

----End

11.36 Data Import and Export in Hive

11.36.1 Importing and Exporting Table/Partition Data in Hive

Scenario

In big data application scenarios, data tables in Hive usually need to be migrated to another cluster. You can run the Hive **import** and **export** commands to migrate data in tables. That is, you can run the **export** command to export Hive tables from the source cluster to the HDFS of the target cluster, run the **import** command in the target cluster to import the exported data to the corresponding Hive table.

NOTE

The Hive table import and export function does not support encrypted tables, HBase external tables, Hudi tables, view tables, or materialized view tables.

Prerequisites

- If Hive tables or partition data is imported or exported across clusters and Kerberos authentication is enabled for both the source and destination clusters, configure cross-cluster mutual trust.
- If you want to run the **import** or **export** command to import or export tables or partitions created by other users, grant the corresponding table permission to the users.

  - If Ranger authentication is not enabled for the cluster, log in to FusionInsight Manager to grant the **Select Authorization** permission of the table corresponding to the role to which the user belongs. For details, see section **Configuring Permissions for Hive Tables, Columns, or Databases**.
  - If Ranger authentication is enabled for the cluster, grant users the permission to import and export tables. For details, see **Adding a Ranger Access Permission Policy for Hive**.
- Enable the inter-cluster copy function in the source cluster and destination cluster.
- Configure the HDFS service address parameter for the source cluster to access the destination cluster.

  Log in to FusionInsight Manager of the source cluster, click **Cluster**, choose **Services** > **Hive**, and click **Configuration**. On the displayed page, search for **hdfs.site.customized.configs**, add custom parameter **dfs.namenode.rpc-address.haclusterX**, and set its value to *Service IP address of the active NameNode instance node in the destination cluster:RPC port*. Add custom parameter **dfs.namenode.rpc-address.haclusterX1** and set its value to *Service IP address of the standby NameNode instance node in the destination cluster:RPC port*. The RPC port of NameNode is **25000** by default. After saving the configuration, roll-restart the Hive service.

Procedure

Step 1 Log in to the node where the client is installed in the destination cluster as the Hive client installation user.

Step 2 Run the following command to switch to the client installation directory, for example, **/opt/client**:

cd /opt/client

Step 3 Run the following command to configure environment variables:

source bigdata_env

Step 4 If Kerberos authentication is enabled for the cluster, run the following command to authenticate the user. Otherwise, skip this step.

kinit *Hive service user*

Step 5 Run the following command to log in to the Hive client in the destination cluster:

beeline

Step 6 Run the following command to create the **export_test** table:

create table *export_test(id int)* **;**

Step 7 Run the following command to insert data to the **export_test** table:

insert into *export_test values(123)***;**

Step 8 Repeat **Step 1** to **Step 4** in the destination cluster and run the following command to create an HDFS path for storing the exported **export_test** table:

dfs -mkdir */tmp/export*

Step 9 Run the following command to log in to the Hive client:

beeline

Step 10 Import and export the **export_test** table.

The Hive **import** and **export** commands can be used to migrate table data in the following modes. Select a proper data migration mode as required.

- Mode 1: Table export and import
  a. Run the following command in the source cluster to export the metadata and service data of the **export_test** table to the directory created in **Step 8**:

     export table *export_test* **to 'hdfs://hacluster***X***/tmp/export';**

  b. Run the following command in the destination cluster to import the table data exported in **Step 10.a** to the **export_test** table:

     import from '*/tmp/export***';**
- Mode 2: Renaming a table during the import
  a. Run the following command in the source cluster to export the metadata and service data of the **export_test** table to the directory created in **Step 8**:

     export table *export_test* **to 'hdfs://hacluster***X***/tmp/export';**

  b. Run the following command in the destination cluster to import the table data exported in **Step 10.a** to the **import_test** table:

     import table *import_test* **from '***/tmp/export***';**
- Mode 3: Partition export and import
  a. Run the following commands in the source cluster to export the **pt1** and **pt2** partitions of the **export_test** table to the directory created in **Step 8**:

     export table *export_test* **partition (***pt1***="***in***", *pt2*="***ka***") to 'hdfs://hacluster***X***/tmp/export';**

  b. Run the following command in the destination cluster to import the table data exported in **Step 10.a** to the **export_test** table:

     import from '*/tmp/export***';**
- Mode 4: Exporting table data to a Partition
  a. Run the following command in the source cluster to export the metadata and service data of the **export_test** table to the directory created in **Step 8**:

     export table *export_test* **to 'hdfs://hacluster***X***/tmp/export';**

  b. Run the following command in the destination cluster to import the table data exported in **Step 10.a** to the **pt1** and **pt2** partitions of the **import_test** table:

     import table *import_test* **partition (***pt1***="***us***", *pt2*="***tn***") from '***/tmp/export***';**
- Mode 5: Specifying the table location during the import
  a. Run the following command in the source cluster to export the metadata and service data of the **export_test** table to the directory created in **Step 8**:

export table *export_test* **to 'hdfs://hacluster***X***/tmp/export';**

b. Run the following command in the destination cluster to import the table data exported in **Step 10.a** to the **import_test** table and specify its location as **tmp/export**:

import table *import_test* **from '***/tmp***' location '/***tmp/export***';**

- Mode 6: Exporting data to an external table

a. Run the following command in the source cluster to export the metadata and service data of the **export_test** table to the directory created in **Step 8**:

export table *export_test* **to 'hdfs://hacluster***X***/tmp/export';**

b. Run the following command in the destination cluster to import the table data exported in **Step 10.a** to external table **import_test**:

import external table *import_test* **from '***/tmp/export***';**

NOTE

Before exporting table or partition data, ensure that the HDFS path for storage has been created and is empty. Otherwise, the export fails.

When partitions are exported or imported, the exported or imported table must be a partitioned table, and data of multiple partition values of the same partition field cannot be exported.

During the data import:

- If the **import from '***/tmp/export***';** statement is used to import a table, the table name is not specified, and the imported data is saved to the table path with the same name as the source table. Pay attention to the following points:
  - If there is no table with the same name as that in the source cluster in the destination cluster, such a table will be created during the table import.
  - Otherwise, the HDFS directory of the table must be empty, or the import fails.
- If the **import external table** *import_test* **from '***/tmp/export***';** statement is used to import a table, the exported table is imported to the specified table. Pay attention to the following points:
  - If there is no table with the same name as the specified table exists in the destination cluster, such a table will be created during the table import.
  - Otherwise, the HDFS directory of the table must be empty, or the import fails.

hacluster *X* is the value of **haclusterX** in new custom parameter**dfs.namenode.rpc-address.haclusterX**.

----End

11.36.2 Importing and Exporting Hive Databases

Scenario

In big data application scenarios, Hive databases and all tables in these databases are usually migrated to another cluster. You can run the Hive database **export** and **import** commands to migrate a complete database.

NOTE

The Hive database import and export function does not support encrypted tables, HBase external tables, Hudi tables, view tables, or materialized view tables.

Prerequisites

- If Hive databases are imported or exported across clusters and Kerberos authentication is enabled for both the source and destination clusters, configure cross-cluster mutual trust.
- If you want to run the **dump** or **load** command to import or export databases created by other users, grant the corresponding database permission to the users.
  - If Ranger authentication is not enabled for the cluster, log in to FusionInsight Manager to grant the administrator rights of the role to which the user belongs. For details, see section **Creating a Hive Role**.
  - If Ranger authentication is enabled for the cluster, grant users the permission to dump and load databases. For details, see **Adding a Ranger Access Permission Policy for Hive**.
- Enable the inter-cluster copy function in the source cluster and destination cluster.
- Configure the HDFS service address parameter for the source cluster to access the destination cluster.

  Log in to FusionInsight Manager of the source cluster, choose **Cluster** > **Services** > **Hive**, and click **Configurations**. On the page that is displayed, search for **hdfs.site.customized.configs**, add custom parameter **dfs.namenode.rpc-address.haclusterX**, and set it to *Service IP address of the active NameNode node in the target cluster*:*RPC port*. Add custom parameter **dfs.namenode.rpc-address.haclusterX1** and set it to *Service IP address of the standby NameNode node in the target cluster*:*RPC port*. The RPC port of NameNode is **25000** by default. After saving the configuration, roll-restart the Hive service.

Procedure

Step 1 Log in to the node where the client is installed in the source cluster as the Hive client installation user.

Step 2 Run the following command to switch to the client installation directory, for example, **/opt/client**:

cd /opt/client

Step 3 Run the following command to configure environment variables:

source bigdata_env

Step 4 If Kerberos authentication is enabled for the cluster, run the following command to authenticate the user. Otherwise, skip this step.

kinit *Hive service user*

Step 5 Run the following command to log in to the Hive client:

beeline

Step 6 Run the following command to create the **dump_db** database:

create database *dump_db*;

Step 7 Run the following command to switch to the **dump_db** database:

use *dump_db*;

Step 8 Run the following command to create the **test** table in the **dump_db** database:

create table *test*(*id int*);

Step 9 Run the following command to insert data to the **test** table:

insert into *test* **values(***123*);

Step 10 Run the following command to set the **dump_db** database as the source of the replication policy:

alter database *dump_db* **set dbproperties ('***repl.source.for***'='**replpolicy1**');**

NOTE

- You must have related permissions on the database when running the alter command to modify database attributes. To configure permissions, perform the following operations:
  - If Ranger authentication is not enabled for the cluster, log in to FusionInsight Manager to grant the administrator rights of the role to which the user belongs. For details, see section **Creating a Hive Role**.
  - If Ranger authentication is enabled for the cluster, grant users the permission to dump and load databases. For details, see **Adding a Ranger Access Permission Policy for Hive**.
- Databases with replication policy sources configured can be deleted only after their replication policy sources are set to null. To do so, run the following command:

  alter database *dump_db* **set dbproperties ('***repl.source.for***'='');**

Step 11 Run the following command to export the **dump_db** database to the **/user/hive/test** directory of the destination cluster:

repl dump *dump_db* **with ('hive.repl.rootdir'='hdfs://hacluster***X/user/hive/test***');**

The following is an example.

```
+----------------------------------------------------------------------+---------------+
|                               dump_dir                               | last_repl_id  |
+----------------------------------------------------------------------+---------------+
| hdfs://hacluster/user/hive/test/b58f0889-adbb-4654-ab97-fdbaa6872f1a  | 0             |
+----------------------------------------------------------------------+---------------+
```

NOTE

- **hacluster *X*** is the value of **haclusterX** in new custom parameter**dfs.namenode.rpc-address.haclusterX**.
- Ensure that the current user has the read and write permissions on the export directory to be specified.

Step 12 Log in to the node where the client is installed in the destination cluster as the Hive client installation user, and perform **Step 2** to **Step 5**.

Step 13 Run the following command to import data from the **dump_db** database in the **/user/hive/test** directory to the **load_db** database:

repl load *load_db* **from 'hdfs://hacluster***X/user/hive/test/XXX***';**

NOTE

- Replace **hdfs://hacluster***X/user/hive/test/XXX* with the specific path in the **dump_dir** column in **Step 11**.
- When the **repl load** command is used to import a database, pay attention to the following points when specifying the database name:
  - If the specified database does not exist, the database will be created during the import.
  - If the specified database exists and the value of **hive.repl.ckpt.key** of the database is the same as the imported path, skip the import operation.
  - If the specified database already exists and no table or function exists in this database, only the tables in the source database are imported to the current database during the import. Otherwise, the import fails.

----End

11.37 Hive Log Overview

Log Description

Log path: The default save path of Hive logs is **/var/log/Bigdata/hive/***role name*, the default save path of Hive1 logs is **/var/log/Bigdata/hive1/***role name*, and the others follow the same rule.

- HiveServer: **/var/log/Bigdata/hive/hiveserver** (run log) and **var/log/Bigdata/audit/hive/hiveserver** (audit log)
- MetaStore: **/var/log/Bigdata/hive/metastore** (run log) and **/var/log/Bigdata/audit/hive/metastore** (audit log)
- WebHCat: **/var/log/Bigdata/hive/webhcat** (run log) and **/var/log/Bigdata/audit/hive/webhcat** (audit log)

Log archive rule: The automatic compression and archiving function of Hive is enabled. By default, when the size of a log file exceeds 20 MB (which is adjustable), the log file is automatically compressed. The naming rule of a compressed log file is as follows: <*Original log name*>-<*yyyy-mm-dd_hh-mm-ss*>.[*ID*].**log.zip** A maximum of 20 latest compressed files are reserved. The number of compressed files and compression threshold can be configured.

Table 11-12 Hive log list

Log Type	Log File Name	Description
Run log	/hiveserver/hiveserver.out	Log file that records HiveServer running environment information.
	/hiveserver/hive.log	Run log file of the HiveServer process.
	/hiveserver/hive-omm-<*Date*>-<*PID*>-gc.log.<*No.*>	GC log file of the HiveServer process.

Log Type	Log File Name	Description
	/hiveserver/prestartDetail.log	Work log file before the HiveServer startup.
	/hiveserver/check-serviceDetail.log	Log file that records whether the Hive service starts successfully
	/hiveserver/cleanupDetail.log	Cleanup log file about the HiveServer uninstallation
	/hiveserver/startDetail.log	Startup log file of the HiveServer process.
	/hiveserver/stopDetail.log	Shutdown log file of the HiveServer process.
	/hiveserver/localtasklog/omm_*<Date>*_*<Task ID>*.log	Run log file of the local Hive task.
	/hiveserver/localtasklog/omm_*<Date>*_*<Task ID>*-gc.log.*<No.>*	GC log file of the local Hive task.
	/metastore/metastore.log	Run log file of the MetaStore process.
	/metastore/hive-omm-*<Date>*-*<PID>*-gc.log.*<No.>*	GC log file of the MetaStore process.
	/metastore/postinstallDetail.log	Work log file after the MetaStore installation.
	/metastore/prestartDetail.log	Work log file before the MetaStore startup
	/metastore/cleanupDetail.log	Cleanup log file of the MetaStore uninstallation
	/metastore/startDetail.log	Startup log file of the MetaStore process.
	/metastore/stopDetail.log	Shutdown log file of the MetaStore process.
	/metastore/metastore.out	Log file that records MetaStore running environment information.
	/webhcat/webhcat-console.out	Log file that records the normal start and stop of the WebHCat process.

Log Type	Log File Name	Description
	/webhcat/webhcat-console-error.out	Log file that records the start and stop exceptions of the WebHCat process.
	/webhcat/prestartDetail.log	Work log file before the WebHCat startup.
	/webhcat/cleanupDetail.log	Cleanup logs generated during WebHCat uninstallation or before WebHCat installation
	/webhcat/hive-omm-<*Date*>-<PID>-gc.log.<*No.*>	GC log file of the WebHCat process.
	/webhcat/webhcat.log	Run log file of the WebHCat process
Audit log	hive-audit.log hive-rangeraudit.log	HiveServer audit log file
	metastore-audit.log	MetaStore audit log file.
	webhcat-audit.log	WebHCat audit log file.
	jetty-<Date>.request.log	Request logs of the jetty service.

Log Levels

Table 11-13 describes the log levels supported by Hive.

Levels of run logs are ERROR, WARN, INFO, and DEBUG from the highest to the lowest priority. Run logs of equal or higher levels are recorded. The higher the specified log level, the fewer the logs recorded.

Table 11-13 Log levels

Level	Description
ERROR	Logs of this level record error information about system running.
WARN	Logs of this level record exception information about the current event processing.
INFO	Logs of this level record normal running status information about the system and events.
DEBUG	Logs of this level record the system information and system debugging information.

To modify log levels, perform the following operations:

Step 1 Go to the **All Configurations** page of the Yarn service by referring to **Modifying Cluster Service Configuration Parameters**.

Step 2 On the menu bar on the left, select the log menu of the target role.

Step 3 Select a desired log level and save the configuration.

NOTE

The Hive log level takes effect immediately after being configured. You do not need to restart the service.

----End

Log Formats

The following table lists the Hive log formats:

Table 11-14 Log formats

Log Type	Format	Example
Run log	<yyyy-MM-dd HH:mm:ss,SSS>| <LogLevel>|<Thread that generates the log>| <Message in the log>| <Location of the log event>	2014-11-05 09:45:01,242 | INFO | main | Starting hive metastore on port 21088 | org.apache.hadoop.hive.metastore.HiveMetaStore.main(HiveMetaStore.java:5198)
Audit log	<yyyy-MM-dd HH:mm:ss,SSS>| <LogLevel>|<Thread that generates the log>|<User Name><User IP><Time><Operation><Resource><Result><Detail >|< Location of the log event >	2018-12-24 12:16:25,319 | INFO | HiveServer2-Handler-Pool: Thread-185 | UserName=hive UserIP=10.153.2.204 Time=2018/12/24 12:16:25 Operation=CloseSession Result=SUCCESS Detail= | org.apache.hive.service.cli.thrift.ThriftCLIService.logAuditEvent(ThriftCLIService.java:434)

11.38 Hive Performance Tuning

11.38.1 Creating Table Partitions

Scenario

During the Select query, Hive generally scans the entire table, which is time-consuming. To improve query efficiency, create table partitions based on service requirements and query dimensions.

Procedure

Step 1 Log in to the node where the Hive client has been installed as user **root**.

Step 2 Run the following command to go to the client installation directory, for example, **/opt/client**:

cd /opt/client

Step 3 Run the **source bigdata_env** command to configure environment variables for the client.

Step 4 Run the following command on the client for login:

kinit *Username*

Step 5 Run the following command to log in to the client tool:

beeline

Step 6 Select the static or dynamic partition.

- Static partition:

  Manually enter a partition name, and use the keyword **PARTITIONED BY** to specify partition column name and data type when creating a table. During application development, use the **ALTER TABLE ADD PARTITION** statement to add a partition and use the **LOAD DATA INTO PARTITION** statement to load data to the partition, which supports only static partitions.

- Dynamic partition: Use a query command to insert results to a partition of a table. The partition can be a dynamic partition.

  The dynamic partition can be enabled on the client tool by running the following command:

  set hive.exec.dynamic.partition=true;

  The default mode of the dynamic partition is strict. That is, at least a column must be specified as a static partition, under which dynamic sub-partitions can be created. You can run the following command to enable a completely dynamic partition:

  set hive.exec.dynamic.partition.mode=nonstrict;

  NOTE

  - The dynamic partition may cause a DML statement to create a large number of partitions and new mapping folders, which deteriorates system performance.
  - If there are a large number of files, it takes a long time to run a SQL statement. You can run the **set mapreduce.input.fileinputformat.list-status.num-threads = 100;** statement before running a SQL statement to shorten the time. The parameter **mapreduce.input.fileinputformat.list-status.num-threads** can be set only after being added to the Hive whitelist.

----End

11.38.2 Optimizing Join

Scenario

When the Join statement is used, the command execution speed and query speed may be slow in case of large data volume. To resolve this problem, you can optimize Join.

Join optimization can be classified into the following modes:

- Map Join
- Sort Merge Bucket Map Join
- Optimizing Join Sequences

Map Join

Hive Map Join applies to small tables (the table size is less than 25 MB) that can be stored in the memory. The table size can be defined using **hive.mapjoin.smalltable.filesize**, and the default table size is 25 MB.

Map Join has two methods:

- Use /*+ MAPJOIN(join_table) */.
- Set the following parameter before running the statement. The default value is true in the current version.

  set hive.auto.convert.join=true;

There is no Reduce task when Map Join is used. Instead, a MapReduce Local Task is created before the Map job. The task uses TableScan to read small table data to the local computer, saves and writes the data in HashTable mode to a hard disk on the local computer, upload the data to DFS, and saves the data in distributed cache. The small table data that the map task reads from the local disk or distributed cache is the output together with the large table join result.

When using Map Join, make sure that the size of small tables cannot be too large. If small tables use up memory, the system performance will deteriorate and even memory leakage occurs.

Sort Merge Bucket Map Join

The following conditions must be met before using Sort Merge Bucket Map Join:

- The two Join tables are large and cannot be stored in the memory.
- The two tables are bucketed (clustered by (column)) and sorted (sorted by(column)) according to the join key, and the buckets counts of the two tables are in integral multiple relationship.

Set the following parameters to enable Sort Merge Bucket Map Join:

set hive.optimize.bucketmapjoin=true;

set hive.optimize.bucketmapjoin.sortedmerge=true;

This type of Map Join does not have Reduce tasks too. A MapReduce Local Task is started before the Map job to read small table data by bucket to the local

computer. The local computer saves the HashTable backup of multiple buckets and writes the backup into HDFS. The backup is also saved in the distributed cache. The small table data that the map task reads from the local disk or distributed cache by bucket is the output after mapping with the large table.

Optimizing Join Sequences

If the Join operation is to be performed on three or more tables and different Join sequences are used, the execution time will be greatly different. Using an appropriate Join sequence can shorten the time for task execution.

Rules of a Join sequence:

- A table with small data volume or a combination with fewer results generated after a Join operation is executed first.
- A table with large data volume or a combination with more results generated after a Join operation is executed later.

For example, the **customer** table has the largest data volume, and fewer results will be generated if a Join operation is performed on the **orders** and **lineitem** tables first.

The original Join statement is as follows.

```
select
  l_orderkey,
  sum(l_extendedprice * (1 - l_discount)) as revenue,
  o_orderdate,
  o_shippriority
from
  customer,
  orders,
  lineitem
where
  c_mktsegment = 'BUILDING'
  and c_custkey = o_custkey
  and l_orderkey = o_orderkey
  and o_orderdate < '1995-03-22'
  and l_shipdate > '1995-03-22'
limit 10;
```

After the sequence is optimized, the Join statements are as follows:

```
select
  l_orderkey,
  sum(l_extendedprice * (1 - l_discount)) as revenue,
  o_orderdate,
  o_shippriority
from
  orders,
  lineitem,
  customer
where
  c_mktsegment = 'BUILDING'
  and c_custkey = o_custkey
  and l_orderkey = o_orderkey
  and o_orderdate < '1995-03-22'
  and l_shipdate > '1995-03-22'
limit 10;
```

Precautions

Join Data Skew Problem

Data skew refers to the symptom that the task progress is 99% for a long time.

Data skew often exists because the data volume of a few Reduce tasks is much larger than that of others. Most Reduce tasks are complete while a few Reduce tasks are not complete.

To resolve the data skew problem, set **hive.optimize.skewjoin=true** and adjust the value of **hive.skewjoin.key**. **hive.skewjoin.key** specifies the maximum number of keys received by a Reduce task. If the number reaches the maximum, the keys are atomically distributed to other Reduce tasks.

11.38.3 Optimizing Group By

Scenario

Optimize the Group by statement to accelerate the command execution and query speed.

During the Group by operation, Map performs grouping and distributes the groups to Reduce; Reduce then performs grouping again. Group by optimization can be performed by enabling Map aggregation to reduce Map output data volume.

Procedure

On a Hive client, set the following parameter:

```
set hive.map.aggr=true
```

Precautions

Group By Data Skew

Group by have data skew problems. When hive.groupby.skewindata is set to true, the created query plan has two MapReduce jobs. The Map output result of the first job is randomly distributed to Reduce tasks, and each Reduce task performs aggregation operations and generates output result. Such processing may distribute the same Group By Key to different Reduce tasks for load balancing purpose. According to the preprocessing result, the second Job distributes Group By Key to Reduce to complete the final aggregation operation.

Count Distinct Aggregation Problem

When the aggregation function count distinct is used in deduplication counting, serious Reduce data skew occurs if the processed value is empty. The empty value can be processed independently. If count distinct is used, exclude the empty value using the where statement and increase the last count distinct result by 1. If there are other computing operations, process the empty value independently and then combine the value with other computing results.

11.38.4 Optimizing Data Storage

Scenario

ORC is an efficient column storage format and has higher compression ratio and reading efficiency than other file formats.

You are advised to use **ORC** as the default Hive table storage format.

Prerequisites

You have logged in to the Hive client. For details, see **Using a Hive Client**.

Procedure

- Recommended: **SNAPPY** compression, which applies to scenarios with even compression ratio and reading efficiency requirements.

  Create table *xx (col_name data_type)* stored as orc tblproperties ("orc.compress"="SNAPPY");

- Available: **ZLIB** compression, which applies to scenarios with high compression ratio requirements.

  Create table *xx (col_name data_type)* stored as orc tblproperties ("orc.compress"="ZLIB");

NOTE

xx indicates the specific Hive table name.

11.38.5 Optimizing SQL Statements

Scenario

When SQL statements are executed on Hive, if the **(a&b) or (a&c)** logic exists in the statements, you are advised to change the logic to **a & (b or c)**.

Example

If condition a is **p_partkey = l_partkey**, the statements before optimization are as follows:

```
select
	sum(l_extendedprice* (1 - l_discount)) as revenue
from
	lineitem,
	part
where
	(
		p_partkey = l_partkey
		and p_brand = 'Brand#32'
		and p_container in ('SM CASE', 'SM BOX', 'SM PACK', 'SM PKG')
		and l_quantity >= 7 and l_quantity <= 7 + 10
		and p_size between 1 and 5
		and l_shipmode in ('AIR', 'AIR REG')
		and l_shipinstruct = 'DELIVER IN PERSON'
	)
	or
	(	p_partkey = l_partkey
		and p_brand = 'Brand#35'
		and p_container in ('MED BAG', 'MED BOX', 'MED PKG', 'MED PACK')
		and l_quantity >= 15 and l_quantity <= 15 + 10
		and p_size between 1 and 10
		and l_shipmode in ('AIR', 'AIR REG')
		and l_shipinstruct = 'DELIVER IN PERSON'
	)
	or
	(	p_partkey = l_partkey
		and p_brand = 'Brand#24'
```

```
            and p_container in ('LG CASE', 'LG BOX', 'LG PACK', 'LG PKG')
            and l_quantity >= 26 and l_quantity <= 26 + 10
            and p_size between 1 and 15
            and l_shipmode in ('AIR', 'AIR REG')
            and l_shipinstruct = 'DELIVER IN PERSON'
      )
```

The statements after optimization are as follows:

```
select
      sum(l_extendedprice* (1 - l_discount)) as revenue
from
      lineitem,
      part
where   p_partkey = l_partkey and
      ((
            p_brand = 'Brand#32'
            and p_container in ('SM CASE', 'SM BOX', 'SM PACK', 'SM PKG')
            and l_quantity >= 7 and l_quantity <= 7 + 10
            and p_size between 1 and 5
            and l_shipmode in ('AIR', 'AIR REG')
            and l_shipinstruct = 'DELIVER IN PERSON'
      )
      or
      (
            p_brand = 'Brand#35'
            and p_container in ('MED BAG', 'MED BOX', 'MED PKG', 'MED PACK')
            and l_quantity >= 15 and l_quantity <= 15 + 10
            and p_size between 1 and 10
            and l_shipmode in ('AIR', 'AIR REG')
            and l_shipinstruct = 'DELIVER IN PERSON'
      )
      or
      (
            p_brand = 'Brand#24'
            and p_container in ('LG CASE', 'LG BOX', 'LG PACK', 'LG PKG')
            and l_quantity >= 26 and l_quantity <= 26 + 10
            and p_size between 1 and 15
            and l_shipmode in ('AIR', 'AIR REG')
            and l_shipinstruct = 'DELIVER IN PERSON'
      ))
```

11.38.6 Optimizing the Query Function Using Hive CBO

Scenario

When joining multiple tables in Hive, Hive supports Cost-Based Optimization (CBO). The system automatically selects the optimal plan based on the table statistics, such as the data volume and number of files, to improve the efficiency of joining multiple tables. Hive needs to collect table statistics before CBO optimization.

NOTE

- The CBO optimizes the joining sequence based on statistics and search criteria. However, the joining sequence may fail to be optimized in some special scenarios, such as data skew occurs and query condition values are not in the table.
- When column statistics collection is enabled, Reduce operations must be performed for aggregation. For insert tasks without the Reduce phase, Reduce operations will be performed to collect statistics.

Prerequisites

You have logged in to the Hive client. For details, see **Using a Hive Client**.

Procedure

Step 1 On the Manager UI, search for the **hive.cbo.enable** parameter in the service configuration of the Hive component, and select **true** to enable the function permanently.

Step 2 Collect statistics about the existing data in Hive tables manually.

Run the following command to manually collect statistics: Statistics about only one table can be collected. If statistics about multiple tables need to be collected, the command needs to be executed repeatedly.

ANALYZE TABLE [db_name.]tablename [PARTITION(partcol1[=val1], partcol2[=val2], ...)]

COMPUTE STATISTICS

[FOR COLUMNS]

[NOSCAN];

NOTE

- When **FOR COLUMNS** is specified, column-level statistics are collected.
- When NOSCAN is specified, statistics about the file size and number of files will be collected, but specific files will not be scanned.

For example:

analyze table table_name compute statistics;

analyze table table_name compute statistics for columns;

Step 3 Configure the automatic statistics collection function of Hive. After the function is enabled, new statistics will be collected only when you insert data by running the **insert overwrite/into** command.

- Run the following commands on the Hive client to enable the statistics collection function temporarily:

  set hive.stats.autogather = true; enables the automatic collection of table/partition-level statistics.

  set hive.stats.column.autogather = true; enables the automatic collection of column-level statistics.

  NOTE

  - The column-level statistics collection does not support complex data types, such as Map and Struct.
  - The automatic table-level statistics collection does not support Hive on HBase tables.

- On the Manager UI, search for the **hive.stats.autogather** and **hive.stats.column.autogather** parameters in the service configuration of Hive, and select **true** to enable the collection function permanently.

Step 4 Run the following command to view statistics:

DESCRIBE FORMATTED table_name[.column_name] PARTITION partition_spec;

For example:

desc formatted table_name;

desc formatted table_name id;

desc formatted table_name partition(time='2016-05-27');

NOTE

Partition tables only support partition-level statistics collection, so you must specify partitions to query statistics for partition tables.

----End

11.39 Common Issues About Hive

11.39.1 How Do I Delete UDFs on Multiple HiveServers at the Same Time?

Question

How can I delete permanent user-defined functions (UDFs) on multiple HiveServers at the same time?

Answer

Multiple HiveServers share one MetaStore database. Therefore, there is a delay in the data synchronization between the MetaStore database and the HiveServer memory. If a permanent UDF is deleted from one HiveServer, the operation result cannot be synchronized to the other HiveServers promptly.

In this case, you need to log in to the Hive client to connect to each HiveServer and delete permanent UDFs on the HiveServers one by one. The operations are as follows:

Step 1 Log in to the node where the Hive client is installed as the Hive client installation user.

Step 2 Run the following command to go to the client installation directory:

cd *Client installation directory*

For example, if the client installation directory is **/opt/client**, run the following command:

cd /opt/client

Step 3 Run the following command to configure environment variables:

source bigdata_env

Step 4 Run the following command to authenticate the user:

kinit *Hive service user*

NOTE

The login user must have the Hive admin rights.

Step 5 Run the following command to connect to the specified HiveServer:

beeline -u "jdbc:hive2:// *10.39.151.74*:*21066*/**default;sasl.qop=auth-conf;auth=KERBEROS;principal=***hive*/*hadoop.<system domain name>*@*<system domain name>*"

NOTE

- *10.39.151.74* is the IP address of the node where the HiveServer is located.
- *21066* is the port number of the HiveServer. The HiveServer port number ranges from 21066 to 21070 by default. Use the actual port number.
- *hive* is the username. For example, if the Hive1 instance is used, the username is **hive1**.
- You can log in to FusionInsight Manager, choose **System** > **Permission** > **Domain and Mutual Trust**, and view the value of **Local Domain**, which is the current system domain name.
- **hive/hadoop.*<system domain name>*** is the username. All letters in the system domain name contained in the username are lowercase letters.

Step 6 Run the following command to enable the Hive admin rights:

set role admin;

Step 7 Run the following command to delete the permanent UDF:

drop function *function_name*;

NOTE

- *function_name* indicates the name of the permanent function.
- If the permanent UDF is created in Spark, the permanent UDF needs to be deleted from Spark and then from HiveServer by running the preceding command.

Step 8 Check whether the permanent UDFs are deleted from all HiveServers.

- If yes, no further action is required.
- If no, go to **Step 5**.

----End

11.39.2 Why Cannot the DROP operation Be Performed on a Backed-up Hive Table?

Question

Why cannot the **DROP** operation be performed for a backed up Hive table?

Answer

Snapshots have been created for an HDFS directory mapping to the backed up Hive table, so the HDFS directory cannot be deleted. As a result, the Hive table cannot be deleted.

When a Hive table is being backed up, snapshots are created for the HDFS directory mapping to the table. The snapshot mechanism of HDFS has the

following limitation: If snapshots have been created for an HDFS directory, the directory cannot be deleted or renamed unless the snapshots are deleted. When the **DROP** operation is performed for a Hive table (except the EXTERNAL table), the system attempts to delete the HDFS directory mapping to the table. If the directory fails to be deleted, the system displays a message indicating that the table fails to be deleted.

If you need to delete this table, manually delete all backup tasks related to this table.

11.39.3 How to Perform Operations on Local Files with Hive User-Defined Functions

Question

How to perform operations on local files (such as reading the content of a file) with Hive user-defined functions?

Answer

By default, you can perform operations on local files with their relative paths in UDF. The following are sample codes:

```
public String evaluate(String text) {
  // some logic
  File file = new File("foo.txt");
  // some logic
  // do return here
}
```

In Hive, upload the file **foo.txt** used in UDF to HDFS, such as **hdfs://hacluster/tmp/foo.txt**. You can perform operations on the **foo.txt** file by creating UDF with the following sentences:

create function testFunc as 'some.class' using jar 'hdfs://hacluster/somejar.jar', file 'hdfs://hacluster/tmp/foo.txt';

In abnormal cases, if the value of **hive.fetch.task.conversion** is **more**, you can perform operations on local files in UDF by using absolute path instead of relative path. In addition, you must ensure that the file exists on all HiveServer nodes and NodeManager nodes and **omm** user have corresponding operation rights.

11.39.4 How Do I Forcibly Stop MapReduce Jobs Executed by Hive?

Question

How do I stop a MapReduce task manually if the task is suspended for a long time?

Answer

Step 1 Log in to FusionInsight Manager.

Step 2 Choose **Cluster** > *Name of the desired cluster* > **Services** > **Yarn**.

Step 3 On the left pane, click **ResourceManager(Host name, Active)**, and log in to Yarn.

Step 4 Click the button corresponding to the task ID. On the task page that is displayed, click **Kill Application** in the upper left corner and click **OK** in the displayed dialog box to stop the task.

----End

11.39.5 How Do I Monitor the Hive Table Size?

Question

How do I monitor the Hive table size?

Answer

The HDFS refined monitoring function allows you to monitor the size of a specified table directory.

Prerequisites

- The Hive and HDFS components are running properly.
- The HDFS refined monitoring function is normal.

Procedure

Step 1 Log in to FusionInsight Manager.

Step 2 Choose **Cluster** > **Services** > **HDFS** and click **Resource**.

Step 3 Click the first icon in the upper left corner of **Resource Usage (by Directory)**, as shown in the following figure.

Step 4 In the displayed sub page for configuring space monitoring, click **Add**.

Step 5 In the displayed **Add a Monitoring Directory** dialog box, set **Name** to the name or the user-defined alias of the table to be monitored and **Path** to the path of the monitored table. Click **OK**. In the monitoring result, the horizontal coordinate indicates the time, and the vertical coordinate indicates the size of the monitored directory.

----End

11.39.6 How Do I Prevent Key Directories from Data Loss Caused by Misoperations of the insert overwrite Statement?

Question

How do I prevent key directories from data loss caused by misoperations of the **insert overwrite** statement?

Answer

During monitoring of key Hive databases, tables, or directories, to prevent data loss caused by misoperations of the **insert overwrite** statement, configure **hive.local.dir.confblacklist** in Hive to protect directories.

This configuration item has been configured for directories such as **/opt/** and **/user/hive/warehouse** by default.

Prerequisites

The Hive and HDFS components are running properly.

Procedure

Step 1 Log in to FusionInsight Manager.

Step 2 Choose **Cluster** > **Services** > **Hive**. Click **Configurations** then **All Configurations**, and search for the **hive.local.dir.confblacklist** parameter.

Step 3 Add paths of databases, tables, or directories to be protected in the parameter value.

Step 4 Click **Save** to save the settings.

----End

11.39.7 Why Is Hive on Spark Task Freezing When HBase Is Not Installed?

Scenario

This function applies to Hive.

Perform the following operations to configure parameters. When Hive on Spark tasks are executed in the environment where the HBase is not installed, freezing of tasks can be prevented.

NOTE

The Spark kernel version of Hive on Spark tasks has been upgraded to Spark. Hive on Spark tasks can be executed without installing Spark. If HBase is not installed, when Spark tasks are executed, the system attempts to connect to the ZooKeeper to access HBase until timeout occurs by default. As a result, task freezing occurs.

If HBase is not installed, perform the following operations to execute Hive on Spark tasks. If HBase is upgraded from an earlier version, you do not need to configure parameters after the upgrade.

Procedure

Step 1 Log in to FusionInsight Manager.

Step 2 Choose **Cluster** > **Services** > **Hive**. Click **Configurations** then **All Configurations**.

Step 3 Choose **HiveServer(Role)** > **Customization**. Add a customized parameter to the **spark-defaults.conf** parameter file. Set **Name** to **spark.security.credentials.hbase.enabled**, and set **Value** to **false**.

Step 4 Click **Save**. In the dialog box that is displayed, click **OK**.

Step 5 Choose **Cluster** > **Services** > **Hive**. Click **Instance**, select all Hive instances, click **More** , and select **Restart Instance**. In the dialog box displayed, enter the password, and click **OK**.

----End

11.39.8 Error Reported When the WHERE Condition Is Used to Query Tables with Excessive Partitions in FusionInsight Hive

Question

When a table with more than 32,000 partitions is created in Hive, an exception occurs during the query with the WHERE partition. In addition, the exception information printed in **metastore.log** contains the following information:

```
Caused by: java.io.IOException: Tried to send an out-of-range integer as a 2-byte value: 32970
    at org.postgresql.core.PGStream.SendInteger2(PGStream.java:199)
    at org.postgresql.core.v3.QueryExecutorImpl.sendParse(QueryExecutorImpl.java:1330)
    at org.postgresql.core.v3.QueryExecutorImpl.sendOneQuery(QueryExecutorImpl.java:1601)
    at org.postgresql.core.v3.QueryExecutorImpl.sendParse(QueryExecutorImpl.java:1191)
    at org.postgresql.core.v3.QueryExecutorImpl.execute(QueryExecutorImpl.java:346)
```

Answer

During a query with partition conditions, HiveServer optimizes the partitions to avoid full table scanning. All partitions whose metadata meets the conditions need to be queried. However, the **sendOneQuery** interface provided by GaussDB limits the parameter value to **32767** in the **sendParse** method. If the number of partition conditions exceeds **32767**, an exception occurs. If you have to query a large number of partitions in a single SQL statement, see **Procedure**.

Procedure

Step 1 Log in to FusionInsight Manager, choose **Clusters** > **Services** > **Hive**. On the displayed page, click the **Configurations** tab and select **All Configurations**.

Choose **MetaStore(Role)** > **Customization**, and add **metastore.direct.sql.batch.size** and its value **10000** to the parameter file **hivemetastore-site.xml**.

Step 2 Click **Save**. In the dialog box that is displayed, click **OK**.

Step 3 Click the **Instance** tab, select all MetaStore instances, click **More** > **Restart Instance**, enter the administrator password, and click **OK** to restart the MetaStore instances.

----End

11.39.9 Why Cannot I Connect to HiveServer When I Use IBM JDK to Access the Beeline Client?

Scenario

When users check the JDK version used by the client, if the JDK version is IBM JDK, the Beeline client needs to be reconstructed. Otherwise, the client will fail to connect to HiveServer.

Procedure

Step 1 Log in to FusionInsight Manager and choose **System** > **Permission** > **User**. In the **Operation** column of the target user, choose **More** > **Download Authentication Credential**, select the cluster information, and click **OK** to download the keytab file.

Step 2 Decompress the keytab file and use WinSCP to upload the decompressed **user.keytab** file to the Hive client installation directory on the node to be operated, for example, **/opt/client**.

Step 3 Run the following command to open the **Hive/component_env** configuration file in the Hive client directory:

vi *Hive client installation directory*/**Hive/component_env**

Add the following content to the end of the line where **export CLIENT_HIVE_URI** is located:

```
\; user.principal=Username @HADOOP.COM\;user.keytab=user.keytab file path/user.keytab
```

----End

11.39.10 Description of Hive Table Location (Either Be an OBS or HDFS Path)

Question

Can Hive tables be stored in OBS or HDFS?

Answer

1. The location of a common Hive table stored on OBS can be set to an HDFS path.

2. In the same Hive service, you can create tables stored in OBS and HDFS, respectively.
3. For a Hive partitioned table stored on OBS, the location of the partition cannot be set to an HDFS path. (For a partitioned table stored on HDFS, the location of the partition cannot be changed to OBS.)

11.39.11 Why Cannot Data Be Queried After the MapReduce Engine Is Switched After the Tez Engine Is Used to Execute Union-related Statements?

Question

Hive uses the Tez engine to execute union-related statements to write data. After Hive is switched to the MapReduce engine for query, no data is found.

Answer

When Hive uses the Tez engine to execute the union-related statement, the generated output file is stored in the **HIVE_UNION_SUBDIR** directory. After Hive is switched back to the MapReduce engine, files in the directory are not read by default. Therefore, data in the **HIVE_UNION_SUBDIR** directory is not read.

In this case, you can set **mapreduce.input.fileinputformat.input.dir.recursive** to **true** to enable union optimization and determine whether to read data in the directory.

11.39.12 Why Does Hive Not Support Concurrent Data Writing to the Same Table or Partition?

Question

Why Does Data Inconsistency Occur When Data Is Concurrently Written to a Hive Table Through an API?

Answer

Hive does not support concurrent data insertion for the same table or partition. As a result, multiple tasks perform operations on the same temporary data directory, and one task moves the data of another task, causing task data exception. The service logic is modified so that data is inserted to the same table or partition in single thread mode.

11.39.13 Why Does Hive Not Support Vectorized Query?

Question

When the vectorized parameter **hive.vectorized.execution.enabled** is set to **true**, why do some null pointers or type conversion exceptions occur occasionally when Hive on Tez/MapReduce/Spark is executed?

Answer

Currently, Hive does not support vectorized execution. Many community issues are introduced during vectorized execution and are not resolved stably. The default value of **hive.vectorized.execution.enabled** is **false**. You are advised not to set this parameter to **true**.

11.39.14 Why Does Metadata Still Exist When the HDFS Data Directory of the Hive Table Is Deleted by Mistake?

Question

The HDFS data directory of the Hive table is deleted by mistake, but the metadata still exists. As a result, an error is reported during task execution.

Answer

This is an exception caused by misoperation. You need to manually delete the metadata of the corresponding table and try again.

Example:

Run the following command to go to the console:

source ${BIGDATA_HOME}/FusionInsight_BASE_8.1.0.1/install/FusionInsight-dbservice-2.7.0/.dbservice_profile

gsql -p 20051 -U hive -d hivemeta -W HiveUser@

Run the **delete from tbls where tbl_id='xxx';** command.

11.39.15 How Do I Disable the Logging Function of Hive?

Question

How do I disable the logging function of Hive?

Answer

Step 1 Log in to the node where the client is installed as user **root**.

Step 2 Run the following command to switch to the client installation directory, for example, **/opt/client**:

cd /opt/client

Step 3 Run the following command to configure environment variables:

source bigdata_env

Step 4 Log in to the Hive client based on the cluster authentication mode.

- In security mode, run the following command to complete user authentication and log in to the Hive client:

  kinit *Component service user*

  beeline

- In normal mode, run the following command to log in to the Hive client:
  - Run the following command to log in to the Hive client as the component service user:

    beeline -n *component service user*
  - If no component service user is specified, the current OS user is used to log in to the Hive client.

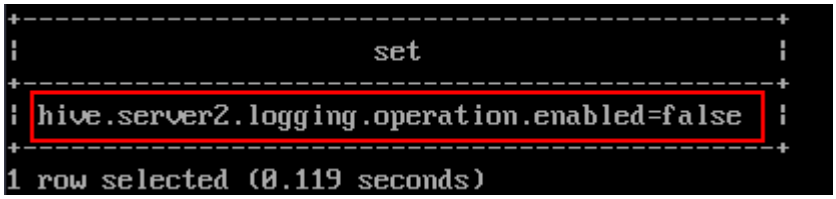
    beeline

Step 5 Run the following command to disable the logging function:

set hive.server2.logging.operation.enabled=false;

Step 6 Run the following command to check whether the logging function is disabled. If the following information is displayed, the logging function is disabled successfully.

set hive.server2.logging.operation.enabled;



----End

11.39.16 Why Hive Tables in the OBS Directory Fail to Be Deleted?

Question

In the scenario where the fine-grained permission is configured for multiple MRS users to access OBS, after the permission for deleting Hive tables in the OBS directory is added to the custom configuration of Hive, tables are deleted on the Hive client but still exist in the OBS directory.

Answer

You do not have the permission to delete directories on OBS. As a result, Hive tables cannot be deleted. In this case, modify the custom IAM policy of the agency and configure Hive with the permission for deleting tables in the OBS directory.

11.39.17 Hive Configuration Problems

- The error message "java.lang.OutOfMemoryError: Java heap space." is displayed during Hive SQL execution.

  Solution:
  - For MapReduce tasks, increase the values of the following parameters:

    set mapreduce.map.memory.mb=8192;

    set mapreduce.map.java.opts=-Xmx6554M;

    set mapreduce.reduce.memory.mb=8192;

set mapreduce.reduce.java.opts=-Xmx6554M;

- For Tez tasks, increase the value of the following parameter:

  set hive.tez.container.size=8192;

- After a column name is changed to a new one using the Hive SQL **as** statement, the error message "Invalid table alias or column reference 'xxx'." is displayed when the original column name is used for compilation.

  Solution: Run the **set hive.cbo.enable=true;** statement.

- The error message "Unsupported SubQuery Expression 'xxx': Only SubQuery expressions that are top level conjuncts are allowed." is displayed during Hive SQL subquery compilation.

  Solution: Run the **set hive.cbo.enable=true;** statement.

- The error message "CalciteSubquerySemanticException [Error 10249]: Unsupported SubQuery Expression Currently SubQuery expressions are only allowed as Where and Having Clause predicates." is displayed during Hive SQL subquery compilation.

  Solution: Run the **set hive.cbo.enable=true;** statement.

- The error message "Error running query: java.lang.AssertionError: Cannot add expression of different type to set." is displayed during Hive SQL compilation.

  Solution: Run the **set hive.cbo.enable=false;** statement.

- The error message "java.lang.NullPointerException at org.apache.hadoop.hive.ql.udf.generic.GenericUDAFComputeStats $GenericUDAFNumericStatsEvaluator.init." is displayed during Hive SQL execution.

  Solution: Run the **set hive.map.aggr=false;** statement.

- When **hive.auto.convert.join** is set to **true** (enabled by default) and **hive.optimize.skewjoin** is set to **true**, the error message "ClassCastException org.apache.hadoop.hive.ql.plan.ConditionalWork cannot be cast to org.apache.hadoop.hive.ql.plan.MapredWork" is displayed.

  Solution: Run the **set hive.optimize.skewjoin=false;** statement.

- When **hive.auto.convert.join** is set to **true** (enabled by default), **hive.optimize.skewjoin** is set to **true**, and **hive.exec.parallel** is set to **true**, the error message "java.io.FileNotFoundException: File does not exist:xxx/reduce.xml" is displayed.

  Solution:

  - Method 1: Switch the execution engine to Tez. For details, see **Switching the Hive Execution Engine to Tez**.
  - Method 2: Run the **set hive.exec.parallel=false;** statement.
  - Method 3: Run the **set hive.auto.convert.join=false;** statement.

- Eerror message "NullPointerException at org.apache.hadoop.hive.ql.exec.CommonMergeJoinOperator.mergeJoinComputeKeys" is displayed when Hive on Tez executes bucket map join.

  Solution: Run the **set tez.am.container.reuse.enabled=false;** statement.

11.39.18 How Do I Handle the Error Reported When Setting hive.exec.stagingdir on the Hive Client?

Scenario

By default, Hive client does not support the modification of the temporary directory created when data is inserted. If you run **set hive.exec.stagingdir=*xxx*** on the client to modify the temporary directory, the following error message is displayed:

```
0: jdbc:hive2://192.168.20.106:21066/> set hive.exec.stagingdir=/tmp/.hive-staging;
Error: Error while processing statement: Cannot modify hive.exec.stagingdir at runtime. It is in the list of parameters that can't be modified at runtime or is prefixed by a restri
cted variable (state=42000,code=1)
0: jdbc:hive2://192.168.20.106:21066/>
```

Answer

hive.exec.stagingdir is used to set the temporary directory created when data is inserted. Data may be lost when concurrently inserted into a same table. By default, this parameter is not allowed. If no data will be inserted concurrently, you can set this parameter on the client. For details, see **Procedure**.

Procedure

Step 1 Log in to FusionInsight Manager, choose **Clusters** > **Services** > **Hive**. On the displayed page, click the **Configurations** tab and select **All Configurations**. Choose **HiveServer(Role)** > **Customization**, and add **hive.conf.internal.variable.list** and its value **hive.added.files.path,hive.added.jars.path,hive.added.archives.path** to the parameter file **hive-site.xml**.

Step 2 Click **Save**. In the dialog box that is displayed, click **OK**.

Step 3 Click the **Instance** tab, select all HiveServer instances, click **More** > **Restart Instance**, enter the administrator password, and click **OK** to restart the HiveServer instances.

----End

12 Using Hudi

12.1 Getting Started

Scenario

This section describes capabilities of Hudi using spark-shell. Using the Spark data source, this section describes how to insert and update a Hudi dataset of the default storage mode Copy-on Write (COW) tables based on code snippets. After each write operation, you will be introduced how to read snapshot and incremental data.

Prerequisites

- You have created a user and added the user to user groups **hadoop** (primary group) and **hive** on Manager.

Procedure

Step 1 Log in to the node where the client is installed as user **root** and run the following command:

cd /opt/client

Step 2 Run the following commands to load environment variables:

source bigdata_env

source Hudi/component_env

kinit *Created user*

NOTE

- You need to change the password of the created user, and then run the **kinit** command to log in to the system again.
- In normal mode (Kerberos authentication disabled), you do not need to run the **kinit** command.
- If multiple services are installed, run the **source Spark_env** command and then the **source Hudi_env** command after you run the **source bigdata_env** command.

Step 3 Use **spark-shell --master yarn-client** to import Hudi packages to generate test data:

- Import required packages.

  import org.apache.hudi.QuickstartUtils._

  import scala.collection.JavaConversions._

  import org.apache.spark.sql.SaveMode._

  import org.apache.hudi.DataSourceReadOptions._

  import org.apache.hudi.DataSourceWriteOptions._

  import org.apache.hudi.config.HoodieWriteConfig._

- Define the table name and storage path to generate test data.

  val tableName = "hudi_cow_table"

  val basePath = "hdfs://hacluster/tmp/hudi_cow_table"

  val dataGen = new DataGenerator

  val inserts = convertToStringList(dataGen.generateInserts(10))

  val df = spark.read.json(spark.sparkContext.parallelize(inserts, 2))

Step 4 Write data to the Hudi table in overwrite mode.

df.write.format("org.apache.hudi").

options(getQuickstartWriteConfigs).

option(PRECOMBINE_FIELD_OPT_KEY, "ts").

option(RECORDKEY_FIELD_OPT_KEY, "uuid").

option(PARTITIONPATH_FIELD_OPT_KEY, "partitionpath").

option(TABLE_NAME, tableName).

mode(Overwrite).

save(basePath)

Step 5 Query the Hudi table.

Register a temporary table and query the table.

val roViewDF = spark.read.format("org.apache.hudi").load(basePath + "/*/*/*/*")

roViewDF.createOrReplaceTempView("hudi_ro_table")

spark.sql("select fare, begin_lon, begin_lat, ts from hudi_ro_table where fare > 20.0").show()

Step 6 Generate new data and update the Hudi table in append mode.

val updates = convertToStringList(dataGen.generateUpdates(10))

val df = spark.read.json(spark.sparkContext.parallelize(updates, 1))

df.write.format("org.apache.hudi").

options(getQuickstartWriteConfigs).

option(PRECOMBINE_FIELD_OPT_KEY, "ts").

option(RECORDKEY_FIELD_OPT_KEY, "uuid").

option(PARTITIONPATH_FIELD_OPT_KEY, "partitionpath").

option(TABLE_NAME, tableName).

mode(Append).

save(basePath)

Step 7 Query incremental data in the Hudi table.

- Reload data.

  spark.read.format("org.apache.hudi").load(basePath + "/*/*/*/*").createOrReplaceTempView("hudi_ro_table")

- Perform the incremental query.

  val commits = spark.sql("select distinct(_hoodie_commit_time) as commitTime from hudi_ro_table order by commitTime").map(k => k.getString(0)).take(50)

  val beginTime = commits(commits.length - 2)

  val incViewDF = spark.

  read.

  format("org.apache.hudi").

  option(VIEW_TYPE_OPT_KEY, VIEW_TYPE_INCREMENTAL_OPT_VAL).

  option(BEGIN_INSTANTTIME_OPT_KEY, beginTime).

  load(basePath);

  incViewDF.registerTempTable("hudi_incr_table")

  spark.sql("select `_hoodie_commit_time`, fare, begin_lon, begin_lat, ts from hudi_incr_table where fare > 20.0").show()

Step 8 Perform the point-in-time query.

val beginTime = "000"

val endTime = commits(commits.length - 2)

val incViewDF = spark.read.format("org.apache.hudi").

option(VIEW_TYPE_OPT_KEY, VIEW_TYPE_INCREMENTAL_OPT_VAL).

option(BEGIN_INSTANTTIME_OPT_KEY, beginTime).

option(END_INSTANTTIME_OPT_KEY, endTime).

load(basePath);

incViewDF.registerTempTable("hudi_incr_table")

spark.sql("select `_hoodie_commit_time`, fare, begin_lon, begin_lat, ts from hudi_incr_table where fare > 20.0").show()

Step 9 Delete data.

- Prepare the data to be deleted.

  val df = spark.sql("select uuid, partitionpath from hudi_ro_table limit 2")

  val deletes = dataGen.generateDeletes(df.collectAsList())

- Execute the deletion.
  val df = spark.read.json(spark.sparkContext.parallelize(deletes, 2));
  df.write.format("org.apache.hudi").
  options(getQuickstartWriteConfigs).
  option(OPERATION_OPT_KEY,"delete").
  option(PRECOMBINE_FIELD_OPT_KEY, "ts").
  option(RECORDKEY_FIELD_OPT_KEY, "uuid").
  option(PARTITIONPATH_FIELD_OPT_KEY, "partitionpath").
  option(TABLE_NAME, tableName).
  mode(Append).
  save(basePath);
- Query data again.
  val roViewDFAfterDelete = spark.
  read.
  format("org.apache.hudi").
  load(basePath + "/*/*/*/*")
  roViewDFAfterDelete.createOrReplaceTempView("hudi_ro_table")
  spark.sql("select uuid, partitionPath from hudi_ro_table").show()

----End

12.2 Common Hudi Parameters

This section describes important Hudi configurations.

Write Configuration

Table 12-1 Write configuration parameters

Parameter	Description	Default Value
hoodie.datasource.write.table.name	Name of the Hudi table to which data is written	None

Parameter	Description	Default Value
hoodie.datasource.write.operation	Type of the operation for writing data to the Hudi table. Value options are as follows: • **upsert**: updates and inserts data. • **delete**: deletes data. • **insert**: inserts data. • **bulk_insert**: imports data during initial table creation. Do not use **upsert** or **insert** during initial table creation. • **insert_overwrite**: performs insert and overwrite operations on static partitions. • **insert_overwrite_table**: performs insert and overwrite operations on dynamic partitions. It does not immediately delete the entire table or overwrite the table. Instead, it overwrites the metadata of the Hudi table logically, and Hudi deletes useless data through the clean mechanism. Its efficiency is higher than that of the combination of **bulk_insert** and **overwrite**.	upsert
hoodie.datasource.write.table.type	Type of the Hudi table. This parameter cannot be modified once specified. The value can be **MERGE_ON_READ**.	COPY_ON_WRITE
hoodie.datasource.write.precombine.field	Merges and reduplicates rows with the same key before write.	ts
hoodie.datasource.write.payload.class	Class used to merge the records to be updated and the updated records during update. This parameter can be customized. You can compile it to implement your merge logic.	org.apache.hudi.common.model.DefaultHoodieRecordPayload
hoodie.datasource.write.recordkey.field	Unique primary key of the Hudi table	uuid

Parameter	Description	Default Value
hoodie.datasource.write.partitionpath.field	Partition key. This parameter can be used together with **hoodie.datasource.write.keygenerator.class** to meet different partition needs.	None
hoodie.datasource.write.hive_style_partitioning	Whether to specify a partition mode that is the same as that of Hive. Set this parameter to **true**.	true
hoodie.datasource.write.keygenerator.class	Used with **hoodie.datasource.write.partitionpath.field** and **hoodie.datasource.write.recordkey.field** to generate the primary key and partition mode. **NOTE** If the value of this parameter is different from that saved in the table, a message is displayed, indicating that the value must be the same.	org.apache.hudi.keygen.ComplexKeyGenerator

Configuration of Hive Table Synchronization

Table 12-2 Parameters for synchronizing Hive tables

Parameter	Description	Default Value
hoodie.datasource.hive_sync.enable	Whether to synchronize Hudi tables to Hive MetaStore. **CAUTION** Set this parameter to **true** to use Hive to centrally manage Hudi tables.	false
hoodie.datasource.hive_sync.database	Name of the database to be synchronized to Hive	default
hoodie.datasource.hive_sync.table	Name of the table to be synchronized to Hive. Set this parameter to the value of **hoodie.datasource.write.table.name**.	unknown
hoodie.datasource.hive_sync.username	Username used for Hive synchronization	hive

Parameter	Description	Default Value
hoodie.datasource.hive_sync.password	Password used for Hive synchronization	hive
hoodie.datasource.hive_sync.jdbcurl	Hive JDBC URL for connection	""
hoodie.datasource.hive_sync.use_jdbc	Whether to use Hive JDBC to connect to Hive and synchronize Hudi table information. Set this parameter to **false** to invalidate the JDBC connection configuration.	true
hoodie.datasource.hive_sync.partition_fields	Hive partition columns	""
hoodie.datasource.hive_sync.partition_extractor_class	Class used to extract Hudi partition column values and convert them into Hive partition columns.	org.apache.hudi.hive.SlashEncodedDayPartitionValueExtractor
hoodie.datasource.hive_sync.support_timestamp	If the Hudi table contains fields of the timestamp type, set this parameter to **true** to synchronize data of the timestamp type to Hive metadata. The default value is **false**, indicating that the timestamp type is converted to bigint during synchronization by default. In this case, an error may occur when you query a Hudi table that contains a field of the timestamp type using SQL statements.	true

Index Configuration

Table 12-3 Index parameters

Parameter	Description	Default Value
hoodie.index.class	Full path of a user-defined index, which must be a subclass of HoodieIndex. When this parameter is specified, the configuration takes precedence over that of **hoodie.index.type**.	""
hoodie.index.type	Index type. The default value is **BLOOM**. The possible options are **BLOOM**, **HBASE**, **GLOBAL_BLOOM**, **SIMPLE**, and **GLOBAL_SIMPLE**. The Bloom filter eliminates the dependency on an external system and is stored in the footer of a Parquet data file.	BLOOM
hoodie.index.bloom.num_entries	This is the number of entries to be stored in the bloom filter. We assume the maxParquetFileSize is 128 MB and averageRecordSize is 1024 bytes and hence we approx a total of 130 KB records in a file. The default (60000) is roughly half of this approximation. **CAUTION** Setting this very low will generate a lot of false positives and index lookup will have to scan a lot more files than it has to and setting this to a very high number will increase the size every data file linearly (roughly 4 KB for every 50,000 entries).	60000
hoodie.index.bloom.fpp	Error rate allowed given the number of entries. This is used to calculate how many bits should be assigned for the bloom filter and the number of hash functions. This is usually set very low (default: **0.000000001**), we like to tradeoff disk space for lower false positives.	0.000000001

Parameter	Description	Default Value
hoodie.bloom.index.parallelism	Parallelism for index lookup, which involves Spark shuffling. By default, it is automatically calculated based on input workload characteristics.	0
hoodie.bloom.index.prune.by.ranges	When **true**, range information from files to leveraged speed up index lookups. Particularly helpful, if the key has a monotonously increasing prefix, such as timestamp.	true
hoodie.bloom.index.use.caching	When **true**, the input RDD will be cached to speed up index lookup by reducing I/O for computing parallelism or affected partitions.	true
hoodie.bloom.index.use.treebased.filter	When **true**, interval tree based file pruning optimization is enabled. This mode speeds up file pruning based on key ranges when compared with the brute-force mode.	true
hoodie.bloom.index.bucketized.checking	When **true**, bucketized bloom filtering is enabled. This reduces skew seen in sort based bloom index lookup.	true
hoodie.bloom.index.keys.per.bucket	Only applies if bloomIndexBucketizedChecking is enabled and the index type is **BLOOM**. This configuration controls the "bucket" size which tracks the number of record-key checks made against a single file and is the unit of work allocated to each partition performing bloom filter lookup. A higher value would amortize the fixed cost of reading a bloom filter to memory.	10000000

Parameter	Description	Default Value
hoodie.bloom.index.update.partition.path	This parameter is applicable only when the index type is **GLOBAL_BLOOM**. If this parameter is set to **true**, an update including the partition path of a record that already exists will result in the insertion of the incoming record into the new partition and the deletion of the original record in the old partition. If this parameter is set to **false**, the original record will only be updated in the old partition.	true
hoodie.index.hbase.zkquorum	Mandatory. This parameter is available only when the index type is **HBASE**. HBase ZooKeeper quorum URL to be connected.	None
hoodie.index.hbase.zkport	Mandatory. This parameter is available only when the index type is **HBASE**. HBase ZooKeeper quorum port to be connected.	None
hoodie.index.hbase.zknode.path	Mandatory. This parameter is available only when the index type is **HBASE**. It is the root znode that will contain all the znodes created and used by HBase.	None
hoodie.index.hbase.table	Mandatory. This parameter is available only when the index type is **HBASE**. HBase table name to be used as an index. Hudi stores the **row_key** and **[partition_path, fileID, commitTime]** mapping in the table.	None

Storage Configuration

Table 12-4 Storage parameter configuration

Parameter	Description	Default Value
hoodie.parquet.max.file.size	Specifies the target size for Parquet files generated in Hudi write phases. For DFS, this parameter needs to be aligned with the underlying file system block size for optimal performance.	120 * 1024 * 1024 byte
hoodie.parquet.block.size	Specifies the Parquet page size. Page is the unit of read in a Parquet file. In a block, pages are compressed separately.	120 * 1024 * 1024 byte
hoodie.parquet.compression.ratio	Specifies the expected compression ratio of Parquet data when Hudi attempts to adjust the size of a new Parquet file. If the size of the file generated by **bulk_insert** is smaller than the expected size, increase the value.	0.1
hoodie.parquet.compression.codec	Specifies the name of the Parquet compression encoding or decoding mode. The default value is **gzip**. Possible options are **[gzip | snappy | uncompressed | lzo]**.	snappy
hoodie.logfile.max.size	Specifies the maximum size of LogFile. It is the maximum size allowed for a log file before it is rolled over to the next version.	1GB
hoodie.logfile.data.block.max.size	Specifies the maximum size of a LogFile data block. It is the maximum size allowed for a single data block to be appended to a log file. It helps to ensure that the data appended to the log file is broken up into sizable blocks to prevent OOM errors. The size should be greater than the JVM memory.	256MB

Parameter	Description	Default Value
hoodie.logfile.to.parquet.compression.ratio	Specifies the expected additional compression when records move from log files to Parquet files. It is used for MOR tables to send inserted content into log files and control the size of compacted Parquet files.	0.35

Compaction and Cleaning Configurations

Table 12-5 Compaction & cleaning parameter configuration

Parameter	Description	Default Value
hoodie.clean.automatic	Specifies whether to perform automatic cleanup.	true
hoodie.cleaner.policy	Specifies the cleaning policy to be used. Hudi will delete the Parquet file of an old version to reclaim space. Any query or computation referring to this version of the file will fail. You are advised to ensure that the data retention time exceeds the maximum query execution time.	KEEP_LATEST_COMMITS
hoodie.cleaner.commits.retained	Specifies the number of commits to retain. Data will be retained for **num_of_commits * time_between_commits** (scheduled). This also directly translates into the number of datasets can be incrementally pulled.	10
hoodie.keep.max.commits	Number of commits that triggers the archiving operation.	30
hoodie.keep.min.commits	Number of commits reserved by the archiving operation.	20
hoodie.commits.archival.batch	This parameter controls the number of commit instants read in memory as a batch and archived together.	10

Parameter	Description	Default Value
hoodie.parquet.small.file.limit	The value must be smaller than that of **maxFileSize**. If **maxFileSize** is set to **0**, this function is disabled. Small files always exist because of the large number of insert records in a partition of batch processing. Hudi provides an option to solve the problem of small files by masking inserts into this partition as updates to existing small files. The size here is the minimum file size that is considered as a "small file size".	104857600 byte
hoodie.copyonwrite.insert.split.size	Specifies the parallelism for inserting and writing data. It is the number of inserts grouped for a single partition. Writing out 100 MB files with at least 1 KB records means 100 KB records exist in each file. Overprovision to 500 KB by default. To improve insert latency, adjust the value to match the number of records in a single file. If it is set to a smaller value, the file size will shrink (especially when **compactionSmallFileSize** is set to **0**).	500000
hoodie.copyonwrite.insert.auto.split	Specifies whether Hudi dynamically computes **insertSplitSize** based on the last 24 commit metadata. This function is disabled by default.	true
hoodie.copyonwrite.record.size.estimate	Specifies the average record size. If specified, Hudi will use this parameter and not compute dynamically based on the last 24 commit metadata. There is no default value. This is critical in computing the insert parallelism and packing inserts into small files.	1024

Parameter	Description	Default Value
hoodie.compact.inline	If this parameter is set to **true**, compaction is triggered by the ingestion itself right after a commit or delta commit action as part of **insert**, **upsert**, or **bulk_insert**.	true
hoodie.compact.inline.max.delta.commits	Specifies the maximum number of delta commits to be retained before inline compression is triggered.	5
hoodie.compaction.lazy.block.read	When **CompactedLogScanner** merges all log files, this parameter helps to choose whether the logblocks should be read lazily. Set it to **true** to use I/O-intensive lazy block read (low memory usage) or **false** to use memory-intensive immediate block read (high memory usage).	true
hoodie.compaction.reverse.log.read	**HoodieLogFormatReader** reads a log file in the forward direction from **pos=0** to **pos=file_length**. If this parameter is set to **true**, Reader reads a log file in reverse direction from **pos=file_length** to **pos=0**.	false
hoodie.cleaner.parallelism	Increase this parameter if cleaning becomes slow.	200
hoodie.compaction.strategy	Determines which file groups are selected for compaction during each compaction run. By default, Hudi selects the log file with most accumulated unmerged data.	org.apache.hudi.table.action.compact.strategy. LogFileSizeBasedCompactionStrategy
hoodie.compaction.target.io	Specifies the number of MBs to spend during compaction run for **LogFileSizeBasedCompactionStrategy**. This parameter can limit ingestion latency when compaction is run in inline mode.	500 * 1024 MB

Parameter	Description	Default Value
hoodie.compaction.daybased.target.partitions	Used by **org.apache.hudi.io.compact.strategy.DayBasedCompactionStrategy** to denote the number of latest partitions to compact during a compaction run.	10
hoodie.compaction.payload.class	It needs to be same as class used during insert or upsert. Similar to writing, compaction also uses the record payload class to merge records in the log against each other, merge again with the base file, and produce the final record to be written after compaction.	org.apache.hudi.common.model.Defaulthoodierecordpayload
hoodie.schedule.compact.only.inline	Specifies whether to generate only a compression plan during a write operation. This parameter is valid only when **hoodie.compact.inline** is set to **true**.	false
hoodie.run.compact.only.inline	Specifies whether to perform only the compression operation when the **run compaction** command is executed using SQL. If the compression plan does not exist, no action is needed.	false

Single-Table Concurrency Control Configuration

Table 12-6 Single-table concurrency control configuration

Parameter	Description	Default Value
hoodie.write.lock.provider	Specifies the lock provider. You are advised to set the parameter to **org.apache.hudi.hive.HiveMetastoreBasedLockProvider**.	org.apache.hudi.client.transaction.lock.ZookeeperBasedLockProvider
hoodie.write.lock.hivemetastore.database	Specifies the Hive database.	None
hoodie.write.lock.hivemetastore.table	Specifies the Hive table name.	None

Parameter	Description	Default Value
hoodie.write.lock.client.num_retries	Specifies the retry times.	10
hoodie.write.lock.client.wait_time_ms_between_retry	Specifies the retry interval.	10000
hoodie.write.lock.conflict.resolution.strategy	Specifies the lock provider class, which must be a subclass of **ConflictResolutionStrategy**.	org.apache.hudi.client.transaction.SimpleConcurrentFileWritesConflictResolutionStrategy
hoodie.write.lock.zookeeper.base_path	Path for storing ZNodes. The parameter must be the same for all concurrent write configurations of the same table.	None
hoodie.write.lock.zookeeper.lock_key	ZNode name. It is recommended that the ZNode name be the same as the Hudi table name.	None
hoodie.write.lock.zookeeper.connection_timeout_ms	ZooKeeper connection timeout period.	15000
hoodie.write.lock.zookeeper.port	ZooKeeper port number.	None
hoodie.write.lock.zookeeper.url	URL of ZooKeeper.	None
hoodie.write.lock.zookeeper.session_timeout_ms	Session expiration time of ZooKeeper.	60000

Clustering Configuration

NOTE

Clustering has two strategies: **hoodie.clustering.plan.strategy.class** and **hoodie.clustering.execution.strategy.class**. Typically, if **hoodie.clustering.plan.strategy.class** is set to **SparkRecentDaysClusteringPlanStrategy** or **SparkSizeBasedClusteringPlanStrategy**, **hoodie.clustering.execution.strategy.class** does not need to be specified. However, if **hoodie.clustering.plan.strategy.class** is set to **SparkSingleFileSortPlanStrategy**, **hoodie.clustering.execution.strategy.class** must be set to **SparkSingleFileSortExecutionStrategy**.

Table 12-7 Clustering parameter configuration

Parameter	Description	Default Value
hoodie.clustering.inline	Whether to execute clustering synchronously	false
hoodie.clustering.inline.max.commits	Number of commits that trigger clustering	4
hoodie.clustering.async.enabled	Whether to enable asynchronous clustering	false
hoodie.clustering.async.max.commits	Number of commits that trigger clustering during asynchronous execution	4
hoodie.clustering.plan.strategy.target.file.max.bytes	Maximum size of each file after clustering	1024 * 1024 * 1024 byte
hoodie.clustering.plan.strategy.small.file.limit	Files smaller than this size will be clustered.	300 * 1024 * 1024 byte
hoodie.clustering.plan.strategy.sort.columns	Columns used for sorting in clustering	None
hoodie.layout.optimize.strategy	Clustering execution strategy. Three sorting modes are available: **linear**, **z-order**, and **hilbert**.	linear
hoodie.layout.optimize.enable	Set this parameter to **true** when **z-order** or **hilbert** is used.	false
hoodie.clustering.plan.strategy.class	Strategy class for filtering file groups for clustering. By default, files whose size is less than the value of **hoodie.clustering.plan.strategy.small.file.limit** are filtered.	org.apache.hudi.client.clustering.plan.strategy.SparkSizeBasedClusteringPlanStrategy
hoodie.clustering.execution.strategy.class	Strategy class for executing clustering (subclass of RunClusteringStrategy), which is used to define the execution mode of a cluster plan. The default classes sort the file groups in the plan by the specified column and meet the configured target file size.	org.apache.hudi.client.clustering.run.strategy.SparkSortAndSizeExecutionStrategy

Parameter	Description	Default Value
hoodie.clustering.plan.strategy.max.num.groups	Maximum number of file groups that can be selected during clustering. A larger value indicates a higher concurrency.	30
hoodie.clustering.plan.strategy.max.bytes.per.group	Maximum number of data records in each file group involved in clustering	2 * 1024 * 1024 * 1024 byte

12.3 Basic Operations

12.3.1 Hudi Table Schema

When writing data, Hudi generates a Hudi table based on attributes such as the storage path, table name, and partition structure.

Hudi table data files can be stored in the OS file system or distributed file system such as HDFS. To ensure analysis performance and data reliability, HDFS is generally used for storage. The following uses HDFS as an example. Storage files of a Hudi table are classified into two types.

Log in to FusionInsight Manager and choose **Cluster** > **Services** > **HDFS**. On the **Dashboard** tab page, click the link next to **NameNode WebUI**. On the HDFS web UI that is displayed, choose **Utilities** > **Browse the file system**.

Permission	Owner	Group	Size	Last Modified	Replication	Block Size	Name
drwxr-xr-x	testcz	hadoop	0 B	Apr 25 15:32	0	0 B	.hoodie
drwxr-xr-x	testcz	hadoop	0 B	Apr 25 15:30	0	0 B	americas
drwxr-xr-x	testcz	hadoop	0 B	Apr 25 15:30	0	0 B	asia

- The **.hoodie** folder stores the log files related to file merging.

drwxr-xr-x	admintest	hadoop	0 B	Mar 30 09:44	0	0 B	.aux
drwxr-xr-x	admintest	hadoop	0 B	Mar 30 11:45	0	0 B	.temp
-rw-r--r--	admintest	hadoop	4.58 KB	Mar 30 09:44	3	128 MB	20210330094435.deltacommit
-rw-r--r--	admintest	hadoop	0 B	Mar 30 09:44	3	128 MB	20210330094435.deltacommit.inflight
-rw-r--r--	admintest	hadoop	0 B	Mar 30 09:44	3	128 MB	20210330094435.deltacommit.requested

- The path containing **_partition_key** stores actual data files and metadata by partition.

  Hudi data files of are stored in Parquet base files and Avro log files.

-rw-r--r--	admintest	hadoop	93 B	Mar 30 09:44	3	128 MB	.hoodie_partition_metadata
-rw-r--r--	admintest	hadoop	441.77 KB	Mar 30 09:46	3	128 MB	2b4d098e-4dc8-4633-a22a-dc22f87c57d9-1_0-13-22_20210330094613.parquet
-rw-r--r--	admintest	hadoop	445.28 KB	Mar 30 09:44	3	128 MB	4010e8a8-1b20-4be7-8442-4e30af401e84-0_1-4-8_20210330094435.parquet

12.3.2 Write

12.3.2.1 Before You Start

Currently, Spark and Flink can be used as write engines for Hudi. The capability of Flink of the current version is weak and not recommended. It will be enhanced in later versions.

12.3.2.2 Batch Write

Scenario

Hudi provides multiple write modes. For details, see the configuration item **hoodie.datasource.write.operation**. This section describes **upsert**, **insert**, and **bulk_insert**.

- **insert**: The operation process is similar to **upsert**. The query on updated file partitions is not based on indexes. Therefore, **insert** is faster than **upsert**. This operation is recommended for data sources that do not contain updated data. If the data source contains updated data, duplicate data will exist in the data lake.
- **bulk_insert** (insert in batches): It is used for initial dataset loading. This operation sorts primary keys and then inserts data into a Hudi table by writing data to a common Parquet table. It has the best performance but cannot control small files. The **upsert** and **insert** operations can control small files by using heuristics.
- **upsert** (insert and update): It is the default operation type. Hudi determines whether historical data exists based on the primary key. Historical data is updated, and other data is inserted. This operation is recommended for data sources, such as change data capture (CDC), that include updated data.

NOTE

- Primary keys are not sorted during **insert**. Therefore, you are not advised to use **insert** during dataset initialization.
- You are advised to use **insert** if data is new, use **upsert** if data needs to be updated, and use **bulk_insert** if datasets need to be initialized.

Writing Data to Hudi Tables In Batches

1. Import the Hudi package to generate test data. For details, see **Step 1** to **Step 3** in **Getting Started**.
2. Add the **option("hoodie.datasource.write.operation", "bulk_insert")** parameter to the command for writing data to a Hudi table to set the write mode to bulk_insert. For example:

```
df.write.format("org.apache.hudi").
options(getQuickstartWriteConfigs).
option("hoodie.datasource.write.precombine.field", "ts").
option("hoodie.datasource.write.recordkey.field", "uuid").
option("hoodie.datasource.write.partitionpath.field", "").
option("hoodie.datasource.write.operation", "bulk_insert").
option("hoodie.table.name", tableName).
option("hoodie.datasource.write.keygenerator.class",
"org.apache.hudi.keygen.NonpartitionedKeyGenerator").
```

```
option("hoodie.datasource.hive_sync.enable", "true").
option("hoodie.datasource.hive_sync.partition_fields", "").
option("hoodie.datasource.hive_sync.partition_extractor_class",
"org.apache.hudi.hive.NonPartitionedExtractor").
option("hoodie.datasource.hive_sync.table", tableName).
option("hoodie.datasource.hive_sync.use_jdbc", "false").
option("hoodie.bulkinsert.shuffle.parallelism", 4).
mode(Overwrite).
save(basePath)
```

NOTE

- For details about the parameters in the example, see **Table 12-1**.
- If the Spark DataSource API is used to update the MOR table, small files of the updated data may be merged when a small volume of data is inserted. As a result, some updated data can be found in the read-optimized view of the MOR table.
- If the base file of the data to be updated is a small file, the data to be inserted and new data for update are merged with the base file to generate a new base file instead of being written to logs.

Configuring Partitions

Hudi supports multiple partitioning modes, such as multi-level partitioning, non-partitioning, single-level partitioning, and partitioning by date. You can select a proper partitioning mode as required. The following describes how to configure different partitioning modes for Hudi.

- Multi-level partitioning

  Multi-level partitioning indicates that multiple fields are specified as partition keys. Pay attention to the following configuration items:

Configuration Item	Description
hoodie.datasource.write.partitionpath.field	Configure multiple partition fields, for example, **p1**, **p2**, and **p3**.
hoodie.datasource.hive_sync.partition_fields	Set this parameter to **p1**, **p2**, and **p3**. The values must be the same as the partition fields of **hoodie.datasource.write.partitionpath.field**.
hoodie.datasource.write.keygenerator.class	Set this parameter to **org.apache.hudi.keygen.ComplexKeyGenerator**.
hoodie.datasource.hive_sync.partition_extractor_class	Set this parameter to **org.apache.hudi.hive.MultiPartKeysValueExtractor**.

- Non-partitioning

  Hudi supports non-partitioned tables. Pay attention to the following configuration items:

Configuration Item	Description
hoodie.datasource.write.partitionpath.field	Leave this parameter blank.
hoodie.datasource.hive_sync.partition_fields	Leave this parameter blank.
hoodie.datasource.write.keygenerator.class	Set this parameter to **org.apache.hudi.keygen.NonpartitionedKeyGenerator**.
hoodie.datasource.hive_sync.partition_extractor_class	Set this parameter to **org.apache.hudi.hive.NonPartitionedExtractor**.

- Single-level partitioning

  It is similar to multi-level partitioning. Pay attention to the following configuration items:

Configuration Item	Description
hoodie.datasource.write.partitionpath.field	Set this parameter to one field, for example, **p**.
hoodie.datasource.hive_sync.partition_fields	Set this parameter to **p**. The value must be the same as the partition field of **hoodie.datasource.write.partitionpath.field**
hoodie.datasource.write.keygenerator.class	(Optional) The default value is **org.apache.hudi.keygen.SimpleKeyGenerator**.
hoodie.datasource.hive_sync.partition_extractor_class	Set this parameter to **org.apache.hudi.hive.MultiPartKeysValueExtractor**.

- Partitioning by date

  The **date** field is specified as the partition field. Pay attention to the following configuration items:

Configuration Item	Description
hoodie.datasource.write.partitionpath.field	Set this parameter to the **date** field, for example, **operationTime**.
hoodie.datasource.hive_sync.partition_fields	Set this parameter to **operationTime**. The value must be the same as the preceding partition field.

Configuration Item	Description
hoodie.datasource.write.keygenerator.class	(Optional) The default value is **org.apache.hudi.keygen.SimpleKeyGenerator**.
hoodie.datasource.hive_sync.partition_extractor_class	Set this parameter to **org.apache.hudi.hive.SlashEncodedDayPartitionValueExtractor**.

NOTE

Date format for **SlashEncodedDayPartitionValueExtractor** must be *yyyy/mm/dd*.

- Partition sorting

Configuration Item	Description
hoodie.bulkinsert.user.defined.partitioner.class	Specifies the partition sorting class. You can customize a sorting method. For details, see the sample code.

NOTE

By default, **bulk_insert** sorts data by character and applies only to primary keys of StringType.

12.3.2.3 Stream Write

Stream Write Using HoodieDeltaStreamer

The HoodieDeltaStreamer tool provided by Hudi supports stream write. You can also use SparkStreaming to write data in microbatch mode. HoodieDeltaStreamer provides the following functions:

- Supports multiple data sources, such as Kafka and DFS.
- Manages checkpoints, rollback, and recovery to ensure exactly-once semantics.
- Supports user-defined transformations.

Example:

Prepare the configuration file **kafka-source.properties**.

```
#Hudi configuration
hoodie.datasource.write.recordkey.field=id
hoodie.datasource.write.partitionpath.field=age
hoodie.upsert.shuffle.parallelism=100
#hive config
hoodie.datasource.hive_sync.table=hudimor_deltastreamer_partition
hoodie.datasource.hive_sync.partition_fields=age
hoodie.datasource.hive_sync.partition_extractor_class=org.apache.hudi.hive.MultiPartKeysValueExtractor
hoodie.datasource.hive_sync.use_jdbc=false
hoodie.datasource.hive_sync.support_timestamp=true
```

```
# Kafka Source topic
hoodie.deltastreamer.source.kafka.topic=hudimor_deltastreamer_partition
#checkpoint
hoodie.deltastreamer.checkpoint.provider.path=hdfs://hacluster/tmp/huditest/
hudimor_deltastreamer_partition
# Kafka props
# The kafka cluster we want to ingest from
bootstrap.servers= xx.xx.xx.xx:xx
auto.offset.reset=earliest
#auto.offset.reset=latest
group.id=hoodie-delta-streamer
offset.rang.limit=10000
```

Run the following commands to specify the HoodieDeltaStreamer execution parameters:

spark-submit --master yarn

--jars /opt/hudi-java-examples-1.0.jar // Specify the Hudi **jars** directory required for Spark running.

--driver-memory 1g

--executor-memory 1g --executor-cores 1 --num-executors 2 --conf spark.kryoserializer.buffer.max=128m

--driver-class-path /opt/client/Hudi/hudi/conf:/opt/client/Hudi/hudi/lib/*:/opt/client/Spark/spark/jars/*:/opt/hudi-examples-0.6.1-SNAPSHOT.jar:/opt/hudi-examples-0.6.1-SNAPSHOT-tests.jar // Specify the Hudi **jars** directory required by the Spark driver.

--class org.apache.hudi.utilities.deltastreamer.HoodieDeltaStreamer spark-internal

--props file:///opt/kafka-source.properties // Specify the configuration file. You need to set the configuration file path to the HDFS path when submitting tasks in yarn-cluster mode.

--target-base-path /tmp/huditest/hudimor1_deltastreamer_partition // Specify the path of the Hudi table.

--table-type MERGE_ON_READ // Specify the type of the Hudi table to be written.

--target-table hudimor_deltastreamer_partition // Specify the Hudi table name.

--source-ordering-field name // Specify the columns to be pre-combined in the Hudi table.

--source-class org.apache.hudi.utilities.sources.JsonKafkaSource // Set the consumed data source to **JsonKafkaSource**. Different source classes are specified based on different data sources.

--schemaprovider-class com.xxx.bigdata.hudi.examples.DataSchemaProviderExample // Specify the schema required by the Hudi table.

--transformer-class com.xxx.bigdata.hudi.examples.TransformerExample // Specify how to process the data obtained from the data source. Set this parameter based on service requirements.

--enable-hive-sync // Enable Hive synchronization to synchronize the Hudi table to Hive.

--continuous // Set the stream processing mode to **continuous**.

Stream Write Using HoodieMultiTableDeltaStreamer

HoodieDeltaStreamer allows you to capture data from multiple types of source tables and write the data to Hudi tables. However, you can only write data in one source table to one destination table. By contrast, HoodieMultiTableDeltaStreamer supports data write from multiple source tables to one or multiple destination tables.

- **The following example describes how to write data in two Kafka source tables to two Hudi tables.**

  NOTE

  Set the following parameters:

  ```
  // Specify the target table.
  hoodie.deltastreamer.ingestion.tablesToBeIngested=Directory name.target table
  //Specify all source tables to specific destination tables.
  hoodie.deltastreamer.source.sourcesBoundTo.Destination table=Directory name.Source table 1,Directory name.Source table 2
  // Specify the configuration file path of each source table.
  Hoodie.deltastreamer.Source.directory name.Source table 1.configFile=Path 1
  Hoodie.deltastreamer.source.Directory name.Source table 2.configFile=Path 2
  // Specify the check point of each source table. The format of the recovery point varies according to the source table type. For example, the recovery point format of Kafka source is "Topic name,Partition name:offset".
  hoodie.deltastreamer.current.source.checkpoint=Topic name,Partition name:offset
  // Specify the associated table (Hudi table) of each source table. If there are multiple associated tables, separate them with commas (,).
  hoodie.deltastreamer.source.associated.tables=hdfs://hacluster/....., hdfs://hacluster/.....
  // Specify the transform operation before the data in each source table is written to Hudi. Note that the columns to be written must be listed. Do not use select *.
  // <SRC> indicates the current source table and cannot be changed.
  hoodie.deltastreamer.transformer.sql=select field1,field2,field3,... from <SRC>
  ```

  Spark submission command:

  ```
  spark-submit \
  --master yarn \
  --driver-memory 1g \
  --executor-memory 1g \
  --executor-cores 1 \
  --num-executors 5 \
  --conf spark.driver.extraClassPath=/opt/client/Hudi/hudi/conf:/opt/client/Hudi/hudi/lib/*:/opt/client/Spark/spark/jars/* \
  --class org.apache.hudi.utilities.deltastreamer.HoodieMultiTableDeltaStreamer /opt/client/Hudi/hudi/lib/hudi-utilities_2.12-0.7.0.jar \
  --props file:///opt/hudi/testconf/sourceCommon.properties \
  --config-folder file:///opt/hudi/testconf/ \
  --source-class org.apache.hudi.utilities.sources.JsonKafkaSource \
  --schemaprovider-class org.apache.hudi.examples.common.HoodieMultiTableDeltaStreamerSchemaProvider \
  --transformer-class org.apache.hudi.utilities.transform.SqlQueryBasedTransformer \
  --source-ordering-field col6 \
  --base-path-prefix hdfs://hacluster/tmp/ \
  --table-type COPY_ON_WRITE \
  --target-table KafkaToHudi \
  --enable-hive-sync \
  --allow-fetch-from-multiple-sources \
  --allow-continuous-when-multiple-sources
  ```

NOTE

1. When the **source** type is **kafka source**, the schema provider class specified by **--schemaprovider-class** needs to be developed by users.
2. **--allow-fetch-from-multiple-sources** indicates that multi-source table writing is enabled.
3. **--allow-continuous-when-multiple-sources** indicates that multi-source table continuous write is enabled. If this parameter is not set, the task ends after all source tables are written once.

sourceCommon.properties:

```
hoodie.deltastreamer.ingestion.tablesToBeIngested=testdb.KafkaToHudi
hoodie.deltastreamer.source.sourcesBoundTo.KafkaToHudi=source1,source2
hoodie.deltastreamer.source.default.source1.configFile=file:///opt/hudi/testconf/source1.properties
hoodie.deltastreamer.source.default.source2.configFile=file:///opt/hudi/testconf/source2.properties

hoodie.datasource.write.keygenerator.class=org.apache.hudi.keygen.SimpleKeyGenerator
hoodie.datasource.write.partitionpath.field=col0
hoodie.datasource.write.recordkey.field=primary_key
hoodie.datasource.write.precombine.field=col6

hoodie.datasource.hive_sync.table=kafkatohudisync
hoodie.datasource.hive_sync.partition_fields=col0
hoodie.datasource.hive_sync.partition_extractor_class=org.apache.hudi.hive.MultiPartKeysValueExtracto
r

bootstrap.servers=192.168.34.221:21005,192.168.34.136:21005,192.168.34.175:21005
auto.offset.reset=latest
group.id=hoodie-test
```

source1.properties:

```
hoodie.deltastreamer.current.source.name=source1 // Specify the name of a Kafka source table.
hoodie.deltastreamer.source.kafka.topic=s1
hoodie.deltastreamer.current.source.checkpoint=s1,0:0,1:0 // Checkpoint of the source table when the task is started. The deltastreamer tasks resume from offset 0 of partition 0 and offset 0 of partition 1.
// Specify the Hudi table to be combined with the source1 table. If the Hudi table has been synchronized to Hive, skip this step and use the table name in the SQL statement.
hoodie.deltastreamer.source.associated.tables=hdfs://hacluster/tmp/huditest/tb_test_cow_par
// <SRC> indicates the current source table, that is, source1. The value is fixed.
hoodie.deltastreamer.transformer.sql=select A.primary_key, A.col0, B.col1, B.col2, A.col3, A.col4, B.col5, B.col6, B.col7 from <SRC> as A join tb_test_cow_par as B on A.primary_key = B.primary_key
```

source2.properties

```
hoodie.deltastreamer.current.source.name=source2
hoodie.deltastreamer.source.kafka.topic=s2
hoodie.deltastreamer.current.source.checkpoint=s2,0:0,1:0
hoodie.deltastreamer.source.associated.tables=hdfs://hacluster/tmp/huditest/tb_test_cow_par
hoodie.deltastreamer.transformer.sql=select A.primary_key, A.col0, B.col1, B.col2, A.col3, A.col4, B.col5, B.col6, B.col7 from <SRC> as A join tb_test_cow_par as B on A.primary_key = B.primary_key
```

- **The following example describes how to write data in two Hudi tables to one Hudi table**

  Spark submission command:

```
spark-submit \
--master yarn \
--driver-memory 1g \
--executor-memory 1g \
--executor-cores 1 \
--num-executors 2 \
--conf spark.driver.extraClassPath=/opt/client/Hudi/hudi/conf:/opt/client/Hudi/hudi/lib/*:/opt/client/Spark/spark/jars/* \
--class org.apache.hudi.utilities.deltastreamer.HoodieMultiTableDeltaStreamer /opt/client/Hudi/hudi/lib/hudi-utilities_2.12-0.7.0.jar \
--props file:///opt/testconf/sourceCommon.properties \
--config-folder file:///opt/testconf/ \
--source-class org.apache.hudi.utilities.sources.HoodieIncrSource \ // Specify that the source table is a
```

```
Hudi table, which can only be COW.
--payload-class org.apache.hudi.common.model.OverwriteNonDefaultsWithLatestAvroPayload \ // Specify a payload, which determines how the original value is changed to a new value.
--transformer-class org.apache.hudi.utilities.transform.SqlQueryBasedTransformer \ // Specify a transformer class. If the schema of the source table is different from that of the target table, the source table data can be written to the target table only after being transformed.
--source-ordering-field col6 \
--base-path-prefix hdfs://hacluster/tmp/ \ // Path for saving the destination tables
--table-type MERGE_ON_READ \ // Type of the destination table, which can be COW or MOR.
--target-table tb_test_mor_par_300 \ // Specify the name of the target table. When you write data in multiple source tables to a target table, the name of the target table must be specified.
--checkpoint 000 \ // Specify a checkpoint (commit timestamp), which indicates that Delta Streamer is restored from this checkpoint. 000 indicates that Delta Streamer is restored from the beginning.
--enable-hive-sync \
--allow-fetch-from-multiple-sources \
--allow-continuous-when-multiple-sources \
--op UPSERT // Specify the write type.
```

NOTE

- If the **source** type is **HoodieIncrSourc**, **--schemaprovider-class** does not need to be specified.
- If **transformer-class** is set to **SqlQueryBasedTransformer**, you can use SQL queries to convert the data structure of the source table to that of the destination table.

file:///opt/testconf/sourceCommon.properties:

```
# Common properties of source tables
hoodie.deltastreamer.ingestion.tablesToBeIngested=testdb.tb_test_mor_par_300 // Specify a target table (common property) to which multiple source tables are written.
hoodie.deltastreamer.source.sourcesBoundTo.tb_test_mor_par_300=testdb.tb_test_mor_par_100,testdb.tb_test_mor_par_200 //Specify multiple source tables.
hoodie.deltastreamer.source.testdb.tb_test_mor_par_100.configFile=file:///opt/testconf/tb_test_mor_par_100.properties // Property file path of the source table tb_test_mor_par_100
hoodie.deltastreamer.source.testdb.tb_test_mor_par_200.configFile=file:///opt/testconf/tb_test_mor_par_200.properties //Property file path of the source table tb_test_mor_par_200

# Hudi write configurations shared by all source tables. The independent configurations of a source table need to be written to its property file.
hoodie.datasource.write.keygenerator.class=org.apache.hudi.keygen.SimpleKeyGenerator
hoodie.datasource.write.partitionpath.field=col0
hoodie.datasource.write.recordkey.field=primary_key
hoodie.datasource.write.precombine.field=col6
```

file:///opt/testconf/tb_test_mor_par_100.properties

```
# Configurations of the source table tb_test_mor_par_100
hoodie.deltastreamer.source.hoodieincr.path=hdfs://hacluster/tmp/testdb/tb_test_mor_par_100 // Path of the source table
hoodie.deltastreamer.source.hoodieincr.partition.fields=col0 // Partitioning key of the source table
hoodie.deltastreamer.source.hoodieincr.read_latest_on_missing_ckpt=false
hoodie.deltastreamer.source.associated.tables=hdfs://hacluster/tmp/testdb/tb_test_mor_par_400 // Specify the table to be associated with the source table.
hoodie.deltastreamer.transformer.sql=select A.primary_key, A.col0, B.col1, B.col2, A.col3, A.col4, B.col5, A.col6, B.col7 from <SRC> as A join tb_test_mor_par_400 as B on A.primary_key = B.primary_key //This configuration takes effect only when transformer-class is set to SqlQueryBasedTransformer.
```

file:///opt/testconf/tb_test_mor_par_200.properties

```
# Configurations of the source table tb_test_mor_par_200
hoodie.deltastreamer.source.hoodieincr.path=hdfs://hacluster/tmp/testdb/tb_test_mor_par_200
hoodie.deltastreamer.source.hoodieincr.partition.fields=col0
hoodie.deltastreamer.source.hoodieincr.read_latest_on_missing_ckpt=false
hoodie.deltastreamer.source.associated.tables=hdfs://hacluster/tmp/testdb/tb_test_mor_par_400
hoodie.deltastreamer.transformer.sql=select A.primary_key, A.col0, B.col1, B.col2, A.col3, A.col4, B.col5, A.col6, B.col7 from <SRC> as A join tb_test_mor_par_400 as B on A.primary_key = B.primary_key // Convert the data structure of the source table to that of the destination table. If the source table needs to be associated with Hive, you can use the table name in the SQL query for association. If the source table needs to be associated with a Hudi table, you need to specify the path of the Hudi table first and then use the table name in the SQL query for association.
```

12.3.2.4 Synchronizing Hudi Table Data to Hive

You can run **run_hive_sync_tool.sh** to synchronize data in the Hudi table to Hive.

For example, run the following command to synchronize the Hudi table in the **hdfs://hacluster/tmp/huditest/hudimor1_deltastreamer_partition** directory on HDFS to the Hive table **table hive_sync_test3** with **unite**, **country**, and **state** as partition keys:

run_hive_sync_tool.sh --partitioned-by unite,country,state --base-path hdfs://hacluster/tmp/huditest/hudimor1_deltastreamer_partition --table hive_sync_test3 --partition-value-extractor org.apache.hudi.hive.MultiPartKeysValueExtractor --support-timestamp

Table 12-8 Parameter description

Command	Description	Mandatory or Not (Yes or No)	Default Value
--database	Specifies the Hive database name.	No	default
--table	Specifies the Hive table name.	Yes	-
--base-file-format	Specifies the file format (**PARQUET** or **HFILE**).	No	PARQUET
--user	Specifies the Hive username.	No	-
--pass	Specifies the Hive password.	No	-
--jdbc-url	Specifies the Hive JDBC connection URL.	No	-
--base-path	Specifies the storage path of the Hudi table to be synchronized.	Yes	-
--partitioned-by	Specifies the partition key.	No	-
--partition-value-extractor	Specifies the partition class. PartitionValueExtractor needs to be implemented. The partition value can be extracted from the HDFS path.	No	SlashEncodedDayPartitionValueExtractor

Command	Description	Mandatory or Not (Yes or No)	Default Value
--assume-date-partitioning	Creates partitions in yyyy/mm/dd format to support backward compatibility.	No	false
--use-pre-apache-input-format	Use InputFormat in the **com.uber.hoodie** package to replace the one in the **org.apache.hudi** package. Do not use this command except for migrating projects from **com.uber.hoodie** to **org.apache.hudi**.	No	false
--use-jdbc	Uses Hive JDBC connection.	No	true
--auto-create-database	Specifies whether to automatically create a Hive database.	No	true
--skip-ro-suffix	Specifies whether to skip the read-optimized view with the **_ro** suffix during registration.	No	false
--use-file-listing-from-metadata	Specifies whether to obtain the file list from the Hudi metadata.	No	false
--verify-metadata-file-listing	Specifies whether to verify the file list in the Hudi metadata based on the file system.	No	false
--help/-h	Specifies whether to display help information.	No	false
--support-timestamp	Specifies whether to convert **TIMESTAMP_MICROS** of INT64 to Hive timestamp.	No	false
--decode-partition	Specifies whether to decode the partition value if the partition is encoded during the write process.	No	false

Command	Description	Mandatory or Not (Yes or No)	Default Value
--batch-sync-num	Specifies the number of Hive partitions to be synchronized in each batch.	No	1000

NOTE

During Hive synchronization, if the table does not exist, an external table is created and partitions are added. If the table exists, check whether table schemas are different. If they are different, replace the table. Check whether new partitions exist. If new partitions exist, partitions are added accordingly.

Therefore, there are the following restrictions when Hive synchronization is used:

- Fields can only be added to the schema and cannot be modified or deleted.
- Partition directories can only be added but cannot be deleted.
- **Overwrite** can only overwrite the Hudi table. The Hive table cannot be overwritten synchronously.
- Do not use the timestamp type as the partition column when synchronizing a Hudi table to Hive.

12.3.3 Read

12.3.3.1 Overview

Read operations on Hudi tables are based on three types of views. You can select a proper view for query as required.

Hudi supports multiple query engines, including Spark and Hive. For details, see **Table 12-9** and **Table 12-10**.

Table 12-9 COW tables

Query Engine	Real-time View/Read-optimized View	Incremental View
Hive	Y	Y
Spark (SparkSQL)	Y	Y
Spark (SparkDataSource API)	Y	Y

Table 12-10 MOR tables

Query Engine	Real-time View	Incremental View	Read-optimized View
Hive	Y	Y	Y
Spark (SparkSQL)	Y	Y	Y
Spark (SparkDataSource API)	Y	Y	Y

CAUTION

- Currently, the partition deduction capability is not supported when Hudi uses the Spark DataSource API to read data. For example, when the DataSource API is used to query a bootstrap table, the partition field may not be displayed or may be displayed as null.
- For an incremental view, set **hoodie.hudicow.consume.mode** to **INCREMENTAL**. This parameter applies only to queries on the incremental view and cannot be used for queries on other types of Hudi tables or queries on other tables. You can set **hoodie.hudicow.consume.mode** to **SNAPSHOT** or any value to restore the configuration.

12.3.3.2 Reading COW Table Views

- Reading the real-time view (using Hive and SparkSQL as an example): Directly read the Hudi table stored in Hive.

```
select count(*) from test;
```

- Reading the real-time view (using the Spark DataSource API as an example): This is similar to reading a common DataSource table.

  QUERY_TYPE_OPT_KEY must be set to **QUERY_TYPE_SNAPSHOT_OPT_VAL**.

```
spark.read.format("hudi")
.option(QUERY_TYPE_OPT_KEY, QUERY_TYPE_SNAPSHOT_OPT_VAL) // Set the query type to the real-time view.
.load("/tmp/default/cow_bugx/") // Specify the path of the Hudi table to read.
.createTempView("mycall")
spark.sql("select * from mycall").show(100)
```

- Reading the incremental view (using Hive as an example):

```
set hoodie.test.consume.mode=INCREMENTAL;  // Specify the incremental reading mode.
set hoodie.test.consume.max.commits=3;  // Specify the maximum number of commits to be consumed.
set hoodie.test.consume.start.timestamp=20201227153030;  // Specify the initial incremental pull commit.
select count(*) from default.test where `_hoodie_commit_time`>'20201227153030'; // Results must be filtered by start.timestamp and end.timestamp. If end.timestamp is not specified, only start.timestamp is required for filtering.
```

- Reading the incremental view (using Spark SQL as an example):

```
set hoodie.test.consume.mode=INCREMENTAL;  // Specify the incremental reading mode.
set hoodie.test.consume.start.timestamp=20201227153030;  // Specify the initial incremental pull commit.
set hoodie.test.consume.end.timestamp=20210308212318;  // Specify the end commit of the incremental pull. If this parameter is not specified, the latest commit is used.
```

```
select count(*) from test_rt where `_hoodie_commit_time`>'20201227153030' and
`_hoodie_commit_time`<='20210308212318'; // Results must be filtered by start.timestamp and
end.timestamp. If end.timestamp is not specified, only start.timestamp is required for filtering.
```

- Reading the incremental view (using the Spark DataSource API as an example):

  QUERY_TYPE_OPT_KEY must be set to **QUERY_TYPE_INCREMENTAL_OPT_VAL**.

```
spark.read.format("hudi")
.option(QUERY_TYPE_OPT_KEY, QUERY_TYPE_INCREMENTAL_OPT_VAL) // Set the query type to the
incremental mode.
.option(BEGIN_INSTANTTIME_OPT_KEY, "20210308212004")  // Specify the initial incremental pull
commit.
.option(END_INSTANTTIME_OPT_KEY, "20210308212318")  //: Specify the end commit of the
incremental pull.
.load("/tmp/default/cow_bugx/")  // Specify the path of the Hudi table to read.
.createTempView("mycall")  // Register as a Spark temporary table.
spark.sql("select * from mycall where `_hoodie_commit_time`>'20210308212004' and
`_hoodie_commit_time`<='20210308212318'").show(100, false) // Results must be filtered by
START_INSTANTTIME and END_INSTANTTIME. If END_INSTANTTIME is not specified, only
START_INSTANTTIME is required for filtering.
```

- Reading the read-optimized view: The read-optimized view of COW tables is equivalent to the real-time view.

12.3.3.3 Reading MOR Table Views

After the MOR table is synchronized to Hive, the following two tables are synchronized to Hive: *Table name*_**rt** and *Table name*_**ro**. The table suffixed with **rt** indicates the real-time view, and the table suffixed with **ro** indicates the read-optimized view. For example, the name of the Hudi table to be synchronized to Hive is **test**. After the table is synchronized to Hive, two more tables **test_rt** and **test_ro** are generated in the Hive table.

- Reading the real-time view (using Hive and SparkSQL as an example): Directly read the Hudi table with suffix **_rt** stored in Hive.

```
select count(*) from test_rt;
```

- Reading the real-time view (using the Spark DataSource API as an example): The operations are the same as those for the COW table. For details, see the operations for the COW table.
- Reading the incremental view (using Hive as an example):

```
set hive.input.format=org.apache.hudi.hadoop.hive.HoodieCombineHiveInputFormat; // This
parameter does not need to be specified for SparkSQL.
set hoodie.test.consume.mode=INCREMENTAL;
set hoodie.test.consume.max.commits=3;
set hoodie.test.consume.start.timestamp=20201227153030;
select count(*) from default.test_rt where `_hoodie_commit_time`>'20201227153030'; // Results must
be filtered by start.timestamp and end.timestamp. If end.timestamp is not specified, only
start.timestamp is required for filtering.
```

- Reading the incremental view (using Spark SQL as an example):

```
set hoodie.test.consume.mode=INCREMENTAL;
set hoodie.test.consume.start.timestamp=20201227153030;  // Specify the initial incremental pull
commit.
set hoodie.test.consume.end.timestamp=20210308212318;  // Specify the end commit of the
incremental pull. If this parameter is not specified, the latest commit is used.
select count(*) from test_rt where `_hoodie_commit_time`>'20201227153030' and
`_hoodie_commit_time`<='20210308212318'; // Results must be filtered by start.timestamp and
end.timestamp. If end.timestamp is not specified, only start.timestamp is required for filtering.
```

- Incremental view (using the Spark DataSource API as an example): The operations are the same as those for the COW table. For details, see the operations for the COW table.

- Reading the read-optimized view (using Hive and SparkSQL as an example): Directly read the Hudi table with suffix **_ro** stored in Hive.

```
select count(*) from test_ro;
```

- Reading the read-optimized view (using the Spark DataSource API as an example): This is similar to reading a common DataSource table.

  QUERY_TYPE_OPT_KEY must be set to **QUERY_TYPE_READ_OPTIMIZED_OPT_VAL**.

```
spark.read.format("hudi")
.option(QUERY_TYPE_OPT_KEY, QUERY_TYPE_READ_OPTIMIZED_OPT_VAL) // Set the query type to the read-optimized view.
.load("/tmp/default/mor_bugx/") // Specify the path of the Hudi table to read.
.createTempView("mycall")
spark.sql("select * from mycall").show(100)
```

12.3.4 Data Management and Maintenance

12.3.4.1 Clustering

Introduction to Clustering

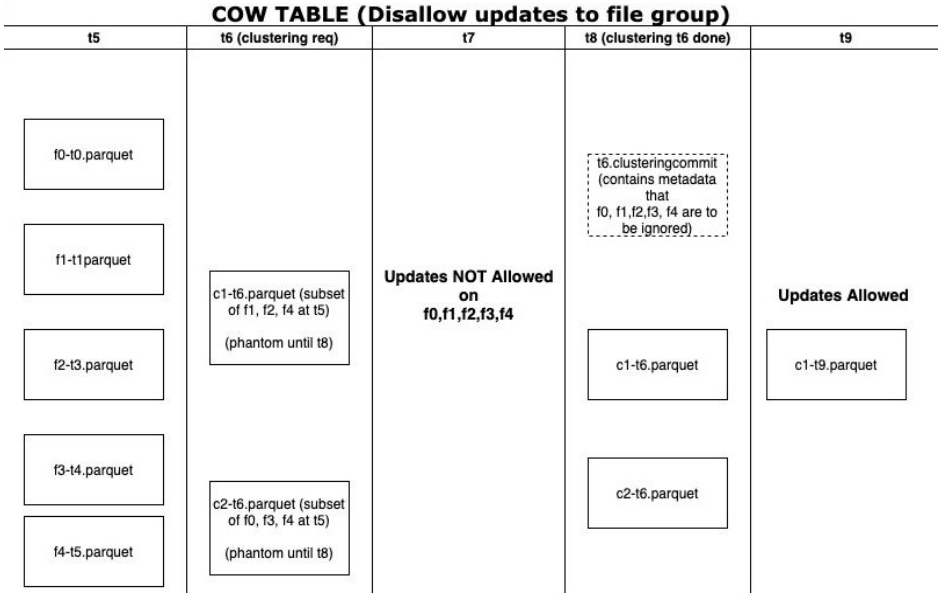
Clustering reorganizes data layout to improve query performance without affecting the ingestion speed.

Hudi provides different operations, such as **insert**, **upsert**, and **bulk_insert**, through its write client API to write data to a Hudi table. To weight between file size and speed of importing data into the data lake, Hudi provides **hoodie.parquet.small.file.limit** to configure the minimum file size. You can set it to **0** to force new data to be written to new file groups, or to a higher value to ensure that new data is "padded" to existing small file groups until it reaches the specified size, but this increases ingestion latency.

To support fast ingestion without affecting query performance, the clustering service is introduced to rewrite data to optimize the layout of Hudi data lake files.

The clustering service can run asynchronously or synchronously. It adds a new operation type called **REPLACE**, which will mark the clustering operation in the Hudi metadata timeline.

Clustering service is based on the MVCC design of Hudi to allow new data to be inserted. Clustering operations run in the background to reformat data layout, ensuring snapshot isolation between concurrent readers and writers.



Clustering is divided into two parts:

- Scheduling clustering: Create a clustering plan using a pluggable clustering strategy.
  a. Identify files that are eligible for clustering: Depending on the selected clustering strategy, the scheduling logic will identify the files eligible for clustering.
  b. Group files that are eligible for clustering based on specific criteria. The data size of each group must be a multiple of **targetFileSize**. Grouping is a part of the strategy defined in the plan. Additionally, there is an option to control group size to improve parallelism and avoid shuffling large volumes of data.
  c. Save the clustering plan to the timeline in Avro metadata format.
- Execute clustering: Process the plan using an execution strategy to create new files and replace old files.
  a. Read the clustering plan and get **clusteringGroups** that marks the file groups to be clustered.
  b. Instantiate appropriate strategy class for each group using **strategyParams** (for example, **sortColumns**) and apply the strategy to rewrite data.
  c. Create a **REPLACE** commit and update the metadata in HoodieReplaceCommitMetadata.

Using Clustering

1. Executing clustering synchronously

   Add the following configuration parameters when the data write operation is performed:

   option("hoodie.clustering.inline", "true").

   option("hoodie.clustering.inline.max.commits", "4").

   option("hoodie.clustering.plan.strategy.target.file.max.bytes", "1073741824").

option("hoodie.clustering.plan.strategy.small.file.limit", "629145600").

option("hoodie.clustering.plan.strategy.sort.columns", "column1,column2").

2. Executing clustering asynchronously

   Run the following spark-sql command to perform clustering. For details, see **CLUSTERING**.

   To execute clustering asynchronously, run the **set** command to set the following parameters:

   set hoodie.clustering.async.enabled = true;

   set hoodie.clustering.async.max.commits = 4;

3. Specifying the ordering mode and sequence of clustering

   Currently, clustering supports three sorting modes: Linear, Z-Order, and Hilbert, which can be configured in option or set mode.

   - Linear ordering: a common but default ordering mode, which applies to ordering one field or multiple low-level fields.
   - Z-order or Hilbert: multi-dimensional ordering, which is available when you set **hoodie.layout.optimize.strategy** to **z-order** or **hilbert**.

     These two ordering modes apply to sorting 2 to 4 fields, for example, multiple fields involved in a query condition.

     Hilbert has a better multi-dimensional ordering effect than Z-order but lower ordering efficiency.

For details, see **Common Hudi Parameters**.

CAUTION

1. The sorting column of clustering cannot be null. This is restricted by Spark RDD.
2. If the value of **target.file.max.bytes** is large, increase the value of **--spark-memory** to execute clustering. Otherwise, the executor memory overflow occurs.
3. Currently, the cleaning operation cannot be performed to delete junk files generated after the clustering fails.
4. After the clustering, sizes of new files may be different, causing data skew.
5. Clustering and upsert operations cannot be performed at the same time.
6. If the clustering is in the **inflight** state, the files in the file group do not support the **update** operation.
7. If there is an unfinished clustering plan, an error will be reported when the compaction scheduling plan is generated upon subsequent writing. You must execute the clustering plan in a timely manner.

12.3.4.2 Cleaning

Introduction to Cleaning

Cleaning is used to delete data of versions that are no longer required.

Hudi uses the cleaner working in the background to continuously delete unnecessary data of old versions. You can configure **hoodie.cleaner.policy** and **hoodie.cleaner.commits.retained** to use different cleaning policies and determine the number of saved commits.

Using Cleaning

You can use either of the following methods to perform cleaning:

- Synchronous cleaning is controlled by the **hoodie.clean.automatic** parameter, which is automatically enabled by default.

  Disable synchronous cleaning:

  When a data source is written, you can use **.option("hoodie.clean.automatic", "false")** to disable automatic cleaning.

  When spark-sql is written, you can use **set hoodie.clean.automatic=false;** to disable automatic cleaning.
- You can use spark-sql to perform asynchronous cleaning.

For more cleaning parameters, see **Compaction and Cleaning Configurations**.

12.3.4.3 Compaction

Introduction to Compaction

A compaction merges base and log files of MOR tables.

For MOR tables, data is stored in columnar Parquet files and row-based Avro files, updates are recorded in incremental files, and then a synchronous or asynchronous compaction is performed to generate new versions of columnar files. MOR tables can reduce data ingestion latency, so an asynchronous compaction that does not block ingestion is useful.

Using Compaction

Compaction consists of two steps:

1. Generate a compaction scheduling plan. Hudi scans partitions, select the file slices to be compacted, and writes the timeline of Hudi in the compaction plan.
2. Execute the compaction plan. Read the compaction plan and perform compaction on file slices.

Compactions can be synchronously or asynchronously performed, which is controlled by the **hoodie.compact.inline** parameter. The default value is **true**.

- In synchronous mode, a compaction scheduling plan is automatically generated and compactions are executed.
  a. Disable synchronous compactions.

     When a data source is written, run the **.option("hoodie.compact.inline", "false")** command to disable automatic compaction.

     When spark-sql is written, run the **set hoodie.compact.inline=false;** command to disable automatic compaction.

b. Only compaction scheduling is generated synchronously, but compaction is not executed.

- · A data source can be written by configuring the following option parameters:

  option("hoodie.compact.inline", "true").

  option("hoodie.schedule.compact.only.inline", "true").

  option("hoodie.run.compact.only.inline", "false").

- · spark-sql can be written by configuring the following set parameters:

  set hoodie.compact.inline=true;

  set hoodie.schedule.compact.only.inline=true;

  set hoodie.run.compact.only.inline=false;

- The asynchronous mode is implemented by spark-sql.

  To execute only the compaction scheduling plan that has been generated during asynchronous compaction without creating a new scheduling plan, run the following commands to configure set parameters:

  set hoodie.compact.inline=true;

  set hoodie.schedule.compact.only.inline=false;

  set hoodie.run.compact.only.inline=true;

  For more compaction parameters, see **Compaction and Cleaning Configurations**.

  NOTE

  To ensure the maximum efficiency of data import into the lake, you are advised to generate compaction scheduling plans synchronously and execute compaction scheduling plans asynchronously.

12.3.4.4 Savepoint

Introduction to Savepoint

Savepoints are used to save and restore custom version data.

Savepoints provided by Hudi can save different commits so that the cleanup program does not delete them. You can use the rollback function to restore them later.

Using Savepoint

Use spark-sql to manage savepoints.

Example:

- Creating a savepoint
  ```
  call create_savepoints('hudi_test1', '20220908155421949');
  ```
- Viewing all existing savepoints
  ```
  call show_savepoints(table =>'hudi_test1');
  ```
- Rolling back a savepoint
  ```
  call rollback_savepoints('hudi_test1', '20220908155421949');
  ```

NOTE

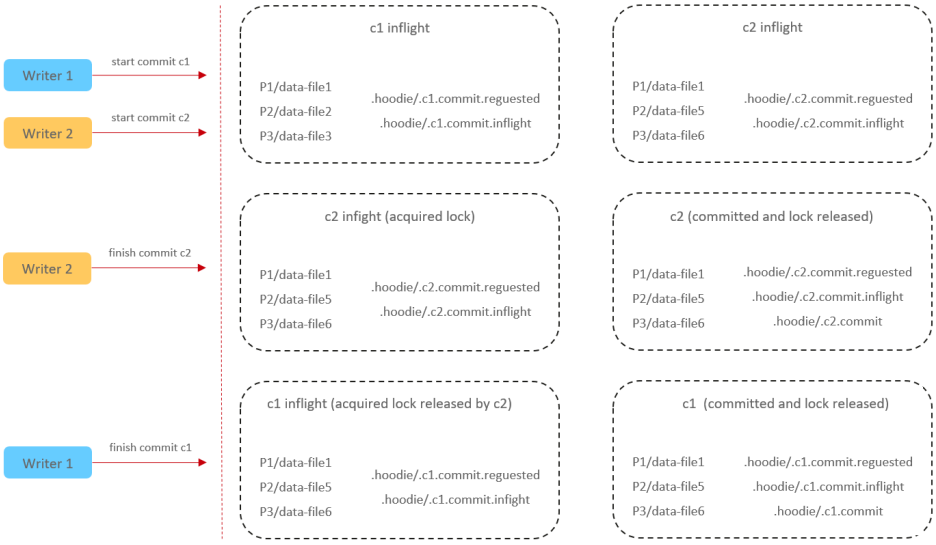
The **savepoint rollback** command is the same as the **commit rollback** commands. Both must be rolled back from the latest instant one by one.

12.3.4.5 Single-Table Concurrency Control

By default, Hudi does not support concurrent write and compaction operations on a single table. When Flink or Spark is used to write data or Spark is used to perform compaction operations, Hudi attempts to obtain the lock corresponding to the table. (ZooKeeper in the cluster provides the distributed lock service and the configuration takes effect automatically.) If the lock fails to obtain, the task exits directly to prevent table damage caused by concurrent operations of the lock task. If the concurrent write function is enabled for a single Hudi table, these functions automatically become invalid.

Hudi Single-Table Concurrent Write Solution

1. Uses an external service (ZooKeeper or Hive MetaStore) as the distributed mutex lock service.
2. Files can be concurrently written, but commits cannot be concurrent. The commit operation is encapsulated in a transaction.
3. When the commit operation is performed, the system performs conflict check. If the modified file list in the current commit operation overlaps with the file list in the commit operation after the instance time, the commit operation fails and the write operation is invalid.



Precautions

1. The current Hudi concurrency mechanism cannot ensure that the primary key of the table is unique after data is written. You need to ensure that the primary key is unique.
2. For incremental queries, data consumption and checkpoints may be out of order. As a result, multiple concurrent write operations are completed at different time points.

3. Concurrent write is supported only after this feature is enabled.

Using the Concurrency Mechanism

1. Enable the concurrent write mechanism.

   hoodie.write.concurrency.mode=optimistic_concurrency_control

   hoodie.cleaner.policy.failed.writes=LAZY

2. Sets the concurrent lock mode.

   Hive MetaStore:

   hoodie.write.lock.provider=org.apache.hudi.hive.HiveMetastoreBasedLockProvider

   hoodie.write.lock.hivemetastore.database=*<database_name>*

   hoodie.write.lock.hivemetastore.table=*<table_name>*

   ZooKeeper:

   hoodie.write.lock.provider=org.apache.hudi.client.transaction.lock.ZookeeperBasedLockProvider

   hoodie.write.lock.zookeeper.url=*<zookeeper_url>*

   hoodie.write.lock.zookeeper.port=*<zookeeper_port>*

   hoodie.write.lock.zookeeper.lock_key=*<table_name>*

   hoodie.write.lock.zookeeper.base_path=*<table_path>*

For details about more parameters, see **Common Hudi Parameters**.

CAUTION

If **cleaner policy** is set to **Lazy**, the system can only check whether the written files expire but cannot check and clear junk files generated by historical writes. That is, junk files cannot be automatically cleared in concurrent scenarios.

12.3.4.6 Partition Concurrency Control

Each task determines whether a write conflict occurs based on the modified partition information stored in the commit operation in the inflight state. In this way, concurrent write is implemented.

Lock control during concurrency is implemented based on ZooKeeper locking. You do not need to configure additional parameters.

Precautions

Concurrent write control for partitions is implemented based on concurrent write control for a single table. So, the constraints are basically the same as those for the latter.

Currently, data can be concurrently written to partitions only in Spark.

To prevent a large number of concurrent requests from occupying too many ZooKeeper resources, a quota limit function is added to Hudi on ZooKeeper. You can modify the **zk.quota.number** parameter of Spark on the server to adjust the

quota of Hudi. The default value is **500000**, and the minimum value is **5**. This parameter cannot be used to control the number of concurrent tasks. It is used only to control the access pressure on ZooKeeper.

Using Partition Concurrency

Set **hoodie.support.partition.lock** to **true** to enable concurrent partition write.

Example:

Enable concurrent partition write in Spark datasource mode:

```
upsert_data.write.format("hudi").
option("hoodie.datasource.write.table.type", "COPY_ON_WRITE").
option("hoodie.datasource.write.precombine.field", "col2").
option("hoodie.datasource.write.recordkey.field", "primary_key").
option("hoodie.datasource.write.partitionpath.field", "col0").
option("hoodie.upsert.shuffle.parallelism", 4).
option("hoodie.datasource.write.hive_style_partitioning", "true").
option("hoodie.support.partition.lock", "true").
option("hoodie.table.name", "tb_test_cow").
mode("Append").save(s"/tmp/huditest/tb_test_cow")
```

Enable concurrent partition write in Spark SQL mode:

```
set hoodie.support.partition.lock=true;
insert into hudi_table1 select 1,1,1;
```

12.3.4.7 Deleting Historical Data

Scenario

Delete old data from Hudi tables to reduce space occupation and save storage costs.

Running the delete/drop partition Statement

The **delete/drop paritition** command can be used to delete historical data. For details, see **Hudi SQL Syntax Reference**.

Advantages: The operation is simple and COW and MOR tables are supported.

Disadvantages: The concurrency is low. When Hudi tables are in the real-time write state, concurrent execution of the **delete/drop partition** command may cause the real-time data import job to fail.

Running the call clean_data Command

- Function

  The **call clean_data** is used to delete historical data from MOR tables.

  Advantages: The deletion operation can be executed concurrently with the data import task, which does not affect the real-time import of data.

  Disadvantages: Only MOR tables are supported, and lazy deletion depends on compaction.

- Syntax

  call clean_data(table => 'table_name', sql => 'delete statement')

- Parameters

  Table 12-11 Parameters

Parameter	Description
table_name	Name of the table whose data is to be deleted. The value can be in the **database.tablename** format.
delete statement	SQL statement of the select type, which is used to find the data to be deleted.

- Example

  Delete all data whose primaryKey is smaller than 100 from the **mytable** table:

  ```
  call clean_data(table => 'mytable', sql=>'select *  from mytable where primaryKey < 100')
  ```

  Clear the residual files of the clean_data command. If the clean_data command fails to execute, temporary files are generated. This command can be used to clear these temporary files.

  ```
  call clean_data(table => 'mytable', sql=>'delete cleanData')
  ```

- System response

  You can view query results on the client.

12.3.5 Using Hudi Payload

Introduction to Payload

Payload is the key for Hudi to implement incremental data update and deletion. It helps Hudi efficiently manage data changes in the data lake. The format of Hudi Payload is based on Apache Avro. It uses the Avro schema to define the data structure and type. Payloads can be serialized and deserialized so that data can be read and written in Hudi. In a word, Hudi Payload is an important part of Hudi. It provides a reliable, efficient, and scalable way to manage data changes in a large-scale data lake.

Typical Payload

- DefaultHoodieRecordPayload

  By default, DefaultHoodieRecordPayload is used in the Hudi. The payload compares the value of the **preCombineField** field in the incremental data with that in the inventory data to determine whether the inventory data with the same primary key can be updated by the incremental data with the same primary key. If the value of the **preCombineField** field in the incremental data with the same primary key is greater than that in the inventory data with the same primary key, the incremental data with the same primary key will be updated.

- OverwriteWithLatestAvroPayload

  The Payload ensures that the incremental data with the same primary key will always be updated.

- PartialUpdateAvroPayload

  This payload inherits **OverwriteNonDefaultsWithLatestAvroPayload**, which ensures that null values in incremental data do not overwrite inventory data in any scenario.

Using Payload

- Specify a Payload during Spark table creation.

```
create table hudi_test(id int, comb int, price string, name string, par string) using hudi options(
primaryKey = "id",
preCombineField = "comb",
payloadClass="org.apache.hudi.common.model.OverwriteWithLatestAvroPayload") partitioned by
(par);
```

- Specify a Payload when data is written in Datasource mode.

```
data.write.format("hudi").
option("hoodie.datasource.write.table.type", COW_TABLE_TYPE_OPT_VAL).
option("hoodie.datasource.write.precombine.field", "comb").
option("hoodie.datasource.write.recordkey.field", "id").
option("hoodie.datasource.write.partitionpath.field", "par").
option("hoodie.datasource.write.payload.class",
"org.apache.hudi.common.model.DefaultHoodieRecordPayload").
option("hoodie.datasource.write.keygenerator.class", "org.apache.hudi.keygen.SimpleKeyGenerator").
option("hoodie.datasource.write.operation", "upsert").
option("hoodie.datasource.hive_sync.enable", "true").
option("hoodie.datasource.hive_sync.partition_fields", "par").
option("hoodie.datasource.hive_sync.partition_extractor_class",
"org.apache.hudi.hive.MultiPartKeysValueExtractor").
option("hoodie.datasource.hive_sync.table", "hudi_test").
option("hoodie.datasource.hive_sync.use_jdbc", "false").
option("hoodie.upsert.shuffle.parallelism", 4).
option("hoodie.datasource.write.hive_style_partitioning", "true").
option("hoodie.table.name", "hudi_test").mode(Append).save(s"/tmp/hudi_test")
```

12.3.6 Using the Hudi Client

12.3.6.1 Operating a Hudi Table Using hudi-cli.sh

Prerequisites

- For a cluster with Kerberos authentication enabled, a user has been created on FusionInsight Manager of the cluster and associated with user groups **hadoop** and **hive**.
- The Hudi cluster client has been downloaded and installed.

Basic Operations

1. Log in to the cluster client as user **root** and run the following commands:

   cd *Client installation directory*

   source bigdata_env

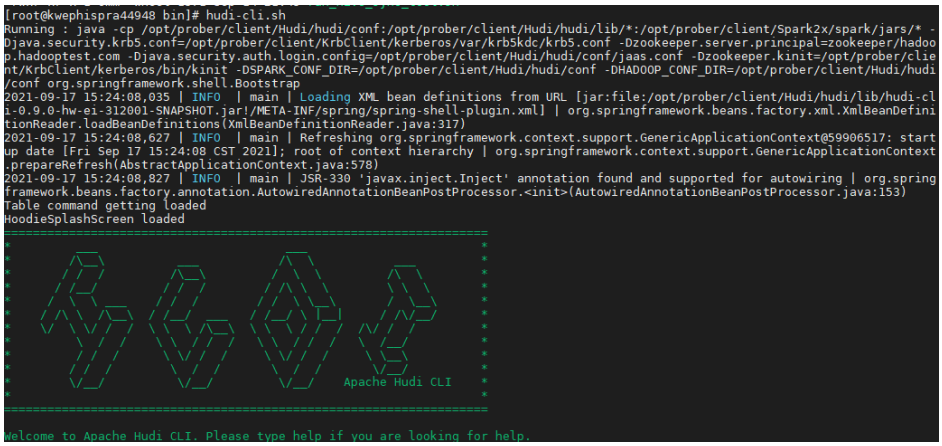
   source Hudi/component_env

   kinit *Created user*

2. Run the **hudi-cli.sh** command to access the Hudi client.

   cd *{Client installation directory}***/Hudi/hudi/bin/**

   ./hudi-cli.sh



3. Run the following example commands as required.
   - Viewing help information

     help // View all Hudi CLI commands.

     help 'command' // View the help information and parameter list of a certain command.
   - Connecting to a table

     connect --path '*/tmp/huditest/test_table*'
   - Viewing table information

     desc
   - Viewing compaction plans

     compactions show all
   - Viewing cleaning plans

     cleans show
   - Performing the cleaning operation

     cleans run
   - Viewing commit information

     commits show
   - Viewing the partition where the commit is written to

     commit showpartitions --commit *20210127153356*

     NOTE

     20210127153356 indicates the commit timestamp.
   - Viewing the file where the commit is written to

     commit showfiles --commit *20210127153356*
   - Comparing the commit information of two tables

     commits compare --path */tmp/hudimor/mytest100*
   - Rolling back a commit (Only the last commit can be rolled back.)

     commit rollback --commit *20210127164905*
   - Scheduling a compaction

     compaction schedule --*hoodieConfigs* *'hoodie.compaction.strategy=org.apache.hudi.table.action.compact.strateg*

y.BoundedIOCompactionStrategy,hoodie.compaction.target.io=1,hoodie.compact.inline.max.delta.commits=1'

- Performing a compaction

  compaction run --*parallelism 100 --sparkMemory 1g --retry 1 --compactionInstant 20210602101315 --hoodieConfigs 'hoodie.compaction.strategy=org.apache.hudi.table.action.compact.strategy.BoundedIOCompactionStrategy,hoodie.compaction.target.io=1,hoodie.compact.inline.max.delta.commits=1' --propsFilePath hdfs://hacluster/tmp/default/tb_test_mor/.hoodie/hoodie.properties --schemaFilePath /tmp/default/tb_test_mor/.hoodie/compact_tb_base.json*

- Creating a savepoint

  savepoint create --commit *20210318155750*

- Rolling back a specified savepoint

  savepoint rollback --savepoint *20210318155750*

CAUTION

1. If the commit operation causes metadata conflicts, you can run the **commit rollback** and **savepoint rollback** commands to roll back data, but the Hive metadata cannot be rolled back. In this case, you can delete the Hive table and manually synchronize data.
2. The **commit rollback** command rolls back only the latest commit, and the **savepoint rollback** command rolls back only the latest savepoint. You cannot specify a commit or savepoint to roll back.

12.4 Hudi SQL Syntax Reference

12.4.1 Constraints

Hudi supports the DDL/DML syntax of using Spark SQL, making it easier for all users (non-engineers and analysts) to access and operate Hudi.

Constraints

- You can use Spark SQL to operate Hudi on the Hudi client.
- Spark SQL operations can be performed on Hudi in JDBCServer of Spark.
- Spark SQL operations cannot be performed on Hudi on the Spark client.
- You cannot write data to Hudi tables or modify the Hudi table structure in Hive and Hetu engines. Only read operations are supported.
- The default value of **KeyGenerator** in SQL is **org.apache.hudi.keygen.ComplexKeyGenerator**. Therefore, you need to set the **KeyGenerator** value to that of SQL when data is written in DataSource mode.
- Only primary MOR tables can be modified. The MOR tables suffixed with **ro** or **rt** are used only for query.

12.4.2 DDL

12.4.2.1 CREATE TABLE

Function

This command is used to create a Hudi table by specifying the list of fields along with the table options.

Syntax

CREATE TABLE *[IF NOT EXISTS] [database_name.]table_name*

[(columnTypeList)]

USING hudi

[COMMENT table_comment]

[LOCATION location_path]

[OPTIONS (options_list)]

Parameter Description

Table 12-12 Parameters

Parameter	Description
database_name	Database name that contains letters, digits, and underscores (_).
table_name	Database table name that contains letters, digits, and underscores (_).
columnTypeList	A comma-separated list of data types and optional column default values. The column name contains letters, digits, and underscores (_).
using	Uses **hudi** to define and create a Hudi table.
table_comment	Description of the table.
location_path	HDFS path. If this parameter is set, the Hudi table will be created as an external table.
options_list	List of Hudi table options.

Table 12-13 Table options

Parameter	Description
primaryKey	Mandatory. Primary key name. Separate multiple primary key names with commas (,).
type	Type of the table. **'cow'** indicates a copy-on-write (COW) table, and **'mor'** indicates a merge-on-read (MOR) table. If this parameter is not specified, the default value is **'cow'**.
preCombineField	The **Pre-Combine** field in the table. This field is mandatory.
payloadClass	Logic that uses **preCombineField** for data filtering. **DefaultHoodieRecordPayload** is used by default. In addition, multiple preset payloads are provided, such as **OverwriteNonDefaultsWithLatestAvroPayload**, **OverwriteWithLatestAvroPayload**, and **EmptyHoodieRecordPayload**.
useCache	Whether to cache table relationships in Spark. This parameter does not need to be configured. This parameter is set to **false** by default to support the incremental view query of the COW table in Spark SQL.

Examples

- **Create a non-partitioned table.**

```
create table if not exists hudi_table0 (
id int,
name string,
price double
) using hudi
options (
type = 'cow',
primaryKey = 'id',
preCombineField = 'price'
);
```

- **Create a partitioned table.**

```
create table if not exists hudi_table_p0 (
id bigint,
name string,
ts bigint,
dt string,
hh string
) using hudi
options (
type = 'cow',
primaryKey = 'id',
preCombineField = 'ts'
)
partitioned by (dt, hh);
```

- **Create a table in a specified path.**

```
create table if not exists h3(
id bigint,
name string,
price double
) using hudi
```

```
options (
primaryKey = 'id',
preCombineField = 'price'
)
location '/path/to/hudi/h3';
```

- **Create a table and specify table attributes.**

```
create table if not exists h3(
id bigint,
name string,
price double
) using hudi
options (
primaryKey = 'id',
type = 'mor',
preCombineField = 'name',
hoodie.cleaner.fileversions.retained = '20',
hoodie.keep.max.commits = '20'
);
```

- **Create a table and specify column default values.**

```
create table if not exists h3(
id bigint,
name string,
price double default 12.34
) using hudi
options (
primaryKey = 'id',
type = 'mor',
preCombineField = 'name'
);
```

Precautions

- Currently, Hudi does not support the CHAR, VARCHAR, TINYINT, and SMALLINT data types. You are advised to use the string or INT data type.
- Currently, only the following types of data supports the configuration of default values: **int**, **bigint**, **float**, **double**, **decimal**, **string**, **date**, **timestamp**, **boolean**, and **binary**.
- You must specify **primaryKey** and **preCombineField** for Hudi tables.
- When you create a table in a specified path and there already are Hudi tables in the path, you do not need to specify columns during table creation.

System Response

The table is successfully created, and the success message is logged in the system.

12.4.2.2 CREATE TABLE AS SELECT

Function

This command is used to create a Hudi table by specifying the list of fields along with the table options.

Syntax

CREATE TABLE *[IF NOT EXISTS] [database_name.]table_name*

USING hudi

[COMMENT table_comment]

[LOCATION location_path]

[OPTIONS (options_list)]

[AS query_statement]

Parameter Description

Table 12-14 Parameters

Parameter	Description
database_name	Database name that contains letters, digits, and underscores (_).
table_name	Database table name that contains letters, digits, and underscores (_).
using	Uses **hudi** to define and create a Hudi table.
table_comment	Description of the table.
location_path	HDFS path. If this parameter is set, the Hudi table will be created as an external table.
options_list	List of Hudi table options.
query_statement	SELECT statement

Examples

- Create a partitioned table.

```
create table h2 using hudi
options (type = 'cow', primaryKey = 'id', preCombineField = 'ts')
partitioned by (dt)
as
select 1 as id, 'a1' as name, 10 as price, 1000 as dt;
```

- Create a non-partitioned table.

```
Load data from a parquet table to the Hudi table.
# Create a parquet table.
create table parquet_mngd using parquet options(path='hdfs:///tmp/parquet_dataset/*.parquet');

# Create a Hudi table by Creating a Table from Query Results (CTAS).
create table hudi_tbl using hudi location 'hdfs:///tmp/hudi/hudi_tbl/' options (
type = 'cow',
primaryKey = 'id',
preCombineField = 'ts'
)
partitioned by (datestr) as select * from parquet_mngd;
```

Precautions

For better data loading performance, CTAS uses **bulk insert** to write data.

System Response

The table is successfully created, and the success message is logged in the system.

12.4.2.3 DROP TABLE

Function

This command is used to delete an existing table.

Syntax

DROP TABLE *[IF EXISTS] [db_name.]table_name;*

Parameter Description

Table 12-15 Parameters

Parameter	Description
db_name	Database name. If this parameter is not specified, the current database is selected.
table_name	Name of the table to be deleted.

Precautions

In this command, **IF EXISTS** and **db_name** are optional.

Examples

DROP TABLE IF EXISTS hudidb.h1;

System Response

The table will be deleted.

12.4.2.4 SHOW TABLE

Function

This command is used to display all tables in current database or all tables in a specific database.

Syntax

SHOW TABLES *[IN db_name];*

Parameter Description

Table 12-16 Parameters

Parameter	Description
IN db_name	Name of the specific database whose tables need to be all displayed.

Precautions

IN db_Name is optional. It is required only when you need to display all tables of a specific database.

Examples

```
SHOW TABLES IN hudidb;
```

System Response

All tables are listed.

12.4.2.5 ALTER RENAME TABLE

Function

This command is used to rename an existing table.

Syntax

ALTER TABLE *oldTableName* **RENAME TO** *newTableName*

Parameter Description

Table 12-17 Parameters

Parameter	Description
oldTableName	Current name of the table
new_table_name	New name of the table

Examples

```
alter table h0 rename to h0_1;
```

System Response

The table name is changed. You can run the **SHOW TABLES** command to display the new table name.

12.4.2.6 ALTER ADD COLUMNS

Function

This command is used to add columns to an existing table.

Syntax

ALTER TABLE *tableIdentifier* **ADD COLUMNS***(colAndType (,colAndType)*)*

Parameter Description

Table 12-18 Parameters

Parameter	Description
tableIdentifier	Table name.
colAndType	Name of a comma-separated column with data types and optional default values. A column name consists of letters, digits, and underscores (_).

Examples

```
alter table h0_1 add columns(ext0 string);
alter table h0_1 add columns(ext1 string default 'ext1_default_value');
```

System Response

The columns are added to the table. You can run the **DESCRIBE** command to display the columns.

12.4.2.7 ALTER ALTER COLUMN

Function

This command is used to change the default values of a column.

Syntax

ALTER TABLE *tableIdentifier* **ALTER COLUMN** *colName* **SET DEFAULT** *defaultValue*

Parameter Description

Table 12-19 ADD COLUMNS parameters

Parameter	Description
tableIdentifier	Table name
colName	Column name
defaultValue	Default value of a column

Example

```
alter table h0_1 alter column extl set default 'new_default_value';
```

System Response

You can view query results on the client.

12.4.2.8 TRUNCATE TABLE

Function

This command is used to clear all data in a specific table.

Syntax

TRUNCATE TABLE *tableIdentifier*

Parameter Description

Table 12-20 Parameters

Parameter	Description
tableIdentifier	Table name.

Examples

```
truncate table h0_1;
```

System Response

Data in the table is cleared. You can run the **QUERY** statement to check whether data in the table has been deleted.

12.4.3 DML

12.4.3.1 INSERT INTO

Function

This command is used to insert the output of the **SELECT** statement to a Hudi table.

Syntax

INSERT INTO *tableIndentifier select query;*

Parameter Description

Table 12-21 Parameters

Parameter	Description
tableIndentifier	Name of the Hudi table.
select query	SELECT statement.

Precautions

- Insert mode: Hudi supports three insert modes for tables with primary keys. You can set **hoodie.sql.insert.mode** to specify the insert mode. The default value is **upsert**.
  - In strict mode, the INSERT statement retains the primary key constraint of COW tables and is not allowed to insert duplicate records. If a record already exists during data insertion, HoodieDuplicateKeyException is thrown for COW tables. For MOR tables, the behavior in this mode is the same as that in upsert mode.
  - In non-strict mode, records are inserted to primary key tables.
  - In upsert mode, duplicate values in the primary key table are updated.
- When executing a SQL statement, you can set **hoodie.sql.bulk.insert.enable** to **true** and **hoodie.sql.insert.mode** to **non-strict** to enable the bulk insert statement as the write mode of the insert statement.

  You can also set **hoodie.datasource.write.operation** to control the write mode of the insert statement, including **bulk_insert**, **insert**, and **upsert**. If you use this setting method, you must run **reset hoodie.datasource.write.operation;** to reset the Hudi write mode after executing the SQL statement. Otherwise, this parameter may affect the execution of other SQL statements.

Examples

```
insert into h0 select 1, 'a1', 20;

-- insert static partition
insert into h_p0 partition(dt = '2021-01-02') select 1, 'a1';

-- insert dynamic partition
insert into h_p0 select 1, 'a1', dt;
```

```
-- insert dynamic partition
insert into h_p1 select 1 as id, 'a1', '2021-01-03' as dt, '19' as hh;

-- insert overwrite table
insert overwrite table h0 select 1, 'a1', 20;

-- insert overwrite table with static partition
insert overwrite h_p0 partition(dt = '2021-01-02') select 1, 'a1';

-- insert overwrite table with dynamic partition
insert overwrite table h_p1 select 2 as id, 'a2', '2021-01-03' as dt, '19' as hh;
```

System Response

You can view the result in driver logs.

12.4.3.2 MERGE INTO

Function

This command is used to query another table based on the join condition of a table or subquery. If **UPDATE** or **DELETE** is executed for the table matching the join condition, and **INSERT** is executed if the join condition is not met. This command completes the synchronization requiring only one full table scan, delivering higher efficiency than **INSERT** plus **UPDATE**.

Syntax

MERGE INTO *tableIdentifier AS target_alias*

USING *(sub_query | tableIdentifier) AS source_alias*

ON *<merge_condition>*

[WHEN MATCHED [AND <condition>] THEN <matched_action>]

[WHEN MATCHED [AND <condition>] THEN <matched_action>]

[WHEN NOT MATCHED [AND <condition>] THEN <not_matched_action>]

<merge_condition> =A equal bool condition

<matched_action> =

DELETE |

*UPDATE SET * |*

UPDATE SET column1 = expression1 [, column2 = expression2 ...]

<not_matched_action> =

*INSERT * |*

INSERT (column1 [, column2 ...]) VALUES (value1 [, value2 ...])

Parameter Description

Table 12-22 Parameters

Parameter	Description
tableIdentifier	Name of the Hudi table.
target_alias	Alias of the target table.
sub_query	Subquery.
source_alias	Alias of the source table or source expression.
merge_condition	Condition for associating the source table or expression with the target table.
condition	Filtering condition. This parameter is optional.
matched_action	DELETE or UPDATE operation to be performed when conditions are met.
not_matched_action	INSERT operation to be performed when conditions are not met.

Precautions

1. The merge-on condition supports only primary key columns currently.
2. Currently, only some fields in the COW table can be updated, and the updated values must contain the pre-merged columns. All fields in the MOR table must be provided in the Update statement.

Examples

- Update some fields.

```
create table h0(id int, comb int, name string, price int) using hudi options(primaryKey = 'id',
preCombineField = 'comb');
create table s0(id int, comb int, name string, price int) using hudi options(primaryKey = 'id',
preCombineField = 'comb');
insert into h0 values(1, 1, 1, 1);
insert into s0 values(1, 1, 1, 1);
insert into s0 values(2, 2, 2, 2);
// Method 1
merge into h0 using s0
on h0.id = s0.id
when matched then update set h0.id = s0.id, h0.comb = s0.comb, price = s0.price * 2;
// Method 2
merge into h0 using s0
on h0.id = s0.id
when matched then update set id = s0.id,
name = h0.name,
comb = s0.comb + h0.comb,
price = s0.price + h0.price;
```

- Update and insert default fields.

```
create table h0(id int, comb int, name string, price int, flag boolean) using hudi options(primaryKey =
'id', preCombineField = 'comb');
create table s0(id int, comb int, name string, price int, flag boolean) using hudi options(primaryKey =
'id', preCombineField = 'comb');
insert into h0 values(1, 1, 1, 1, false);
```

```
insert into s0 values(1, 2, 1, 1, true);
insert into s0 values(2, 2, 2, 2, false);

merge into h0 as target
using (
select id, comb, name, price, flag from s0
) source
on target.id = source.id
when matched then update set *
when not matched then insert *;
```

- Update and delete data with multiple conditions.

```
create table h0(id int, comb int, name string, price int, flag boolean) using hudi options(primaryKey =
'id', preCombineField = 'comb');
create table s0(id int, comb int, name string, price int, flag boolean) using hudi options(primaryKey =
'id', preCombineField = 'comb');
insert into h0 values(1, 1, 1, 1, false);
insert into h0 values(2, 2, 1, 1, false);
insert into s0 values(1, 1, 1, 1, true);
insert into s0 values(2, 2, 2, 2, false);
insert into s0 values(3, 3, 3, 3, false);

merge into h0
using (
select id, comb, name, price, flag from s0
) source
on h0.id = source.id
when matched and flag = false then update set id = source.id, comb = h0.comb + source.comb, price =
source.price * 2
when matched and flag = true then delete
when not matched then insert *;
```

System Response

You can view the result in driver logs or on the client.

12.4.3.3 UPDATE

Function

This command is used to update the Hudi table based on the column expression and optional filtering conditions.

Syntax

UPDATE *tableIdentifier SET column = EXPRESSION(,column = EXPRESSION) [WHERE boolExpression]*

Parameter Description

Table 12-23 Parameters

Parameter	Description
tableIdentifier	Name of the Hudi table to be updated.
column	Target column to be updated.
EXPRESSION	Expression of the source table column to be updated in the target table.

Parameter	Description
boolExpression	Filtering condition expression.

Examples

```
update h0 set price = price + 20 where id = 1;
update h0 set price = price *2, name = 'a2' where id = 2;
```

System Response

You can view the result in driver logs or on the client.

12.4.3.4 DELETE

Function

This command is used to delete records from a Hudi table.

Syntax

DELETE from *tableIdentifier [WHERE boolExpression]*

Parameter Description

Table 12-24 Parameters

Parameter	Description
tableIdentifier	Name of the Hudi table to delete records.
boolExpression	Filtering conditions for deleting records.

Examples

- Example 1:
  ```
  delete from h0 where column1 = 'country';
  ```
- Example 2:
  ```
  delete from h0 where column1 IN ('country1', 'country2');
  ```
- Example 3:
  ```
  delete from h0 where column1 IN (select column11 from sourceTable2);
  ```
- Example 4:
  ```
  delete from h0 where column1 IN (select column11 from sourceTable2 where column1 = 'xxx');
  ```
- Example 5:
  ```
  delete from h0;
  ```

System Response

You can view the result in driver logs or on the client.

12.4.3.5 COMPACTION

Function

This command is used to convert row-based log files in MOR tables into column-based data files in parquet tables to accelerate record search.

Syntax

SCHEDULE COMPACTION on *tableIdentifier* |tablelocation;

SHOW COMPACTION on *tableIdentifier* |tablelocation;

RUN COMPACTION on *tableIdentifier* |tablelocation [at instant-time];

Parameter Description

Table 12-25 Parameters

Parameter	Description
tableIdentifier	Name of the Hudi table to convert log files.
tablelocation	The storage path of the Hudi table.
instant-time	Time to run the command. You can run the **show compaction** command to view the **instant-time** value.

Examples

```
schedule compaction  on h1;
show compaction on h1;
run compaction on h1 at 20210915170758;

schedule compaction  on '/tmp/hudi/h1';
run compaction on '/tmp/hudi/h1';
```

Precautions

You need to set **hoodie.payload.ordering.field** to the value of **preCombineField** when you use the Hudi CLI or API to trigger compaction for the Hudi table created by SQL.

System Response

You can view the result in driver logs or on the client.

12.4.3.6 SET/RESET

Function

This command is used to dynamically add, update, display, or reset Hudi parameters without restarting the driver.

Syntax

- Add or update a parameter value:

  SET *parameter_name=parameter_value*

  This command is used to add or update the value of **parameter_name**.
- Display a parameter value:

  SET *parameter_name*

  This command is used to display the value of **parameter_name**.
- Display session parameters:

  SET

  This command is used to display all supported session parameters.
- Display session parameters along with usage details:

  SET -v

  This command is used to display all supported session parameters and their usage details.
- Reset parameter values:

  RESET

  This command is used to reset all session parameters.

Parameter Description

Table 12-26 Parameters

Parameter	Description
parameter_name	Name of the parameter to be dynamically added, updated, or displayed.
parameter_value	New value to be set for **parameter_name**.

Precautions

The following table lists the properties to be used in the **SET** or **RESET** commands.

Table 12-27 Properties

Property	Description
hoodie.insert.shuffle.parallelism	Degree of parallelism (DOP) of Spark shuffle for writing data in insert mode.
hoodie.upsert.shuffle.parallelism	DOP of Spark shuffle for writing data in upsert mode.
hoodie.delete.shuffle.parallelism	DOP of Spark shuffle for deleting data in delete mode.

Property	Description
hoodie.sql.insert.mode	Insert mode. The value can be strict, non-strict, or upsert.
hoodie.sql.bulk.insert.enable	Whether to enable bulk insert.
spark.sql.hive.convertMetastoreParquet	Converts the parquet table into a data source table for reading. If the provider of Hudi is Hive and Spark SQL or Spark Beeline is used to read data, set this parameter to **false**.

Examples

- Add or Update command:

```
set hoodie.insert.shuffle.parallelism = 100;
set hoodie.upsert.shuffle.parallelism = 100;
set hoodie.delete.shuffle.parallelism = 100;
```

- Reset command:

```
RESET
```

System Response

- You can view the success result in driver logs.
- You can view the failure result on the UI.

12.4.3.7 ARCHIVELOG

Function

Archives instants on the Timeline based on configurations and deletes archived instants from the Timeline to reduce the operation pressure on the Timeline.

Syntax

RUN ARCHIVELOG ON tableIdentifier;

RUN ARCHIVELOG ON tablelocation;

Parameter Description

Table 12-28 Parameters

Parameter	Description
tableIdentifier	Name of the Hudi table
tablelocation	Storage path of the Hudi table

Example

```
run archivelog on h1;
run archivelog on "/tmp/hudi/h1";
```

Precautions

- Only instants that are not cleaned can be archived.
- No matter whether the compaction operation is performed, at least *x* (*x* indicates the value of **hoodie.compact.inline.max.delta.commits**) instants are retained and not archived to ensure that there are enough instants to trigger the compaction schedule.

System Response

You can view command execution results in the driver log or on the client.

12.4.3.8 CLEAN

Function

Cleans instants on the Timeline based on configurations and deletes historical version files to reduce the data storage and read/write pressure of Hudi tables.

Syntax

RUN CLEAN ON tableIdentifier;

RUN CLEAN ON tablelocation;

Parameter Description

Table 12-29 Parameters

Parameter	Description
tableIdentifier	Name of the Hudi table
tablelocation	Storage path of the Hudi table

Example

```
run clean on h1;
run clean on "/tmp/hudi/h1";
```

Precautions

Only the table owner can perform the clean operation on a table.

To modify the default cleaning parameters, run set commands to configure the parameters such as the number of commits to be retained.

System Response

You can view command execution results in the driver log or on the client.

12.4.3.9 CLEANARCHIVE

Function

Deletes the archive files of Hudi tables to reduce data storage and read/write pressure of Hudi tables.

Syntax

set hoodie.archive.file.cleaner.policy = KEEP_ARCHIVED_FILES_BY_SIZE;

set hoodie.archive.file.cleaner.size.retained = 5368709120;

run cleanarchive on *tableIdentifier*|*tablelocation*;

set hoodie.archive.file.cleaner.policy = KEEP_ARCHIVED_FILES_BY_DAYS;

set hoodie.archive.file.cleaner.days.retained = 30;

run cleanarchive on *tableIdentifier*|*tablelocation*;

Parameter Description

Table 12-30 Parameters

Parameter	Description
tableIdentifier	Name of the Hudi table
tablelocation	Storage path of the Hudi table
hoodie.archive.file.cleaner.policy	Policy for clearing archived files: Currently, only the **KEEP_ARCHIVED_FILES_BY_SIZE** and **KEEP_ARCHIVED_FILES_BY_DAYS** policies are supported. The default policy is **KEEP_ARCHIVED_FILES_BY_DAYS**. ● **KEEP_ARCHIVED_FILES_BY_SIZE**: used to configure the storage capacity that can be used by archived files. ● **KEEP_ARCHIVED_FILES_BY_DAYS**: used to delete archived files beyond a specified time point.
hoodie.archive.file.cleaner.size.retained	When the deletion policy is **KEEP_ARCHIVED_FILES_BY_SIZE**, this parameter specifies the number of bytes of archived files to be retained. The default value is **5368709120** bytes (5 GB).

Parameter	Description
hoodie.archive.file.cleaner.days.retained	When the deletion policy is **KEEP_ARCHIVED_FILES_BY_DAYS**, this parameter specifies the number of days for storing archived files. The default value is **30** days.

Precautions

Archived files are not backed up and cannot be restored after being deleted.

System Response

You can view command execution results in the driver log or on the client.

12.4.4 CALL COMMAND

12.4.4.1 CHANGE_TABLE

Function

The **CHANGE_TABLE** command can be used to modify the type and index of a table. Key parameters such as the type and index of Hudi tables cannot be modified. Therefore, this command is actually used to rewrite Hudi tables.

Syntax

```
call change_table(table => '[table_name]', hoodie.index.type => '[index_type]',
hoodie.datasource.write.table.type => '[table_type]');
```

Parameter Description

Table 12-31 Parameters

Parameter	Description
table_name	Name of the table to be modified
table_type	Type of the table to be modified
index_type	Type of the index to be modified

Precautions

If the index type to be modified has other configuration parameters, the parameters must be transferred to the SQL statement in the **key =>'value'** format.

For example, to change the index type to bucket, run the following command:

```
call change_table(table => 'hudi_table1', hoodie.index.type => 'BUCKET', hoodie.bucket.index.num.buckets
=> '3');
```

Example

call change_table(table => 'hudi_table1', hoodie.index.type => 'SIMPLE', hoodie.datasource.write.table.type => 'MERGE_ON_READ');

System Response

After the execution is complete, you can run the **desc formatted table** command to view the table properties.

12.4.4.2 CLEAN_FILE

Function

Cleans invalid data files from the Hudi table directory.

Syntax

call clean_file(table => '[table_name]', start_instant_time=>'[start_time]', end_instant_time=>'[end_time]', mode=>'[op_type]', backup_path=>'[backup_path]', parallelism => '[parallelism]');

Parameter Description

Table 12-32 Parameters

Parameter	Description
table_name	Mandatory. Name of the Hudi table from which invalid data files are to be deleted.
op_type	Optional. Command running mode. The default value is **dry_run**. Value options are **dry_run**, **repair**, **undo**, and **query**. **dry_run**: displays invalid data files to be cleaned. **repair**: displays and cleans invalid data files. **undo**: restores deleted data files. **query**: displays the backup directories that have been cleaned.
backup_path	Mandatory. Backup directory of the data files to be restored. This parameter is available only when the running mode is **undo**.

Parameter	Description
start_time	Optional. Start time for generating invalid data files. This parameter is available only when the running mode is **dry_run** or **repair**. The start time is not limited by default.
end_time	Optional. End time for generating invalid data files. This parameter is available only when the running mode is **dry_run** or **repair**. The end time is not limited by default.
parallelism	Degree of parallelism. This parameter is available only when **op_type** is set to **dry_run**, **repair**, or **undo**. The default value is **2**.

Example

```
call clean_file(table => 'h1', mode=>'repair', parallelism => 2);
call clean_file(table => 'h1', mode=>'dry_run', parallelism => 2);
call clean_file(table => 'h1', mode=>'query');
call clean_file(table => 'h1', mode=>'undo', backup_path=>'/tmp/hudi/h1/.hoodie/.cleanbackup/
hoodie_repair_backup_20220222222222', parallelism => 2);
```

Precautions

The command cleans only invalid Parquet and log files.

System Response

You can view command execution results in the driver log or on the client.

12.4.4.3 SHOW_TIME_LINE

Function

Displays the effective or archived Hudi timelines and details of a specified instant time.

Syntax

- Viewing the list of effective timelines of a table:

  call show_active_instant_list(table => '[table_name]');
- Viewing the list of effective timelines after a timestamp in a table:

  call show_active_instant_list(table => '[table_name]', instant => '[instant]');
- Viewing information about an instant that takes effect in a table:

  call show_active_instant_detail(table => '[table_name]', instant => '[instant]');

- Viewing the list of archived instant timelines in a table:

  call show_archived_instant_list(table => '[table_name]');
- Viewing the list of archived instant timelines after a timestamp in a table:

  call show_archived_instant_list(table => '[table_name]', instant => '[instant]');
- Viewing information about archived instants in a table:

  call show_archived_instant_detail(table => '[table_name], instant => '[instant]');

Parameter Description

Table 12-33 Parameters

Parameter	Description
table_name	Name of the table to be queried. The value can be in the **database.tablename** format.
instant	Instant timestamp to be queried

Example

```
call show_active_instant_detail(table => 'hudi_table1', instant => '20220913144936897'");
```

System Response

You can view query results on the client.

12.4.4.4 SHOW_HOODIE_PROPERTIES

Function

Displays the configuration in the **hoodie.properties** file of a specified Hudi table.

Syntax

call show_hoodie_properties(table => '[table_name]');

Parameter Description

Table 12-34 Parameters

Parameter	Description
table_name	Name of the table to be queried. The value can be in the **database.tablename** format.

Example

```
call show_hoodie_properties(table => "hudi_table5");
```

System Response

You can view query results on the client.

12.4.4.5 SAVE_POINT

Function

Manages savepoints of Hudi tables.

Syntax

- Creating a savepoint:

  call create_savepoints('[table_name]', '[commit_Time]', '[user]', '[comments]');
- Viewing all existing savepoints

  call show_savepoints(table =>'[table_name]');
- Rolling back a savepoint:

  call rollback_savepoints('[table_name]', '[commit_Time]');

Parameter Description

Table 12-35 Parameters

Parameter	Description	Mandatory
table_name	Name of the table to be queried. The value can be in the **database.tablename** format.	Yes
commit_Time	Specified creation or rollback timestamp	Yes
user	User who creates a savepoint	No
comments	Description of the savepoint	No

Example

```
call create_savepoints('hudi_test1', '20220908155421949');
call show_savepoints(table =>'hudi_test1');
call rollback_savepoints('hudi_test1', '20220908155421949');
```

Precautions

- MOR tables do not support savepoints.

- The commit-related files before the latest savepoint are not cleaned.
- If there are multiple savepoints, perform the rollback from the latest savepoint. The logic is as follows: roll back the latest savepoint; delete the savepoint; and roll back the next savepoint.

System Response

You can view query results on the client.

12.4.4.6 ROLL_BACK

Function

Rolls back a specified commit.

Syntax

call rollback_to_instant(table => '[table_name]', instant_time => '[instant]');

Parameter Description

Table 12-36 Parameters

Parameter	Description
table_name	Mandatory. Name of the Hudi table to be rolled back.
instant	Mandatory. Commit instant timestamp of the Hudi table to be rolled back.

Example

```
call rollback_to_instant(table => 'h1', instant_time=>'20220915113127525');
```

Precautions

Only the latest commit timestamps can be rolled back in sequence.

System Response

You can view command execution results in the driver log or on the client.

12.4.4.7 CLUSTERING

Function

Clusters Hudi tables. For details, see **Clustering**.

Syntax

- Performing clustering:

  call run_clustering(table=>'[table]', path=>'[path]', predicate=>'[predicate]', order=>'[order]');

- Viewing the clustering plan:

  call show_clustering(table=>'[table]', path=>'[path]', limit=>'[limit]');

Parameter Description

Table 12-37 Parameters

Parameter	Description	Mandatory
table	Name of the table to be queried. The value can be in the **database.tablename** format.	No
path	Path of the table to be queried	No
predicate	Predicate sentence to be defined	No
order	Sorting field for clustering	No
limit	Number of query results to display	No

Example

```
call show_clustering(table => 'hudi_table1');

call run_clustering(table => 'hudi_table1', predicate => '(ts >= 1006L and ts < 1008L) or ts >= 1009L', order => 'ts');

call run_clustering(path => '/user/hive/warehouse/hudi_test2', predicate => "dt = '2021-08-28'", order => 'id');
```

Precautions

- Either **table** or **path** must exist. Otherwise, the Hudi table to be clustered cannot be determined.
- To cluster a specified partition, refer to the format **predicate => "dt = '2021-08-28'"**.

System Response

You can view query results on the client.

12.4.4.8 Cleaning

Function

Cleans Hudi tables. For details, see **Cleaning**.

Syntax

call run_clean(table=>'[table]', clean_policy=>'[clean_policy]', retain_commits=>'[retain_commits]', hours_retained=> '[hours_retained]', file_versions_retained=> '[file_versions_retained]');

Parameter Description

Table 12-38 Parameters

Parameter	Description	Mandatory
table	Name of the table to be queried. The value can be in the **database.tablename** format.	Yes
clean_policy	Policy for deleting data files of an earlier version. The default value is **KEEP_LATEST_COMMITS**.	No
retain_commits	This parameter is available only when **clean_policy** is set to **KEEP_LATEST_COMMITS**.	No
hours_retained	This parameter is available only when **clean_policy** is set to **KEEP_LATEST_BY_HOURS**.	No
file_version_retained	This parameter is available only when **clean_policy** is set to **KEEP_LATEST_FILE_VERSIONS**.	No

Example

```
call run_clean(table => 'hudi_table1');

call run_clean(table => 'hudi_table1', retain_commits => 2);

call run_clean(table => 'hudi_table1', clean_policy => 'KEEP_LATEST_FILE_VERSIONS', file_version_retained => 1);
```

Precautions

The cleaning operation cleans data files of an earlier version in partitions only when trigger conditions are met. If trigger conditions are not met, this operation does not clean the data files even if the command is successfully executed.

System Response

You can view query results on the client.

12.4.4.9 Compaction

Function

Compacts Hudi tables. For details, see **Compaction**.

Syntax

call run_compaction(op => '[op]', table=>'[table]', path=>'[path]', timestamp=>'[timestamp]');

Parameter Description

Table 12-39 Parameters

Parameter	Description	Mandatory
op	Set this parameter to **schedule** to generate a compaction plan or to **run** to execute a generated compaction plan.	Yes
table	Name of the table to be queried. The value can be in the **database.tablename** format.	No
path	Path of the table to be queried	No
timestamp	When **op** is set to **run**, you can specify **timestamp** to execute the compaction plan corresponding to the timestamp and the compaction plan that is not executed before the timestamp.	No

Example

```
call run_compaction(table => 'hudi_table1', op => 'schedule');
call run_compaction(table => 'hudi_table1', op => 'run');
```

```
call run_compaction(table => 'hudi_table1', op => 'run', timestamp => 'xxx');
call run_compaction(path => '/user/hive/warehouse/hudi_table1', op => 'run', timestamp => 'xxx');
```

Precautions

Only MOR tables can be compacted.

System Response

You can view query results on the client.

12.4.4.10 SHOW_COMMIT_FILES

Function

Checks whether multiple files are updated in or inserted to a specified instant.

Syntax

call show_commit_files(table=>'[table]', instant_time=>'[instant_time]', limit=>'[limit]');

Parameter Description

Table 12-40 Parameters

Parameter	Description	Mandatory
table	Name of the table to be queried. The value can be in the **database.tablename** format.	Yes
instant_time	Timestamp corresponding to a commit operation	Yes
limit	Number of returned items	No

Example

```
call show_commit_files(table=>'hudi_mor', instant_time=>'20230216144548249');
call show_commit_files(table=>'hudi_mor', instant_time=>'20230216144548249', limit=>'1');
```

Returned Result

Parameter	Description
action	Action type of the commit operation corresponding to **instant_time**, such as **compaction**, **deltacommit**, and **clean**

Parameter	Description
partition_path	Partition where the file updated in or inserted to a specified instant is located
file_id	ID of the file updated in or inserted to the specified instant
previous_commit	Timestamp in the file name of the file updated in or inserted to the specified instant
total_records_updated	Number of updated records in the file
total_records_written	Number of records inserted into the file
total_bytes_written	Number of bytes of data added to the file
total_errors	Total number of errors reported during the update in or insertion to the specified instant
file_size	File size, in Bytes

System Response

You can view query results on the client.

12.4.4.11 SHOW_FS_PATH_DETAIL

Function

This command is used to view statistics about a specified FS path.

Syntax

call show_fs_path_detail(path=>'[path]', is_sub=>'[is_sub]', sort=>'[sort]');

Parameter Description

Table 12-41 Parameters

Parameter	Description	Mandatory
path	Path of the FS to be queried	Yes

Parameter	Description	Mandatory
is_sub	The default value is **false**, indicating that statistics about a specified directory is collected. The value **true** indicates that statistics about subdirectories in a specified directory is collected.	No
sort	The default value is **true**, indicating that the results are sorted based on **storage_size**. The value **false** indicates that the results are sorted based on the number of files.	No

Example

```
call show_commit_files(path=>'/user/hive/warehouse/hudi_mor/dt=2021-08-28');
call show_fs_path_detail(path=>'/user/hive/warehouse/hudi_mor/dt=2021-08-28', is_sub=>false, sort=>true);
```

Returned Result

Parameter	Description
path_num	Number of subdirectories in a specified directory
file_num	Number of files in a specified directory
storage_size	Size of the directory, in bytes
storage_size(unit)	Size of the directory, in KB
storage_path	Complete FS absolute path of the specified directory
space_consumed	Actual space occupied by the returned files/directories in the cluster, that is, the replication factor set for the cluster is considered.
quota	Name quota, which is a mandatory restriction on the number of files and directory names in the current directory tree
space_quota	Space quota, which is a mandatory restriction on the number of bytes used by files in the current directory tree

System Response

You can view query results on the client.

12.4.4.12 SHOW_LOG_FILE

Function

This command is used to view the meta and record information in log files.

Syntax

- Viewing meta information:

  call show_logfile_metadata(table => '[table]', log_file_path_pattern => '[log_file_path_pattern]', limit => '[limit]')

- Viewing record information:

  call show_logfile_records(table => '[table]', log_file_path_pattern => '[log_file_path_pattern]', merge => '[merge]', limit => '[limit]')

Parameter Description

Table 12-42 Parameters

Parameter	Description	Mandatory
table	Name of the table to be queried. The value can be in the **database.tablename** format.	Yes
log_file_path_pattern	Path of log files. Regular expression matching is supported.	No
merge	When the show_logfile_records command is executed, this parameter is used to control whether to combine records in multiple log files and return them together.	No
limit	Number of returned items	No

Example

```
call show_logfile_metadata(table => 'hudi_mor', log_file_path_pattern => 'http://hacluster/user/hive/warehouse/hudi_mor/dt=2021-08-28/.*?log.*?');
call show_logfile_records(table => 'hudi_mor', log_file_path_pattern => 'http://hacluster/user/hive/warehouse/hudi_mor/dt=2021-08-28/.*?log.*?', merge => false, limit => 1);
```

Precautions

- This command is used only for MOR tables.

System Response

You can view query results on the client.

12.4.4.13 SHOW_INVALID_PARQUET

Function

This command is used to view the damaged parquet file in the execution path.

Syntax

call show_invalid_parquet(path => 'path')

Parameter Description

Table 12-43 Parameters

Parameter	Description	Mandatory
path	Path of the FS to be queried	Yes

Example

```
call show_invalid_parquet(path => '/user/hive/warehouse/hudi_mor/dt=2021-08-28');
```

System Response

You can view query results on the client.

12.5 Setting Default Values for Hudi Columns

This feature allows you to set default values for columns when adding columns to a table and allows the system to return the default values of new columns when you query historical data.

Constraints

- If data has been rewritten before default values are set for a new column, the default values of the column cannot be returned when historical data is queried. In this case, NULL values are returned. Some or all data will be rewritten when data is imported to the database, updated, compacted, or clustered.
- The default values of a column must match the column type. If they do not match, the type will be forcibly converted. As a result, the precision of the default values is lost or the default values are NULL values.

- The default values of historical data are the same as the default values set for the column for the first time. Changing the default values of a column for multiple times does not affect the query result of historical data.
- After the default value is set, the rollback operation cannot roll back the default value.
- Currently, Spark SQL does not support the function of viewing default column values. You can run the **show create table** command on Hive beeline to view default column values.

Scope

Currently, only the **int**, **bigint**, **float**, **double**, **decimal**, **string**, **date**, **timestamp**, **boolean**, and **binary** data types are supported.

Table 12-44 Supported engines

Engine	DDL Operation Support	Write Operation Support	Read Operation Support
SparkSQL	Y	Y	Y
Spark DataSource	N	N	Y
Flink	N	N	Y
HetuEngine	N	N	Y
Hive	N	N	Y

Example

For details about the SQL syntax, see **Hudi SQL Syntax Reference**.

Example:

- Create a table and specify default values for columns.

```
create table if not exists h3(
id bigint,
name string,
price double default 12.34
) using hudi
options (
primaryKey = 'id',
type = 'mor',
preCombineField = 'name'
);
```

- Add columns and specify default values for the columns.

```
alter table h3 add columns(col1 string default 'col1_value');
alter table h3 add columns(col2 string default 'col2_value', col3 int default 1);
```

- Change default values of columns.

```
alter table h3 alter column price set default 14.56;
```

- Inset data and use column default values.

```
insert into h3(id, name) values(1, 'aaa');
insert into h3(id, name, price) select 2, 'bbb', 12.5;
```

12.6 Hudi Performance Tuning

Performance Tuning Methods

In the current version, Spark is recommended for Hudi write operations. Therefore, the tuning methods of Hudi are similar to those of Spark. For details, see **Spark Performance Tuning**.

Recommended Resource Configuration

- For MOR tables:

  The essence of MOR tables is to write incremental files, so the tuning is based on the data size (dataSize) of Hudi.

  If dataSize is only several GBs, you are advised to run Spark in single-node mode or run Spark in Yarn mode with only one container allocated.

  Parallelism (**p**) of programs for importing data to the lake: **p** = dataSize/128 MB. The number of cores allocated to programs must be the same as the value of **p**. It is recommended that the ratio of the memory size to the number of cores be greater than 1.5:1. That is, a core is configured with 1.5 GB memory. For off-heap memory, it is recommended that the ratio of the memory size to the number of cores be greater than 0.5:1.

- For COW tables:

  The principle of COW tables is to rewrite the original data. Therefore, dataSize and the number of rewritten files must be considered during tuning. Typically, more cores lead to better performance. The number of cores is directly related to the number of rewritten files. The settings of parallelism (**p**) and memory size are similar to those of MOR tables.

12.7 Common Issues About Hudi

12.7.1 Data Write

12.7.1.1 Parquet/Avro schema Is Reported When Updated Data Is Written

Question

The following error is reported when data is written:

```
org.apache.parquet.io.InvalidRecordException: Parquet/Avro schema mismatch: Avro field 'col1' not found
```

Answer

You are advised to evolve schemas in backward compatible mode while using Hudi. This error usually occurs when you delete some columns, such as **col1**, in backward incompatible mode and then update **col1** written with the old schema in the Parquet file. In this case, the Parquet file attempts to search for all the

current fields in the input record, if **col1** does not exist, the preceding exception is thrown.

To solve this problem, create an uber schema using all the schema versions evolved and use this uber schema as the target schema. You can obtain a schema from Hive MetaStore and merge it with the current schema.

12.7.1.2 UnsupportedOperationException Is Reported When Updated Data Is Written

Question

The following error is reported when data is written:

```
java.lang.UnsupportedOperationException: org.apache.parquet.avro.AvroConverters$FieldIntegerConverter
```

Answer

This error will occur again because schema evolutions are in non-backwards compatible mode. Basically, there is some update U for a record R which is already written to the Hudi dataset in the Parquet file. R contains field F which includes certain data type, that is long. U has the same field F with the int data type. Parquet FS does not support incompatible data type conversions.

For such errors, perform valid data type conversions in the data source where you collect data.

12.7.1.3 SchemaCompatabilityException Is Reported When Updated Data Is Written

Question

The following error is reported when data is written:

```
org.apache.hudi.exception.SchemaCompatabilityException: Unable to validate the rewritten record <record>
against schema <schema>at
org.apache.hudi.common.util.HoodieAvroUtils.rewrite(HoodieAvroUtils.java:215)
```

Answer

This error may occur if a schema contains some **non-nullable** field whose value is not present or is null.

You are advised to evolve schemas in backward compatible mode. Essentially, this means either you need to set each newly added field to null or to default values. In Hudi 0.5.1 and later versions, the troubleshooting is invalid if fields rely on default values.

12.7.1.4 What Should I Do If Hudi Consumes Much Space in a Temporary Folder During Upsert?

Question

Hudi consumes much space in a temporary folder during upsert.

Answer

Hudi will spill part of input data to disk if the maximum memory for merge is reached when much input data is upserted.

If the memory is sufficient, increase the memory of the Spark executor and add the **hoodie.memory.merge.fraction** option, for example, **option("hoodie.memory.merge.fraction", "0.8")**.

12.7.1.5 Hudi Fails to Write Decimal Data with Lower Precision

Question

Decimal data is initially written to a Hudi table using the **BULK_INSERT** command. Then when data is subsequently written using **UPSERT**, the following error is reported:

```
java.lang.UnsupportedOperationException: org.apache.parquet.avro.AvroConverters$FieldFixedConverter
```

Answer

Cause:

The Hudi table contains decimal data.

The initial bulk insert of data is implemented using the Spark class for writing Parquet files. However, Spark processes the decimal data with different precisions differently.

When data is written using the **UPSERT** command, Hudi uses the Avro-compliant class for writing Parquet files, which is incompatible with the Spark class.

Solutions:

When executing the **BULK_INSERT** command, set **hoodie.datasource.write.row.writer.enable** to **false** to enable Hoodie to use the Avro-compliant class for writing Parquet files.

12.7.1.6 Data in ro and rt Tables Cannot Be Synchronized to a MOR Table Recreated After Being Deleted Using Spark SQL

Question

After a MOR table is deleted using Spark SQL and then re-created, data in ro and rt tables cannot be synchronized to the MOR table in real time. The following error information is displayed:

```
WARN HiveSyncTool: Got runtime exception when hive syncing, but continuing as ignoreExceptions config is set
java.lang.IllegalArgumentException: Failed to get schema for table hudi_table2_ro does not exist
at org.apache.hudi.hive.HoodieHiveClient.getTableSchema(HoodieHiveClient.java:183)
at org.apache.hudi.hive.HiveSyncTool.syncHoodieTable(HiveSyncTool.java:286)
at org.apache.hudi.hive.HiveSyncTool.doSync(HiveSyncTool.java:213)
```

Answer

Cause:

To reduce access to Hive Metastore, a cache mechanism is added for Hudi tables. By default, data is cached for 1 hour. So, after a MOR table is deleted using Spark SQL and then recreated, data in ro and rt tables cannot be synchronized to the MOR table in real time.

Solution:

Set **hoodie.datasource.hive_sync.interval** to **0**.

```
set hoodie.datasource.hive_sync.interval=0;
```

12.7.2 Data Collection

12.7.2.1 IllegalArgumentException Is Reported When Kafka Is Used to Collect Data

Question

The error "org.apache.kafka.common.KafkaException: Failed to construct kafka consumer" is reported in the **main** thread, and the following error is reported.

```
java.lang.IllegalArgumentException: Could not find a 'KafkaClient' entry in the JAAS configuration. System property 'java.security.auth.login.config' is not set
```

Answer

This error may occur when you try to collect data from the Kafka source with SSL enabled and the installation program cannot read the **jars.conf** file and its properties.

To solve this problem, pass the required property as part of the command submitted through Spark. Example: **--files jaas.conf,failed_tables.json --conf 'spark.driver.extraJavaOptions=-Djava.security.auth.login.config=jaas.conf' --conf 'spark.executor .extraJavaOptions=-Djava.security.auth.login.config=jaas.conf'**

12.7.2.2 HoodieException Is Reported When Data Is Collected

Question

The following error is reported when data is collected:

```
com.uber.hoodie.exception.HoodieException: created_at(Part -created_at) field not found in record. Acceptable fields were :[col1, col2, col3, id, name, dob, created_at, updated_at]
```

Answer

This error usually occurs when a field marked as recordKey or partitionKey is not present in the input record. Cross verify the input record.

12.7.2.3 HoodieKeyException Is Reported When Data Is Collected

Question

Is it possible to use a nullable field that contains null records as a primary key when creating a Hudi table?

Answer

No. HoodieKeyException will be thrown.

```
Caused by: org.apache.hudi.exception.HoodieKeyException: recordKey value: "null" for field: "name" cannot be null or empty.
at org.apache.hudi.keygen.SimpleKeyGenerator.getKey(SimpleKeyGenerator.java:58)
at org.apache.hudi.HoodieSparkSqlWriter$$anonfun$1.apply(HoodieSparkSqlWriter.scala:104)
at org.apache.hudi.HoodieSparkSqlWriter$$anonfun$1.apply(HoodieSparkSqlWriter.scala:100)
```

12.7.3 Hive Synchronization

12.7.3.1 SQLException Is Reported During Hive Data Synchronization

Question

The following error is reported during Hive data synchronization:

```
Caused by: java.sql.SQLException: Error while processing statement: FAILED: Execution Error, return code 1 from org.apache.hadoop.hive.ql.exec.DDLTask. Unable to alter table. The following columns have types incompatible with the existing columns in their respective positions :
__col1,__col2
```

Answer

This error usually occurs when you try to add a new column to an existing Hive table using the **HiveSyncTool.java** class. Databases usually do not allow the modification of a column data type from a higher order to lower order or cases where the data types may conflict with the data that is already stored or will be stored in the table. To solve this problem,

set **hive.metastore.disallow.in compatible.col.type.changes** to **false**.

12.7.3.2 HoodieHiveSyncException Is Reported During Hive Data Synchronization

Question

The following error is reported during Hive data synchronization:

```
com.uber.hoodie.hive.HoodieHiveSyncException: Could not convert field Type from <type1> to <type2> for field col1
```

Answer

This error occurs because HiveSyncTool currently supports only few compatible data type conversions. The exception is thrown if any other incompatible changes are made.

Check the data type evolution for the related field and verify if it indeed can be considered as a valid data type conversion based on the Hudi code base.

12.7.3.3 SemanticException Is Reported During Hive Data Synchronization

Question

The following error is reported during Hive data synchronization:

```
org.apache.hadoop.hive.ql.parse.SemanticException: Database does not exist: test_db
```

Answer

This error typically occurs when Hive synchronization is performed on the Hudi data set but the configured **hive_sync** database does not exist.

Create the corresponding database on your Hive cluster and try again.

13 Using IoTDB

13.1 Using IoTDB from Scratch

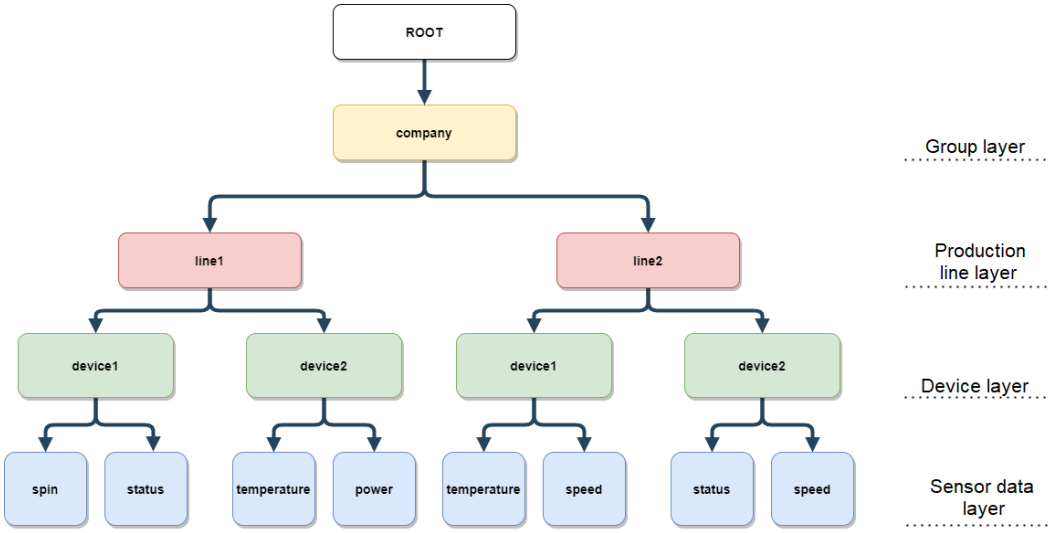
IoTDB is a data management engine that integrates collection, storage, and analysis of time series data. It features lightweight, high performance, and ease of use. It perfectly interconnects with the Hadoop and Spark ecosystems and meets the requirements of high-speed write and complex analysis and query on massive time series data in industrial IoT applications.

Background

Assume that a group has three production lines with five devices on each. Sensors collect indicators (such as temperature, speed, and running status) of these devices in real time, as shown in **Figure 13-1**. The service process of storing and managing data using IoTDB is as follows:

1. Create a database named **root.***Group name* to represent the group.
2. Create time series to store the device indicators.
3. Simulate sensors and record indicators.
4. Run SQL statements to query indicators.
5. After the service is complete, delete the stored data.

Figure 13-1 Data structure



Procedure

Step 1 Log in to the client.

1. Log in to the node where the client is installed as the client installation user and run the following command to switch to the client installation directory, for example, **/opt/client**.

   cd /opt/client

2. Run the following command to configure environment variables:

   source bigdata_env

3. If this is your first time logging in to the IoTDB client, perform the following steps to generate an SSL certificate:

   a. Run the following command to generate a client SSL certificate:

   keytool -noprompt -import -alias myservercert -file ca.crt -keystore truststore.jks

   You are required to set a password.

   b. Copy the generated **truststore.jks** file to the ***Client installation directory*/IoTDB/iotdb/conf** directory.

   cp truststore.jks *Client installation directory*/**IoTDB/iotdb/conf**

4. If Kerberos authentication is enabled for the current cluster, run the following command to authenticate the current user. The current user must have the permission to create IoTDB tables. For details, see **IoTDB Permission Management**. If Kerberos authentication is disabled for the current cluster, skip this step.

   kinit *MRS cluster user*

   Example:

   kinit iotdbuser

Step 2 Run the following command to switch to the directory where the script for running IoTDB client is stored:

cd /opt/client/IoTDB/iotdb/sbin

Step 3 If Kerberos authentication is disabled for the cluster (the cluster is in normal mode), invoke the **alter-cli-password.sh** script to change the default password of the default user **root**.

sh alter-cli-password.sh *IP address of the IoTDBServer instance RPC port number*

NOTE

- The default RPC port number of IoTDBServer is **22260**, which can be configured in the **IOTDB_SERVER_RPC_PORT** parameter.
- Obtain the default password of user **root** from the system administrator.

Step 4 Run the following command to log in to the client:

./start-cli.sh -h *IP address of the IoTDBServer instance node* **-p** *IoTDBServer RPC port*

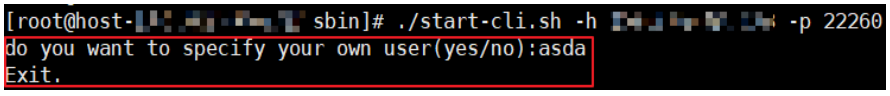
The default RPC port number of IoTDBServer is **22260**, which can be configured in the **IOTDB_SERVER_RPC_PORT** parameter.

After running this command, specify the service username as needed (user **root** is used for login when Kerberos authentication is disabled for the cluster (the cluster is in normal mode)).

- To specify the service username, enter **yes** and enter the service username and password as prompted.

- If you will not specify the service username, enter **no**. In this case, you will perform subsequent operations as the user in **Step 1.4**.

- If you enter other information, you will log out.



Step 5 Create the **root.company** database based on the **Figure 13-1** file.

create database root.company;

Step 6 Create corresponding time series for sensors of the devices on the production line.

create timeseries root.company.line1.device1.spin WITH DATATYPE=FLOAT, ENCODING=RLE;

create timeseries root.company.line1.device1.status WITH DATATYPE=BOOLEAN, ENCODING=PLAIN;

create timeseries root.company.line1.device2.temperature WITH DATATYPE=FLOAT, ENCODING=RLE;

create timeseries root.company.line1.device2.power WITH DATATYPE=FLOAT, ENCODING=RLE;

create timeseries root.company.line2.device1.temperature WITH DATATYPE=FLOAT, ENCODING=RLE;

create timeseries root.company.line2.device1.speed WITH DATATYPE=FLOAT, ENCODING=RLE;

create timeseries root.company.line2.device2.speed WITH DATATYPE=FLOAT, ENCODING=RLE;

create timeseries root.company.line2.device2.status WITH DATATYPE=BOOLEAN, ENCODING=PLAIN;

Step 7 Adds data to time series.

insert into root.company.line1.device1(timestamp, spin) values (now(), 6684.0);

insert into root.company.line1.device1(timestamp, status) values (now(), false);

insert into root.company.line1.device2(timestamp, temperature) values (now(), 66.7);

insert into root.company.line1.device2(timestamp, power) values (now(), 996.4);

insert into root.company.line2.device1(timestamp, temperature) values (now(), 2684.0);

insert into root.company.line2.device1(timestamp, speed) values (now(), 120.23);

insert into root.company.line2.device2(timestamp, speed) values (now(), 130.56);

insert into root.company.line2.device2(timestamp, status) values (now(), false);

Step 8 Query indicators of all devices on the production line 1.

select * from root.company.line1.;**

```
+-----------------------------+-----------------------------+---------------------------------
+-------------------------------------+-------------------------------+
|                         Time|root.company.line1.device1.spin|root.company.line1.device1.status|
root.company.line1.device2.temperature|root.company.line1.device2.power|
+-----------------------------+-----------------------------+---------------------------------
+-------------------------------------+-------------------------------+
|2021-06-17T11:29:08.131+08:00|                       6684.0|                             null|
null|                         null|
|2021-06-17T11:29:08.220+08:00|                         null|                            false|
null|                         null|
|2021-06-17T11:29:08.249+08:00|                         null|                             null|
66.7|                         null|
```

```
|2021-06-17T11:29:08.282+08:00|                    null|                    null|
null|                  996.4|
+-----------------------------+------------------------------+--------------------------------
+-------------------------------------+------------------------------+
```

Step 9 Delete all device indicators on the production line 2.

delete timeseries root.company.line2.;**

Query the indicator data on production line 2. The result shows no indicator data exists.

select * from root.company.line2.;**

```
+----+
|Time|
+----+
+----+
Empty set.
```

----End

13.2 Using the IoTDB Client

Scenario

This section describes how to use the IoTDB client in the O&M or service scenario.

Prerequisites

- The client has been installed. For example, the installation directory is **/opt/client**. The client directory in the following operations is only an example. Change it based on the actual installation directory onsite.
- Service component users have been created by the MRS cluster administrator. In security mode, machine-machine users need to download the keytab file. A human-machine user must change the password upon the first login.

Procedure

Step 1 Log in to the node where the client is installed as the client installation user.

Step 2 Switch to the IoTDB client installation directory, for example, **/opt/client**.

cd /opt/client

Step 3 Run the following command to configure environment variables:

source bigdata_env

Step 4 If this is your first time logging in to the IoTDB client, perform the following steps to generate an SSL certificate:

1. Run the following command to generate a client SSL certificate:

   keytool -noprompt -import -alias myservercert -file ca.crt -keystore truststore.jks

   After running this command, you are required to set a password.
2. Copy the generated **truststore.jks** file to the ***Client installation directory*/IoTDB/iotdb/conf** directory.

cp truststore.jks *Client installation directory*/**IoTDB/iotdb/conf**

Step 5 Log in to the IoTDB client based on the cluster authentication mode.

- In security mode, run the following command to authenticate the user and log in to the IoTDB client:

  kinit *Component service user*

- Skip this step in normal mode.

Step 6 Run the following command to switch to the directory where the IoTDB client running script is stored:

cd /opt/client/IoTDB/iotdb/sbin

Step 7 If Kerberos authentication is disabled for the cluster (the cluster is in normal mode), invoke the **alter-cli-password.sh** script to change the default password of the default user **root**.

sh alter-cli-password.sh *IP address of the IoTDBServer instance RPC port number*

NOTE

- The default RPC port number of IoTDBServer is **22260**, which can be configured in the **IOTDB_SERVER_RPC_PORT** parameter.
- Obtain the default password of user **root** from the system administrator.

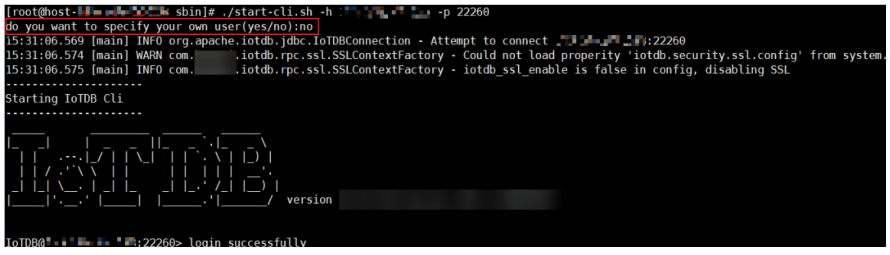
Step 8 Run the following command to log in to the client:

./start-cli.sh -h *IP address of the IoTDBServer instance node* **-p** *IoTDBServer RPC port*

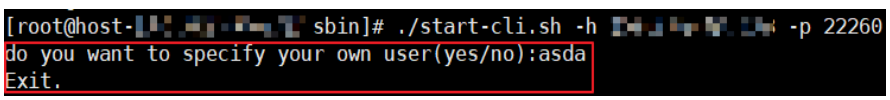
After you run this command, specify the service username as required.

- To specify the service username, enter **yes** and enter the service username and password as prompted.

- If you will not specify the service username, enter **no**. In this case, you will perform subsequent operations as the user in **Step 5**.



- If you enter other information, you will log out.



NOTE

- If Kerberos authentication is disabled for the cluster (the cluster is in normal mode), use the default user **root** to log in to the IoTDB client.
- When you log in to the client, you can configure the **-maxRPC** parameter to control the number of lines of execution results to be printed at a time. The default value is **1000**. If the value of **-maxRPC** is less than or equal to 0, all results are printed at a time. This parameter is typically used to redirect SQL execution results.
- Meanwhile, you can optionally use the **-disableISO8601** parameter to control the display format of the time column in the query result. If this parameter is not specified, the time is displayed in YYYYMMDDHHMMSS format. If this parameter is specified, the timestamp is displayed.
- If the SSL configuration is disabled on the server, you need to disable it on the client as follows:

  cd *Client installation directory*/**IoTDB/iotdb/conf**

  vi iotdb-client.env

  Change the value of **iotdb_ssl_enable** to **false**, save the configuration, and exit.

  To check the SSL configuration of the server, log in to FusionInsight Manager, choose **Cluster** > **Services** > **IoTDB** > **Configurations**, and search for **SSL_ENABLE**. Value **true** indicates that SSL is enabled, and value **false** indicates that it is disabled.

Step 9 After logging in to the client, you can run SQL statements.

----End

13.3 Configuring IoTDB Parameters

Scenario

IoTDB uses the multi-replica deployment architecture to implement cluster high availability. Each region (DataRegion and SchemaRegion) has three replicas by default. You can also configure more replicas. If a node is faulty, replicas on other nodes of the region replica can take over services from the faulty node, ensuring service continuity and improving cluster stability.

Procedure

Step 1 Log in to FusionInsight Manager and choose **Cluster** > **Services** > **IoTDB**. Click **Configurations** then **All Configurations**.

Step 2 Enter a parameter name in the search box in the upper right corner and change the parameter value. **Table 13-1** describes common IoTDB parameters.

Table 13-1 Common parameters

Parameter	Role	Default Value	Description
schema_replication_factor	ConfigNode	3	Number of SchemaRegion replicas. The default value is **3**. This parameter can be modified only when the service is installed.
data_replication_factor	ConfigNode	3	Number of DataRegion replicas. The default value is **3**. This parameter can be modified only when the service is installed.
region_data_lost_proportion	ConfigNode	0.5	Region data supplementation starts when the lost data reaches the threshold (50% by default).
region_repair_data_volume	ConfigNode	10	If the data volume in a region exceeds the threshold, the system automatically rectifies the fault. The default value is **10** GB.
dest_datanode_remaining_disk_space_proportion	ConfigNode	0.7	Percentage of the region data volume to the remaining disk space of the target DataNode when region replicas are supplemented. The default value is **70%**.
read_consistency_level	ConfigNode	strong	Read consistency level. Currently, the value can only be **strong** or **weak**. ● **strong**: strong data consistency ● **weak**: weak data consistency
flush_proportion	IoTDBServer	0.4	Write memory ratio for invoking disk flushing. If the write load is too high (for example, batch processing = 1000), you can reduce the value.
replica_affinity_policy	IoTDBServer	random	The policy for selecting a region replica node for a query task when **read_consistency_level** is set to **weak**. That is, whether a local node is selected or a node is randomly selected from the current cluster. ● **random**: a node is randomly selected from the current cluster. ● **local**: a local node is selected.

Parameter	Role	Default Value	Description
coordinator_read_executor_size	IoTDB Server	20	Sets the number of read thread cores of IoTDBServer Coordinator. Click **IoTDBServer(Role)**, select **Customization**, and add the **coordinator_read_executor_size** parameter and its value to the customized parameter **engine.customized.configs**.
rpc_thrift_compression_enable	ALL	false	Whether to enable the RPC Thrift compression function during data transmission. Data is not compressed by default. • **true**: Enable the function. • **false**: Disable the function.
root.log.level	ALL	INFO	IoTDB log level. The modification of this parameter takes effect without restarting related instances. Log levels include **DEBUG**, **INFO**, **WARN**, **ERROR**, and **OFF**.
SSL_ENABLE	ALL	true	Whether to encrypt the channel between the client and server using SSL • **true**: SSL encryption is enabled. • **false**: SSL encryption is disabled. **NOTICE** For clusters with Kerberos authentication enabled (security mode), SSL encryption is enabled by default. For clusters with Kerberos authentication disabled (normal mode), SSL encryption is disabled by default. Disabling SSL encryption is a high-risk operation. Data may be intercepted, which poses security risks. Exercise caution when performing this operation.

Step 3 Click **Save**.

Step 4 Click the **Instance** tab. Select the corresponding instance and choose **More** > **Restart Instance** to make the configuration take effect.

----End

13.4 Data Types and Encodings Supported by IoTDB

IoTDB supports the following data types and encodings. For details, see **Table 13-2**.

Table 13-2 Data types and encodings supported by IoTDB

Type	Description	Supported Encoding
BOOLEAN	Boolean	PLAIN, RLE
INT32	Integer	PLAIN, RLE, TS_2DIFF, GORILLA, FREQ, ZIGZAG
INT64	Long integer	PLAIN, RLE, TS_2DIFF, GORILLA, FREQ, ZIGZAG
FLOAT	Float	PLAIN, RLE, TS_2DIFF, GORILLA, FREQ
DOUBLE	Double	PLAIN, RLE, TS_2DIFF, GORILLA, FREQ
TEXT	String	PLAIN, DICTIONARY

13.5 IoTDB Permission Management

13.5.1 IoTDB Permissions

MRS supports users, user groups, and roles. Permissions must be assigned to roles and then roles are bound to users or user groups. Users can obtain permissions only by binding a role or joining a group that is bound with a role.

NOTE

In security mode, you need to manage IoTDB permissions and add the created user to the **iotdbgroup** user group. In normal mode, IoTDB permission management is not required.

IoTDB Permission List

The **Name** column in **Table 13-3** lists the permissions supported by open-source IoTDB. If an MRS user needs to use corresponding permissions to perform operations, grant the permissions to the user on Manager by referring to the **Required Permission** column in **Table 13-3**. For details, see **Creating an IoTDB Role**.

Table 13-3 IoTDB permissions

Name	Description	Required Permission	Example
CREATE_DATABASE	Used for creating a database, including setting permissions for the database and setting or canceling its time to live (TTL).	Create databases	Eg1: create database root.ln; Example 2: set ttl to root.ln 3600000; Example 3: unset ttl to root.ln;
CREATE_TIMESERIES	Used for creating a time series.	Create	Example 1: Creating a time series create timeseries root.ln.wf02.status with datatype=BOOLEAN,encoding=PLAIN; Example 2: Creating an aligned time series create aligned timeseries root.ln.device1(latitude FLOAT encoding=PLAIN compressor=SNAPPY, longitude FLOAT encoding=PLAIN compressor=SNAPPY);
INSERT_TIMESERIES	Used for inserting data.	Write	Example 1: insert into root.ln.wf02(timestamp,status) values(1,true); Example 2: insert into root.sg1.d1(time, s1, s2) aligned values(1, 1, 1);
ALTER_TIMESERIES	Used for modifying a time series, and adding attributes and tags.	Alter	Example 1: alter timeseries root.turbine.d1.s1 ADD TAGS tag3=v3, tag4=v4; Example 2: ALTER timeseries root.turbine.d1.s1 UPSERT ALIAS=newAlias TAGS(tag2=newV2, tag3=v3) ATTRIBUTES(attr3=v3, attr4=v4);

Name	Description	Required Permission	Example
READ_TIMESERIES	Used for querying data.	Read	Example 1: show storage group; Example 2: show child paths root.ln, show child nodes root.ln; Example 3: show devices; Example 4: show timeseries root.**; Example 5: show all ttl; Example 6: Querying data select * from root.ln.**; Example 7: Querying performance tracing tracing select * from root.**; Example 8: Querying the UDF select example(*) from root.sg.d1; Example 9: Querying statistics count devices;
DELETE_TIMESERIES	Used for deleting data or time series.	Delete	Example 1: Deleting a time series delete timeseries root.ln.wf01.wt01.status; Example 2: Deleting data delete from root.ln.wf02.wt02.status where time < 10;
DELETE_DATABASE	Used for deleting databases.	IoTDB Admin Privilege	Eg: delete database root.ln;
CREATE_FUNCTION	Used for registering a UDF.	IoTDB Admin Privilege	Example: create function example AS 'org.apache.iotdb.udf.UDTFExample';
DROP_FUNCTION	Used for dropping a UDF.	IoTDB Admin Privilege	Example: drop function example;

Name	Description	Required Permission	Example
UPDATE_TEMPLATE	Used for creating, deleting, and modifying metadata templates.	IoTDB Admin Privilege	Example 1: create schema template t1(s1 int32);
READ_TEMPLATE	Used for viewing all metadata templates and metadata template content.	IoTDB Admin Privilege	Example 1: show schema templates; Example 2: show nodes in template t1;
APPLY_TEMPLATE	Used for attaching, detaching, and activating a metadata template.	IoTDB Admin Privilege	Example 1: set schema template t1 to root.sg.d; Example 2: create timeseries of schema template on root.sg.d;
READ_TEMPLATE_APPLICATION	Used for viewing the path for attaching or activating the metadata template.	IoTDB Admin Privilege	Example 1: show paths set schema template t1; Example 2: show paths using schema template t1;
FLUSH_DATA	Used for running the flush command to write the memory data to the disk.	IoTDB administrator privilege	Example: flush

13.5.2 Creating an IoTDB Role

Create and configure an IoTDB role on Manager as an MRS cluster administrator. An IoTDB role can be configured with IoTDB administrator permissions or a common user's permissions to read, write, or delete data.

Prerequisites

- The MRS cluster administrator has understood service requirements.
- You have installed the IoTDB client.

Procedure

Step 1 On Manager, choose **System** > **Permission** > **Role**.

Step 2 On the displayed page, click **Create Role** and specify **Role Name** and **Description**.

Step 3 Configure **Configure Resource Permission**. For details, see **Table 13-4**.

IoTDB permissions:

- **Common User Privileges**: includes data operation permissions. Permissions on the IoTDB **root** directory, storage group, and any node path from a storage group to a time series can be granted selectively. The minimum permissions are read, write, modify, and delete permissions on the time series.
- **IoTDB Admin Privilege**: includes all permissions in **Table 13-3**.

Table 13-4 Configuring a role

Scenario	Role Authorization
Configuring the IoTDB administrator permission	In the **Configure Resource Permission** table, choose *Name of the desired cluster* > **IoTDB** and select **IoTDB Admin Privilege**.
Configuring the permission for users to create databases	1. In the **Configure Resource Permission** table, choose *Name of the desired cluster* > **IoTDB** > **Common User Privileges**. 2. Select **Set Database** for the **root** directory. 3. A user with this permission can create storage groups in the **root** directory.
Configuring the permission for users to create time series	1. In the **Configure Resource Permission** table, choose *Name of the desired cluster* > **IoTDB** > **Common User Privileges**. 2. Select **Create** for the **root** directory. You will have the permission to create time series in all recursive paths in the **root** directory. 3. Click **root** to go to the database page and select the **Create** permission for the corresponding database. You will have the permission to create time series in all recursive paths in the database directory.

Scenario	Role Authorization
Configuring the permission for users to modify time series	1. In the **Configure Resource Permission** table, choose *Name of the desired cluster* > **IoTDB** > **Common User Privileges**. 2. Select **Alter** for the **root** directory. You will have the permission to modify time series in all recursive paths in the **root** directory. 3. Click **root** to go to the database page and select the **Alter** permission for the corresponding database. You will have the permission to modify time series in all recursive paths of the database. 4. Click the specified storage group to go the time series page and select the **Alter** permission for the corresponding time series. You will have the permission to modify the time series.
Configuring the permission for users to insert data into time series	1. In the **Configure Resource Permission** table, choose *Name of the desired cluster* > **IoTDB** > **Common User Privileges**. 2. Select **Insert** for the **root** directory. You will have the permission to insert data into the time series in all recursive paths in the **root** directory. 3. Click **root** to go to the database page and select the **Insert** permission for the corresponding database. You will have the permission to insert data into the time series in all recursive paths of the database. 4. Click the specified database to go the time series page and select the **Insert** permission for the corresponding time series. You will have the permission to insert data into the time series.
Configuring the permission for users to read data from time series	1. In the **Configure Resource Permission** table, choose *Name of the desired cluster* > **IoTDB** > **Common User Privileges**. 2. Select **Read** for the **root** directory. You will have the permission to read data from the time series in all recursive paths in the **root** directory. 3. Click **root** to go to the database page and select the **Read** permission for the corresponding database. You will have the permission to read data from the time series in all recursive paths of the database. 4. Click the specified database to go the time series page and select the **Read** permission for the corresponding time series. You will have the permission to read data from the time series.

Scenario	Role Authorization
Configuring the permission for users to delete time series	1. In the **Configure Resource Permission** table, choose *Name of the desired cluster* > **IoTDB** > **Common User Privileges**. 2. Select **Delete** for the **root** directory. You will have the permission to delete data or time series in all recursive paths in the **root** directory. 3. Click **root** to go to the database page and select the **Delete** permission for the corresponding database. You will have the permission to delete data or time series in all recursive paths of the database. 4. Click the specified database to go the time series page and select the **Delete** permission for the corresponding time series. You will have the permission to delete data from the time series or delete the time series.

----End

13.6 IoTDB Log Overview

Description

Log Description

Log paths: The default storage paths of IoTDB logs are **/var/log/Bigdata/iotdb/confignode** and **/var/log/Bigdata/iotdb/iotdbserver** (for run logs) as well as **/var/log/Bigdata/audit/iotdb/iotdbserver** (for audit logs).

Log archive rule: The automatic compression and archiving function of IoTDB is enabled. By default, when the size of a log file exceeds 20 MB (which is adjustable), the log file is automatically compressed. The naming rule of the compressed log file is as follows: <*Original log file name*>-<*yyyymmdd*>.*ID*.**log.gz**. A maximum of 10 latest compressed files are reserved. The number of compressed files and compression threshold can be configured.

Table 13-5 IoTDB log list

Type	Name	Description
ConfigNode run log	log_confignode_all.log	ConfigNode instance all log
	log_confignode_error.log	ConfigNode instance error log
	log-measure.log	ConfigNode instance monitoring log
	log-query-debug.log	ConfigNode query debug log

Type	Name	Description
	log-query-frequency.log	ConfigNode query frequency log
	log-sync.log	ConfigNode synchronization log
	log-slow-sql.log	ConfigNode slow SQL log
	server.out	ConfigNode instance startup exception log
	postinstall.log	ConfigNode process startup log
	prestart.log	ConfigNode process startup exception log
	service-healthcheck.log	IoTDB database initialization log.
	start.log	ConfigNode instance startup log
	stop.log	ConfigNode instance stopping log
	ConfigNode-threadDump-<timestamp>.log	ConfigNode instance stack log
	ConfigNode-gc.log.0.current	ConfigNode instance GC log
IoTDBServer run log	log_datanode_all.log	IoTDBServer instance all log
	log_datanode_error.log	IoTDBServer instance error log
	log_datanode_measure.log	IoTDBServer instance monitoring log
	log_datanode_query_debug.log	IoTDBServer query debug log
	log_datanode_query_frequency.log	IoTDBServer query frequency log
	log_datanode_sync.log	IoTDBServer synchronization log
	log_datanode_slow_sql.log	IoTDBServer slow SQL log
	server.out	IoTDBServer instance startup exception log
	postinstall.log	IoTDBServer process startup log

Type	Name	Description
	prestart.log	IoTDBServer process startup exception log
	service-healthcheck.log	IoTDB database initialization log.
	start.log	IoTDBServer instance startup log
	stop.log	IoTDBServer instance stopping log
	IoTDBServer-threadDump-<timestamp>.log	IoTDBServer instance stack log
	IoTDBServer-gc.log.0.current	IoTDBServer instance GC log
ConfigNode audit log	log_audit.log	ConfigNode audit log
IoTDBServer audit log	log_audit.log	IoTDBServer audit log

Log levels

Table 13-6 describes the log levels supported by IoTDB.

Levels of logs are ERROR, WARN, INFO, and DEBUG from the highest to the lowest priority. Run logs of equal or higher levels are recorded. The higher the specified log level, the fewer the logs recorded.

Table 13-6 Log levels

Level	Description
ERROR	Logs of this level record error information about system running.
WARN	Logs of this level record exception information about the current event processing.
INFO	Logs of this level record normal running status information about the system and events.
DEBUG	Logs of this level record the system information and system debugging information.

To modify log levels, perform the following operations:

1. Go to the **All Configurations** page of the IoTDB service by referring to **Modifying Cluster Service Configuration Parameters**.
2. In the navigation tree on the left, select **Log** corresponding to the role to be modified.
3. Select a desired log level and save the configuration.

NOTE

The IoTDB log level takes effect 60 seconds after being configured. You do not need to restart the service.

Log Formats

The following table lists the IoTDB log formats:

Table 13-7 Log formats

Type	Format	Example
Run log	*<yyyy-MM-dd HH:mm:ss,SSS>* | *Log level* | [*Thread name*] | *Log information* | *Log printing class* (*File*:*Line number*)	2021-06-08 10:08:41,221 | ERROR | [main] | Client failed to open SaslClientTransport to interact with a server during session initiation: | org.apache.iotdb.rpc.sasl.TFastSaslTransport (TFastSaslTransport.java:257)
Audit log	*<yyyy-MM-dd HH:mm:ss,SSS>* | *Log level* | [*Thread name*] | *Log information* | *Log printing class* (*File*:*Line number*)	2021-06-08 11:03:49,365 | INFO | [ClusterClient-1] | Session-1 is closing | IoTDB_AUDIT_LOGGER (TSServiceImpl.java:326)

13.7 UDFs

13.7.1 UDF Overview

IoTDB provides multiple built-in functions and user-defined functions (UDFs) to meet users' computing requirements.

UDF Types

Table 13-8 lists the UDF types supported by IoTDB.

Table 13-8 UDF types

Type	Description
User-defined timeseries generating function (UDTF)	This type of function can take multiple time series as input and generate one time series, which can contain any number of data points.

UDTF

To write a UDTF, you need to inherit the **org.apache.iotdb.db.query.udf.api.UDTF** class and implement at least the **beforeStart** method and one **transform** method.

Table 13-9 describes all interfaces that can be implemented by users.

Table 13-9 Interface description

Interface Definition	Description	Mandatory
void validate(UDFParameterValidator validator) throws Exception	This method is used to validate **UDFParameters** and is executed before **beforeStart** is called.	No
void beforeStart(UDFParameters parameters, UDTFConfigurations configurations) throws Exception	This is an initialization method used to call the user-defined initialization behavior before the UDTF processes the input data. Each time a user executes a UDTF query, the framework constructs a new UDF instance, and this method is called. It is called only once in the lifecycle of each UDF instance.	Yes
void transform(Row row, PointCollector collector) throws Exception	This method is called by the framework. When you choose to use the **RowByRowAccessStrategy** strategy in **beforeStart** to consume raw data, this data processing method is called. The input data is passed in by **Row**, and the result is output by **PointCollector**. You need to call the data collection method provided by **collector** in this method to determine the output data.	Use either this method or **transform(RowWindow rowWindow, PointCollector collector)**.

Interface Definition	Description	Mandatory
void transform(RowWindow rowWindow, PointCollector collector) throws Exception	This method is called by the framework. When you choose to use the **SlidingSizeWindowAccessStrategy** or **SlidingTimeWindowAccessStrategy** strategy in **beforeStart** to consume raw data, this data processing method will be called. The input data is passed in by **RowWindow**, and the result is output by **PointCollector**. You need to call the data collection method provided by **collector** in this method to determine the output data.	Use either this method or **transform(Row row, PointCollector collector)**.
void terminate(PointCollector collector) throws Exception	This method is called by the framework. This method is called after all **transform** calls have been executed and before **beforeDestory** is called. In a single UDF query, this method will be called only once. You need to call the data collection method provided by **collector** in this method to determine the output data.	No
void beforeDestroy()	This method is called by the framework after the last input data is processed, and will be called only once in the lifecycle of each UDF instance.	No

Calling sequence of each method:

1. **void validate(UDFParameterValidator validator) throws Exception**
2. **void beforeStart(UDFParameters parameters, UDTFConfigurations configurations) throws Exception**
3. **void transform(Row row, PointCollector collector) throws Exception** or **void transform(RowWindow rowWindow, PointCollector collector) throws Exception**
4. **void terminate(PointCollector collector) throws Exception**
5. **void beforeDestroy()**

NOTICE

Each time the framework executes a UDTF query, a new UDF instance will be constructed. When the query ends, this UDF instance will be destroyed. Therefore, the internal data of the instances in different UDTF queries (even in the same SQL statement) is isolated. You can maintain some state data in the UDTF without considering the impact of concurrency and other factors.

Interface usage:

- void validate(UDFParameterValidator validator) throws Exception

  The **validate** method is used to validate the parameters entered by users.

  In this method, you can limit the number and types of input time series, check the attributes of user input, or perform any custom logic verification.

- void beforeStart(UDFParameters parameters, UDTFConfigurations configurations) throws Exception

  Using this method, you can do the following things:

  – Use **UDFParameters** to get the time series paths and parse the entered key-value pair attributes.

  – Set information required for running the UDF. That is, set the strategy to access the raw data and set the output data type in **UDTFConfigurations**.

  – Create resources, such as creating external connections and opening files.

UDFParameters

UDFParameters is used to parse the UDF parameters in SQL statements (the part in the parentheses following the UDF name in the SQL statements). The parameters include two parts. The first part is the path and its data type of the time series to be processed by the UDF. The second part is the key-value pair attributes for customization.

Example:

```
SELECT UDF(s1, s2, 'key1'='iotdb', 'key2'='123.45') FROM root.sg.d;
```

Usage:

```
void beforeStart(UDFParameters parameters, UDTFConfigurations configurations) throws Exception {
  // parameters
 for (PartialPath path : parameters.getPaths()) {
    TSDataType dataType = parameters.getDataType(path);
   // do something
  }
  String stringValue = parameters.getString("key1"); // iotdb
  Float floatValue = parameters.getFloat("key2"); // 123.45
  Double doubleValue = parameters.getDouble("key3"); // null
  int intValue = parameters.getIntOrDefault("key4", 678); // 678
  // do something

  // configurations
  // ...
}
```

UDTFConfigurations

You can use **UDTFConfigurations** to specify the strategy used by the UDF to access raw data and the type of the output time series.

Usage:

```
void beforeStart(UDFParameters parameters, UDTFConfigurations configurations) throws Exception {
  // parameters
  // ...

  // configurations
  configurations
    .setAccessStrategy(new RowByRowAccessStrategy())
```

```
    .setOutputDataType(TSDataType.INT32);
}
```

The **setAccessStrategy** method is used to set the strategy used by the UDF to access raw data. The **setOutputDataType** method is used to set the data type of the output time series.

- setAccessStrategy

  Note that the raw data access strategy you set here determines which **transform** method the framework will call. Implement the **transform** method corresponding to the raw data access strategy. You can also dynamically decide which strategy to set based on the attribute parameters parsed by **UDFParameters**. Therefore, the two **transform** methods are also allowed to be implemented in one UDF.

  The following are the strategies you can set.

Interface Definition	Description	transform Method to Call
RowByRowAccessStrategy	Processes raw data row by row. The framework calls the **transform** method once for each row of raw data input. When a UDF has only one input time series, a row of input is a data point in the input time series. When a UDF has multiple input time series, a row of input is a result record of the raw query (aligned by time) on these input time series. (In a row, there may be a column with a value of **null**, but not all of them are **null**.)	void transform(Row row, PointCollector collector) throws Exception
SlidingTimeWindowAccessStrategy	Processes a batch of data in a fixed time interval each time. A data batch is called a window. The framework calls the **transform** method once for each raw data input window. A window may contain multiple rows of data. Each row of data is a result record of the raw query (aligned by time) on these input time series. (In a row, there may be a column with a value of **null**, but not all of them are **null**.)	void transform(RowWindow rowWindow, PointCollector collector) throws Exception

Interface Definition	Description	transform Method to Call
SlidingSizeWindowAccessStrategy	Processes raw data batch by batch, and each batch contains a fixed number of raw data rows (except the last batch). A data batch is called a window. The framework calls the **transform** method once for each raw data input window. A window may contain multiple rows of data. Each row of data is a result record of the raw query (aligned by time) on these input time series. (In a row, there may be a column with a value of **null**, but not all of them are **null**.)	void transform(RowWindow rowWindow, PointCollector collector) throws Exception

The construction of **RowByRowAccessStrategy** does not require any parameters.

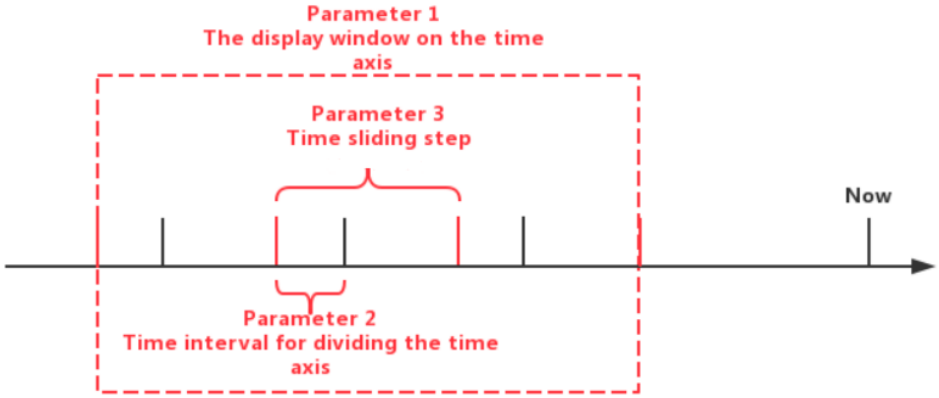
SlidingTimeWindowAccessStrategy has multiple constructors, and you can pass the following types of parameters to the constructors:

- Start time and end time of the display window on the time axis
- Time interval for dividing the time axis (must be positive)
- Time sliding step (not required to be greater than or equal to the time interval, but must be a positive number)

The display window on the time axis is optional. If these parameters are not provided, the start time of the display window will be set to the same as the minimum timestamp of the query result set, and the end time of the display window will be set to the same as the maximum timestamp of the query result set.

The sliding step parameter is also optional. If the parameter is not provided, the sliding step will be set to the same as the time interval for dividing the time axis.

The following figure shows the relationship between the three types of parameters.



Note that the actual time interval of some of the last time windows may be less than the specified time interval parameter. In addition, the number of data rows in some time windows may be 0. In this case, the framework will also call the **transform** method for the empty windows.

SlidingSizeWindowAccessStrategy has multiple constructors, and you can pass the following types of parameters to the constructors:

- Window size, that is, the number of data rows in a data processing window. Note that the number of data rows in some of the last time windows may be less than the specified number of data rows.
- Sliding step, that is, the number of rows between the first point of the next window and the first point of the current window. (This parameter is not required to be greater than or equal to the window size, but must be a positive number.)

The sliding step parameter is optional. If this parameter is not provided, the sliding step will be set to the same as the window size.

Note that the type of output time series you set here determines the type of data that **PointCollector** in the **transform** method can actually receive. The relationship between the output data type set in **setOutputDataType** and the actual data output type that **PointCollector** can receive is as follows.

Output Data Type Set in setOutputDataType	Data Type That PointCollector Can Receive
INT32	int
INT64	long
FLOAT	float
DOUBLE	double
BOOLEAN	boolean
TEXT	java.lang.String and org.apache.iotdb.tsfile.utils.Binary

- The type of the output time series of a UDTF is determined at runtime. The UDTF can dynamically determine the type of the output time series according to the type of the input time series.

  Example:

```
void beforeStart(UDFParameters parameters, UDTFConfigurations configurations) throws Exception {
  // do something
  // ...

  configurations
    .setAccessStrategy(new RowByRowAccessStrategy())
    .setOutputDataType(parameters.getDataType(0));
}
```

  - void transform(Row row, PointCollector collector) throws Exception

    You need to implement this method when you specify the strategy for the UDF to read raw data as **RowByRowAccessStrategy** in **beforeStart**.

    This method processes one row of raw data at a time. The raw data is input from **Row** and output by **PointCollector**. You can choose to output any number of data points in one **transform** call. Note that the type of

the output data points must be the same as you set in the **beforeStart** method, and the timestamp of the output data points must be strictly monotonically increasing.

The following is a complete UDF example that implements the **void transform(Row row, PointCollector collector) throws Exception** method. It is an adder that receives two columns of time series as input. When two data points in a row are not **null**, this UDF will output the algebraic sum of these two data points.

```
import org.apache.iotdb.db.query.udf.api.UDTF;
import org.apache.iotdb.db.query.udf.api.access.Row;
import org.apache.iotdb.db.query.udf.api.collector.PointCollector;
import org.apache.iotdb.db.query.udf.api.customizer.config.UDTFConfigurations;
import org.apache.iotdb.db.query.udf.api.customizer.parameter.UDFParameters;
import org.apache.iotdb.db.query.udf.api.customizer.strategy.RowByRowAccessStrategy;
import org.apache.iotdb.tsfile.file.metadata.enums.TSDataType;

public class Adder implements UDTF {

  @Override
  public void beforeStart(UDFParameters parameters, UDTFConfigurations configurations) {
    configurations
        .setOutputDataType(TSDataType.INT64)
        .setAccessStrategy(new RowByRowAccessStrategy());
  }

  @Override
  public void transform(Row row, PointCollector collector) throws Exception {
    if (row.isNull(0) || row.isNull(1)) {
      return;
    }
    collector.putLong(row.getTime(), row.getLong(0) + row.getLong(1));
  }
}
```

- void transform(RowWindow rowWindow, PointCollector collector) throws Exception

  You need to implement this method when you specify the strategy for the UDF to read raw data as **SlidingTimeWindowAccessStrategy** or **SlidingSizeWindowAccessStrategy**.

  This method processes a batch of data in a fixed number of rows or a fixed time interval each time, and the container containing this batch of data is called a window. The raw data is input from **RowWindow** and output by **PointCollector**. **RowWindow** can help you access a batch of rows, and it provides a set of interfaces for random access and iterative access to this batch of rows. You can choose to output any number of data points in one **transform** call. Note that the type of output data points must be the same as you set in the **beforeStart** method, and the timestamps of output data points must be strictly monotonically increasing.

  The following is a complete UDF example that implements the **void transform(RowWindow rowWindow, PointCollector collector) throws Exception** method. It is a counter that receives any number of time series as input, and its function is to count and output the number of data rows in each time window within a specified time range.

  ```
  import java.io.IOException;
  import org.apache.iotdb.db.query.udf.api.UDTF;
  import org.apache.iotdb.db.query.udf.api.access.RowWindow;
  import org.apache.iotdb.db.query.udf.api.collector.PointCollector;
  import org.apache.iotdb.db.query.udf.api.customizer.config.UDTFConfigurations;
  ```

```
import org.apache.iotdb.db.query.udf.api.customizer.parameter.UDFParameters;
import org.apache.iotdb.db.query.udf.api.customizer.strategy.SlidingTimeWindowAccessStrategy;
import org.apache.iotdb.tsfile.file.metadata.enums.TSDataType;

public class Counter implements UDTF {

  @Override
  public void beforeStart(UDFParameters parameters, UDTFConfigurations configurations) {
    configurations
        .setOutputDataType(TSDataType.INT32)
        .setAccessStrategy(new SlidingTimeWindowAccessStrategy(
            parameters.getLong("time_interval"),
            parameters.getLong("sliding_step"),
            parameters.getLong("display_window_begin"),
            parameters.getLong("display_window_end")));
  }

  @Override
  public void transform(RowWindow rowWindow, PointCollector collector) throws Exception {
    if (rowWindow.windowSize() != 0) {
      collector.putInt(rowWindow.getRow(0).getTime(), rowWindow.windowSize());
    }
  }
}
```

- void terminate(PointCollector collector) throws Exception

  In some scenarios, a UDF needs to traverse all the raw data to calculate the final output data points. The **terminate** interface provides support for those scenarios.

  This method is called after all **transform** calls have been executed and before **beforeDestory** is called. You can implement the **transform** method to perform pure data processing, and implement the **terminate** method to output the processing results.

  The processing results need to be output by **PointCollector**. You can choose to output any number of data points in one **terminate** call. Note that the type of the output data points must be the same as you set in the **beforeStart** method, and the timestamp of the output data points must be strictly monotonically increasing.

  The following is a complete UDF example that implements the **void terminate(PointCollector collector) throws Exception** method. It takes one time series whose data type is **INT32** as input, and outputs the maximum value point of the series.

```
import java.io.IOException;
import org.apache.iotdb.db.query.udf.api.UDTF;
import org.apache.iotdb.db.query.udf.api.access.Row;
import org.apache.iotdb.db.query.udf.api.collector.PointCollector;
import org.apache.iotdb.db.query.udf.api.customizer.config.UDTFConfigurations;
import org.apache.iotdb.db.query.udf.api.customizer.parameter.UDFParameters;
import org.apache.iotdb.db.query.udf.api.customizer.strategy.RowByRowAccessStrategy;
import org.apache.iotdb.tsfile.file.metadata.enums.TSDataType;

public class Max implements UDTF {

  private Long time;
  private int value;

  @Override
  public void beforeStart(UDFParameters parameters, UDTFConfigurations configurations) {
    configurations
        .setOutputDataType(TSDataType.INT32)
        .setAccessStrategy(new RowByRowAccessStrategy());
  }
```

```
@Override
public void transform(Row row, PointCollector collector) {
  int candidateValue = row.getInt(0);
  if (time == null || value < candidateValue) {
    time = row.getTime();
    value = candidateValue;
  }
}

@Override
public void terminate(PointCollector collector) throws IOException {
  if (time != null) {
    collector.putInt(time, value);
  }
 }
}
```

- void beforeDestroy()

  This method is used to terminate a UDF.

  This method is called by the framework. For a UDF instance, **beforeDestroy** will be called after the last record is processed. In the entire lifecycle of the instance, **beforeDestroy** will be called only once.

13.7.2 UDF Sample Code and Operations

Complete UDF Sample Code

For details, see "IoTDB UDF Program" in .

Procedure

Step 1 Register a UDF.

Register a UDF with a full class name **com.huawei.bigdata.iotdb.UDTFExample** as follows:

1. Pack the project into a JAR file. To use Maven to manage your project, refer to step "Build a JAR file" in "Registering a UDF" in .
2. Log in to the node where IoTDBServer is located as user **root**, run **su - omm** to switch to user **omm**, and import the JAR package obtained in **Step 1.1** to the **$BIGDATA_HOME/FusionInsight_IoTDB_*/install/FusionInsight-IoTDB-*/iotdb/ext/udf** directory.

   NOTICE

   During cluster deployment, ensure that a corresponding JAR package exists in the UDF JAR package path of each IoTDBserver node. You can modify the IoTDB configuration **file udf_root_dir** to specify the root path for the UDF to load the JAR package.

3. Execute the following SQL statement to register the UDF:

   CREATE FUNCTION <UDF-NAME> **AS** '<UDF-CLASS-FULL-PATHNAME>'

   For example, to register a UDF named **example**, execute the following statement:

   ```
   CREATE FUNCTION example AS 'com.huawei.bigdata.iotdb.UDTFExample'
   ```

Because IoTDB UDF instances are dynamically loaded through the reflection technology, you do not need to restart the server during the UDF registration process.

NOTICE

- UDF function names are case insensitive.
- Ensure that the function name given to the UDF is different from all built-in function names. A UDF with the same name as a built-in function cannot be registered.
- It is recommended that you do not use classes that have the same class name but different function logic in different JAR packages. For example, in **UDF(UDAF/UDTF): udf1, udf2**, the JAR package of **udf1** is **udf1.jar** and the JAR package of **udf2** is **udf2.jar**. Assume that both JAR packages contain the **com.huawei.bigdata.iotdb.UDTFExample** class. If you use two UDFs in the same SQL statement at the same time, the system will randomly load either of them and may cause inconsistency in UDF execution behavior.

Step 2 Query the UDF.

- Basic SQL syntax supported:
  - SLIMIT / SOFFSET
  - LIMIT / OFFSET
  - NON ALIGN
  - Queries with value filters
  - Queries with time filters
- Queries with aligned time series

  Currently, aligned time series are not supported in UDF queries. An error message is reported if you use UDF queries with aligned time series selected.
- Queries with an asterisk (*) in **SELECT** clauses

  Assume that there are two time series (**root.sg.d1.s1** and **root.sg.d1.s2**) in the system.
  - Execute **SELECT example(*) from root.sg.d1**.

    Then the result set will include the results of **example (root.sg.d1.s1)** and **example (root.sg.d1.s2)**.
  - Execute **SELECT example(s1, *) from root.sg.d1**.

    Then the result set will include the results of **example(root.sg.d1.s1, root.sg.d1.s1)** and **example(root.sg.d1.s1, root.sg.d1.s2)**.
  - Execute **SELECT example(*, *) from root.sg.d1**.

    Then the result set will include the results of **example(root.sg.d1.s1, root.sg.d1.s1)**, **example(root.sg.d1.s2, root.sg.d1.s1)**, **example(root.sg.d1.s1, root.sg.d1.s2)**, and **example(root.sg.d1.s2, root.sg.d1.s2)**.
- Queries with key-value pair attributes in UDF parameters

  You can pass any number of key-value pair parameters to the UDF when constructing a UDF query. The key and value in the key-value pair need to be

enclosed in single or double quotes. Note that key-value pair parameters can be passed in only after all time series have been passed in. Example:

```
SELECT example(s1, 'key1'='value1', 'key2'='value2'), example(*, 'key3'='value3') FROM root.sg.d1;
SELECT example(s1, s2, 'key1'='value1', 'key2'='value2') FROM root.sg.d1;
```

- Showing all registered UDFs

  SHOW FUNCTIONS

Step 3 Deregister the UDF.

The following shows the SQL syntax of how to deregister a UDF:

DROP FUNCTION <UDF-NAME>

To deregister the UDF named **example**, execute the following statement:

```
DROP FUNCTION example
```

----End

13.8 IoTDB Data Import and Export

13.8.1 Importing IoTDB Data

Scenario

This section describes how to use **import-csv.sh** to import data in CSV format to IoTDB.

Prerequisites

- The client has been installed. For example, the installation directory is **/opt/client**. The client directory in the following operations is only an example. Change it based on the actual installation directory onsite.
- Service component users have been created by the MRS cluster administrator. In security mode, machine-machine users need to download the keytab file.. A human-machine user must change the password upon the first login.
- By default, SSL is enabled on the server. You have generated the **truststore.jks** certificate by following the instructions provided in **Using the IoTDB Client** and copied it to the ***Client installation directory*/IoTDB/iotdb/conf** directory.

Procedure

1. Prepare a CSV file named **example-filename.csv** on the local PC with the following content:

```
Time,root.fit.d1.s1,root.fit.d1.s2,root.fit.d2.s1,root.fit.d2.s3,root.fit.p.s1
1,100,hello,200,300,400
2,500,world,600,700,800
3,900,"hello, \"world\"",1000,1100,1200
```

NOTICE

Before importing data, pay attention to the following:

- The data to be imported cannot contain spaces. Otherwise, the data import fails. In this case, you need to check the type of the data to be imported.
- Data that contains commas (,) must be enclosed in single or double quotation marks. For example, **hello,world** is changed to **"hello,world"**.
- Quotation marks ("") in the data must be replaced with the escape character **\"**. For example, **"world"** is changed to **\"world\"**.
- Single quotation marks (') in the data must be replaced with the escape character **\'**. For example, **'world'** will be changed to **\'world\'**.
- If the data to be imported is time, the format is **yyyy-MM-dd'T'HH:mm:ss**, **yyy-MM-dd HH:mm:ss** or **yyyy-MM-dd'T'HH:mm:ss.SSSZ**, for example, **2022-02-28T11:07:00**, **2022-02-28T11:07:00**, or **2022-02-28T11:07:00.000Z**.

2. Use WinSCP to import the CSV file to the directory of the node where the client is installed, for example, **/opt/client/IoTDB/iotdb/sbin**.
3. Log in to the node where the client is installed as the client installation user.
4. Run the following command to switch to the client installation directory:

   cd /opt/client

5. Run the following command to configure environment variables:

   source bigdata_env

6. (Optional) Perform this step to authenticate the current user if Kerberos authentication is enabled for the cluster. If Kerberos authentication is not enabled, skip this step.

   kinit *Component service user*

7. Run the following command to switch to the directory where the IoTDB client running script is stored:

   cd /opt/client/IoTDB/iotdb/sbin

8. If Kerberos authentication is disabled for the cluster (the cluster is in normal mode), invoke the **alter-cli-password.sh** script to change the default password of the default user **root**.

   sh alter-cli-password.sh *IP address of the IoTDBServer instance RPC port number*

   NOTE

   - The default RPC port number of IoTDBServer is **22260**, which can be configured in the **IOTDB_SERVER_RPC_PORT** parameter.
   - Obtain the default password of user **root** from the system administrator.

9. Run the following command to log in to the client:

   ./start-cli.sh -h *Service IP address of the IoTDBServer instance node* **-p** *IoTDBServer RPC port*

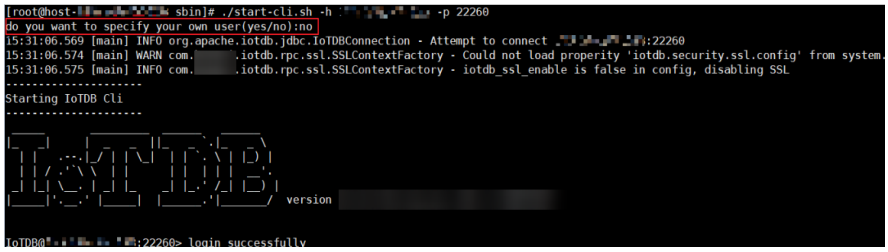
NOTE

- You can log in to FusionInsight Manager and choose **Cluster** > **Services** > **IoTDB** > **Instance** to view the service IP address of the IoTDBServer instance node.
- The default RPC port number is **22260**. To obtain the port number, choose **Cluster** > **Services** > **IoTDB**, click **Configurations** then **All Configurations**, and search for **IOTDB_SERVER_RPC_PORT**.
- If Kerberos authentication is disabled for the cluster (the cluster is in normal mode), use the default user **root** to log in to the IoTDB client.

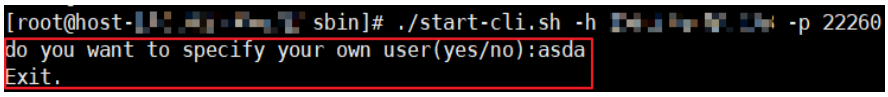
After you run this command, specify the service username as required.

- To specify the service username, enter **yes** and enter the service username and password as prompted.

- If you will not specify the service username, enter **no**. In this case, you will perform subsequent operations as the user in **6**.



- If you enter other information, you will log out.



10. (Optional) Create metadata.

    IoTDB has the capability of type inference, so it is not necessary to create metadata before data import. However, it is recommended that you create metadata before using the CSV tool to import data, because this avoids unnecessary type conversion errors. The commands are as follows:

```
SET STORAGE GROUP TO root.fit.d1;
SET STORAGE GROUP TO root.fit.d2;
SET STORAGE GROUP TO root.fit.p;
CREATE TIMESERIES root.fit.d1.s1 WITH DATATYPE=INT32,ENCODING=RLE;
CREATE TIMESERIES root.fit.d1.s2 WITH DATATYPE=TEXT,ENCODING=PLAIN;
CREATE TIMESERIES root.fit.d2.s1 WITH DATATYPE=INT32,ENCODING=RLE;
CREATE TIMESERIES root.fit.d2.s3 WITH DATATYPE=INT32,ENCODING=RLE;
CREATE TIMESERIES root.fit.p.s1 WITH DATATYPE=INT32,ENCODING=RLE;
```

11. Run the following command to exit the client:

    quit;

12. Run the following command to switch to the directory where the **import-csv.sh** script is stored:

    cd /opt/client/IoTDB/iotdb/tools

13. Run the following command to run **import-csv.sh** and import the **example-filename.csv** file:

    ./import-csv.sh -h *Service IP address of the IoTDBServer instance* **-p** *IoTDBServer RPC port* **-f** *example-filename.csv*

    Enter the service username and password in interactive mode as prompted. If information in the following figure is displayed, the CSV file is imported:

14. Verify data consistency.

    a. Run the following command to switch to the directory where the IoTDB client running script is stored:

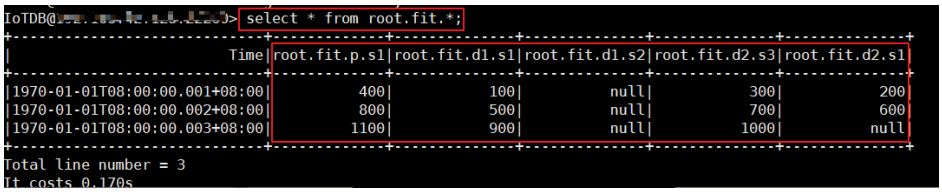
    cd /opt/client/IoTDB/iotdb/sbin

    b. Log in to the IoTDB client by referring to **9**. Run SQL statements to query data and compare the data with that in the **1** file.

    c. Check whether the imported data is consistent with the data in the **1**. If they are, the import is successful.

    Run the following command to check the imported data:

    SELECT * FROM root.fit.;**

    NOTE

    - To prevent security risks, you are advised to import CSV files in interactive mode.
    - You can also import CSV files by running the **./import-csv.sh -h** *Service IP address of the IoTDBServer instance* **-p** *IoTDBServer RPC port* **-u** *Service username* **-pw** *Service user password***-f** *example-filename.csv* command.

      If information in the following figure is displayed, the CSV file is imported.

    - If nanosecond (ns) time precision is enabled for the IoTDB on the server, the **-tp ns** parameter needs to be added when the client imports data with the nanosecond timestamp. To check whether nanosecond time precision is enabled for a cluster, log in to FusionInsight Manager, choose **Cluster** > **Configurations** > **All Non-default Values**, and search for **timestamp_precision**.

13.8.2 Exporting IoTDB Data

Scenario

This section describes how to use **export-csv.sh** to export data from IoTDB to a CSV file.

NOTICE

Exporting data to CSV files may cause injection risks. Exercise caution when performing this operation.

Prerequisites

- The client has been installed. For example, the installation directory is **/opt/client**. The client directory in the following operations is only an example. Change it based on the actual installation directory onsite.
- Service component users have been created by the MRS cluster administrato. In security mode, machine-machine users need to download the keytab file. A human-machine user must change the password upon the first login.
- By default, SSL is enabled on the server. You have generated the **truststore.jks** certificate by following the instructions provided in **Using the IoTDB Client** and copied it to the ***Client installation directory*/IoTDB/iotdb/conf** directory.

Procedure

1. Log in to the node where the client is installed as the client installation user.
2. Run the following command to switch to the client installation directory:

   cd /opt/client
3. Run the following command to configure environment variables:

   source bigdata_env
4. (Optional) Perform this step to authenticate the current user if Kerberos authentication is enabled for the cluster. If Kerberos authentication is not enabled, skip this step.

   kinit *Component service user*
5. Run the following command to switch to the directory where the **export-csv.sh** script is stored:

   cd /opt/client/IoTDB/iotdb/tools
6. Before executing the export script, input some queries or specify some SQL files. If a SQL file contains multiple SQL statements, the SQL statements must be separated by newline characters. For example:

   ```
   select * from root.fit.d1
   select * from root.sg1.d1
   ```
7. Execute **export-csv.sh** to export data.

   ./export-csv.sh -h *Service IP address of the IoTDBServer instance* **-p** *IoTDBServer RPC port* **-td <directory> [-tf <time-format> -s <sqlfile>]**

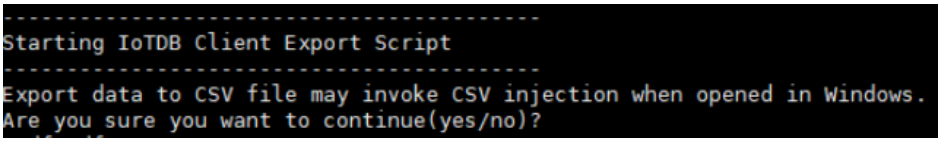
   Example:

   ```
   ./export-csv.sh -h x.x.x.x -p 22260 -td ./
   # Or
   ./export-csv.sh -h x.x.x.x -p 22260 -td ./ -tf yyyy-MM-dd\ HH:mm:ss
   # Or
   ./export-csv.sh -h x.x.x.x -p 22260 -td ./ -s sql.txt
   # Or
   ./export-csv.sh -h x.x.x.x -p 22260 -td ./ -tf yyyy-MM-dd\ HH:mm:ss -s sql.txt
   ```

NOTE

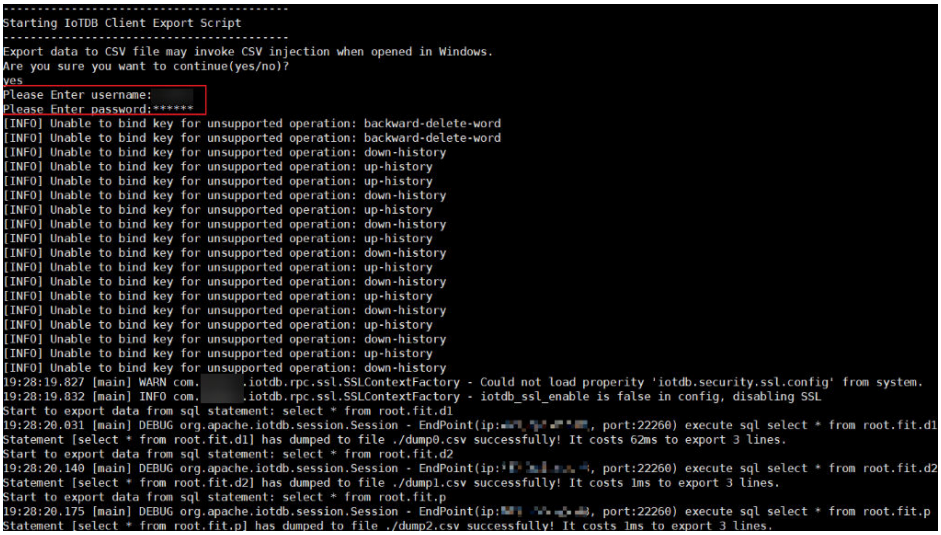
- You can log in to FusionInsight Manager, choose **Cluster** > **Services** > **IoTDB**, and click the **Instance** tab to view the service IP address of the IoTDBServer instance node.
- The default RPC port number is **22260**. To obtain the port number, choose **Cluster** > **Services** > **IoTDB**, click **Configurations** then **All Configurations**, and search for **IOTDB_SERVER_RPC_PORT**.
- If the data exported contains a comma (,), it will be enclosed in double quotation marks (""). For example, **hello,world** is exported as **"hello,world"**.
- If the data exported contains double quotation marks (""), it will be enclosed in double quotation marks ("") and the original double quotation masks are replaced with **\"**. For example, **"world"** is exported as **"\"world\""**

8. When you run the command in 7, a message is displayed indicating that CSV injection may occur. Enter **yes** to continue the command. If you enter another value, the data export operation will be canceled.



```
-----------------------------------------
Starting IoTDB Client Export Script
-----------------------------------------
Export data to CSV file may invoke CSV injection when opened in Windows.
Are you sure you want to continue(yes/no)?
```

For example, after you enter **yes**, enter the service username and password as prompted. If information in the following figure is displayed, the data is exported:



```
-----------------------------------------
Starting IoTDB Client Export Script
-----------------------------------------
Export data to CSV file may invoke CSV injection when opened in Windows.
Are you sure you want to continue(yes/no)?
yes
Please Enter username:[redacted]
Please Enter password:******
[INFO] Unable to bind key for unsupported operation: backward-delete-word
[INFO] Unable to bind key for unsupported operation: backward-delete-word
[INFO] Unable to bind key for unsupported operation: down-history
[INFO] Unable to bind key for unsupported operation: up-history
[INFO] Unable to bind key for unsupported operation: up-history
[INFO] Unable to bind key for unsupported operation: down-history
[INFO] Unable to bind key for unsupported operation: up-history
[INFO] Unable to bind key for unsupported operation: down-history
[INFO] Unable to bind key for unsupported operation: up-history
[INFO] Unable to bind key for unsupported operation: down-history
[INFO] Unable to bind key for unsupported operation: up-history
[INFO] Unable to bind key for unsupported operation: down-history
[INFO] Unable to bind key for unsupported operation: up-history
[INFO] Unable to bind key for unsupported operation: down-history
[INFO] Unable to bind key for unsupported operation: up-history
[INFO] Unable to bind key for unsupported operation: down-history
[INFO] Unable to bind key for unsupported operation: up-history
[INFO] Unable to bind key for unsupported operation: down-history
19:28:19.827 [main] WARN com.[redacted].iotdb.rpc.ssl.SSLContextFactory - Could not load properity 'iotdb.security.ssl.config' from system.
19:28:19.832 [main] INFO com.[redacted].iotdb.rpc.ssl.SSLContextFactory - iotdb_ssl_enable is false in config, disabling SSL
Start to export data from sql statement: select * from root.fit.d1
19:28:20.031 [main] DEBUG org.apache.iotdb.session.Session - EndPoint(ip:[redacted], port:22260) execute sql select * from root.fit.d1
Statement [select * from root.fit.d1] has dumped to file ./dump0.csv successfully! It costs 62ms to export 3 lines.
Start to export data from sql statement: select * from root.fit.d2
19:28:20.140 [main] DEBUG org.apache.iotdb.session.Session - EndPoint(ip:[redacted], port:22260) execute sql select * from root.fit.d2
Statement [select * from root.fit.d2] has dumped to file ./dump1.csv successfully! It costs 1ms to export 3 lines.
Start to export data from sql statement: select * from root.fit.p
19:28:20.175 [main] DEBUG org.apache.iotdb.session.Session - EndPoint(ip:[redacted], port:22260) execute sql select * from root.fit.p
Statement [select * from root.fit.p] has dumped to file ./dump2.csv successfully! It costs 1ms to export 3 lines.
```

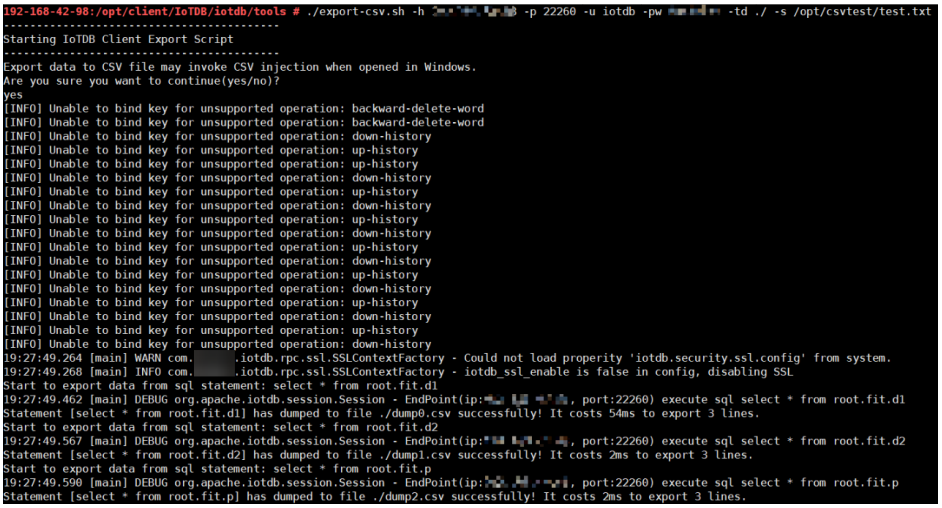
NOTE

- To prevent security risks, you are advised to export CSV files in interactive mode.
- You can also export CSV files by running the **./export-csv.sh -h** *Service IP address of the IoTDBServer instance* **-p** *IoTDBServer RPC port* **-u** *Service username* **-pw** *Service user password* **-td <directory> [-tf <time-format> -s <sqlfile>]** command.

  Example:

```
./export-csv.sh -h x.x.x.x -p 22260 -u test -pw Password -td ./
# Or
./export-csv.sh -h x.x.x.x -p 22260 -u test -pw Password -td ./
# Or
./export-csv.sh -h x.x.x.x -p 22260 -u test -pw Password -td ./ -s sql.txt
# Or
./export-csv.sh -h x.x.x.x -p 22260 -u test -pw Password -td ./ -tf yyyy-MM-dd\ HH:mm:ss -s sql.txt
```

  If information in the following figure is displayed, the CSV file is exported:



13.9 Planning IoTDB Capacity

IoTDB has the multi-replica mechanism. By default, both schema regions and data regions have three replicas. The ConfigNode stores the mapping between regions and the IoTDBServer. The IoTDBServer stores region data and uses the file system of the OS to manage metadata and data files.

Capacity Specifications

- ConfigNode capacity specifications

  When a new storage group is created, IoTDB allocates 10,000 slots to it by default. When data is written, IoTDB allocates or creates a data region and mounts it to a slot based on the device name and time value. Therefore, the memory usage of a ConfigNode is related to the number of storage groups and the continuous write time of the storage groups.

Objects of Slot Allocation	Object Size (Byte)
TTimePartitionSlot	4
TSeriesPartitionSlot	8

Objects of Slot Allocation	Object Size (Byte)
TConsensusGroupId	4

According to the preceding table, creating one storage group that keeps running for 10 years requires about 0.68 GB of memory on a ConfigNode.

10,000 (slots) x 10 (years) x 365 (partitions) x (TTimePartitionSlot size + TSeriesPartitionSlot size + TConsensusGroupId size) = 0.68 GB

- IoTDBServer capacity specifications

  Data in IoTDB is allocated to IoTDBServers by region. By default, a region stores data as three replicas, and therefore three files are stored in the IoTDBServer file system. The upper limit of the IoTDBServer capacity is the maximum number of files that can be stored in the OS. For Linux, the upper limit is the number of inodes.

13.10 IoTDB Performance Tuning

Scenario

You can increase IoTDB memory to improve IoTDB performance because read and write operations are performed in HBase memory.

Configuration

Log in to Manager, choose **Cluster** > **Services** > **IoTDB**, and click the **Configurations** tab and then **All Configurations**. Search the parameters and modify their values.

For details, see **Table 13-10**.

Table 13-10 Description

Parameter	Description	Default Value	Optimization Suggestion
SSL_ENABLE	Whether to encrypt the channel between the client and server using SSL	true	**true** indicates that SSL encryption is enabled, and **false** indicates that SSL encryption is disabled. Data encryption and decryption during transmission have a great impact on performance. The test result shows that the performance gap is 200%. Therefore, you are advised to disable SSL encryption during the performance test. The parameter for the ConfigNode and IoTDBServer roles must be both modified.
iotdb_server_kerberos_qop	Data transmission encryption for each IoTDBServer instance in the cluster. Only clusters with Kerberos authentication enabled support this parameter.	auth-int	**auth-int** indicates that data transmission is encrypted, and **auth** indicates that data is authenticated only without being encrypted. Therefore, you are advised to set this parameter to **auth**. The parameter for the ConfigNode and IoTDBServer roles must be both modified.

Parameter	Description	Default Value	Optimization Suggestion
GC_OPTS	Memory and garbage collection (GC) configuration parameters used by IoTDBServer	**-Xms2G -Xmx2G -XX:MaxDirectMemorySize=512M -XX:+UseG1GC -XX:+UseGCLogFileRotation -XX:NumberOfGCLogFiles=10 -XX:GCLogFileSize=1M -Djdk.tls.ephemeralDHKeySize=3072** (set this parameter as required.)	• **-Xms2G -Xmx2G** indicates the IoTDB JVM heap memory. Set this parameter to a large value in the scenarios with a large number of time series and concurrent writes. You can adjust the parameter value based on the GC duration threshold alarm or heap memory threshold alarm. If an alarm is generated, increase the parameter value by 0.5 times. If this alarm is frequently generated, double the value. When you adjust **HeapSize**, set **Xms** and **Xmx** to the same value to avoid performance deterioration during dynamic heap size adjustment by JVM. • **-XX:MaxDirectMemorySize** indicates the IoTDB JVM direct memory. The recommended value is 1/4 of the heap memory. This parameter mainly affects the write performance. If the write performance deteriorates significantly, you can increase the parameter value by 0.5 times. Note that the sum of the heap memory and direct memory must be less than or equal to 80% of the available system memory. Otherwise, IoTDB fails to be started. • Query scenario optimization example: If the query range is large, for example, a single time series contains more than 10,000 data points, the

Parameter	Description	Default Value	Optimization Suggestion
			quotient of 20% of the JVM memory allocated divided by the number of time series is recommended to be bigger than 160 KB for better performance of the storage engine in the default configuration. ● For example, if there are 5 million sequences, the corresponding memory configuration is **-Xms128G -Xmx128G**.
storage_query_schema_consensus_free_memory_proportion	Memory allocation ratio: write, read, schema, consensus, and free	3:3:1:1:2	You can adjust the memory based on the load. ● A larger write memory means the better write throughput and single query performance. ● A larger read memory means more supported concurrent queries. ● A larger metadata memory means a lower probability of error message "IoTDB system load is too large". ● A larger free memory means a lower probability of memory exhaustion.
iot_consensus_throttle_threshold_in_byte	Maximum size of the WAL directory, in bytes. The default maximum size is 50 GB. If the directory size exceeds the value you set, write operations are slowed down or rejected.	53687091200	You can adjust the value based on the number of writes. ● For a small number of concurrent writes, do not change the value. ● If there are a large number of concurrent writes, increase the value.

Parameter	Description	Default Value	Optimization Suggestion
data_region_iot_max_pending_batches_num	Maximum number of concurrent requests for synchronizing leader data copies to followers.	12	You can adjust the value based on the CPU usage and pending WAL files. To use this parameter, select **IoTDBServer(Role)** > **Customization** and add this parameter and its value to **engine.customized.configs**. ● For a small number of concurrent writes, do not change the value. ● If there are a large number of concurrent writes, increase the value. ● If there are a large number of pending WAL files, decrease the value. ● If the CPU usage is greater than 80% for a long time, decrease the value.
avg_series_point_number_threshold	Maximum average number of memory data points. When this threshold is reached, data is flushed to Tsfile.	10000	You can adjust the value based on the heap memory usage and GC duration. ● If the GC duration is long, decrease the value. ● If the memory usage is high, decrease the value.
flush_proportion	Write memory ratio for invoking disk flushing. If the write load is too high (for example, batch processing = 1000), you can decrease the value.	0.4	You can adjust the value based on the heap memory usage. If the memory usage is high, decrease the value.

13.11 IoTDB Error Logs

14 Using JobGateway

14.1 Using JobGateway from Scratch

JobGateway is a gateway service that simulates big data component (such as Flink, Hive, and HBase) clients to allow you to submit big data jobs through HTTP/HTTPS-based REST APIs. It features ease of use, high performance, availability, and scalability, as well as separated monitoring, alarm, and configuration, significantly shortening job submission links and simplifying the big data job submission process.

Context

For example, a group submits a large number of jobs through different big data component clients, which is complex and time-consuming. JobGateway provides a much easier way. You only need to construct HTTP/HTTPS-based REST APIs.

The following is an example of submitting a Hive job (for details about how to submit other big data jobs, see the JobGateway API document):

```
curl --location --request POST 'https://{host}:{port}/mrsjob/submit?user.name={username}'
--header 'JobServerAuthorization: {AuthorizationInfo}'
--header 'Content-Type: application/json'
--data-raw '{
"job_name":"{job-name}",
"job_type":"HiveSql",
"arguments":["SHOW TABLES"]
}'
```

Return value:

```
{
    "id": null,
    "state": "COMPLETE",
    "errorCode": 0,
    "errorCodeDescription": null,
    "errorDescription": null,
    "failedNodeList": null,
    "totalProgress": "0",
    "job_id": "466710d2-b1ff-4a98-805b-4675292e5cc8"
}
```

Hive job submission parameters		
Parameter	Description	Remarks
host	IP address of the Nginx server	-
port	Nginx monitoring port	The default value is **29970** for HTTPS and **29971** for HTTP.
user.name	Name of the user who submits a job	-
JobServerAuthorization	Authorization information	For details, see the JobGateway API document.
job_name	Job name	-
job_type	Job type	HiveSql indicates a HiveSql job.
arguments	HiveSql job content	-

NOTE

If the configuration of other components such as ZooKeeper and KMS is modified on the server and the JobGateway configuration expires, you need to restart the JobGateway component and update the client configuration of the node where the JobServer role is used. To refresh the client configuration of the node where JobServer is, perform the following steps:

1. Log in to the node where the client is installed as user **root** and run the following command to switch to user **omm**:

   su - omm

2. Go to the client installation directory, for example, **/opt/Bigdata/client** and run the following commands to update the configuration file:

   cd /opt/Bigdata/client

   sh autoRefreshConfig.sh

3. Enter the username and password of the FusionInsight Manager administrator and the floating IP address of FusionInsight Manager.
4. Enter the components whose configuration needs to be updated. Use commas (,) to separate the component names. Press **Enter** to update the configurations of all components if necessary.

   If the following information is displayed, the configurations have been updated successfully.

   ```
   Succeed to refresh components client config.
   ```

14.2 Configuring JobGateway Parameters

Page Access

Go to the JobGateway configuration page by referring to **Modifying Cluster Service Configuration Parameters**.

Parameters

Table 14-1 JobGateway parameters

Parameter	Description	Default Value
HTTP_INSTANCE_PORT	HTTP port of the JobServer service	Default value: **29973** Value range: 29970 to 29979
HTTPS_INSTANCE_PORT	HTTPS port of the JobServer service	Default value: **29972** Value range: 29970 to 29979
JAVA_OPTS	JVM parameter used for garbage collection (GC). Ensure that **GC_OPT** is set correctly. Otherwise, the process will fail to start.	See the default configuration on the page.
job.record.batch.delete.count	25	Number of aged data records in each batch of JobServers
job.record.expire.count	500000	Number of aged JobServer data records
job.record.expire.day	7	Time when a JobServer job expires
logging.level.org.apache.tomcat	Log level of Tomcat logs on the JobServer server	Default value: **INFO** Value range: **DEBUG**, **INFO**, **WARN**, **ERROR**, or **FATAL**
root.level	Level of logs on the JobServer server	Default value: **INFO** Value range: **DEBUG**, **INFO**, **WARN**, **ERROR**, or **FATAL**

Parameter	Description	Default Value
NGINX_PORT	Listening port of the JobBalancer service	Default value: The default HTTPS port number is **29970**, and the default HTTP port number is **29971**. Value range: 29970 to 29979
client_body_buffer_size	Sets the size of the buffer for reading the client request body. If the request body is larger than the buffer, the entire body or only part of it is written to the temporary file.	Default value: **10240** Value range: greater than 0
client_body_timeout	Defines the timeout interval for reading the client request body, in seconds. The timeout is set only for a period of time between two consecutive read operations, not for the transmission of the entire request body. If the client does not transmit any content within this period, the request is terminated and a 408 (request timeout) error occurs.	Default value: **60** Value range: 1 to 86400
client_header_buffer_size	Sets the buffer size for reading client request headers. For most requests, a 1 KB of buffer is sufficient. However, if the request contains a long cookie or comes from a WAP client, 1KB may not be appropriate. If the request line or request header field is not suitable for this buffer, a larger buffer configured by the **large_client_header_buffers** directive is allocated.	Default value: **1024** Value range: greater than 0

Parameter	Description	Default Value
client_header_timeout	Defines the timeout interval for reading the client request header. If the client does not transmit the entire header during this period, the request is terminated and a 408 (request timeout) error occurs.	Default value: **60** Value range: 1 to 86400
client_max_body_size	Maximum size of an HTTP request body, in MB	Default value: **80** Value range: 1 to 10240
keepalive_requests	Sets the maximum number of requests that can be served through a keepalive connection. After the maximum number of requests is sent, the connection is closed. Closing connections periodically is necessary to free up the memory allocation for each connection. Using a high maximum number of requests may cause excessive memory usage. Therefore, this method is not recommended.	Default value: **1000** Value range: 1 to 100000
keepalive_time	Limits the maximum time that a request can be processed through a keepalive connection, in seconds. After the time specified by this parameter is reached, the connection is closed after subsequent requests are processed.	Default value: **3600** Value range: 1 to 86400
keepalive_timeout	Sets a timeout period during which keepalive client connections remain open on the server, in seconds. The zero value disables keepalive client connections.	Default value: **75** Value range: 0 to 86400

Parameter	Description	Default Value
large_client_header_buffers.size	Sets the maximum number (**large_client_header_buffers.number**) and size of buffers used to read large client request headers. A request line cannot exceed the size of a buffer. Otherwise, error 414 (Request-URI Too Large) is returned to the client. The request header field cannot exceed the size of a buffer. Otherwise, error 400 (Bad Request) is returned to the client. The buffer is allocated only on demand. These buffers are released if the connection transitions to keep active after the request processing is complete.	Default value: **4096** Value range: greater than 0
lb_limit_req_burst	When a large number of requests are sent, the requests that exceed the access frequency limit are stored in the buffer, and error 503 is returned if the requests exceed the buffer size.	Default value: **50** Value range: 1 to 1000
lb_limit_zone_rate	Rate limit on HTTP requests of clients with the same ID, in r/s or r/m. For example, **30r/s** indicates that 30 accesses are allowed per second.	Default value: **30r/s** Value range: 1 to 100r/s or 1 to 6000r/m
lb_limit_zone_size	Size of the HTTP memory buffer, in MB	Default value: **20** Value range: 1 to 10240
lb_req_timeout	Timeout interval for Nginx read/write	Default value: **60s** Value range: 1 to 3600s

Parameter	Description	Default Value
proxy_connect_timeout	Defines the timeout interval for setting up a TCP connection with the proxy server. The value is a combination of numbers and units. m indicates minute and s indicates second.	Default value: **3m** Value range: 1 to 60 m or 1 to 3600s
proxy_timeout	Timeout between two consecutive read or write operations on a TCP connection to the proxy server. If no data is transmitted within this period, the connection is closed. The value is a combination of numbers and units. m indicates minute and s indicates second.	Default value: **3m** Value range: 1 to 60 m or 1 to 3600s

14.3 JobGateway Logs

Log Description

Log path: **/var/log/Bigdata/job-gateway/**

Log archive rule: The automatic compression and archive function is enabled for JobGateway run logs. When the total size of all log files exceeds 20 MB (configurable), the log files are automatically compressed into a package named in the format of *Original log file name*-*yyyy-mm-dd*.*No.*.**log.zip**. A maximum of 20 latest compressed files are retained. The number of compressed files and compression threshold can be configured.

Table 14-2 JobGateway log list

Log Type	Log File Name	Description
JobServer run log	job-gateway.log	Service run log
	prestart.log	Service prestart log
	availability-check.log	Service availability check log
	verbose-gc-sp.txt	Service GC log
	gc.log	Service GC log

Log Type	Log File Name	Description
JobServer audit log	access_log.{yyyy-MM-dd}.log	Service audit log
Balance run log	availability-check.log	Service availability check log
	error.log	Service error log
	prestart.log	Service prestart log
	start.log	Service startup log
Balance audit log	access_http.log	Service audit log

Log Levels

The following table describes the log levels provided by JobGateway.

The log levels are ERROR, WARN, INFO, and DEBUG in descending order of priority. Only logs whose levels are higher than or equal to the specified level are recorded. The higher the log level specified, the fewer the logs are recorded.

Table 14-3 Log levels

Level	Description
ERROR	Logs of this level record error information about system running
WARN	Logs of this level record exception information about the current event processing
INFO	Logs of this level record normal running status information about the system and events
DEBUG	Logs of this level record the system information and system debugging information

To modify log levels, perform the following operations:

1. Log in to FusionInsight Manager.
2. Choose **Cluster** > **Services** > **JobGateway** and click **Configurations**.
3. Click **All Configurations**.
4. On the menu bar on the left, select the log menu of the target role.
5. Select a desired log level.

6. Click **Save** then **OK**.

15 Using Kafka

15.1 Using Kafka from Scratch

Scenario

You can create, query, and delete topics on a cluster client.

Prerequisites

The client has been installed in a directory, for example, **/opt/client**. The client directory in the following operations is only an example. Change it based on site requirements.

Using the Kafka Client

Step 1 View the IP addresses of the ZooKeeper role instance.

Record any IP address of the ZooKeeper instance.

Step 2 Log in to the node where the client is installed.

Step 3 Run the following command to switch to the client installation directory, for example, **/opt/client/Kafka/kafka/bin**.

cd /opt/client/Kafka/kafka/bin

Step 4 Run the following command to configure environment variables:

source /opt/client/bigdata_env

Step 5 If Kerberos authentication is enabled for the current cluster, run the following command to authenticate the current user. If Kerberos authentication is disabled for the current cluster, skip this step.

kinit *Kafka user*

Step 6 Log in to FusionInsight Manager, choose **Cluster** > **Name of the desired cluster** > **Services** > **ZooKeeper**, and click the **Configurations** tab and then **All Configurations**. On the displayed page, search for the **clientPort** parameter and record its value.

Step 7 Create a topic.

sh kafka-topics.sh --create --topic *Topic name* **--partitions** *Number of partitions occupied by the topic* **--replication-factor** *Number of replicas of the topic* **--zookeeper** *IP address of the node where the ZooKeeper instance resides:clientPort***/kafka**

Example: **sh kafka-topics.sh --create --topic TopicTest --partitions 3 --replication-factor 3 --zookeeper 10.10.10.100:2181/kafka**

Step 8 Run the following command to view the topic information in the cluster:

sh kafka-topics.sh --list --zookeeper *IP address of the node where the ZooKeeper instance resides:clientPort***/kafka**

Example: **sh kafka-topics.sh --list --zookeeper 10.10.10.100:2181/kafka**

Step 9 Delete the topic created in **Step 7**.

sh kafka-topics.sh --delete --topic *Topic name* **--zookeeper** *IP address of the node where the ZooKeeper instance resides*:*clientPort***/kafka**

Example: **sh kafka-topics.sh --delete --topic TopicTest --zookeeper 10.10.10.100:2181/kafka**

----End

15.2 Managing Kafka Topics

Scenario

You can manage Kafka topics on a cluster client based on service requirements. Management permission is required for clusters with Kerberos authentication enabled.

Prerequisites

You have installed the Kafka client.

Procedure

Step 1 View the IP addresses of the ZooKeeper role instance.

Record any IP address of the ZooKeeper instance.

Step 2 Prepare the client based on service requirements. Log in to the node where the client is installed.

Log in to the node where the client is installed based on the client location.

Step 3 Run the following command to switch to the client installation directory, for example, **/opt/client/Kafka/kafka/bin**.

cd /opt/client/Kafka/kafka/bin

Step 4 Run the following command to configure environment variables:

source /opt/client/bigdata_env

Step 5 Run the following command to perform user authentication (skip this step in normal mode):

kinit *Component service user*

Step 6 Use **kafka-topics.sh** to manage Kafka topics.

- Creating a topic:

  By default, partitions of a topic are distributed based on the number of partitions on the node and disk. To distribute partitions based on the disk capacity, set **log.partition.strategy** to **capacity** for the Kafka service.

  When a topic is created in Kafka, partitions and copies can be generated based on the combination of rack awareness and cross-AZ feature. The **--zookeeper** and **--bootstrap-server** modes are supported.

  – Disable the rack policy and cross-AZ feature (default policy).

    Copies of topics created based on this policy are randomly allocated to any node in the cluster.

    ./kafka-topics.sh --create --topic *topic name* **--partitions** *number of partitions occupied by the topic***--replication-factor** *number of replicas of the topic***--zookeeper** *IP address of any ZooKeeper node:clientPort***/kafka**

    ./kafka-topics.sh --create --topic *topic name* **--partitions** *number of partitions occupied by the topic***--replication-factor** *number of replicas of the topic* **--bootstrap-server** *IP address of the Kafkacluster:21007* **--command-config ../config/client.properties**

    If you use **--bootstrap-server** to create a topic, set **rack.aware.enable** and **az.aware.enable** to **false**.

  – Enable the rack policy and disable the cross-AZ feature.

    The leader of each partition of the topic created based on this policy is randomly allocated on the cluster node. However, different replicas of the same partition are allocated to different racks. Therefore, when this policy is used, ensure that the number of nodes in each rack is the same, otherwise, the load of nodes in the rack with fewer nodes is much higher than the average load of the cluster.

    ./kafka-topics.sh --create --topic *topic name* **--partitions** *number of partitions occupied by the topic***--replication-factor** *number of replicas of the topic* **--zookeeper** *IP address of any ZooKeeper node:clientPort***/kafka --enable-rack-aware**

    ./kafka-topics.sh --create --topic *topic name* **--partitions** *number of partitions occupied by the topic***--replication-factor** *number of replicas of the topic* **--bootstrap-server** *IP address of the Kafkacluster:21007* **--command-config ../config/client.properties**

    If you use **--bootstrap-server** to create a topic, set **rack.aware.enable** to **true** and **az.aware.enable** to **false**.

  – Disable the rack policy and enable the cross-AZ feature.

    The leader of each partition of the topic created based on this policy is randomly allocated on the cluster node. However, different replicas of the same partition are allocated to different AZs. Therefore, when this policy is used, ensure that the number of nodes in each AZ is the same, otherwise, the load of nodes in the AZ with fewer nodes is much higher than the average load of the cluster.

./kafka-topics.sh --create --topic *topic name* **--partitions** *number of partitions occupied by the topic*--**replication-factor** *number of replicas of the topic* **--zookeeper** *IP address of any ZooKeeper node:clientPort*/**kafka --enable-az-aware**

./kafka-topics.sh --create --topic *topic name* **--partitions** *number of partitions occupied by the topic*--**replication-factor** *number of replicas of the topic* **--bootstrap-server** *IP address of the Kafkacluster:21007* **--command-config ../config/client.properties**

If you use **--bootstrap-server** to create a topic, set **rack.aware.enable** to **false** and **az.aware.enable** to **true**.

- Enable the rack policy and cross-AZ feature.

  The leader of each partition of the topic created based on this policy is randomly allocated on the cluster node. However, different replicas of the same partition are allocated to different racks in different AZs. This policy ensures that the number of nodes on each rack in each AZ is the same, otherwise, the load in the cluster is unbalanced.

  ./kafka-topics.sh --create --topic *topic name* **--partitions** *number of partitions occupied by the topic* **--replication-factor** *number of replicas of the topic* **--zookeeper** *IP address of any ZooKeeper node:clientPort*/**kafka --enable-rack-aware --enable-az-aware**

  ./kafka-topics.sh --create --topic *topic name* **--partitions** *number of partitions occupied by the topic*--**replication-factor** *number of replicas of the topic* **--bootstrap-server** *IP address of the Kafkacluster:21007* **--command-config ../config/client.properties**

  If you use **--bootstrap-server** to create a topic, set **rack.aware.enable** and **az.aware.enable** to **true**.

  NOTE

  - Kafka supports topic creation in either of the following modes:
    - In **--zookeeper** mode, the client generates a copy allocation scheme. The community supports this mode from the beginning. To reduce the dependency on the ZooKeeper component, the community will delete the support for this mode in later versions. When creating a topic in this mode, you can select a copy allocation policy by combining the **--enable-rack-aware** and **--enable-az-aware** options. Note: The **--enable-az-aware** option can be used only when the cross-AZ feature is enabled on the server, that is, **az.aware.enable** is set to **true**. Otherwise, the execution fails.
    - In **--bootstrap-server** mode, the server generates a copy allocation solution. In later versions, the community supports only this mode for topic management. When a topic is created in this mode, the **--enable-rack-aware** and **--enable-az-aware** options cannot be used to control the copy allocation policy. The **rack.aware.enable** and **az.aware.enable** parameters can be used together to control the copy allocation policy. Note that the **az.aware.enable** parameter cannot be modified; if the cross-AZ feature is enabled during cluster creation, this parameter is automatically set to **true**; the **rack.aware.enable** parameter can be customized.

- List of topics:
  - **./kafka-topics.sh --list --zookeeper** *service IP address of any ZooKeeper node:clientPort*/**kafka**
  - **./kafka-topics.sh --list --bootstrap-server** *IP address of the Kafkacluster:21007* **--command-config ../config/client.properties**

- Viewing the topic:
  - **./kafka-topics.sh --describe --zookeeper** *service IP address of any ZooKeeper node:clientPort*/**kafka** --**topic** *topic name*
  - **./kafka-topics.sh --describe --bootstrap-server** *IP address of the Kafkacluster:21007* **--command-config ../config/client.properties --topic** *topic name*
- Modifying a topic:
  - **./kafka-topics.sh --alter --topic** *topic name*--**config** *configuration item=configuration value* **--zookeeper** *service IP address of any ZooKeeper node:clientPort*/**kafka**
- Expanding partitions:
  - **./kafka-topics.sh --alter --topic** *topic name* **--zookeeper** *service IP address of any ZooKeeper node:clientPort*/**kafka --command-config Kafka/kafka/config/client.properties --partitions** *number of partitions after the expansion*
  - **./kafka-topics.sh --alter --topic** *topic name* **--bootstrap-server** *IP address of the Kafka cluster:21007* **--command-config Kafka/kafka/config/client.properties --partitions** *number of partitions after the expansion*
- Deleting a topic
  - **./kafka-topics.sh --delete --topic** *topic name* **--zookeeper** *Service IP address of any ZooKeeper node:clientPort*/**kafka**
  - **./kafka-topics.sh --delete --topic** *topic name*--**bootstrap-server** *IP address of the Kafka cluster:21007* **--command-config ../config/client.properties**

----End

15.3 Querying Kafka Topics

Scenario

You can query existing Kafka topics on MRS.

Procedure

Step 1 Click **KafkaTopicMonitor**.

All topics are displayed in the list by default. You can view the number of partitions and replicas of the topics.

Step 2 Click the desired topic in the list to view its details.

NOTE

If the following operations are performed, Kafka topic monitoring may not be displayed:

- Capacity expansion or reduction has been performed on Kafka or ZooKeeper.
- Instances have been added to or deleted from Kafka or ZooKeeper.
- The Elasticsearch service is reinstalled.
- Kafka is switched to another ZooKeeper service.

Perform the following steps to rectify the fault:

1. Log in to the active OMS node of the cluster and run the following command to switch to user **omm**:

   su - omm

2. Restart the CEP service.

   restart_app cep

   Wait for 3 minutes and check the Kafka topic monitoring again.

----End

15.4 Managing Kafka User Permissions

Scenario

For clusters with Kerberos authentication enabled, using Kafka requires relevant permissions. MRS clusters can grant the use permission of Kafka to different users.

Table 15-1 lists the default Kafka user groups.

NOTE

Kafka supports two types of authentication plug-ins: Kafka open source authentication plug-in and Ranger authentication plug-in.

This section describes the user permission management based on the Kafka open source authentication plug-in. For details about how to use the Ranger authentication plug-in, see **Adding a Ranger Access Permission Policy for Kafka**.

If Kerberos authentication is enabled for the cluster (the cluster is in security mode), Ranger authentication is enabled for Kafka, and the server parameter **allow.everyone.if.no.acl.found** is set to **true**, Ranger does not authenticate any operation.

Table 15-1 Default Kafka user groups

User Group	Description
kafkaadmin	Kafka administrator group. Users in this group have the permissions to create, delete, read, and write all topics, and authorize other users.
kafkasuperuser	Kafka super user group. Users in this group have the permissions to read and write all topics.
kafka	Kafka common user group. Users in this group can access a topic only when they are granted with the read and write permissions of the topic by a user in the **kafkaadmin** group.

User Group	Description
kafkaui	Kafka UI user group. Users in this group have the permission to view Kafka UI.

Prerequisites

- You have installed the Kafka client.
- A user in the **kafkaadmin** group, for example **admin**, has been prepared.

Procedure

Step 1 View the IP addresses of the ZooKeeper role instance.

Record the IP address of any ZooKeeper instance.

Step 2 Prepare the client based on service requirements. Log in to the node where the client is installed.

Log in to the node where the client is installed based on the client location.

Step 3 Run the following command to switch to the client installation directory, for example, **/opt/client/Kafka/kafka/bin**.

cd /opt/client/Kafka/kafka/bin

Step 4 Run the following command to configure environment variables:

source /opt/client/bigdata_env

Step 5 Run the following command to authenticate the user(skip this step in normal mode):

kinit *Component service user*

Step 6 Run the following kafka-acls.sh commands to grant permissions to the user.

- View the permission control list of a topic:

  ./kafka-acls.sh --authorizer-properties zookeeper.connect=*<Service IP address of any ZooKeeper node>***:2181/kafka** *>* **--list --topic** *<Topic name>*

  ./kafka-acls.sh --bootstrap-server <*IP address of the Kafkacluster:21007*> **--command-config ../config/client.properties --list --topic** <*topic name*>

- Add the Producer permission for a user:

  ./kafka-acls.sh --authorizer-properties zookeeper.connect=*<Service IP address of any ZooKeeper node>***:2181/kafka > --add --allow-principal User:***<Username>* **--producer --topic** *<Topic name>*

  ./kafka-acls.sh --bootstrap-server <*IP address of the Kafkacluster:21007*> **--command-config ../config/client.properties --add --allow-principal User:***<username>* **--producer --topic** <*topic name*>

- Assign the Producer permission to a user in batches.

  ./kafka-acls.sh --authorizer-properties zookeeper.connect=*<Service IP address of any ZooKeeper node>***:2181/kafka > --add --allow-principal User:***<Username>* **--producer --topic** *<Topic name>* **--resource-pattern-type prefixed**

./kafka-acls.sh --bootstrap-server <*IP address of the Kafkacluster:21007*> **--command-config ../config/client.properties --add --allow-principal User:**<*username*> **--producer --topic** *<topic name>***--resource-pattern-type prefixed**

- Remove the Producer permission from a user:

  ./kafka-acls.sh --authorizer-properties zookeeper.connect=*<Service IP address of any ZooKeeper node>***:2181/kafka > --remove --allow-principal User:***<Username>* **--producer --topic** *<Topic name>*

  ./kafka-acls.sh --bootstrap-server <*IP address of the Kafkacluster:21007*> **--command-config ../config/client.properties --remove --allow-principal User:**<*username*> **--producer --topic** <*topic name*>

- Delete the Producer permission of a user in batches:

  ./kafka-acls.sh --authorizer-properties zookeeper.connect=*<Service IP address of any ZooKeeper node>***:2181/kafka > --remove --allow-principal User:***<Username>* **--producer --topic** *<Topic name>* **--resource-pattern-type prefixed**

  ./kafka-acls.sh --bootstrap-server <*IP address of the Kafkacluster:21007*> **--command-config ../config/client.properties --remove --allow-principal User:**<*username*> **--producer --topic** *<topic name>***--resource-pattern-type prefixed**

- Add the Consumer permission for a user:

  ./kafka-acls.sh --authorizer-properties zookeeper.connect=*<Service IP address of any ZooKeeper node>***:2181/kafka > --add --allow-principal User:***<Username>* **--consumer --topic** *<Topicname>* **--group** *<Consumer group name>*

  ./kafka-acls.sh --bootstrap-server <*IP address of the Kafkacluster:21007*> **--command-config ../config/client.properties --add --allow-principal User:**<*username*> **--consumer --topic** *<topicname>* **--group** *<consumer group name>*

- Add consumer permissions to a user in batches:

  ./kafka-acls.sh --authorizer-properties zookeeper.connect=*<Service IP address of any ZooKeeper node>***:2181/kafka > --add --allow-principal User:***<Username>* **--consumer --topic** *<Topic name>* **--group** *<Consumer group name>* **--resource-pattern-type prefixed**

  ./kafka-acls.sh --bootstrap-server <*IP address of the Kafkacluster:21007*> **--command-config ../config/client.properties --add --allow-principal User:**<*username*> **--consumer --topic** *<topicname>* **--group** *<consumer group name>* **--resource-pattern-type prefixed**

- Remove the consumer permission from a user:

  ./kafka-acls.sh --authorizer-properties zookeeper.connect=*<Service IP address of any ZooKeeper node>***:2181/kafka > --remove --allow-principal User:***<Username>* **--consumer --topic** *<Topic name>* **--group** *<Consumer group name>*

  ./kafka-acls.sh --bootstrap-server <*IP address of the Kafkacluster:21007*> **--command-config ../config/client.properties --remove --allow-principal User:***<username>* ***--consumer --topic*** *<topic name>* **--group** *<consumer group name>*

- Delete the consumer permission of a user in batches:

./kafka-acls.sh --authorizer-properties zookeeper.connect=*<Service IP address of any ZooKeeper node>***:2181/kafka > --remove --allow-principal User:***<Username>* **--consumer --topic** *<Topic name>* **--group** *<Consumer group name>* **--resource-pattern-type prefixed**

./kafka-acls.sh --bootstrap-server *<IP address of the Kafkacluster:21007>* **--command-config ../config/client.properties --remove --allow-principal User:***<username>* **--consumer --topic** *<topicname>* **--group** *<consumer group name>* **--resource-pattern-type prefixed**

----End

15.5 Managing Messages in Kafka Topics

Scenario

You can produce or consume messages in Kafka topics using the MRS cluster client.

Prerequisites

- The cluster client has been installed.
- For clusters with Kerberos authentication enabled, you need to create a service user on Manager in advance. The user has the permission to perform operations in Kafka topics.

Procedure

Step 1 Log in to FusionInsight Manager. Choose **Cluster** > *Name of the desired cluster* > **Services** > **Kafka**.

Step 2 Click **instance**. Query the IP addresses of the Kafka broker instances.

Record the IP address of any Kafka instance.

Step 3 Prepare the client based on service requirements. Log in to the node where the client is installed.

Log in to the node where the client is installed based on the client location.

Step 4 Run the following command to switch to the client installation directory, for example, **/opt/client/Kafka/kafka/bin**.

cd /opt/client/Kafka/kafka/bin

Step 5 Run the following command to configure environment variables:

source /opt/client/bigdata_env

Step 6 For clusters with Kerberos authentication enabled, run the following command to authenticate the user. For clusters with Kerberos authentication disabled, skip this step.

kinit *Kafka user*

Step 7 Manage messages in Kafka topics using the following commands:

- Producing messages

  sh kafka-console-producer.sh --broker-list *IP address of the node where the broker instance is located*:**9092 --topic** *Topic name* **--producer.config /opt/client/Kafka/kafka/config/producer.properties**

  A topic must be created in advance. You can input specified information as the messages produced by the producer and then press **Enter** to send the messages. To end message producing, press **Ctrl + C** to exit.

- Consuming messages

  Start another client connection and run the following commands to consume messages in the topic:

  cd /opt/client/Kafka/kafka/bin

  source bigdata_env

  sh kafka-console-consumer.sh --topic *Topic name* **--bootstrap-server** *IP address of the node where the broker instance is located*:**9092 --consumer.config /opt/client/Kafka/kafka/config/consumer.properties**

  In the configuration file, **group.id** (indicating the consumer group) is set to **example-group1** by default. Users can change the value as required. The value takes effect each time consumption occurs.

  By default, the system reads unprocessed messages in the current consumer group when the command is executed. If a new consumer group is specified in the configuration file and the **--from-beginning** parameter is added to the command, the system reads all messages that have not been automatically deleted in Kafka.

----End

15.6 Synchronizing Binlog-based MySQL Data to the MRS Cluster

This section describes how to use the Maxwell data synchronization tool to migrate offline binlog-based data to an MRS Kafka cluster.

Maxwell is an open source application that reads MySQL binlogs, converts operations, such as addition, deletion, and modification, into JSON format, and sends them to an output end, such as a console, a file, and Kafka. Maxwell can be deployed on a MySQL server or on other servers that can communicate with MySQL.

Maxwell runs on a Linux server, including EulerOS, Ubuntu, Debian, CentOS, and OpenSUSE. Java 1.8+ must be supported.

The following provides details about data synchronization.

1. **Configuring MySQL**
2. **Installing Maxwell**
3. **Configuring Maxwell**
4. **Starting Maxwell**
5. **Verifying Maxwell**

6. **Stopping Maxwell**
7. **Format of the Maxwell Generated Data and Description of Common Fields**

Configuring MySQL

Step 1 Start the binlog, open the **my.cnf** file in MySQL, and check whether **server_id**, **log-bin**, and **binlog_format** are configured in the **[mysqld]** block. If they are not configured, run the following command to add configuration items and restart MySQL. If they are configured, skip this step.

```
$ vi my.cnf

[mysqld]
server_id=1
log-bin=master
binlog_format=row
```

Step 2 Maxwell needs to connect to MySQL, create a database named **maxwell** for storing metadata, and access the database to be synchronized. Therefore, you are advised to create a MySQL user for Maxwell to use. Log in to MySQL as user **root** and run the following commands to create a user named **maxwell** (*XXXXXX* indicates the password and needs to be replaced with actual one).

- If Maxwell is deployed on a non-MySQL server, the created user **maxwell** must have a permission to remotely log in to the database. In this case, run the following command to create the user:

  mysql> GRANT ALL on maxwell.* to 'maxwell'@'%' identified by 'XXXXXX';

  mysql> GRANT SELECT, REPLICATION CLIENT, REPLICATION SLAVE on *.* to 'maxwell'@'%';

- If Maxwell is deployed on the MySQL server, the created user **maxwell** can be configured to log in to the database only on the local host. In this case, run the following command:

  mysql> GRANT SELECT, REPLICATION CLIENT, REPLICATION SLAVE on *.* to 'maxwell'@'localhost' identified by 'XXXXXX';

  mysql> GRANT ALL on maxwell.* to 'maxwell'@'localhost';

----End

Installing Maxwell

Step 1 Download the installation package at **https://github.com/zendesk/maxwell/releases** and select the **maxwell-XXX.tar.gz** binary file for download. In the file name, **XXX** indicates a version number.

Step 2 Upload the **tar.gz** package to any directory (the **/opt** directory of the Master node used as an example here).

Step 3 Log in to the server where Maxwell is deployed and run the following command to go to the directory where the **tar.gz** package is stored.

cd /opt

Step 4 Run the following commands to decompress the **maxwell-XXX.tar.gz** package and go to the **maxwell-XXX** directory:

tar -zxvf maxwell-XXX.tar.gz

cd maxwell-XXX

----End

Configuring Maxwell

If the **conf** directory exists in the **maxwell-XXX** folder, configure the **config.properties** file. For details about the configuration items, see **Table 15-2**. If the **conf** directory does not exist, change **config.properties.example** in the **maxwell-XXX** folder to **config.properties**.

Table 15-2 Maxwell configuration item description

Parameter	Mandatory	Description	Default Value
user	Yes	Name of the user for connecting to MySQL, that is, the user created in **Step 2**.	-
password	Yes	Password for connecting to MySQL	-
host	No	MySQL address	localhost
port	No	MySQL port	3306
log_level	No	Log print level. The options are as follows: • debug • info • warn • error	info
output_ddl	No	Whether to send a DDL (modified based on definitions of the database and data table) event • **true**: Send DDL events. • **false**: Do not send DDL events.	false
producer	Yes	Producer type. Set this parameter to **kafka**. • **stdout**: Log the generated events. • **kafka**: Send the generated events to Kafka.	stdout
producer_partition_by	No	Partition policy used to ensure that data of the same type is written to the same partition of Kafka. • **database**: Events of the same database are written to the same partition of Kafka. • **table**: Events of the same table are written to the same partition of Kafka.	databa

Parameter	Mandatory	Description	Default Value
ignore_producer_error	No	Specifies whether to ignore the error that the producer fails to send data. • **true**: The error information is logged and the error data is skipped. The program continues to run. • **false**: The error information is logged and the program is terminated.	true
metrics_slf4j_interval	No	Interval for outputting statistics on data successfully uploaded or failed to be uploaded to Kafka in logs. The unit is second.	60
kafka.bootstrap.servers	Yes	Address of the Kafka proxy node. The value is in the format of **HOST:PORT[,HOST:PORT]**.	-
kafka_topic	No	Name of the topic that is written to Kafka	maxwell
dead_letter_topic	No	Kafka topic used to record the primary key of the error log record when an error occurs when the record is sent	-
kafka_version	No	Kafka producer version used by Maxwell, which cannot be configured in the **config.properties** file. You need to use the **--kafka_version xxx** parameter to import the version number when starting the command.	-
kafka_partition_hash	No	Kafka topic partitioning algorithm. The value can be **default** or **murmur3**.	default
kafka_key_format	No	Key generation method of the Kafka record. The value can be **array** or **Hash**.	Hash
ddl_kafka_topic	No	Topic that is written to the DDL operation when **output_ddl** is set to **true**	{kafka_topic}

Parameter	Mandatory	Description	Default Value
filter	No	Used to filter databases or tables. ● If only the **mydatabase** database needs to be collected, set this parameter to the following: exclude: *.*,include: mydatabase.* ● If only the **mydatabase.mytable** table needs to be collected, set this parameter to the following: exclude: *.*,include: mydatabase.mytable ● If only the **mytable**, **mydate_123**, and **mydate_456** tables in the **mydatabase** database need to be collected, set this parameter to the following: exclude: *.*,include: mydatabase.mytable, include: mydatabase./mydate_\\d*/	-

Starting Maxwell

Step 1 Log in to the server where Maxwell is deployed.

Step 2 Run the following command to go to the Maxwell installation directory:

cd /opt/maxwell-1.21.0/

NOTE

For the first time to use Maxwell, you are advised to change **log_level** in **conf/config.properties** to **debug** (debug level) so that you can check whether data can be obtained from MySQL and sent to Kafka after startup. After the entire process is debugged, change **log_level** to **info**, and then restart Maxwell for the modification to take effect.

```
# log level [debug | info | warn | error]
log_level=debug
```

Step 3 Run the following commands to start Maxwell:

source /opt/client/bigdata_env

bin/Maxwell

**bin/maxwell --user='maxwell' --password='XXXXXX' --host='127.0.0.1' **

--producer=kafka --kafka.bootstrap.servers=kafkahost:9092 --kafka_topic=Maxwell

In the preceding commands, **user**, **password**, and **host** indicate the username, password, and IP address of MySQL, respectively. You can configure the three parameters by modifying configurations of the configuration items or using the preceding commands. **kafkahost** indicates the IP address of the Core node in the streaming cluster.

If information similar to the following appears, Maxwell has started successfully:

```
Success to start Maxwell [78092].
```

----End

Verifying Maxwell

Step 1 Log in to the server where Maxwell is deployed.

Step 2 View the logs. If the log file does not contain an ERROR log and the following information is displayed, the connection between Maxwell and MySQL is normal:

```
BinlogConnectorLifecycleListener - Binlog connected.
```

Step 3 Log in to the MySQL database and update, create, or delete test data. The following provides operation statement examples for your reference.

```
--Creating a database
create database test;
--Creating a table
create table test.e (
  id int(10) not null primary key auto_increment,
  m double,
  c timestamp(6),
  comment varchar(255) charset 'latin1'
);
-- Adding a record
insert into test.e set m = 4.2341, c = now(3), comment = 'I am a creature of light.';
--Updating a record
update test.e set m = 5.444, c = now(3) where id = 1;
--Deleting a record
delete from test.e where id = 1;
--Modifying a table
alter table test.e add column torvalds bigint unsigned after m;
--Deleting a table
drop table test.e;
-- Deleting a database
drop database test;
```

Step 4 Check the Maxwell logs. If no WARN/ERROR is displayed, Maxwell is installed and configured properly.

To check whether the data is successfully uploaded, set **log_level** in the **config.properties** file to **debug**. When the data is successfully uploaded, the following JSON data is printed immediately. For details about the fields, see **Format of the Maxwell Generated Data and Description of Common Fields**.

```
{"database":"test","table":"e","type":"insert","ts":1541150929,"xid":60556,"commit":true,"data":
{"id":1,"m":4.2341,"c":"2018-11-02 09:28:49.297000","comment":"I am a creature of light."}}
......
```

NOTE

After the entire process is debugged, you can change the value of **log_level** in the **config.properties** file to **info** to reduce the number of logs to be printed and restart Maxwell for the modification to take effect.

```
# log level [debug | info | warn | error]
log_level=info
```

----End

Stopping Maxwell

Step 1 Log in to the server where Maxwell is deployed.

Step 2 Run the command to obtain the Maxwell process ID (PID). The second field in the command output is PID.

ps -ef | grep Maxwell | grep -v grep

Step 3 Run the following command to forcibly stop the Maxwell process:

kill -9 PID

----End

Format of the Maxwell Generated Data and Description of Common Fields

The data generated by Maxwell is in JSON format. The common fields are described as follows:

- **type**: operation type. The options are **database-create**, **database-drop**, **table-create**, **table-drop**, **table-alter**, **insert**, **update**, and **delete**.
- **database**: name of the database to be operated
- **ts**: operation time, which is a 13-digit timestamp
- **table**: name of the table to be operated
- **data**: content after data is added, deleted, or modified
- **old**: content before data is modified or schema definition before a table is modified
- **sql**: SQL statement for DDL operations
- **def**: schema definition for table creation and modification
- **xid**: unique ID of an object
- **commit**: check whether such operations as data addition, deletion, and modification have been submitted.

15.7 Creating a Kafka Role

Scenario

Create and configure a Kafka role as an MRS cluster administrator.

NOTE

Users can create Kafka roles only in security mode.

If the current component uses Ranger for permission control, you need to configure permission management policies based on Ranger. For details, see **Adding a Ranger Access Permission Policy for Kafka**.

Prerequisites

The MRS cluster administrator has understood service requirements.

Procedure

Step 1 Log in to FusionInsight Manager and choose **System** > **Permission** > **Role**.

Step 2 On the displayed page, click **Create Role** and enter a **Role Name** and **Description**.

Step 3 On the **Configure Resource Permission** page, choose *Name of the desired cluster* > **Kafka**.

Step 4 Select permissions based on service requirements. For details about configuration items, see **Table 15-3**.

Table 15-3 Description

Scenario	Role Authorization
Setting the Kafka administrator permissions	In the **Configure Resource Permission** table, choose *Name of the desired cluster* > **Kafka** > **Kafka Manager Privileges**. **NOTE** This permission allows you to create and delete topics, but does not allow you to produce or consume any topics.
Setting the production permission of a user on a topic	1. In the **Configure Resource Permission** table, choose *Name of the desired cluster* > **Kafka** > **Kafka Topic Producer And Consumer Privileges**. 2. In the **Permission** column of the specified topic, select **Kafka Producer Permission**.
Setting the consumption permission of a user on a topic	1. In the **Configure Resource Permission** table, choose *Name of the desired cluster* > **Kafka** > **Kafka Topic Producer And Consumer Privileges**. 2. In the **Permission** column of the specified topic, select **Kafka Consumer Privileges**.

Step 5 Click **OK**, and return to the **Role** page.

----End

15.8 Kafka Common Parameters

Navigation path for setting parameters:

For details about how to set parameters, see **Modifying Cluster Service Configuration Parameters**.

Common Parameters

Table 15-4 Parameter description

Parameter	Description	Default Value
log.dirs	List of Kafka data storage directories. Use commas (,) to separate multiple directories.	% {@auto.detect.datapart.bk.log.logs}
KAFKA_HEAP_OPTS	Specifies the JVM option used for Kafka to start broker. It is recommended that you set this parameter based on service requirements.	-Xmx6G -Xms6G
auto.create.topics.enable	Indicates whether a topic is automatically created. If this parameter is set to **false**, you need to run a command to create a topic before sending a message.	true
default.replication.factor	Default number of replicas of a topic is automatically created.	2
monitor.preInitDelay	Delay of the first health check after the server is started. If the startup takes a long time, increase the value of the parameter. Unit: millisecond	600,000

Timeout Parameters

Table 15-5 Broker-related timeout parameters

Parameter	Description	Default Value	Impact
controller.socket.timeout.ms	Specifies the timeout for connecting controller to broker. Unit: millisecond	30,000	Generally, retain the default value of this parameter.

Parameter	Description	Default Value	Impact
group.max.session.timeout.ms	Specifies the maximum session timeout during the consumer registration. Unit: millisecond	1800000	The configured value must be less than the value of this parameter.
group.min.session.timeout.ms	Specifies the minimum session timeout during the consumer registration. Unit: millisecond	6,000	The configured value must be greater than the value of this parameter.
offsets.commit.timeout.ms	Specifies the timeout for the Offset to submit requests. Unit: millisecond	5,000	This parameter specifies the maximum delay for processing an Offset request.
replica.socket.timeout.ms	Specifies the timeout of the request for synchronizing replica data. Its value must be greater than or equal to that of the **replica.fetch.wait.max.ms** parameter. Unit: millisecond	30,000	Specifies the maximum timeout for establishing a channel before the synchronization thread sends a synchronization request. The value must be greater than that of the **replica.fetch.wait.max.ms** parameter.
request.timeout.ms	Specifies the timeout for waiting for a response after the client sends a connection request. If no response is received within the timeout, the client resends the request. A request failure is returned after the maximum retry times is reached. Unit: millisecond	30,000	This parameter is configured when the networkclient connection is transferred in the controller and replica threads on the broker node.
transaction.max.timeout.ms	Specifies the maximum timeout allowed by the transaction. If the client request time exceeds the value of this parameter, broker returns an error in InitProducerIdRequest. This prevents a long client request timeout, ensuring that consumer can receive topics. Unit: millisecond	900,000	Specifies the maximum timeout for transactions.

Parameter	Description	Default Value	Impact
user.group.cache.timeout.sec	Specifies the time when the user group information is stored in the cache. Unit: second	300	Specifies the time for caching the mapping between users and user groups. If time exceeds the threshold, the system automatically runs the **id -Gn** command to query the user information. During this period, the mapping in the cache is used.
zookeeper.connection.timeout.ms	Specifies the timeout for connecting to ZooKeeper. Unit: millisecond	45,000	This parameter specifies the duration for connecting the ZooKeeper and zkclient for the first time. If the duration exceeds the value of this parameter, the zkclient automatically disconnects the connection.

Parameter	Description	Default Value	Impact
zookeeper.session.timeout.ms	Specifies the ZooKeeper session timeout duration. During this period, ZooKeeper disconnects the connection if broker does not report its heartbeats to ZooKeeper. Unit: millisecond	45,000	ZooKeeper session timeout has the following functions: 1) Based on value of this parameter and the number of ZooKeeper URLs in ZKURL, if the connection duration exceeds the node timeout value (sessionTimeout/ Number of transferred ZooKeeper URLs), the connection fails and the system attempts to connect to the next node. 2) After the connection is established, a session (for example, the temporary BrokerId node registered on the ZooKeeper) is cleared by the ZooKeeper a session timeout later if the broker is stopped.

Table 15-6 Producer-related timeout parameters

Parameter	Description	Default Value	Impact
request.timeout.ms	Specifies the timeout of a message request.	30,000	If a network fault occurs, increase the value of this parameter. If the value is too small, the Batch Expire occurs.

Table 15-7 Consumer-related timeout parameters

Parameter	Description	Default Value	Impact
connections.max.idle.ms	Specifies the maximum retention period for idle connections.	600,000	If the idle connection time is greater than this parameter value, this connection is disconnected. If necessary, a new connection is created.
request.timeout.ms	Specifies the timeout for consumer requests.	30,000	If the request times out, the request will fail and be sent again.

15.9 Safety Instructions on Using Kafka

Brief Introduction to Kafka APIs

- Producer API

  Indicates the API defined in **org.apache.kafka.clients.producer.KafkaProducer**. When **kafka-console-producer.sh** is used, the API is used by default.

- Consumer API

  Indicates the API defined in **org.apache.kafka.clients.consumer.KafkaConsumer**. When **kafka-console-consumer.sh** is used, the API is used by default.

NOTE

Kafka no longer support old Producer or Consumer APIs.

Protocol Description for Accessing Kafka

The protocols used to access Kafka are as follows: PLAINTEXT, SSL, SASL_PLAINTEXT, and SASL_SSL.

When Kafka service is started, the security authentications using the PLAINTEXT and SASL_PLAINTEXT protocols are started. You can set **ssl.mode.enable** to **true** in Kafka service configuration to start the security authentications using SSL and SASL_SSL protocols. The following table describes the four protocols:

Protocol	Description	Default Port
PLAINTEXT	Supports plaintext access without authentication.	9092

Protocol	Description	Default Port
SASL_PLAINTEXT	Supports Kerberos users' plaintext access or access using keytab.	21007
SSL	Supports SSL-encrypted access without authentication.	9093
SASL_SSL	Supports SSL-encrypted access with Kerberos authentication.	21009

ACL Settings for a Topic

To view and set topic permission information, run the **kafka-acls.sh** script on the Linux client. For details, see **Managing Kafka User Permissions**.

Use of Kafka APIs in Different Scenarios

- Scenario 1: accessing the topic with an ACL

Used API	User Group	Client Parameter	Server Parameter	Accessed Port
API	Users need to meet one of the following conditions: • Assigned the **System_administrator** role • In the **kafkaadmin** group • In the **kafkasuperuser** group • In the **kafka** group and be authorized	security.inter.broker.protocol=SASL_PLAINTEXT sasl.kerberos.service.name = kafka	-	sasl.port (The default number is 21007.)
		security.protocol=SASL_SSL sasl.kerberos.service.name = kafka	Set **ssl.mode.enable** to **true**.	sasl-ssl.port (The default number is 21009.)

- Scenario 2: accessing the topic without an ACL

Used API	User Group	Client Parameter	Server Parameter	Accessed Port
API	Users need to meet one of the following conditions: • Assigned the **System_administrator** role • In the **kafkaadmin** group • In the **kafkasuperuser** group	security.protocol=SASL_PLAINTEXT sasl.kerberos.service.name = kafka	-	sasl.port (The default number is 21007.)
	Users are in the **kafka** group.		Set **allow.everyone.if.no.acl.found** to **true**. **NOTE** In normal mode, the server parameter **allow.everyone.if.no.acl.found** does not need to be modified.	sasl.port (The default number is 21007.)
	Users need to meet one of the following conditions: • Assigned the **System_administrator** role • In the **kafkaadmin** group • In the **kafkasuperuser** group	security.protocol=SASL_SSL sasl.kerberos.service.name = kafka	Set **ssl.mode.enable** to **true**.	sasl-ssl.port (The default number is 21009.)

Used API	User Group	Client Parameter	Server Parameter	Accessed Port
	Users are in the **kafka** group.		1. Set **allow.everyone.if.no.acl.found** to **true**. 2. Set **ssl.mode.enable** to **true**.	sasl-ssl.port (The default number is 21009.)
	-	security.protocol=PLAINTEXT	Set **allow.everyone.if.no.acl.found** to **true**.	port (The default number is 9092.)
	-	security.protocol=SSL	1. Set **allow.everyone.if.no.acl.found** to **true**. 2. Set **ssl.mode.enable** to **true**.	ssl.port (The default number is 9063.)

15.10 Kafka Specifications

Upper Limit of Topics

The maximum number of topics depends on the number of file handles (mainly used by data and index files on site) opened in the process.

1. Run the **ulimit -n** command to view the maximum number of file handles that can be opened in the process.
2. Run the **lsof -p** *<Kafka PID>* command to view the file handles (which may keep increasing) that are opened in the Kafka process on the current single node.
3. Determine whether the maximum number of file handles will be reached and whether the running of Kafka is affected after required topics are created, and estimate the maximum size of data that each partition folder can store and the number of data (*.log file, whose default size is 1 GB and can be adjusted by modifying **log.segment.bytes**) and index (*.index file, whose default size is 10 MB and can be adjusted by modifying **log.index.size.max.bytes**) files that will be produced after required topics are created.

Number of Concurrent Consumers

In an application, it is recommended that the number of concurrent consumers in a group be the same as the number of partitions in a topic, ensuring that a consumer consumes data in only a specified partition. If the number of concurrent consumers is more than the number of partitions, the redundant consumers have no data to consume.

Relationship Between Topic and Partition

- If *K* Kafka nodes are deployed in the cluster, each node is configured with *N* disks, the size of each disk is *M*, the cluster contains *n* topics (named as T1, T2, ..., Tn), the data input traffic per second of the *m* topic is *X* (Tm) MB/s, the number of configured replicas is *R* (Tm), and the configured data retention time is *Y* (Tm) hour, the following requirement must be met:

$$M \times N \times K > \sum_{i=T1}^{Tn} (X(i)R(i)Y(i) \times 3600)$$

- If the size of a disk is *M*, the disk has *n* partitions (named as P0, P1, ..., Pn), the data write traffic per second of the *m* partition is *Q* (Pm) MB/s (calculation method: data traffic of the topic to which the *m* partition belongs divided by the number of partitions), and the data retention time is *T* (Pm) hours, the following requirement must be met for the disk:

$$M > \sum_{i=P0}^{Pn} (Q(i)T(i) \times 3600)$$

- Based on the throughput, if the throughput that can be reached by the producer is *P*, the throughput that can be reached by the consumer is *C*, and the expected throughput of Kafka is *T*, it is recommended that the number of partitions of the topic be set to Max(T/P, T/C).

NOTE

- In a Kafka cluster, more partitions mean higher throughput. However, too many partitions also pose potential impacts, such as a file handle increase, unavailability increase (for example, if a node is faulty, the time window becomes large after the leader is reselected in some partitions), and end-to-end latency increase.
- Suggestion: The disk usage of a partition is smaller than or equal to 100 GB; the number of partitions on a node is smaller than or equal to 3,000; the number of partitions in the entire cluster is smaller than or equal to 10,000.

15.11 Using the Kafka Client

Scenario

This section guides users to use a Kafka client in an O&M or service scenario.

Prerequisites

- The client has been installed. For example, the installation directory is **/opt/client**.

- Service component users have been created by the MRS cluster administrator. Machine-machine users need to download the keytab file. A human-machine user must change the password upon the first login. (Not involved in normal mode)
- After changing the domain name of a cluster, redownload the client to ensure that the **kerberos.domain.name** value in the configuration file of the client is set to the correct server domain name.

Procedure

Step 1 Log in to the node where the client is installed as the client installation user.

Step 2 Run the following command to go to the client installation directory:

cd /opt/client

Step 3 Run the following command to configure environment variables:

source bigdata_env

Step 4 Run the following command to perform user authentication (skip this step in normal mode):

kinit *Component service user*

Step 5 Run the following command to switch to the Kafka client installation directory:

cd Kafka/kafka/bin

Step 6 Run the following command to use the client tool to view and use the help information:

- **./kafka-console-consumer.sh**: Kafka message reading tool
- **./kafka-console-producer.sh**: Kafka message publishing tool
- **./kafka-topics.sh**: Kafka topic management tool

----End

15.12 Configuring Kafka HA and High Reliability Parameters

Scenario

For the Kafka message transmission assurance mechanism, different parameters are available for meeting different performance and reliability requirements. This section describes how to configure Kafka high availability (HA) and high reliability parameters.

Impact on the System

- Impact of HA and high performance configurations:

NOTICE

After HA and high performance are configured, the data reliability decreases. Specifically, data may be lost if disks or nodes are faulty or Kafka is restarted.

- Impact of high reliability configurations:
  - Deteriorated performance

    If **ack** is set to **–1**, data written is considered as successful only when data is written to multiple replicas. As a result, the delay of a single message increases and the client processing capability decreases. The impact is subject to the actual test data.
  - Reduced availability

    A replica that is not in the ISR list cannot be elected as a leader. If the leader goes offline and other replicas are not in the ISR list, the partition remains unavailable until the leader node recovers. When the node where a replica of a partition is located is faulty, the minimum number of successful replicas cannot be met. As a result, service writing fails.
- If parameters are at the service level, Kafka needs to be restarted. You are advised to modify the service-level configuration in the change window.

Parameter Description

- If services require high availability and high performance,

  set the parameters listed in **Table 15-8** on the server. For details about the parameter configuration entry, see **Modifying Cluster Service Configuration Parameters**.

  Table 15-8 Server HA and high performance parameters

Parameter	Default Value	Description
unclean.leader.election.enable	true	Specifies whether a replica that is not in the ISR can be selected as the leader. If this parameter is set to **true**, data may be lost.
auto.leader.rebalance.enable	true	Specifies whether the leader automated balancing function is used. If this parameter is set to **true**, the controller periodically balances the leader of each partition on all nodes and assigns the leader to a replica with a higher priority.
min.insync.replicas	1	Specifies the minimum number of replicas to which data is written when **acks** is set to **-1** for the Producer.

Set the parameters listed in **Table 15-9** in the client configuration file **producer.properties**. The path for storing **producer.properties** is **/opt/client/Kafka/kafka/config/producer.properties**, where **/opt/client** indicates the installation directory of the Kafka client.

Table 15-9 Client HA and high performance parameters

Parameter	Default Value	Description
acks	1	The leader needs to check whether the message has been received and determine whether the required operation has been processed. This parameter affects message reliability and performance. ● If this parameter is set to **0**, the producer does not wait for any response from the server, and the message is considered successful. ● If this parameter is set to **1**, when the leader of the replica verifies that data has been written into the cluster, the leader returns a response without waiting for data to be written to all replicas. In this case, if the leader is abnormal when the leader makes the confirmation but replica synchronization is not complete, data will be lost. ● If this parameter is set to **-1**, the message is considered to be successfully received only when all synchronized replicas are confirmed. If the **min.insync.replicas**

Parameter	Default Value	Description
		parameter is also configured, data can be written into multiple replicas. In this case, records will not be lost as long as one replica remains active.

- To ensure high data reliability for services,

  set the parameters listed in **Table 15-10** on the server. For details about the parameter configuration entry, see **Modifying Cluster Service Configuration Parameters**.

  Table 15-10 Server HA parameters

Parameter	Recommended Value	Description
unclean.leader.election.enable	false	A replica that is not in the ISR list cannot be elected as a leader.
min.insync.replicas	2	Specifies the minimum number of replicas to which data is written when **acks** is set to **-1** for the Producer. Ensure that the value of **min.insync.replicas** is equal to or less than that of **replication.factor**.

Set the parameters listed in **Table 15-11** in the client configuration file **producer.properties**. The path for storing **producer.properties** is **/opt/client/Kafka/kafka/config/producer.properties**, where **/opt/client** indicates the installation directory of the Kafka client.

Table 15-11 Server HA parameters

Parameter	Recommended Value	Description
acks	-1	The leader needs to check whether the message has been received and determine whether the required operation has been processed. If this parameter is set to **-1**, the message is considered to be successfully received only when all replicas in the ISR list have confirmed to receive the message. This parameter is used along with **min.insync.replicas** to ensure that multiple copies are successfully written. As long as one copy is active, the record will not be lost. If this parameter is set to **-1**, the production performance deteriorates. Therefore, you need to set this parameter based on the actual situation.

Configuration Suggestions

Configure parameters based on requirements on reliability and performance in the following service scenarios:

- For valued data, you are advised to configure RAID1 or RAID5 for Kafka data directory disks to improve data reliability when a single disk is faulty.
- For parameters that can be modified at the topic level, the service level configurations are used by default.

  These parameters can be separately configured based on topic reliability requirements. For example, log in to the Kafka client as user **root**, and run the following command to configure the reliability parameter with topic named test in the client installation directory:

  cd Kafka/kafka/bin

  kafka-topics.sh --zookeeper 192.168.1.205:2181/kafka --alter --topic test --config unclean.leader.election.enable=false --config min.insync.replicas=2

192.168.1.205 indicates the ZooKeeper service IP address.

- If parameters are at the service level, Kafka needs to be restarted. You are advised to modify the service-level configuration in the change window.

15.13 Changing the Broker Storage Directory

Scenario

When a broker storage directory is added, the MRS cluster administrator needs to change the broker storage directory on FusionInsight Manager, to ensure that the Kafka can work properly. The new topic partition will be generated in the directory that has fewest partitions. Changing the ZooKeeper storage directory includes the following scenarios:

NOTE

Because Kafka does not detect disk capacity, ensure that the disk quantity and capacity configured for each Broker instance are the same.

- Change the storage directory of the Broker role. In this way, the storage directories of all Broker instances are changed.
- Change the storage directory of a single Broker instance. In this way, only the storage directory of this Broker instance is changed, and the storage directories of other Broker instances remain the same.

Impact on the System

- Changing the Broker role storage directory requires the restart of services. The services cannot be accessed during the restart.
- The storage directory of a single Broker instance can be changed only after the instance is restarted. The instance cannot provide services during the restart.
- The directory for storing service parameter configurations must also be updated.

Prerequisites

- New disks have been prepared and installed on each data node, and the disks are formatted.
- The Kafka client has been installed.
- When you change the storage directory of a single Broker instance, the number of active Broker instances must be greater than the number of backups specified during topic creation.

Procedure

Changing the storage directory of the Kafka role

Step 1 Log in as user **root** to each node on which the Kafka service is installed, and perform the following operations:

1. Create a target directory.

For example, to create the target directory **${BIGDATA_DATA_HOME}/kafka/data2**, run the following command:

mkdir ${BIGDATA_DATA_HOME}/kafka/data2

2. Mount the directory to the new disk. For example, mount **${BIGDATA_DATA_HOME}/kafka/data2** to the new disk.
3. Modify permissions on the new directory.

   For example, to modify permissions on the **${BIGDATA_DATA_HOME}/kafka/data2** directory, run the following commands:

   chmod 700 ${BIGDATA_DATA_HOME}/kafka/data2 -R and **chown omm:wheel ${BIGDATA_DATA_HOME}/kafka/data2 -R**

Step 2 Log in to FusionInsight Managerand choose **Cluster** > **Services** > **Kafka** > **Configurations**.

Step 3 Add a new directory to the end of the default value of **log.dirs**.

Enter **log.dirs** in the search box and add the new directory to the end of the default value of the **log.dirs** configuration item. Use commas (,) to separate multiple directories. For example:

${BIGDATA_DATA_HOME}/kafka/data1/kafka-logs,${BIGDATA_DATA_HOME}/kafka/data2/kafka-logs

Step 4 Click **Save**, and then click **OK**. When **Operation succeeded** is displayed, click **Finish**.

Step 5 Choose **Cluster** > **Services** > **Kafka**. In the upper right corner, choose **More** > **Restart Service** to restart the Kafka service.

Changing the storage directory of a single Kafka instance

Step 6 Log in to the Broker node as user **root** and perform the following operations:

1. Create a target directory.

   For example, to create the target directory **${BIGDATA_DATA_HOME}/kafka/data2**, run the following command:

   mkdir ${BIGDATA_DATA_HOME}/kafka/data2
2. Mount the directory to the new disk. For example, mount **${BIGDATA_DATA_HOME}/kafka/data2** to the new disk.
3. Modify permissions on the new directory.

   For example, to modify permissions on the **${BIGDATA_DATA_HOME}/kafka/data2** directory, run the following commands:

   chmod 700 ${BIGDATA_DATA_HOME}/kafka/data2 -R and **chown omm:wheel ${BIGDATA_DATA_HOME}/kafka/data2 -R**

Step 7 Log in to FusionInsight Managerand choose **Cluster** > **Services** > **Kafka** > **Instance**.

Step 8 Click the specified broker instance and switch to **Instance Configurations**.

Enter **log.dirs** in the search box and add the new directory to the end of the default value of the **log.dirs** configuration item. Use commas (,) to separate multiple directories, for example, **${BIGDATA_DATA_HOME}/kafka/data1/kafka-logs,${BIGDATA_DATA_HOME}/kafka/data2/kafka-logs**.

Step 9 Click **Save**, and then click **OK**. A message is displayed, indicating that the operation is successful. Click **Finish**.

Step 10 On the Broker instance page, choose **More** > **Restart Instance** to restart the Broker instance.

----End

15.14 Checking the Consumption Status of Consumer Group

Scenario

View the current consumption information on the client as an MRS cluster administrator based on service requirements.

Prerequisites

- The MRS cluster administrator has understood service requirements and prepared a system user.
- The Kafka client has been installed.

Procedure

Step 1 Log in as a client installation user to the node on which the Kafka client is installed.

Step 2 Switch to the Kafka client installation directory, for example, **/opt/client**.

cd /opt/client

Step 3 Run the following command to configure environment variables:

source bigdata_env

Step 4 Run the following command to perform user authentication (skip this step in normal mode):

kinit *Component service user*

Step 5 Run the following command to switch to the Kafka client installation directory:

cd Kafka/kafka/bin

Step 6 Run the **kafka-consumer-groups.sh** command to check the current consumption status.

- Check the Consumer Group list on Kafka saved by Offset:

  ./kafka-consumer-groups.sh --list --bootstrap-server <*Service IP address of any node where a broker instances is located*:*Port number of the Kafka cluster*> **--command-config ../config/consumer.properties**

  Example: **./kafka-consumer-groups.sh --bootstrap-server 192.168.1.1:21007 --list --command-config ../config/consumer.properties**

- Check the consumption status of Consumer Group on Kafka saved by Offset:

./kafka-consumer-groups.sh --describe --bootstrap-server <*Service IP address of any node where a broker instances is located*:*Port number of the Kafka cluster*> **--group** *Consumer group name* **--command-config ../config/consumer.properties**

Example: **./kafka-consumer-groups.sh --describe --bootstrap-server 192.168.1.1:21007 --group example-group --command-config ../config/consumer.properties**

- Query the statuses of multiple consumer groups in batches.

  ./kafka-consumer-groups.sh --bootstrap-server <*Service IP address of any node where a broker instances is located*:*Port number of the Kafka cluster*> **--list --state --command-config ../config/consumer.properties**

  Example:

  – List the statuses of all consumer groups.

  ./kafka-consumer-groups.sh --describe --bootstrap-server 192.168.1.1:21007 --list --state --command-config ../config/consumer.properties

  – List all consumer groups in the stable state.

  ./kafka-consumer-groups.sh --describe --bootstrap-server 192.168.1.1:21007 --list --state stable --command-config ../config/consumer.properties

- Print the offset and header of a topic.

  ./kafka-console-consumer.sh --bootstrap-server <*Service IP address of any broker node*:*Port number of the Kafka cluster*> **--topic** *Topic name* **--from-beginning --property print.partition=true --property print.key=true --property print.timestamp=true --property print.offset=true --property print.headers=true --property key.separator='|' --consumer.config ../config/consumer.properties**

  Example: **./kafka-consumer-groups.sh --bootstrap-server 192.168.1.1:21007 --topic test --from-beginning --property print.partition=true --property print.key=true --property print.timestamp=true --property print.offset=true --property print.headers=true --property key.separator='|' --consumer.config ../config/consumer.properties**

NOTICE

1. Ensure that the current consumer is online and consumes data.
2. Configure the **group.id** in the **consumer.properties** configuration file and **--group** in the command to the group to be queried.
3. The Kafka cluster's IP port number is 21007 in security mode and 9092 in normal mode.

----End

15.15 Kafka Balancing Tool Instructions

Scenario

This section describes how to use the Kafka balancing tool on a client to balance the load of the Kafka cluster based on service requirements in scenarios such as node decommissioning, node recommissioning, and load balancing.

Prerequisites

- The MRS cluster administrator has understood service requirements and prepared a Kafka administrator (belonging to the **kafkaadmin** group. It is not required for the normal mode.).
- The Kafka client has been installed.

Procedure

Step 1 Log in as a client installation user to the node on which the Kafka client is installed.

Step 2 Switch to the Kafka client installation directory, for example, **/opt/client**.

cd /opt/client

Step 3 Run the following command to configure environment variables:

source bigdata_env

Step 4 Run the following command to authenticate the user (skip this step in normal mode):

kinit *Component service user*

Step 5 Run the following command to switch to the Kafka client installation directory:

cd Kafka/kafka

Step 6 Run the **kafka-balancer.sh** command to balance user cluster. The commonly used commands are:

- Run the **--run** command to perform cluster balancing:

  ./bin/kafka-balancer.sh --run --zookeeper *<ZooKeeper service IP address of any ZooKeeper node:zkPort/**kafka**>* **--bootstrap-server** *<Kafka cluster IP:port>* **--throttle 10000000 --consumer-config config/consumer.properties --enable-az-aware --show-details**

  This command consists of generation and execution of the balancing solution. **--show-details** is optional, indicating whether to print the solution details. **--throttle** indicates the bandwidth limit during the execution of the balancing solution. The unit is bytes per second (bytes/sec). **--enable-az-aware** indicates that the cross-AZ feature is enabled when the balancing solution is generated. When this parameter is used, ensure that the cross-AZ feature has been enabled for the cluster.

- Run the **--run** command to decommission a node:

./bin/kafka-balancer.sh --run --zookeeper *<Service IP address of any ZooKeeper node:zkPort/**kafka**>* **--bootstrap-server** *<Kafka cluster IP address:port>* **--throttle 10000000 --consumer-config config/consumer.properties --remove-brokers** *<BrokerId list>* **--enable-az-aware --force**

In the command, **--remove-brokers** indicates the list of broker IDs to be deleted. Multiple broker IDs are separated by commas (,). **--force** is optional, indicating that the disk usage alarm is ignored and the migration solution is forcibly generated. **-enable-az-aware** is optional, indicating that the cross-AZ feature is enabled when the balancing solution is generated. When this parameter is used, ensure that the cross-AZ feature has been enabled for the cluster.

NOTE

This command migrates data on the Broker nodes to be decommissioned to other Broker nodes.

- Run the following command to view the execution status:

  ./bin/kafka-balancer.sh --status --zookeeper *<Service IP address of any ZooKeeper node:zkPort/**kafka**>*

- Run the following command to generate a balancing solution:

  ./bin/kafka-balancer.sh --generate --zookeeper *<Service IP address of any ZooKeeper node:zkPort/**kafka**>* **--bootstrap-server** *<Kafka cluster IP address:port>* **--consumer-config config/consumer.properties --enable-az-aware**

  This command is used to generate a migration solution based on the current cluster status and print the solution to the console. **--enable-az-aware** is optional, indicating that the cross-AZ feature is enabled when a migration solution is generated. If this parameter is used, ensure that the cross-AZ feature has been enabled for the cluster.

- Clearing the intermediate status

  ./bin/kafka-balancer.sh --clean --zookeeper *<Service IP address of any ZooKeeper node:zkPort/**kafka**>*

  This command is used to clear the intermediate status information on the ZooKeeper when the migration is not complete.

NOTICE

The port number of the Kafka cluster's IP address is 21007 in security mode and 9092 in normal mode.

----End

Troubleshooting

During partition migration using the Kafka balancing tool, if the execution progress of the balancing tool is blocked due to a Broker fault in the cluster, you need to manually rectify the fault. The scenarios are as follows:

- The Broker is faulty because the disk usage reaches 100%.

a. Log in to FusionInsight Manager, choose **Cluster** > *Name of the desired cluster* > **Services** > **Kafka** > **Instance**, stop the Broker instance in the **Restoring** state, and record the management IP address of the node where the instance resides and the corresponding **broker.id**. You can click the role name to view the value, on the **Instance Configurations** page, select **All Configurations** and search for the **broker.id** parameter.

b. Log in to the recorded management IP address as user **root**, and run the **df -lh** command to view the mounted directory whose disk usage is 100%, for example, **${BIGDATA_DATA_HOME}/kafka/data1**.

c. Go to the directory, run the **du -sh *** command to view the size of each file in the directory, Check whether files other than files in the **kafka-logs** directory exist, and determine whether these files can be deleted or migrated.

   - If yes, delete or migrate the related data and go to **8**.
   - If no, go to **4**.

d. Go to the **kafka-logs** directory, run the **du -sh *** command, select a partition folder to be moved. The naming rule is **Topic name-Partition ID**. Record the topic and partition.

e. Modify the **recovery-point-offset-checkpoint** and **replication-offset-checkpoint** files in the **kafka-logs** directory in the same way.

   i. Decrease the number in the second line in the file. (To remove multiple directories, the number deducted is equal to the number of files to be removed.)

   ii. Delete the line of the to-be-removed partition. (The line structure is "*Topic name Partition ID Offset*". Save the data before deletion. Subsequently, the content must be added to the file of the same name in the destination directory.)

f. Modify the **recovery-point-offset-checkpoint** and **replication-offset-checkpoint** files in the destination data directory (for example, **${BIGDATA_DATA_HOME}/kafka/data2/kafka-logs**) in the same way.

   - Increase the number in the second line in the file. (To move multiple directories, the number added is equal to the number of files to be moved.)
   - Add the to-be moved partition to the end of the file. (The line structure is "*Topic name Partition ID Offset*". You can copy the line data saved in **5**.)

g. Move the partition to the destination directory. After the partition is moved, run the **chown omm:wheel -R** *Partition directory* command to modify the directory owner group for the partition.

h. Log in to FusionInsight Manager and choose **Cluster** > *Name of the desired cluster* > **Services** > **Kafka** > **Instance** to start the stopped Broker instance.

i. Wait for 5 to 10 minutes and check whether the health status of the Broker instance is **Good**.

   - If yes, resolve the disk capacity insufficiency problem according to the handling method of "ALM-38001 Insufficient Kafka Disk Capacity" after the alarm is cleared.

    - If no, contact O&M support.

  After the faulty Broker is recovered, the blocked balancing task continues. You can run the **--status** command to view the task execution progress.

- The Broker fault occurs because of other causes, the fault scenario is clear, and the fault can be rectified within a short period of time.
  a. Restore the faulty Broker according to the root cause.
  b. After the faulty Broker is recovered, the blocked balancing task continues. You can run the **--status** command to view the task execution progress.
- The Broker fault occurs because of other causes, the fault scenario is complex, and the fault cannot be rectified within a short period of time.
  a. Run the **kinit** *Kafka administrator account* command (skip this step in normal mode).
  b. Run the **zkCli.sh -server <***ZooKeeper cluster service IP address:zkPort***/kafka>** command to log in to ZooKeeper Shell.
  c. Run the **addauth krbgroup** command (skip this step in normal mode).
  d. Delete the **/admin/reassign_partitions** and **/controller** directories.
  e. Perform the preceding steps to forcibly stop the migration. After the cluster recovers, run the **kafka-reassign-partitions.sh** command to delete redundant copies generated during the intermediate process.

15.16 Kafka Token Authentication Mechanism Tool Usage

Scenario

Operations need to be performed on tokens when the token authentication mechanism is used.

This section applies to Kerberos authentication-enabled clusters.

Prerequisites

- The MRS cluster administrator has understood service requirements and prepared a system user.
- The Kafka client has been installed.

Procedure

Step 1 Log in as a client installation user to the node on which the Kafka client is installed.

Step 2 Switch to the Kafka client installation directory, for example, **/opt/client**.

cd /opt/client

Step 3 Run the following command to configure environment variables:

source bigdata_env

Step 4 Run the following command to perform user authentication:

kinit *Component service user*

Step 5 Run the following command to switch to the Kafka client installation directory:

cd Kafka/kafka/bin

Step 6 Use **kafka-delegation-tokens.sh** to perform operations on tokens.

- Generate a token for a user.

  ./kafka-delegation-tokens.sh --create --bootstrap-server <*IP1:PORT, IP2:PORT,...***> --max-life-time-period <***Long: max life period in milliseconds***> --command-config <***config file***> --renewer-principal User:<***user name***>**

  Example: **./kafka-delegation-tokens.sh --create --bootstrap-server 192.168.1.1:21007,192.168.1.2:21007,192.168.1.3:21007 --command-config ../config/producer.properties --max-life-time-period -1 --renewer-principal User:username**

- List information about all tokens of a specified user.

  ./kafka-delegation-tokens.sh --describe --bootstrap-server <*IP1:PORT, IP2:PORT,...***> --command-config <***config file***> --owner-principal User:<***user name***>**

  Example: **./kafka-delegation-tokens.sh --describe --bootstrap-server 192.168.1.1:21007,192.168.1.2:21007,192.168.1.3:21007 --command-config ../config/producer.properties --owner-principal User:username**

- Update the token validity period.

  ./kafka-delegation-tokens.sh --renew --bootstrap-server <*IP1:PORT, IP2:PORT,...***> --renew-time-period <***Long: renew time period in milliseconds***> --command-config <***config file***> --hmac <***String: HMAC of the delegation token***>**

  Example: **./kafka-delegation-tokens.sh --renew --bootstrap-server 192.168.1.1:21007,192.168.1.2:21007,192.168.1.3:21007 --renew-time-period -1 --command-config ../config/producer.properties --hmac ABCDEFG**

- Destroy a token.

  ./kafka-delegation-tokens.sh --expire --bootstrap-server <*IP1:PORT, IP2:PORT,...***> --expiry-time-period <***Long: expiry time period in milliseconds***> --command-config <***config file***> --hmac <***String: HMAC of the delegation token***>**

  Example: **./kafka-delegation-tokens.sh --expire --bootstrap-server 192.168.1.1:21007,192.168.1.2:21007,192.168.1.3:21007 --expiry-time-period -1 --command-config ../config/producer.properties --hmac ABCDEFG**

----End

15.17 Kafka Encryption and Decryption

Scenario

After a RangerKMS instance is installed for Ranger in an MRS cluster, the encryption and decryption feature is available for Kafka. You can create encrypted

Kafka topics. The client automatically encrypts data and transmits it to the Kafka service. The encrypted data is stored on a local disk. The client application reads the encrypted data from the server and automatically decrypts the data on the client.

Prerequisites

- The Ranger service and RangerKMS instance have been installed in the cluster.
- To use this function, the Kafka client JAR package of MRS is required. The open-source client is not available for this function.

Procedure

Step 1 Assign key permissions to users of different roles by referring to **Using the RangerKMS Native UI to Manage Permissions and Keys**. The following table lists the required permission.

Table 15-12 Key permission

Task	Required Key Permission
Creating a topic	• **Get Metadata**: Get the metadata of a key. • **Generate EEK**: Generate an EEK.
Producing data	• **Decrypt EEK**: Decrypt an EEK.
Consuming data	• **Decrypt EEK**: Decrypt an EEK.

Step 2 Log in to the node where the Kafka client is installed as the client installation user and run the following commands to configure environment variables and pass user authentication:

cd *Kafka client installation path*

source bigdata_env

kinit *Component service user*

Step 3 Add a configuration item to the Kafka client configuration file to enable the encryption and decryption feature.

cd Kafka/kafka/config

Add the following parameters to the **client.properties**, **producer.properties**, and **consumer.properties** files respectively and save the changes:

```
encryption.keyprovider.class = org.apache.kafka.clients.encryption.RangerKeyProvider
encryption.keymanager.class = org.apache.kafka.clients.encryption.RangerKeyManager
encryption.keyprovider.rangerkms = https://IP address of the RangerKMS instance:Port number,https://IP address of the RangerKMS instance:Port number
```

NOTICE

- With the preceding configurations, the producer writes encrypted data to the encrypted topic by default.
- Without the preceding configurations, the producer writes plaintext data to the encrypted topic by default.
- With the preceding configurations, the consumer decrypts the encrypted data in the encrypted topic by default.
- If the preceding configurations are added for the consumer and a plaintext topic is subscribed, the plaintext data will be decrypted into garbled characters.
- Without the preceding configurations, the consumer does not decrypt the encrypted data in the encrypted topic.
- To obtain the IP address of the RangerKMS instance, log in to FusionInsight Manager, choose **Cluster** > **Services** > **Ranger** > **Instances**, and view and record the service IP address.
- To obtain the port, log in to FusionInsight Manager, choose **Cluster** > **Services** > **Ranger**, and click **Configurations** > **All Configurations**. Search for **ranger.service.https.port**, and view and record the value for the RangerKMS instance.

Step 4 (Optional) Set the following parameters on the client as you need.

Parameter	Description	Default Value
kms.request.retries	Number of retries allowed to access the RangerKMS instance	2
encryption.keyprovider.rangerkms.hostname	IP address and host name of the RangerKMS instance, for example, **ip|hostname,ip2|hostanme2**	null
ranger.eek.cache.size	Number of tables for caching keys	1000
ranger.eek.max.age.second	Expiration time of cached keys, in seconds	300

Step 5 Run the following command to switch to the client directory, for example, **/opt/client/Kafka/kafka/bin**.

cd *Kafka client installation directory*/**Kafka/kafka/bin**

Step 6 Create a topic.

When you run the client script to create a topic, use **--bootstrap-server**. The **--zookeeper** command is not supported.

kafka-topics.sh --create --topic *Topic name* **--partitions 1 --replication-factor 3 --bootstrap-server** *Broker IP address*:*port*-**-command-config ../config/client.properties --config encryption.keyname=***Key name*

NOTE

- To obtain the IP address of the Broker, log in to FusionInsight Manager, choose **Cluster** > **Services** > **Kafka** > **Instances**, and view and record the service IP address.
- The port number of the Kafka cluster is defaulted to 21007 in security mode and 21005 in normal mode.
- Key name: name of the key used in **Step 1**

Step 7 Write data to the encrypted topic.

Run the client script command to write data to the encrypted topic:

sh kafka-console-producer.sh --broker-list *Broker IP address*:*Port* **--topic** Topic name**--producer.config ../config/producer.properties**

Step 8 Read encrypted topic data.

sh kafka-console-consumer.sh --topic *Topic name*--**bootstrap-server** *Broker IP address*:*Port* **--consumer.config ../config/consumer.properties**

----End

15.18 Using Kafka UI

15.18.1 Accessing Kafka UI

Scenario

After the Kafka component is installed in an MRS cluster, you can use Kafka UI to query cluster information, node status, topic partitions, and data production and consumption details. Kafka UI provides a GUI for users to create and delete topics, modify configurations, as well as add and migrate partitions, simplifying user operations and improving O&M efficiency.

Prerequisites

You have created a user who has the permission to access Kafka UI. To perform related operations on the page, for example, creating a topic, you need to grant related permissions to the user. For details, see **Managing Kafka User Permissions**.

Impact on the System

Site trust must be added to the browser when you access Manager and Kafka UI for the first time. Otherwise, Kafka UI cannot be accessed.

Procedure

Step 1 Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Kafka**.

Step 2 On the right of **KafkaManager WebUI**, click the URL to access Kafka UI.

You can perform the following operations on Kafka UI:

- Redistribute partitions in the cluster.
- Create, view, and delete topics.
- Add partitions to existing topics and modify configurations.
- View produced data in a topic.
- View broker information.
- View the consumption information about the consumer group.

----End

15.18.2 Kafka UI Overview

Scenario

After logging in to Kafka UI, you can view the basic information about the existing topics, brokers, and consumer groups in the current cluster on the home page. You can also create and delete topics, modify configurations, and add and migrate partitions in the cluster.

Procedure

Cluster Summary

Step 1 Log in to Kafka UI. For details, see **Accessing Kafka UI**.

Step 2 In the **Cluster Summary** area, view the number of existing topics, brokers, and consumer groups in the current cluster.

Step 3 Click the number under **Brokers**. The **Brokers** page is displayed. For details about the operations on this page, see **Viewing Brokers on Kafka UI**.

Click the number under **Topics**. The **Topics** page is displayed. For details about the operations on this page, see **Managing Topics on Kafka UI**.

Click the number under **Consumer Group**. The **Consumers** page is displayed. For details about the operations on this page, see **Viewing a Consumer Group on Kafka UI**.

----End

Cluster Action

Step 1 Log in to Kafka UI. For details, see **Accessing Kafka UI**.

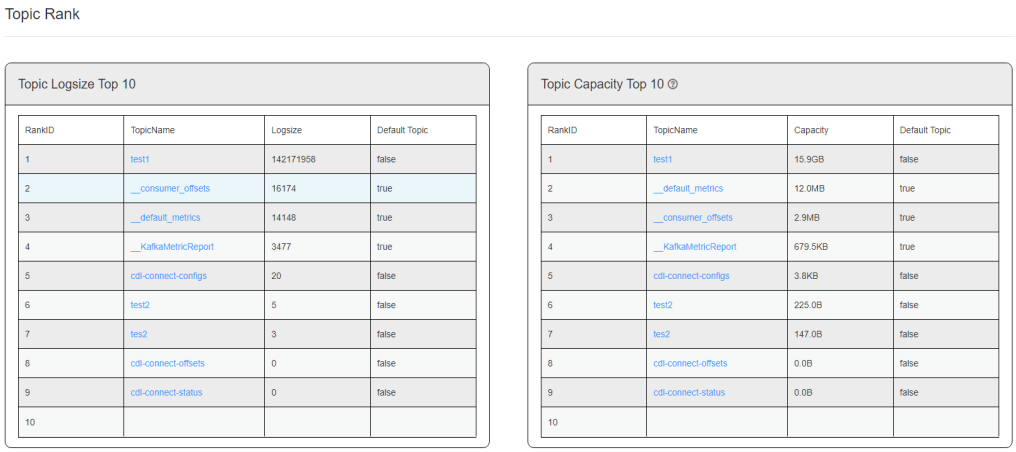
Step 2 In the **Cluster Action** area, create topics and migrate partitions. For details, see **Creating a Topic on Kafka UI** and **Migrating a Partition on Kafka UI**.

----End

Topic Rank

Step 1 Log in to Kafka UI. For details, see **Accessing Kafka UI**.

Step 2 In the **Topic Rank** column, view top 10 topics by the number of topic logs, data volume, incoming data volume, and outgoing data volume in the current cluster.



Step 3 Click a topic name in the **TopicName** column to go to the topic details page. For details about operations on the page, see **Managing Topics on Kafka UI**.

----End

15.18.3 Creating a Topic on Kafka UI

Scenario

Create a topic on Kafka UI.

Creating a Topic

Step 1 Log in to Kafka UI. For details, see **Accessing Kafka UI**.

Step 2 Click **Create Topic**. On the displayed page, configure parameters by referring to **Table 15-13** and click **Create**.

Table 15-13 Topic information

Parameter	Description	Remarks
Topic	Topic name, which can contain a maximum of 249 characters. Only letters, digits, hyphens (-), and underscores (_) are allowed.	Example: **kafka_ui**
Partitions	Number of topic partitions. The value must be greater than or equal to 1. The default value is **3**.	-
Replication Factor	Replication factor of a topic. The value ranges from 1 to *N*. *N* indicates the number of brokers in the current cluster. The default value is **2**.	-

NOTE

- You can click **Advanced Options** to set advanced topic parameters based on service requirements. Generally, retain the default values.
- In a cluster in security mode, the user who creates a topic must belong to the **kafkaadmin** user group. Otherwise, the topic cannot be created due to authentication failure.
- In a cluster in non-security mode, no authentication is required for creating a topic. That is, any user can create a topic.

----End

15.18.4 Migrating a Partition on Kafka UI

Scenario

Migrate a partition on Kafka UI.

NOTE

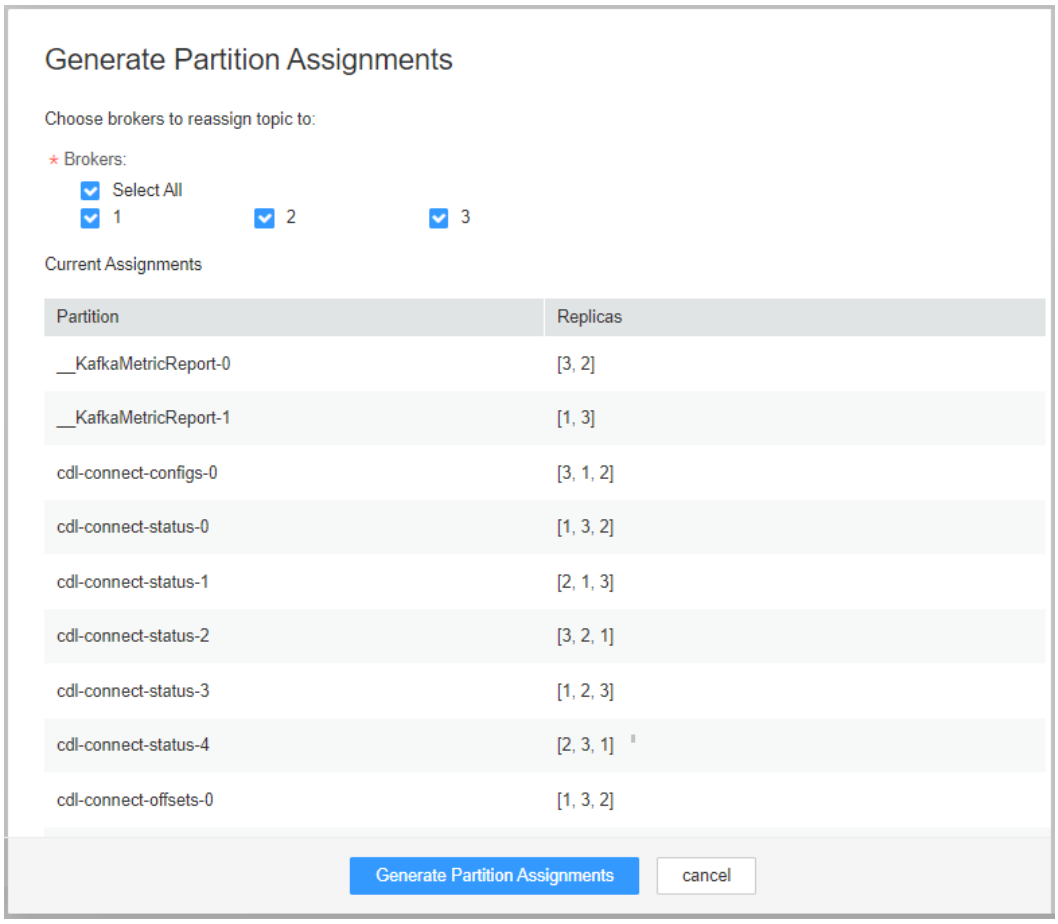
- In security mode, the user who migrates a partition must belong to the **kafkaadmin** user group. Otherwise, the operation fails due to authentication failure.
- In non-security mode, Kafka UI does not authenticate any operation.

Migrating a Partition

Step 1 Log in to Kafka UI. For details, see **Accessing Kafka UI**. Click **Generate assignment**. The **Generate Partition Assignments** page is displayed.

Step 2 In the **Brokers** area, select brokers to which the topic is to be re-assigned.

Step 3 Click **Generate Partition Assignments** to generate a partition migration solution.



Step 4 Click **Run assignment** to migrate a partition.

----End

15.18.5 Managing Topics on Kafka UI

Scenario

On Kafka UI, you can view topic details, modify topic configurations, add topic partitions, delete topics, and view the number of data records produced in different time segments in real time.

NOTE

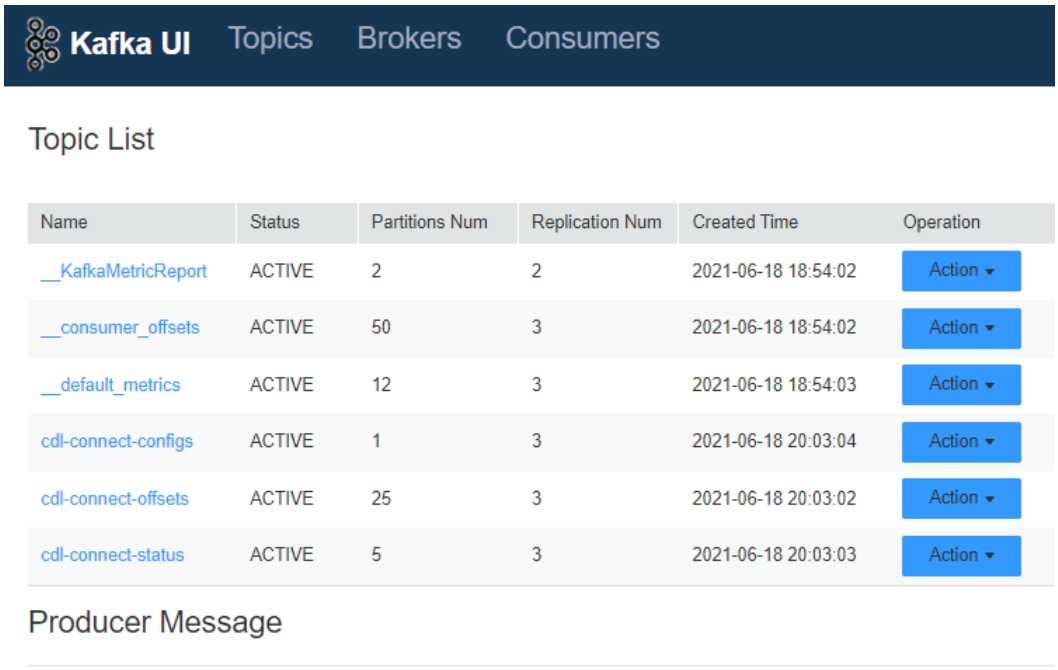
- In security mode, Kafka UI does not authenticate the operation of viewing topic details. That is, any user can query topic information. To modify topic configurations, add topic partitions, or delete topics, ensure that the Kafka UI login user belongs to the **kafkaadmin** user group or grant the corresponding operation permissions to the user. Otherwise, the authentication fails.
- In non-security mode, Kafka UI does not authenticate any operation.

Viewing Topic Details

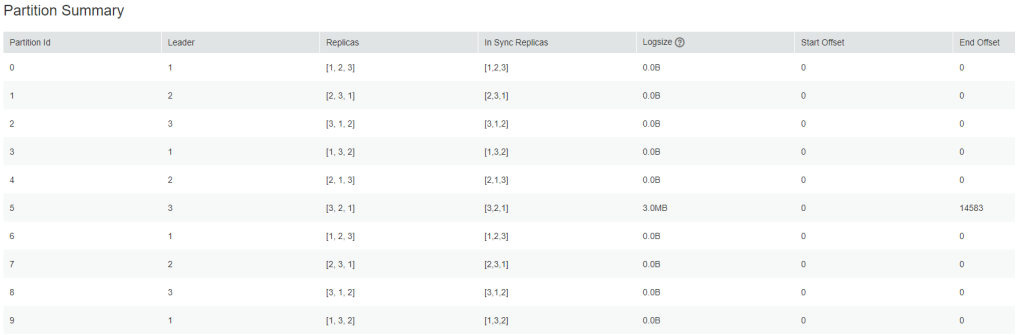
Step 1 Log in to Kafka UI. For details, see **Accessing Kafka UI**.

Step 2 Click **Topics**. The topic management page is displayed.

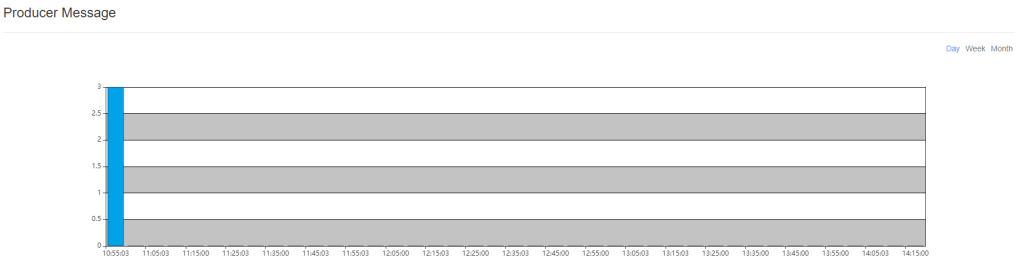
Step 3 In the **Topic List** area, you can view the names, status, number of partitions, creation time, and number of replicas of topics created in the current cluster.



Step 4 Click a topic name to view details about the topic and partition.



Step 5 In the **Producer Message** area, you can select **Day**, **Week**, or **Month** based on service requirements to view the number of data records produced in the topic.



----End

Modifying the Topic Configuration

Step 1 Log in to Kafka UI. For details, see **Accessing Kafka UI**.

Step 2 Click **Topics**. The topic management page is displayed.

Step 3 In the **Operation** column of the item to be modified, choose **Action** > **Config**. On the displayed page, change the values of **Key** and **Value** of the topic. To add multiple items, click +.

Step 4 Click **OK**.

----End

Searching for a Topic

Step 1 Log in to Kafka UI. For details, see **Accessing Kafka UI**.

Step 2 Click **Topics**. The topic management page is displayed.

Step 3 In the upper right corner of the page, enter a topic name to search for the topic.

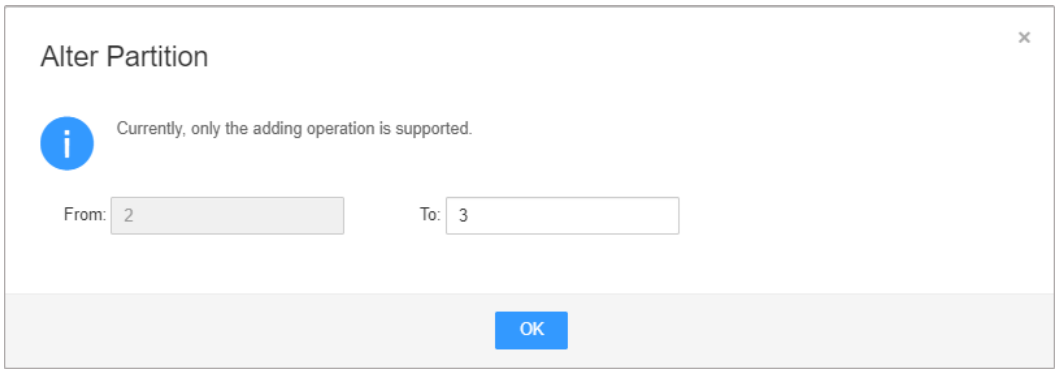
----End

Adding a Partition

Step 1 Log in to Kafka UI. For details, see **Accessing Kafka UI**.

Step 2 Click **Topics**. The topic management page is displayed.

Step 3 In the **Operation** column of the item to be modified, choose **Action** > **Alter**. On the displayed page, modify the topic partition.



NOTE

Currently, you can only add partitions to a cluster. That is, the number of partitions after modification must be greater than the number of original partitions.

Step 4 Click **OK**.

----End

Deleting a Topic

Step 1 Log in to Kafka UI. For details, see **Accessing Kafka UI**.

Step 2 Click **Topics**. The topic management page is displayed.

Step 3 In the **Operation** column of the item to be modified, choose **Action** > **Delete**.

Step 4 In the confirmation dialog box that is displayed, click **OK**.

NOTE

The default built-in topics cannot be deleted.

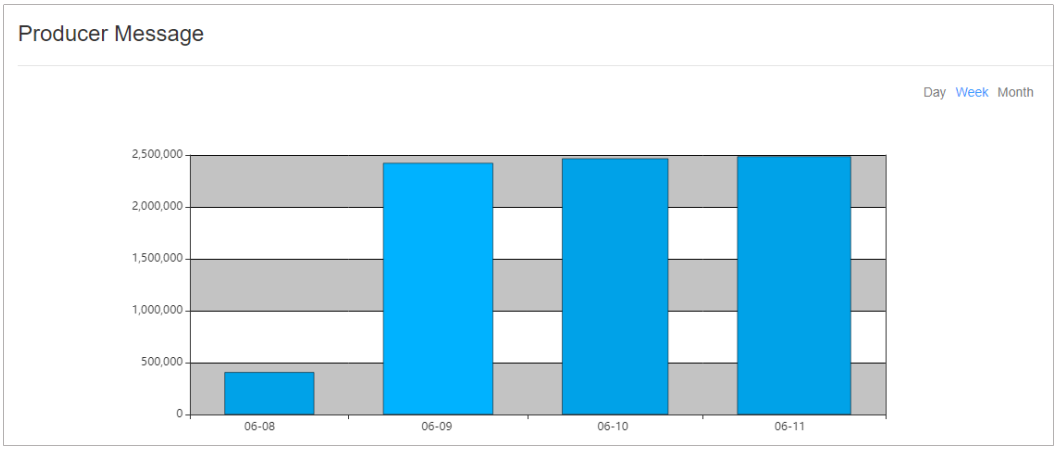
----End

Viewing the Number of Data Records Produced

Step 1 Log in to Kafka UI. For details, see **Accessing Kafka UI**.

Step 2 Click **Topics**. The topic management page is displayed.

Step 3 In the **Producer Message** area, you can select **Day**, **Week**, or **Month** to view the number of data records produced in different time ranges in the current cluster.



----End

15.18.6 Viewing Brokers on Kafka UI

Scenario

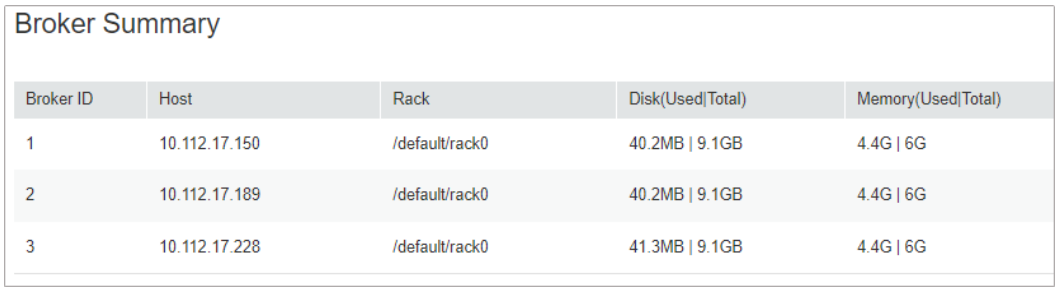
On Kafka UI, you can view broker details and JMX metrics of the broker node data traffic.

Viewing a Broker

Step 1 Log in to Kafka UI. For details, see **Accessing Kafka UI**.

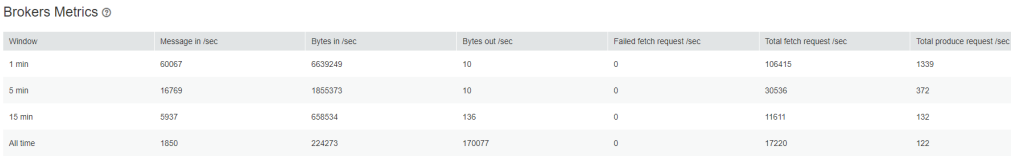
Step 2 Click **Brokers**. The broker details page is displayed.

Step 3 In the **Broker Summary** area, you can view **Broker ID**, **Host**, **Rack**, **Disk(Used|Total)**, and **Memory(Used|Total)** of brokers.


Broker Summary

Broker ID	Host	Rack	Disk(Used|Total)	Memory(Used|Total)
1	10.112.17.150	/default/rack0	40.2MB | 9.1GB	4.4G | 6G
2	10.112.17.189	/default/rack0	40.2MB | 9.1GB	4.4G | 6G
3	10.112.17.228	/default/rack0	41.3MB | 9.1GB	4.4G | 6G

Step 4 In the **Brokers Metrics** area, you can view the JMX metrics of the broker node data traffic, including the average number of incoming messages per second, number of bytes of incoming messages per second, number of bytes of outgoing messages per second, and number of failed requests per second, total number of requests per second, and number of production requests per second in different time windows.



Brokers Metrics

Window	Message in /sec	Bytes in /sec	Bytes out /sec	Failed fetch request /sec	Total fetch request /sec	Total produce request /sec
1 min	60067	6639249	10	0	106415	1339
5 min	16769	1855373	10	0	30536	372
15 min	5937	658534	136	0	11611	132
All time	1850	224273	170077	0	17220	122

----End

Searching for a Broker

Step 1 Log in to Kafka UI. For details, see **Accessing Kafka UI**.

Step 2 Click **Brokers**. The broker details page is displayed.

Step 3 In the upper right corner of the page, you can enter a host IP address or rack configuration information to search for a broker.

----End

15.18.7 Viewing a Consumer Group on Kafka UI

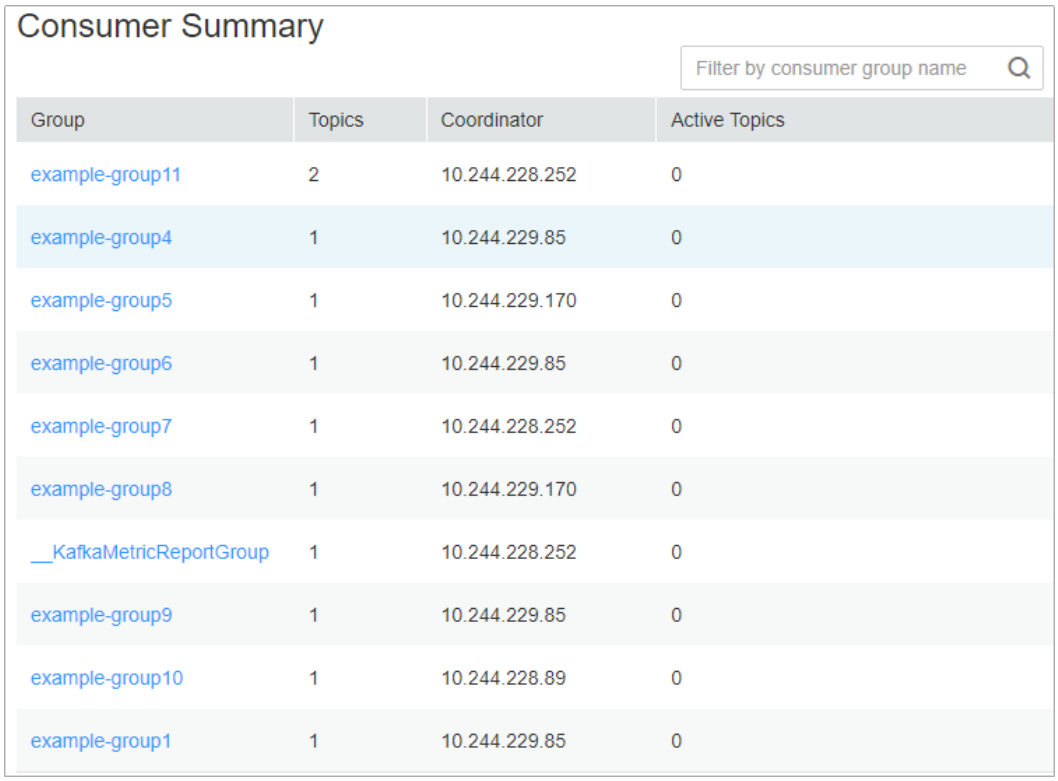
Scenario

On Kafka UI, you can view the basic information about a consumer group and the consumption status of topics in the group.

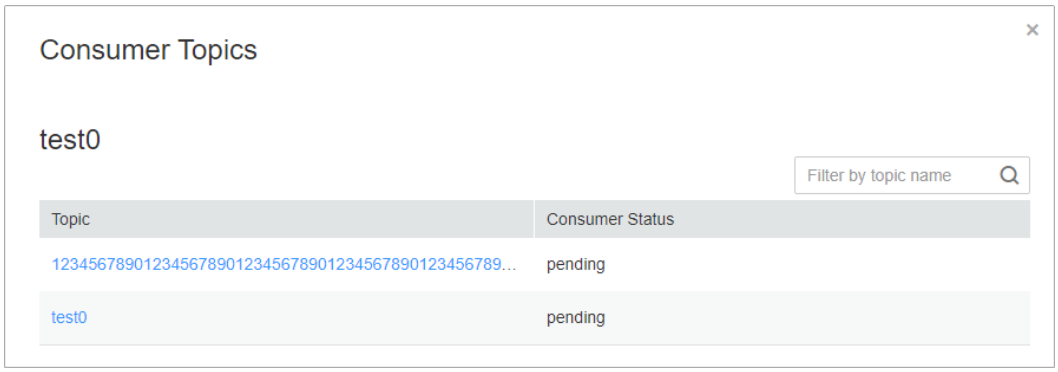
Viewing a Consumer Group

Step 1 Log in to Kafka UI. For details, see **Accessing Kafka UI**.

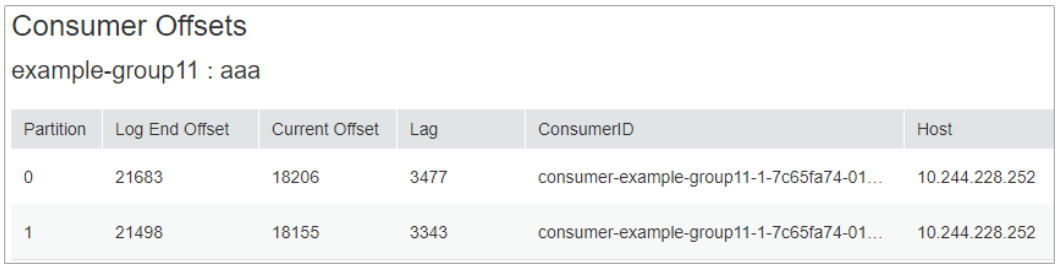
Step 2 Click **Consumers**. On the consumer group details page that is displayed, you can view all consumer groups in the current cluster and the IP address of the node where each consumer group coordinator is located. In the upper right corner of the page, you can enter a consumer group name to search for the specified consumer group.



Step 3 In the **Consumer Summary** area, you can view the existing consumer groups in the current cluster. You can click a consumer group name to view the topics consumed by the consumer group. Consumed topics can be in the **pending** or **running** state. **pending** indicates that the topic has been consumed but not being consumed. **running** indicates that the topic is being consumed. You can enter a topic name in the upper right corner of the dialog box to filter topics.



Step 4 Click a topic name. On the **Consumer Offsets** page that is displayed, view the topic consumption details.

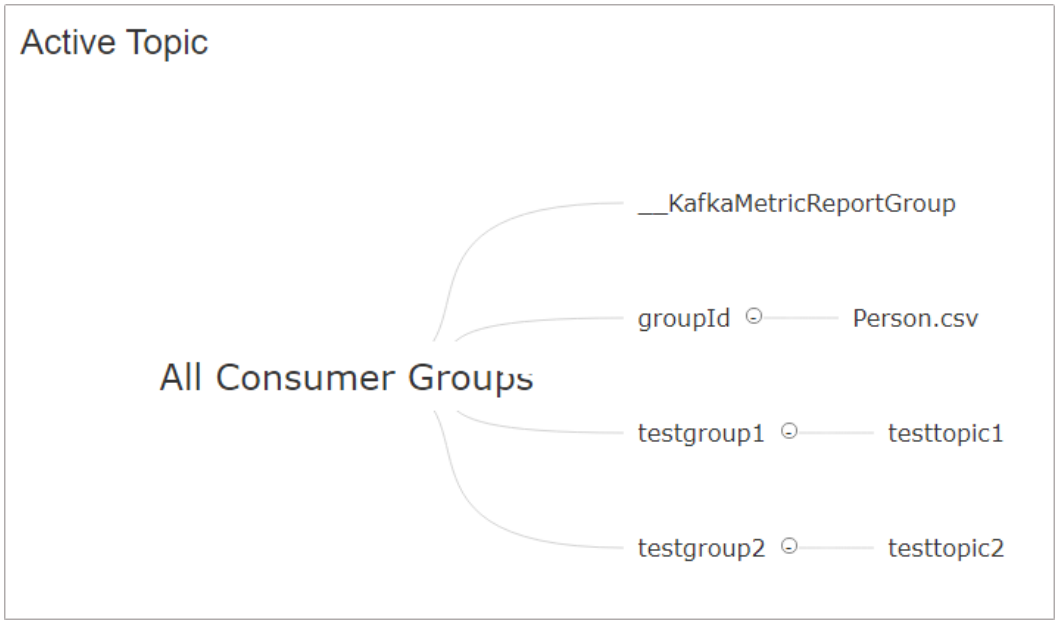


----End

Viewing the Consumption Lineage Graph

Step 1 Log in to Kafka UI. For details, see **Accessing Kafka UI**.

Step 2 Click **Consumers**. The consumer group details page is displayed. In the **Active Topic** area, view all consumer groups in the current cluster and topics that are being consumed by each consumer group.



NOTE

MRS clusters do not support redirection by clicking a consumer group name.

----End

15.19 Kafka Logs

Log Description

Log paths: The default storage path of Kafka logs is **/var/log/Bigdata/kafka**. The default storage path of audit logs is **/var/log/Bigdata/audit/kafka**.

- Broker: **/var/log/Bigdata/kafka/broker** (run logs)

Log archive rule: The automatic Kafka log compression function is enabled. By default, when the size of logs exceeds 30 MB, logs are automatically compressed

into a log file named in the following format: *<Original log file name>-<yyyy-mm-dd_hh-mm-ss>.[ID]*.**log.zip**. A maximum of 20 latest compressed files are retained by default. You can configure the number of compressed files and the compression threshold.

Table 15-14 Broker log list

Type	Log File Name	Description
Run log	server.log	Server run log of the broker process
	controller.log	Controller run log of the broker process
	kafka-request.log	Request run log of the broker process
	log-cleaner.log	Cleaner run log of the broker process
	state-change.log	State-change run log of the broker process
	kafkaServer-<SSH_USER>-<DATE>-<PID>-gc.log	GC log of the broker process
	postinstall.log	Work log after broker installation
	prestart.log	Work log before broker startup
	checkService.log	Log that records whether broker starts successfully
	start.log	Startup log of the broker process
	stop.log	Stop log of the broker process
	checkavailable.log	Log that records the health check details of the Kafka service
	checkInstanceHealth.log	Log that records the health check details of broker instances
	kafka-authorizer.log	Broker authorization log
	kafka-root.log	Broker basic log
	cleanup.log	Cleanup log of broker uninstallation

Type	Log File Name	Description
	metadata-backup-recovery.log	Broker backup and recovery log
	ranger-kafka-plugin-enable.log	Log that records the Ranger plug-ins enabled by brokers
	server.out	Broker JVM log
	audit.log	Authentication log of the Ranger authentication plug-in. This log is archived in the **/var/log/Bigdata/audit/kafka** directory.
	threadDump-Broker-xxx.log	Stack log generated when the Broker thread stops abnormally

Log Level

Table 15-15 describes the log levels supported by Kafka.

Levels of run logs are ERROR, WARN, INFO, and DEBUG from the highest to the lowest priority. Run logs of equal or higher levels are recorded. The higher the specified log level, the fewer the logs recorded.

Table 15-15 Log levels

Level	Description
ERROR	Logs of this level record error information about system running.
WARN	Logs of this level record exception information about the current event processing.
INFO	Logs of this level record normal running status information about the system and events.
DEBUG	Logs of this level record the system information and system debugging information.

To modify log levels, perform the following operations:

Step 1 Go to the **All Configurations** page. See **Modifying Cluster Service Configuration Parameters**.

Step 2 On the menu bar on the left, select the log menu of the target role.

Step 3 Select a desired log level.

Step 4 Save the configuration. In the displayed dialog box, click **OK** to make the configurations take effect.

NOTE

After the log levels of KafkaUI and MirrorMaker are changed, you need to restart the KafkaUI or MirrorMaker instances for the change to take effect. Perform the following operations to restart the instances:

Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Kafka**. Click **Instance**, select the KafkaUI or MirrorMaker instances, click **More**, and select **Restart Instance** to restart the instances.

----End

Log Format

The following table describes the Kafka log format.

Table 15-16 Log formats

Type	Format	Example
Run log	<yyyy-MM-dd HH:mm:ss,SSS>|<Log Level>|<Thread that generates the log>|<Message in the log>|<Full name of the log event invocation class>(<Log file>:<Row>)	2015-08-08 11:09:53,483 | INFO | [main] | Loading logs. | kafka.log.LogManager (Logging.scala:68)
	<yyyy-MM-dd HH:mm:ss><HostName><Component name><logLevel><Message>	2015-08-08 11:09:51 10-165-0-83 Kafka INFO Running kafka-start.sh.

15.20 Performance Tuning

15.20.1 Kafka Performance Tuning

Scenario

You can modify Kafka server parameters to improve Kafka processing capabilities in specific service scenarios.

Parameter Tuning

Modify the service configuration parameters. For details, see **Modifying Cluster Service Configuration Parameters**. For details about the tuning parameters, see **Table 15-17**.

Table 15-17 Tuning parameters

Parameter	Default Value	Scenario
num.recovery.threads.per.data.dir	10	During the Kafka startup process, if a large volume of data exists, you can increase the value of this parameter to accelerate the startup.
background.threads	10	Specifies the number of threads processed by a broker background task. If a large volume of data exists, you can increase the value of this parameter to improve broker processing capabilities.
num.replica.fetchers	1	Specifies the number of threads used when a replica requests to the Leader for data synchronization. If the value of this parameter is increased, the replica I/O concurrency increases.
num.io.threads	8	Specifies the number of threads used by the broker to process disk I/O. It is recommended that the number of threads be greater than or equal to the number of disks.
KAFKA_HEAP_OPTS	-Xmx6G -Xms6G	Specifies the Kafka JVM heap memory setting. If the data volume on the broker is large, adjust the heap memory size.

15.21 Kafka Feature Description

Kafka Idempotent Feature

Feature description: The function of creating idempotent producers is introduced in Kafka 0.11.0.0. After this function is enabled, producers are automatically upgraded to idempotent producers. When producers send messages with the same field values, brokers automatically detect whether the messages are duplicate to avoid duplicate data. Note that this feature can only ensure idempotence in a single partition. That is, an idempotent producer can ensure that no duplicate

messages exist in a partition of a topic. Only idempotence on a single session can be implemented. The session refers to the running of the producer process. That is, idempotence cannot be ensured after the producer process is restarted.

Method for enabling this feature:

1. Add **props.put("enable.idempotence", true)** to the secondary development code.
2. Add **enable.idempotence = true** to the client configuration file.

Kafka Transaction Feature

Feature description: Kafka 0.11 introduces the transaction feature. The Kafka transaction feature indicates that a series of producer message production and consumer offset submission operations are in the same transaction, or are regarded as an atomic operation. Message production and offset submission succeed or fail at the same time. This feature provides transactions at the Read Committed isolation level to ensure that multiple messages are written to the target partition atomically and that the consumer can view only the transaction messages that are successfully submitted. The transaction feature of Kafka is used in the following scenarios:

1. Multiple pieces of data sent by a producer can be encapsulated in a transaction to form an atomic operation. All messages are successfully sent or fail to be sent.
2. read-process-write mode: Message consumption and production are encapsulated in a transaction to form an atomic operation. In a streaming application, a service usually needs to receive messages from the upstream system, process the messages, and then send the processed messages to the downstream system. This corresponds to message consumption and production.

Example of secondary development code:

```
// Initialize the configuration and enable the transaction feature.
Properties props = new Properties();
props.put("enable.idempotence", true);
props.put("transactional.id", "transaction1");
...

KafkaProducer producer = new KafkaProducer<String, String>(props);

// init transaction
producer.initTransactions();
try {
    // Start a transaction.
    producer.beginTransaction();
    producer.send(record1);
    producer.send(record2);
    // Stop a transaction.
    producer.commitTransaction();
} catch (KafkaException e) {
    // Abort a transaction.
    producer.abortTransaction();
}
```

Nearby Consumption

Feature description: In versions earlier than Kafka 2.4.0, the production and consumption of the client are leader copies oriented to each partition. Follower

copies are used only for data redundancy and do not provide services for external systems. As a result, the leader copy has high pressure. In addition, in cross-DC and cross-rack consumption scenarios, a large volume of data is transmitted between DCs and between racks. In Kafka 2.4.0 and later versions, the Kafka kernel can consume data from follower replicas, which greatly reduces the data transmission volume and reduces the network bandwidth pressure in cross-DC and cross-rack scenarios. The community opens the ReplicaSelector API to support this feature. By default, MRS Kafka provides two methods to use this API.

1. **RackAwareReplicaSelector**: indicates that replicas in the same rack are preferentially consumed (nearby consumption in a rack).
2. **AzAwareReplicaSelector**: indicates that copies from nodes in the same AZ are preferentially consumed (nearby consumption in an AZ).

The following uses **RackAwareReplicaSelector** as an example to describe how to consume the closest replica.

```
public class RackAwareReplicaSelector implements ReplicaSelector {

  @Override
  public Optional<ReplicaView> select(TopicPartition topicPartition,
                                      ClientMetadata clientMetadata,
                                      PartitionView partitionView) {
    if (clientMetadata.rackId() != null && !clientMetadata.rackId().isEmpty()) {
      Set<ReplicaView> sameRackReplicas = partitionView.replicas().stream()
              // Filter the replicas that are in the same rack as the client.
              .filter(replicaInfo -> clientMetadata.rackId().equals(replicaInfo.endpoint().rack()))
              .collect(Collectors.toSet());
      if (sameRackReplicas.isEmpty()) {
        // If no replicas are in the same rack as the client, the leader replica is returned.
        return Optional.of(partitionView.leader());
      } else {
        // It shows that a replica that is in the same rack as the client exists.
        if (sameRackReplicas.contains(partitionView.leader())) {
          // If the client and the leader replica are in the same rack, the leader replica returns first.
          return Optional.of(partitionView.leader());
        } else {
          // Otherwise, the latest replica synchronized with the leader is returned.
          return sameRackReplicas.stream().max(ReplicaView.comparator());
        }
      }
    } else {
      // If the rack information is not contained in the client request, the leader replica is returned first.
      return Optional.of(partitionView.leader());
    }
  }
}
```

Method for enabling this feature:

1. Server: Update the **replica.selector.class** configuration item based on different features.
   - To enable "nearby consumption in a rack", set this parameter to **org.apache.kafka.common.replica.RackAwareReplicaSelector**.
   - To enable "nearby consumption in an AZ", set this parameter to **org.apache.kafka.common.replica.AzAwareReplicaSelector**.
2. Client: Add the **client.rack** configuration item to the **consumer.properties** file in the *{Client installation directory}***/Kafka/kafka/config** directory.
   - If the "nearby consumption in a rack" is enabled on the server, add the information about the rack where the client is located, for example, **client.rack = /default0/rack1**.

- If the "nearby consumption in an AZ" is enabled on the server, add the information about the rack where the client is located, for example, **client.rack = /AZ1/rack1**.

Ranger Unified Authentication

Feature description: In versions earlier than Kafka 2.4.0, Kafka supports only the SimpleAclAuthorizer authentication plugin provided by the community. In Kafka 2.4.0 and later versions, MRS Kafka supports both the Ranger authentication plugin and the authentication plugin provided by the community. Ranger authentication is used by default. Based on the Ranger authentication plugin, fine-grained Kafka ACL management can be performed.

NOTE

If the Ranger authentication plugin is used on the server and **allow.everyone.if.no.acl.found** is set to **true**, all actions are allowed when a non-secure port is used for access. You are advised to disable **allow.everyone.if.no.acl.found** for security clusters that use the Ranger authentication plugin.

15.22 Migrating Data Between Kafka Nodes

Scenario

This section describes how to use Kafka client commands to migrate partition data between disks on a node without stopping the Kafka service.

Prerequisites

- The MRS cluster administrator has understood service requirements and prepared a Kafka user (belonging to the **kafkaadmin** group. It is not required for the normal mode.).
- The Kafka client has been installed.
- The Kafka instance status and disk status are normal.
- Based on the current disk space usage of the partition to be migrated, ensure that the disk space will be sufficient after the migration.

Procedure

Step 1 Log in as a client installation user to the node on which the Kafka client is installed.

Step 2 Run the following command to switch to the Kafka client installation directory, for example, **/opt/kafkaclient**:

cd /opt/kafkaclient

Step 3 Run the following command to set environment variables:

source bigdata_env

Step 4 Run the following command to authenticate the user (skip this step in normal mode):

kinit *Component service user*

Step 5 Run the following command to switch to the Kafka client directory:

cd Kafka/kafka/bin

Step 6 Run the following command to view the topic details of the partition to be migrated:

Security mode:

./kafka-topics.sh --describe --bootstrap-server *IP address of the Kafkacluster:21007* **--command-config ../config/client.properties --topic** *topic name*

Normal mode:

./kafka-topics.sh --describe --bootstrap-server *IP address of the Kafka cluster:21005* **--command-config ../config/client.properties --topic** *Topic name*

```
Topic:testws    PartitionCount:24       ReplicationFactor:2     Configs:
        Topic: testws   Partition: 0    Leader: 4       Replicas: 4,3   Isr: 4,3
        Topic: testws   Partition: 1    Leader: 5       Replicas: 5,4   Isr: 5,4
        Topic: testws   Partition: 2    Leader: 6       Replicas: 6,5   Isr: 6,5
        Topic: testws   Partition: 3    Leader: 3       Replicas: 3,6   Isr: 3,6
        Topic: testws   Partition: 4    Leader: 4       Replicas: 4,5   Isr: 4,5
        Topic: testws   Partition: 5    Leader: 5       Replicas: 5,4   Isr: 5,4
        Topic: testws   Partition: 6    Leader: 6       Replicas: 6,3   Isr: 6,3
        Topic: testws   Partition: 7    Leader: 3       Replicas: 3,4   Isr: 3,4
        Topic: testws   Partition: 8    Leader: 4       Replicas: 4,6   Isr: 4,6
        Topic: testws   Partition: 9    Leader: 5       Replicas: 5,3   Isr: 5,3
        Topic: testws   Partition: 10   Leader: 6       Replicas: 6,4   Isr: 6,4
        Topic: testws   Partition: 11   Leader: 3       Replicas: 3,5   Isr: 3,5
        Topic: testws   Partition: 12   Leader: 4       Replicas: 4,3   Isr: 4,3
        Topic: testws   Partition: 13   Leader: 5       Replicas: 5,4   Isr: 5,4
        Topic: testws   Partition: 14   Leader: 6       Replicas: 6,5   Isr: 6,5
        Topic: testws   Partition: 15   Leader: 3       Replicas: 3,6   Isr: 3,6
        Topic: testws   Partition: 16   Leader: 4       Replicas: 4,5   Isr: 4,5
        Topic: testws   Partition: 17   Leader: 5       Replicas: 5,6   Isr: 5,6
        Topic: testws   Partition: 18   Leader: 6       Replicas: 6,3   Isr: 6,3
        Topic: testws   Partition: 19   Leader: 3       Replicas: 3,4   Isr: 3,4
        Topic: testws   Partition: 20   Leader: 4       Replicas: 4,6   Isr: 4,6
        Topic: testws   Partition: 21   Leader: 5       Replicas: 5,3   Isr: 5,3
        Topic: testws   Partition: 22   Leader: 6       Replicas: 6,4   Isr: 6,4
```

Step 7 Run the following command to query the mapping between **Broker_ID** and the IP address:

./kafka-broker-info.sh --zookeeper *IP address of the ZooKeeper quorumpeer instance*:*ZooKeeper port number*/**kafka**

```
Broker_ID     IP_Address
--------------------------
4         192.168.0.100
5         192.168.0.101
6         192.168.0.102
```

NOTE

- IP address of the ZooKeeper quorumpeer instance

  To obtain IP addresses of all ZooKeeper quorumpeer instances, log in to FusionInsight Manager and choose **Cluster** > **Services** > **ZooKeeper**. On the displayed page, click **Instance** and view the IP addresses of all the hosts where the quorumpeer instances locate.

- Port number of the ZooKeeper client

  Log in to FusionInsight Manager and choose **Cluster** > **Service** > **ZooKeeper**. On the displayed page, click **Configurations** and check the value of **clientPort**. The default value is **24002**.

Step 8 Obtain the partition distribution and node information from the command output in **Step 6** and **Step 7**, and create the JSON file for reallocation in the current directory.

To migrate data in the partition whose **Broker_ID** is **6** to the **/srv/BigData/hadoop/data1/kafka-logs** directory, the required JSON configuration file is as follows:

```
{"partitions":[{"topic": "testws","partition": 2,"replicas": [6,5],"log_dirs": ["/srv/BigData/hadoop/data1/kafka-logs","any"]}],"version":1}
```

NOTE

- **topic** indicates the topic name, for example, **testws**.
- **partition** indicates the topic partition.
- The number in **replicas** corresponds to **Broker_ID**.
- **log_dirs** indicates the path of the disk to be migrated. In this example, **log_dirs** of the node whose **Broker_ID** is **5** is set to **any**, and that of the node whose **Broker_ID** is **6** is set to **/srv/BigData/hadoop/data1/kafka-logs.** Note that the path must correspond to the node.

Step 9 Run the following command to perform reallocation:

Security mode:

./kafka-reassign-partitions.sh --bootstrap-server *Service IP address of Broker*:**21007 --command-config ../config/client.properties --zookeeper** *{zk_host}:{port}*/**kafka --reassignment-json-file** *Path of the JSON file compiled in* ***Step 8*** **--execute**

Normal mode:

./kafka-reassign-partitions.sh --bootstrap-server *Service IP address of Broker*:**21005 --command-config ../config/client.properties --zookeeper** *{zk_host}:{port}*/**kafka --reassignment-json-file** *Path of the JSON file compiled in* ***Step 8*** **--execute**

If message "Successfully started reassignment of partitions" is displayed, the execution is successful.

----End

15.23 Common Issues About Kafka

15.23.1 How Do I Solve the Problem that Kafka Topics Cannot Be Deleted?

Question

How do I delete a Kafka topic if it fails to be deleted?

Answer

- Possible cause 1: The **delete.topic.enable** configuration item is not set to **true**. The deletion can be performed only when the configuration item is set to **true**.

- Possible cause 2: The **auto.create.topics.enable** configuration parameter is set to **true**, which is used by other applications and is always running in the background.

Solution:

- For cause 1: Set **delete.topic.enable** to **true** on the configuration page.
- For cause 2: Stop the application that uses the topic in the background, or set **auto.create.topics.enable** to **false** (restart the Kafka service), and then delete the topic.

16 Using Loader

16.1 Common Loader Parameters

Navigation Path

For details about the how to set parameters, see **Modifying Cluster Service Configuration Parameters**.

Parameter Description

Table 16-1 Common Loader parameters

Parameter	Description	Default Value	Value Range
mapreduce.client.submit.file.replication	Number of copies of the job files that the MapReduce task depends on in HDFS. If the number of DataNodes in the cluster is less than the value of this parameter, the number of copies is equal to the number of DataNodes. If the number of DataNodes is greater than or equal to the value of this parameter, the number of copies is the value of this parameter.	10	3 to 256

Parameter	Description	Default Value	Value Range
loader.fault.tolerance.rate	Error tolerance. If the value is greater than 0, the error tolerance mechanism is enabled. When enabling the fault tolerance mechanism, you are advised to set the number of Map jobs to be greater than or equal to 3. It is recommended that this function be used when the job data volume is large.	0	0 to 1.0
loader.input.field.separator	Default input field separator. The parameter value takes effect only when input and output conversion steps are configured. The conversion steps can be left blank. If no separators are configured in job conversion steps, the default separator is used.	,	-
loader.input.line.separator	Default input line separator. The parameter value takes effect only when input and output conversion steps are configured. The conversion steps can be left blank. If no separators are configured in job conversion steps, the default separator is used.	-	-
loader.output.field.separator	Default output field separator. The parameter value takes effect only when input and output conversion steps are configured. The conversion steps can be left blank. If no separators are configured in job conversion steps, the default separator is used.	,	-
loader.output.line.separator	Line separator of data that Loader outputs	-	-

NOTE

- Because it needs time to calculate the fault tolerance rate, you are recommended to use the **loader.fault.tolerance.rate** parameter when the job runtime is longer than 2 minutes to ensure user experience.
- Default separators are configured for the parameters in the preceding table for Loader. If separators are configured in the conversion steps for the jobs, the separators in the conversion steps will be used. If separators are not configured in the conversion steps, the default separators will be used.

16.2 Creating a Loader Role

Scenario

Create and configure a Loader role on FusionInsight Manager as an MRS cluster administrator. The Loader role can set Loader administrator permissions, job connections, job groups, and Loader job operation and scheduling permissions.

Prerequisites

- The MRS cluster administrator has understood service requirements.
- You have logged in to FusionInsight Manager.

Procedure

Step 1 Choose **System** > **Permission** > **Role**.

Step 2 Click **Create Role** and set a role name and enter description.

Step 3 Set permissions. For details, see **Table 16-2**.

NOTE

When setting permissions for a role, you cannot set permissions for multiple resources at the same time. If you need to set permissions for multiple resources, set them one by one.

Loader permissions:

- **Admin**: Loader administrator permission
- **Job Connector**: connection permission of Loader
- **Job Group**: permission to perform operations on Loader job groups. You can set the operation permissions of a specific job in a specified job group, including the **Edit** and **Execute** permissions of the job.
- **Job Scheduler**: permission to schedule Loader jobs

Table 16-2 Setting Loader roles

Task	Role Authorization
Setting the Loader administrator permission	In the **Configure Resource Permission** table, choose *Name of the desired cluster* > **Loader** and select **Admin**.

Task	Role Authorization
Setting the connection permission of Loader (including the editing, deletion, and reference permissions of Job Connection)	1. In the **Configure Resource Permission** table, choose *Name of the desired cluster* > **Loader** > **Job Connector**. 2. In the **Permission** column of the specified job link, select **Edit**.
Setting the edit permission for Loader job groups (including modifying the name of a job group, deleting a specified group, creating jobs in a specified group, importing jobs from external systems to a specified group in batches, and migrating jobs from other groups to a specified group)	1. In the **Permission** table, choose **Loader** > **Job Group**. 2. In the **Permission** column of the specified job group, select **Edit Group**.
Setting the edit permission for all jobs in a Loader job group (including the permission to edit all existing or new jobs in the group)	1. In the **Configure Resource Permission** table, choose *Name of the desired cluster* > **Loader** > **Job Group**. 2. In the **Permission** column of the specified job group, select **Edit Job**.
Setting the execution permission for all jobs in the Loader job group (including the execution permission on all existing or new jobs in the group)	1. In the **Configure Resource Permission** table, choose *Name of the desired cluster* > **Loader** > **Job Group**. 2. In the **Permission** column of the specified job group, select **Execute Job**.
Setting the edit permission for Loader jobs (including editing, deleting, copying, and exporting jobs)	1. In the **Configure Resource Permission** table, choose *Name of the desired cluster* > **Loader** > **Job Group**. 2. Select a job group. 3. In the **Permission** column of the specified job, select **Edit**.
Setting the execution permission for Loader jobs (including permissions to start and stop jobs and view historical records)	1. In the **Configure Resource Permission** table, choose *Name of the desired cluster* > **Loader** > **Job Group**. 2. Select a job group. 3. In the **Permission** column of the specified job, select **Execute**.

Task	Role Authorization
Setting the permission for scheduling Loader jobs (including the editing, deletion, and validation permissions of Scheduler)	1. In the **Configure Resource Permission** table, choose *Name of the desired cluster* > **Loader** > **Job Scheduling**. 2. In the **Permission** column of the specified job scheduling row, select **Edit**.

NOTE

1. In addition to **Admin**, the preceding permissions are configured only for inventory resource information.
2. Users without the preceding roles can also create tasks, groups, and connectors, but cannot perform operations on inventory resources.

Step 4 Click **OK**, and return to the **Role** page.

----End

16.3 Managing Loader Links

Scenario

You can create, view, edit, and delete links on the Loader page.

Creating a Connection

Step 1 Select **Loader**. On the right of **Loader WebUI**, click the link to open the Loader web UI.

Step 2 On the Loader page, click **New job**.

Step 3 Click **Add** next to **Connection** and set connection parameters.

For details about the parameters, see **Loader Connection Configuration**.

Step 4 Click **OK**.

If connection configurations, for example, IP address, port, and access user information, are incorrect, the connection will fail to be verified and saved.

NOTE

You can click **Test** to immediately check whether the connection is available.

----End

Viewing a Connection

Step 1 On the Loader page, click **New job**.

Step 2 Click the drop-down list of **Connection** to view the connections you have created.

----End

Editing a Connection

Step 1 On the Loader page, click **New job**.

Step 2 Select the name of the connection to be edited from the **Connection** drop-down list.

Step 3 Click **Edit** next to **Connection**.

Step 4 On the dialog box displayed, modify the connection parameters based on service requirements.

Step 5 Click **Test**.

- If the test is successful, go to **Step 6**.
- If the test fails, repeat **Step 4**.

Step 6 Click **Save**.

If a Loader job has integrated into a Loader link, editing the link parameters may affect Loader running.

----End

Deleting a Connection

Step 1 On the Loader page, click **New job**.

Step 2 Select the name of the connection to be deleted from the **Connection** drop-down list.

Step 3 Click **Delete**.

Step 4 In the displayed dialog box, click **OK**.

If a Loader job has integrated a Loader connection, the connection cannot be deleted.

----End

Loader Connection Configuration

Loader supports the following connections:

- **generic-jdbc-connector**: For details about parameter settings, see **Table 16-3**.
- **ftp-connector**: For details about parameter settings, see **Table 16-4**.
- **sftp-connector**: For details about parameter settings, see **Table 16-5**.
- **hdfs-connector**: For details about parameter settings, see **Table 16-6**.
- **oracle-connector**: For details about parameter settings, see **Table 16-7**.
- **mysql-fastpath-connector**: For details about parameter settings, see **Table 16-9**.
- **oracle-partition-connector**: For details about parameter settings, see **Table 16-8**.

- **clickhouse-connector**: For details about parameter settings, see **Table 16-10**.

Table 16-3 generic-jdbc-connector configuration

Parameter	Description
Name	Name of a Loader connection
Connector	Select **generic-jdbc-connector**.
JDBC Driver Class	JDBC driver classes are as follows: • oracle: **oracle.jdbc.driver.OracleDriver** • SQLServer: **com.microsoft.sqlserver.jdbc.SQLServerDriver** • mysql: **com.mysql.jdbc.Driver** • postgresql: **org.postgresql.Driver**
JDBC Connection String	Database access address, which can be an IP address or domain name. Enter the database connection string. The following uses the IP address **10.10.10.10** as an example to describe how to access the **test** database. • oracle: **jdbc:oracle:thin:@10.10.10.10:1521:test** • SQLServer: **jdbc:sqlserver://10.10.10.10:1433;DatabaseName=test** (**1433** is an example port number.) • mysql: **jdbc:mysql://10.10.10.10/test?&useUnicode=true&characterEncoding=GBK** • postgresql: **jdbc:postgresql://10.10.10.10:5432/test** • MOTService: **jdbc:opengauss://10.10.10.10:20105/test** (**20105** is an example port number.)
Username	Username for accessing the database
Password	Password of the user. Use the actual password.

Table 16-4 ftp-connector configuration

Parameter	Description
Name	Name of a Loader connection
Connector	Select **ftp-connector**.
FTP Mode	Select **ACTIVE** or **PASSIVE**.

Parameter	Description
FTP Protocol	Select: • FTP • SSL_EXPLICIT • SSL_IMPLICIT • TLS_EXPLICIT • TLS_IMPLICIT
File Name Encoding Type	Encoding type of the file name or file path.

Table 16-5 sftp-connector configuration

Parameter	Description
Name	Name of a Loader connection
Connector	Select **sftp-connector**.

Table 16-6 hdfs-connector configuration

Parameter	Description
Name	Name of a Loader connection
Connector	Select **hdfs-connector**.

Table 16-7 oracle-connector configuration

Parameter	Description
Name	Name of a Loader connection
Connector	Select **oracle-connector**.
JDBC Connection String	Connection string used for connecting to the database
Username	Username for accessing the database
Password	Password of the user. Use the actual password.

Table 16-8 oracle-partition-connector configuration

Parameter	Description
Name	Name of a Loader connection
Connector	Select **oracle-partition-connector**.
JDBC Driver Class	Enter **oracle.jdbc.driver.OracleDriver**.
JDBC Connection String	Connection string used for connecting to the database
Username	Username for accessing the database
Password	Password of the user. Use the actual password.

Table 16-9 mysql-fastpath-connector configuration

Parameter	Description
Name	Name of a Loader connection
Connector	Select **mysql-fastpath-connector**. **NOTICE** When **mysql-fastpath-connector** is used, the **mysqldump** and **mysqlimport** commands of MySQL must be available on NodeManagers, and the MySQL client version to which the two commands belong must be compatible with the MySQL server version. If the two commands are unavailable or the versions are incompatible, see **http://dev.mysql.com/doc/refman/5.7/en/linux-installation-rpm.html**. Install the MySQL client applications and tools. For example, you need to install the following RPM packages in the RHEL-x86 system (select the package version based on the site requirements): • mysql-community-client-5.7.23-1.el7.x86_64.rpm • mysql-community-common-5.7.23-1.el7.x86_64.rpm • mysql-community-devel-5.7.23-1.el7.x86_64.rpm • mysql-community-embedded-5.7.23-1.el7.x86_64.rpm • mysql-community-libs-5.7.23-1.el7.x86_64.rpm • mysql-community-libs-compat-5.7.23-1.el7.x86_64.rpm
JDBC Connection String	Connection string used for connecting to the database
Username	Username for accessing the database
Password	Password of the user. Use the actual password.

Table 16-10 clickhouse-connector configuration

Parameter	Description
Name	Name of a Loader connection
Connector	Select **clickhouse-connector**.

ClickHouse Connection String	• Kerberos authentication has been enabled for the cluster. The format is **jdbc:clickhouse://***Database IP address*:*Database port number*/*Database name*?**ssl=true&sslmode=none**.
	• Kerberos authentication is disabled for the cluster. The format is **jdbc:clickhouse://***Database IP address*:*Database port number*/*Database name*.
	NOTE
	• *Database IP address*: To obtain the IP address of the ClickHouseBalancer instance, log in to FusionInsight Manager, choose **Cluster** > **Services** > **ClickHouse**, and click **Instance**.
	• Database port number:
	  • To obtain the port number of a cluster with Kerberos authentication enabled, log in to FusionInsight Manager, choose **Cluster** > **Services**, click **Logical Cluster**, view the logical cluster, and obtain the value of **Ssl Port** in **HTTP Balancer Port**.
	  • To obtain the port number of a cluster with Kerberos authentication disabled, log in to FusionInsight Manager, choose **Cluster** > **Services**, click **Logical Cluster**, view the logical cluster, and obtain the value of **Port** in **HTTP Balancer Port**.

Username	Username for accessing the database
Password	Password of the user. Use the actual password.

16.4 Preparing a Driver for MySQL Database Link

Scenario

As a component for batch data export, Loader can import and export data using a relational database.

Prerequisites

You have prepared service data.

Procedure

Modify the permission on the JAR package of the relational database driver.

Step 1 Log in to the active and standby management nodes of the Loader service, obtain the driver JAR file of the relational database, and save the file to **$**

{BIGDATA_HOME}/FusionInsight_Porter_8.1.0.1/install/FusionInsight-Sqoop-1.99.3/FusionInsight-Sqoop-1.99.3/server/webapps/loader/WEB-INF/ext-lib on both nodes.

NOTE

The version number **8.1.0.1** is used as an example. Replace it with the actual version number.

Step 2 Run the following commands as user **root** on the active and standby nodes of the Loader service to change the permission:

cd ${BIGDATA_HOME}/FusionInsight_Porter_8.1.0.1/install/FusionInsight-Sqoop-1.99.3/FusionInsight-Sqoop-1.99.3/server/webapps/loader/WEB-INF/ext-lib

chown omm:wheel *JAR package name*

chmod 600 *JARpackage name*

Step 3 Log in to FusionInsight Manager. Choose **Cluster** and click the target cluster name. In the navigation pane on the left, choose **Services** > **Loader**. In the upper right corner, choose **More**, select **Restart Service**, and enter the password of the administrator to restart the Loader service.

----End

16.5 Importing Data

16.5.1 Overview

Description

Loader is an ETL tool that enables MRS to exchange data and files with external data sources, such as relational databases, SFTP servers, and FTP servers. It allows data or files to be imported from relational databases or file systems to MRS.

Loader supports the following data import modes:

- Importing data from a relational database to HDFS or OBS
- Importing data from a relational database to HBase
- Importing data from a relational database to Phoenix tables
- Importing data from a relational database to Hive tables
- Importing data from an SFTP server to HDFS or OBS
- Importing data from an SFTP server to HBase
- Importing data from an SFTP server to Phoenix tables
- Importing data from an SFTP server to Hive tables
- Importing data from an FTP server to HDFS or OBS
- Importing data from an FTP server to HBase
- Importing data from an FTP server to Phoenix tables
- Importing data from an FTP server to Hive tables

- Importing data from HDFS or OBS to HBase in the same cluster

MRS needs to connect to an external data source to exchange data and files with the data source. The following connectors are used to configure connection parameters for different types of data sources:

- generic-jdbc-connector: relational database connector
- ftp-connector: FTP data source connector
- hdfs-connector: HDFS data source connector
- oracle-connector: dedicated connector for Oracle databases. **row_id** serves as partition columns. Compared with generic-jdbc-connector, Map jobs are more evenly distributed on oracle-connector, and whether indexes have been created for the partition columns does not matter.
- mysql-fastpath-connector: dedicated connector for MySQL databases. Data is imported and exported by using the mysqldump and mysqlimport tools of MySQL. Compared with generic-jdbc-connector, mysql-fastpath-connector delivers a faster data import and export speed.
- sftp-connector: SFTP data source connector
- oracle-partition-connector: connector that supports the Oracle partition feature, which is used to optimize the import and export of Oracle partition tables.

NOTE

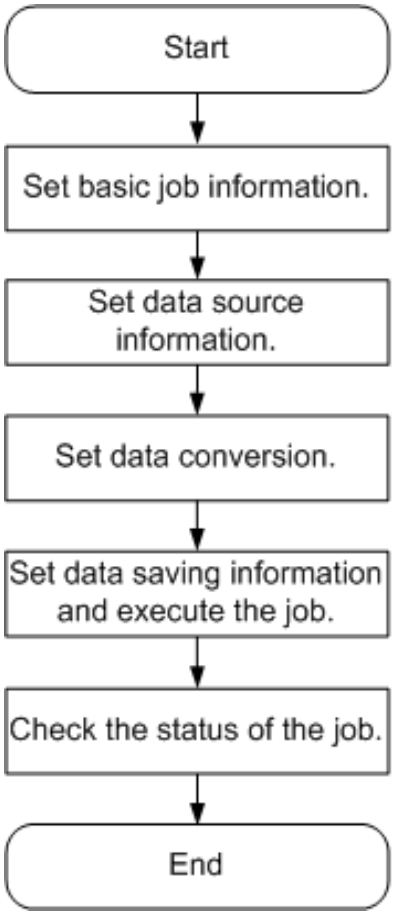
- When an FTP data source connector is used, data is not encrypted. This may result in security risks. You are advised to use an SFTP data source connector.
- You are advised to deploy the SFTP server, FTP server, database server, and Loader into separate subnets to ensure secure data import.
- For connection to relational databases, general database connectors (generic-jdbc-connector) or dedicated database connectors (oracle-connector, oracle-partition-connector, and mysql-fastpath-connector) are available. However, compared with general database connectors, dedicated database connectors perform better in data import and export because they are optimized for specific database types.
- When mysql-fastpath-connector is used, the **mysqldump** and **mysqlimport** commands of MySQL must be available on NodeManager nodes, and the MySQL client version to which the two commands belong must be compatible with the MySQL server version. If the two commands are unavailable or the versions are incompatible, install the MySQL client applications and tools following the instructions at **http://dev.mysql.com/doc/refman/5.7/en/linux-installation-rpm.html**.
- When oracle-connector is used, the connection user must be granted the select permission on the following system catalogs or views:

  dba_tab_partitions, dba_constraints, dba_tables, dba_segments, v$version, dba_objects, v$instance, SYS_CONTEXT, dba_extents, and dba_tab_subpartitions
- When oracle-partition-connector is used, the connection user must be granted the select permission on the following system catalogs: dba_objects and dba_extents.

Import Process

You can import data on the Loader web UI. **Figure 16-1** shows the data import process.

Figure 16-1 Import process



You can also use shell scripts to update and run Loader jobs. To use this method, you need to configure the installed Loader client.

16.5.2 Importing Data Using Loader

Scenario

Import data from external data sources to MRS.

Generally, you can manually manage data import and export jobs on the Loader UI. To use shell scripts to update and run Loader jobs, configure the installed Loader client.

Prerequisites

- You have obtained the service username and password for creating a Loader job.
- You have the permission to access the HDFS or OBS directories, HBase tables, and data involved in job execution.
- You have obtained the username and password used by an external data source (SFTP server or relational database).
- No disk space alarm is reported, and the available disk space is sufficient for importing and exporting data.

- When using Loader to import data from SFTP, FTP, and HDFS/OBS, ensure that the input paths and input path subdirectories of the external data sources and the name of the files in these directories do not contain any of the special characters /"';:;.
- If a task requires the Yarn queue function, the user must be authorized with related Yarn queue permission.
- The user who configures a task must obtain execution permission on the task and obtain usage permission on the related connection of the task.

Procedure

Step 1 Check whether data is imported from MRS to a relational database for the first time.

- If yes, go to **Step 2**.
- If no, go to **Step 3**.

Step 2 Modify the permission on the JAR package of the relational database driver.

1. Log in to the active and standby management nodes of the Loader service, obtain the driver JAR file of the relational database, and save the file to **${BIGDATA_HOME}/FusionInsight_Porter_*/install/FusionInsight-Sqoop-1.99.3/FusionInsight-Sqoop-1.99.3/server/webapps/loader/WEB-INF/ext-lib** on both nodes.
2. Run the following command as user **root** on the active and standby nodes of the Loader service to modify the permission:

   cd ${BIGDATA_HOME}/FusionInsight_Porter_*/install/FusionInsight-Sqoop-1.99.3/FusionInsight-Sqoop-1.99.3/server/webapps/loader/WEB-INF/ext-lib

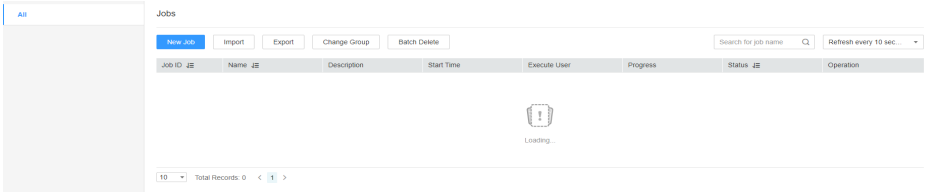
   chown omm:wheel *JAR package name*

   chmod 600 *JAR package name*
3. Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Loader**. On the **Dashboard** tab page that is displayed, click **More** and select **Restart Service**. In the displayed dialog box, enter the administrator password to restart the Loader service.

Step 3 Access the Loader web UI.

1. Log in to FusionInsight Manager.
2. Choose **Cluster** > **Services** > **Loader**.
3. Click **LoaderServer(***Node name***, Active)**. The Loader web UI is displayed.

   Figure 16-2 Loader web UI



Step 4 Create a Loader data import job. Click **New Job**. Select the required job type in **1. Basic Information**, and click **Next**.

1. Set **Name** to the job name and **Type** to **Import**.
2. Select a connection for **Connection**. By default, no connection is created. Click **Add** to create a connection, and then click **Test** to test whether the connection is available. Click **OK** when the system displays a message indicates that the test is successful.

   Data sources need to be connected when MRS exchanges data and files with external data sources. **Connection** indicates the set of connection parameters for connecting to data sources.

   Table 16-11 Connection configuration parameters

Connector	Parameter	Description
generic-jdbc-connector	JDBC Driver Class	Name of a JDBC driver class
	JDBC Connection String	JDBC connection string
	Username	Username for connecting to the database
	Password	Password for connecting to the database
	JDBC Connection Properties	JDBC connection attribute. Click **Add** to manually add connection attributes. – **Name**: connection attribute name – **Value**: connection attribute value
ftp-connector	FTP Server IP Address	IP address of the FTP server
	FTP Server Port	Port number of the FTP server
	FTP Username	Username for accessing the FTP server
	FTP Password	Password for accessing the FTP server
	FTP Mode	FTP access mode. Possible values are **ACTIVE** and **PASSIVE**. If this parameter is not set, FTP access is in passive mode by default.

Connector	Parameter	Description
	FTP Protocol	FTP protocol. – **FTP**: indicates the FTP protocol. – **SSL_EXPLICIT**: indicates the explicit SSL protocol. – **SSL_IMPLICIT**: indicates the implicit SSL protocol. – **TLS_EXPLICIT**: indicates the explicit TLS protocol. – **TLS_IMPLICIT**: indicates the implicit TLS protocol. If this parameter is not set, the FTP protocol is used by default.
	File Name Encoding Type	File name and file path encoding format supported by the FTP server. If this parameter is not set, the default format UTF-8 is used.
hdfs-connector	-	-
oracle-connector	JDBC Connection String	Connection string for a user to connect to the database
	Username	Username for connecting to the database
	Password	Password for connecting to the database
	Connection Properties	Connection attributes. Click **Add** to manually add connection attributes. – **Name**: connection attribute name – **Value**: connection attribute value
mysql-fastpath-connector	JDBC Connection String	JDBC connection string
	Username	Username for connecting to the database
	Password	Password for connecting to the database
	Connection Properties	Connection attributes. Click **Add** to manually add connection attributes. – **Name**: connection attribute name – **Value**: connection attribute value
sftp-connector	SFTP Server IP Address	IP address of the SFTP server

Connector	Parameter	Description
	SFTP Server Port	Port number of the SFTP server
	SFTP Username	Username for accessing the SFTP server
	SFTP Password	Password for accessing the SFTP server
	SFTP Public Key	Public key of the SFTP server
oracle-partition-connector	JDBC Driver Class	Name of a JDBC driver class
	JDBC Connection String	JDBC connection string
	Username	Username for connecting to the database
	Password	Password for connecting to the database
	Connection Properties	Connection attributes. Click **Add** to manually add connection attributes. – **Name**: connection attribute name – **Value**: connection attribute value

3. Set **Group** to the group to which the job belongs. By default, there is no created group. Click **Add** to create a group and click **OK**.
4. **Queue** indicates that Loader tasks are executed in a specified Yarn queue. The default value is **root.default**, which indicates that the tasks are executed in the **default** queue.
5. Set **Priority** to the priority of Loader tasks in the specified Yarn queue. The value can be **VERY_LOW**, **LOW**, **NORMAL**, **HIGH**, or **VERY_HIGH**. The default value is **NORMAL**.

Step 5 On the **From** page, set the data source and click **Next**.

NOTE

- When creating or editing a Loader job, you can use macro definitions when configuring parameters such as the SFTP path, HDFS/OBS path, and Where condition of SQL. For details, see **Using Macro Definitions in Configuration Items** .
- Loader supports common field data types, such as Char, VarChar, Boolean, Binary, SmallInt, Int, BigInt, Decimal, Float, Double, Date, Time, TimeStamp, and String. The supported types may vary according to the data source. For details about the supported types, expand the field data type drop-down list of the corresponding input operator (such as Table Input) on the Loader GUI. Some database-specific fields may not be supported. For example, Loader does not support the CLOB, XMLType, and BLOB fields in Oracle.

Table 16-12 List of input configuration parameters

Source File Type	Parameter	Description
sftp-connector or ftp-connector	Input Path	Input path or name of the source file on an SFTP server. If multiple SFTP server IP addresses are configured for the connector, you can set this parameter to multiple input paths separated with semicolons (;). Ensure that the number of input paths is the same as that of SFTP servers configured for the connector.
	File Split Type	Indicates whether to split source files by file name or size. The files obtained after the splitting are used as the input files of each Map in the MapReduce task for data import. **FILE** indicates that each Map processes one or more complete source files. The same source file cannot be allocated to different Maps. When the data is saved to the output directory, the directory structure of the input path is retained. **SIZE** indicates that each Map processes input files of a certain size. A source file can be split into multiple Maps. The number of files saved when data is saved to the output directory is the same as that of Maps. The file name format is **import_part**_*xxxx*, where *xxxx* is a unique random number generated by the system.
	Filter Type	File filtering criterion. **WILCARD** indicates that a wildcard is used in filtering, and **REGEX** indicates that a regular expression is used in filtering. This parameter is used together with **Path Filter** and **File Filter**. The default value is **WILDCARD**.
	Path Filter	Wildcard or regular expression for filtering the directories in the input path of the source files. This parameter is used when **Filter Type** is set. **Input Path** is not used for filtering. If there are multiple filter conditions, use commas (,) to separate them. If the value is empty, the directories are not filtered.
	File Filter	Wildcard or regular expression for filtering the file names of the source files. This parameter is used when **Filter Type** is set. If there are multiple filter conditions, use commas (,) to separate them. The value cannot be left blank.

Source File Type	Parameter	Description
	Encoding Type	Source file encoding format, for example, UTF-8. This parameter can be set only in text file import.
	Suffix	File name extension added to a source file after the source file is imported. If this parameter is empty, no file name extension is added to the source file.
	Compression	Indicates whether to enable compressed transmission when SFTP is used to export data. **true** indicates that compression is enabled, and **false** indicates that compression is disabled.
hdfs-connector	Input Path	Input path of source files in HDFS
	Path Filter	Wildcard for filtering the directories in the input paths of the source files. **Input Path** is not used for filtering. If there are multiple filter conditions, use commas (,) to separate them. If the value is empty, the directories are not filtered. The regular expression filtering is not supported.
	File Filter	Wildcard for filtering the file names of the source files. If there are multiple filter conditions, use commas (,) to separate them. The value cannot be left blank. The regular expression filtering is not supported.
	Encoding Type	Source file encoding format, for example, UTF-8. This parameter can be set only in text file import.
	Suffix	File name extension added to a source file after the source file is imported. If this parameter is empty, no file name extension is added to the source file.
generic-jdbc-connector	Schema name	Database schema name. This parameter exists in the **Table name** schema.
	Table name	Database table name. This parameter exists in the **Table name** schema.

Source File Type	Parameter	Description
	SQL Statement	SQL statement for the Loader to query data to be imported in **Table SQL statement** mode. The SQL statement requires the query condition **WHERE ${CONDITIONS}**. Without this condition, the SQL statement cannot be run properly, for example, **select * from TABLE WHERE A>B and ${CONDITIONS}**. If **Table column names** is set, the column specified by **Table column names** will replace the column queried in the SQL statement. This parameter cannot be set when **Schema name** or **Table name** is set.
	Table column names	Table columns whose content is to be imported by Loader. Use commas (,) to separate multiple fields.
	Partition column name	Database table column based on which to-be-imported data is determined. This parameter is used for partitioning in a Map job. You are advised to configure the primary key field. **NOTE** • A partition column must have an index. If no index exists, do not specify a partition column. If a partition column without an index is specified, the database server disk I/O will be busy, the access of other services to the database will be affected, and the import will take a long period. • In multiple fields with indexes, select the field that has the most discrete value as the partition column. A partition column that is not discrete may result in load imbalance when multiple MapReduce jobs are imported. • The sorting rules of partition columns must be case-sensitive. Otherwise, data may be lost during data import. • You are not advised to select fields of the float or double type for the partition column. Otherwise, the records containing the minimum and maximum values of the partition column may fail to be imported due to precision issues.
	Nulls in partition column	Indicates whether to process records whose values are null in database table columns. If the value is **true**, the data whose value is null in the partition column is processed. If the value is **false**, the data whose value is null in the partition column is not processed.
	Need partition column	Indicates whether to specify a partition column.

Source File Type	Parameter	Description
oracle-connector	Table Name	Table name.
	Column Name	Column name.
	Query Condition	Query condition in an SQL statement
	Splitting Mode	Data splitting mode. The options are **ROWID** and **PARTITION**.
	Table Partition Name	Name of a table partition. Use commas (,) to separate the names of different partitions.
	Data Block Allocation Mode	Allocation method of data after being split.
	Read Size	Amount of data to be read each time.
mysql-fastpath-connector	Schema Name	Database schema name.
	Table Name	Database table name.
	Query Condition	Query condition of a specified table.
	Partition Column Name	Database table column based on which to-be-imported data is determined. This parameter is used for partitioning in a Map job. You are advised to configure the primary key field. **NOTE** • A partition column must have an index. If no index exists, do not specify a partition column. If a partition column without an index is specified, the database server disk I/O will be busy, the access of other services to the database will be affected, and the import will take a long period. • In multiple fields with indexes, select the field that has the most discrete value as the partition column. A partition column that is not discrete may result in load imbalance when multiple MapReduce jobs are imported. • You are not advised to select fields of the float or double type for the partition column. Otherwise, the records containing the minimum and maximum values of the partition column may fail to be imported due to precision issues.
	Nulls in Partition Column	Indicates whether to process records whose values are null in database table columns. If the value is **true**, the data whose value is null in the partition column is processed. If the value is **false**, the data whose value is null in the partition column is not processed.

Source File Type	Parameter	Description
	Whether to Specify a Partition Column	Indicates whether to specify a partition column.
oracle-partition-connector	Schema Name	Database schema name.
	Table Name	Partition table name.
	Query Condition	Query condition in an SQL statement.
	Table Column Names	Table columns whose content is to be imported by Loader. Use commas (,) to separate multiple fields.

Step 6 On the **Transform** page, configure the transform operations during data transmission.

Check whether source data values in the data operation job created by the Loader can be directly used without conversion, including upper and lower case conversion, cutting, merging, and separation.

- If yes, click **Next**.
- If no, perform **Step 6.1** to **Step 6.4**.

1. No created conversion step exists by default. Drag an example conversion step on the left to the edit box to create a new conversion step.
2. Conversion step types must be selected based on service requirements. A complete conversion process includes the following types:
   a. Input type. Only one conversion step can be added. This parameter is mandatory if the task involves HBase or relational databases.
   b. Conversion type, which is an intermediate conversion step. You can add one or more conversion types or do not add any conversion type.
   c. Output type. Only one output type can be added in the last conversion step. This parameter is mandatory if the task involves HBase or relational databases.

Table 16-13 Example list

Type	Description
Input Type	▪ **CSV File Input**: CSV file input step for configuring separators to generate multiple fields. ▪ **Fixed File Input**: Text file input step for configuring the length of characters or bytes to be truncated to generate multiple fields. ▪ **Table Input**: relational data input step for configuring specified columns in the database as input fields. ▪ **HBase Input**: HBase table input step for configuring the column definition of an HBase table to a specified field. ▪ **HTML File Input**: HTML web page data input step for obtaining the target data of the HTML web page file to the specified field. ▪ **Hive Input**: Hive table input step for defining columns in a Hive table to specified fields. ▪ **Spark Input**: Spark SQL table input step for defining columns in the SparkSQL table to specified fields. Only SparkSQL can access Hive data.

Type	Description
Conversion Type	▪ **Long Integer Time Conversion**: Configure the conversion between a long integer value and a date. ▪ **Null Value Conversion**: Configure a specified value to replace the null value. ▪ **Random Value Conversion**: Configure new value-added fields as random data fields. ▪ **Adding a Constant Field**: Add a constant to directly generate a constant field. ▪ **Concatenation and Conversion**: Concatenate fields, connect generated fields using connection characters, and convert new fields. ▪ **Separator Conversion**: Configure the generated fields to be separated by separators and convert new fields. ▪ **Modulo Conversion**: Configure the generated fields to be converted into new fields through modulo operation. ▪ **Cutting Character String**: Truncate a generated field based on a specified position to generate a new field. ▪ **EL Operation Conversion**: Calculate field values. Currently, the following operators are supported: md5sum, sha1sum, sha256sum, and sha512sum. ▪ **Character String Case Conversion:** Configure the generated fields to be converted to new fields through case conversion. ▪ **Reverse String Conversion**: Reverse the generated fields to generate new fields. ▪ **Character String Space Clearing Conversion**: Configure the generated fields to clear spaces and convert them to new fields. ▪ **Row Filtering Conversion**: Configure logical conditions to filter out rows that contain triggering conditions. ▪ **Update Fields**: Update the value of a specified field when certain conditions are met.

Type	Description
Output Type	▪ **File Output**: Configure generated fields to be connected by separators and exported to a file. ▪ **Table Output**: Configure the mapping between output fields and specified columns in the database. ▪ **HBase Output**: Configure the generated fields to the columns of the HBase table. ▪ **Hive Output**: Configure generated fields to a column of a Hive table. ▪ **Spark Output**: Configure generated fields to the columns of SparkSQL tables. Only SparkSQL can access Hive data.

The edit box allows you to perform the following tasks:

- Rename: Rename an example.
- Edit: Edit the step conversion by referring to **Step 6.3**.
- Delete: Delete an example.

  NOTE

  You can also use the shortcut key **Del** to delete the example.

3. Click **Edit** to edit the step conversion information and configure fields and data.

   For details about how to set parameters in the step conversion information, see **Operator Help**.

   NOTE

   - When sftp-connector or ftp-connector is used to import data, the time type field in the original data must be set to a string during the data conversion so that the time can be accurate to millisecond for data import. The data that has more precise time than millisecond will not be imported.
   - When generic-jdbc-connector is used to import data, it is recommended that the data length of the CHAR or VARCHAR type field be set to -1 during data conversion so that all data can be imported. This prevents the data from being truncated when the actual data length is too long.
   - When generic-jdbc-connector is used to import data, the time type field in the original data must be set to a time type value during the data conversion so that the time can be accurate to second for data import. The data that has more precise time than second will not be imported.
   - When data is imported to a Hive partitioned table, Hive does not scan the newly imported data by default. You need to run the following HQL statement to repair the table so that the newly imported data can be queried:

     MSCK REPAIR TABLE *table_name*;

If the conversion step is incorrectly configured, the source data cannot be converted and become dirty data. The dirty data marking rules are as follows:

- In any input type step, all data becomes dirty data if the number of fields contained in the original data is less than that of configured fields, or the field values in the original data do not match the configured field type.
- In the **CSV File Input** step, **Validate input field** checks whether the input field matches the value type. If the input field and value type of a row do not match, the row is skipped and becomes dirty data.
- In the **Fixed Width File Input** step, **Fixed Length** specifies the field splitting length. If the length is greater than the length of the original field value, data splitting fails and the current row becomes dirty data.
- In the **HBase Input** step, if the HBase table name specified by **HBase Table Name** is incorrect, or no primary key column is configured for **Primary Key**, all data becomes dirty data.
- In any conversion step, rows whose conversion fails become dirty data. For example, in the **Split Conversion** step, if the number of generated fields is less than that of configured fields, or the original data cannot be converted to the String type, the current row becomes dirty data.
- In the **Filter Row Conversion** step, rows filtered by filter criteria become dirty data.
- In the **Modulo Conversion** step, if the original field value is **NULL**, the current row becomes dirty data.
- For jobs that import data to Hive/SparkSQL tables, you must configure the Hive conversion step.

4. Click **Next**.

Step 7 On the **To** page, set the destination location for saving data and click **Save** to save the job or click **Save and Run** to save and run the job.

Table 16-14 List of output configuration parameters

Storage Type	Parameter	Description
HDFS	File Type	Select a file import type from the drop-down list. Available values: ● **TEXT_FILE**: imports a text file and saves it as a text file. ● **SEQUENCE_FILE**: imports a text file and saves it as a sequence file. ● **BINARY_FILE**: imports files of any format by using binary streams but not to process the files. **NOTE** When the file import type to **TEXT_FILE** or **SEQUENCE_FILE**, Loader automatically selects a decompression method based on the file name extension to decompress a file.

Storage Type	Parameter	Description
	Compression Format	Compression format of files imported to HDFS. Select a format from the drop-down list. If you select **NONE** or do not set this parameter, data is not compressed.
	Output Directory	Directory for storing data imported to HDFS.
	Operation	Action during data import. When all data is imported from the input path to the destination path, the data is stored in a temporary directory and then copied from the temporary directory to the destination path. After data import is complete, the data in the temporary directory is deleted. One of the following actions can be taken when there are duplicate file names during data transfer: ● **OVERRIDE**: overrides the old file. ● **RENAME**: renames the new file. For a file without a file name extension, a string is added to the file name as the extension; for a file with a file name extension, a string is added to the extension. The string is unique. ● **APPEND**: adds the content of the new file to the end of the old file. This action only adds content regardless of whether the file can be used. For example, a text file can be used after this action, while a compressed file cannot. ● **IGNORE**: reserves the old file and does not copy the new file. ● **ERROR**: stops the task and reports an error if there are duplicate file names. Transferred files are imported successfully, while files that have duplicate names and files that are not transferred fail to import.
	Extractors	Number of Maps that are started at the same time in a MapReduce task of a data configuration operation. This parameter cannot be set when **Extractor Size** is set. The value must be less than or equal to 3000.

Storage Type	Parameter	Description
	Extractor Size	Size of data processed by Maps that are started in a MapReduce task of a data configuration operation. The unit is MB. The value must be greater than or equal to 100. The recommended value is **1000**. This parameter cannot be set when **Extractors** is set. When a relational database connector is used, **Extractor Size** is unavailable. You need to set **Extractors**.
HBASE_BULKLOAD	HBase Instance	HBase service instance that Loader selects from all available HBase service instances in the cluster. If the selected HBase service instance is not added to the cluster, the HBase job cannot be run properly.
	Clear data before import	Indicates whether to clear data in the original table before importing data. The value **true** indicates that the clearing operation is performed, and the value **false** indicates that the clearing operation is not performed. If you do not set this parameter, the original table is not cleared by default.
	Extractors	Number of Maps that are started at the same time in a MapReduce task of a data configuration operation. The value must be less than or equal to 3000.
	Extractor Size	HBase does not support this parameter. Please set **Extractors**.
HBASE_PUTLIST	HBase Instance	HBase service instance that Loader selects from all available HBase service instances in the cluster. If the selected HBase service instance is not added to the cluster, the HBase job cannot be run properly.
	Extractors	Number of Maps that are started at the same time in a MapReduce task of a data configuration operation. The value must be less than or equal to 3000.
	Extractor Size	HBase does not support this parameter. Please set **Extractors**.
HIVE	Output Directory	Directory for storing data imported to Hive.

Storage Type	Parameter	Description
	Extractors	Number of Maps that are started at the same time in a MapReduce task of a data configuration operation. This parameter cannot be set when **Extractor Size** is set. The value must be less than or equal to 3000.
	Extractor Size	Size of data processed by Maps that are started in a MapReduce task of a data configuration operation. The unit is MB. The value must be greater than or equal to 100. The recommended value is **1000**. This parameter cannot be set when **Extractors** is set. When a relational database connector is used, **Extractor Size** is unavailable. You need to set **Extractors**.
SPARK	Output Directory	Only SparkSQL is supported to access Hive data. You can specify the directory for storing data imported to Hive.
	Extractors	Number of Maps that are started at the same time in a MapReduce task of a data configuration operation. This parameter cannot be set when **Extractor Size** is set. The value must be less than or equal to 3000.
	Extractor Size	Size of data processed by Maps that are started in a MapReduce task of a data configuration operation. The unit is MB. The value must be greater than or equal to 100. The recommended value is **1000**. This parameter cannot be set when **Extractors** is set. When a relational database connector is used, **Extractor Size** is unavailable. You need to set **Extractors**.

Step 8 On the Loader web UI, view, start, stop, copy, delete, edit, or view historical information about created jobs.

Figure 16-3 Viewing Loader jobs

----End

16.5.3 Typical Scenario: Importing Data from an SFTP Server to HDFS or OBS

Scenario

Use Loader to import data from an SFTP server to HDFS or OBS.

Prerequisites

- You have obtained the service username and password for creating a Loader job.
- You have had the permission to access the HDFS or OBS directories and data involved in job execution.
- You have obtained the username and password of the SFTP server as well as the read permission for the source files on the SFTP server. If file name extension needs to be added after a source file is imported, the user must have the write permission of the source file.
- No disk space alarm is reported, and the available disk space is sufficient for importing and exporting data.
- When using Loader to import data from the SFTP server, the input paths and input path subdirectories of the SFTP server and the name of the files in these directories do not contain any of the special characters /"':;.
- If a configured task requires the Yarn queue function, the user must be authorized with related Yarn queue permission.
- The user who configures a task must obtain execution permission on the task and obtain usage permission on the related connection of the task.

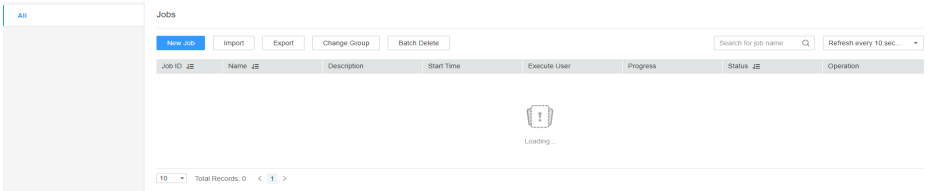
Procedure

Configure basic job information.

Step 1 Access the Loader web UI.

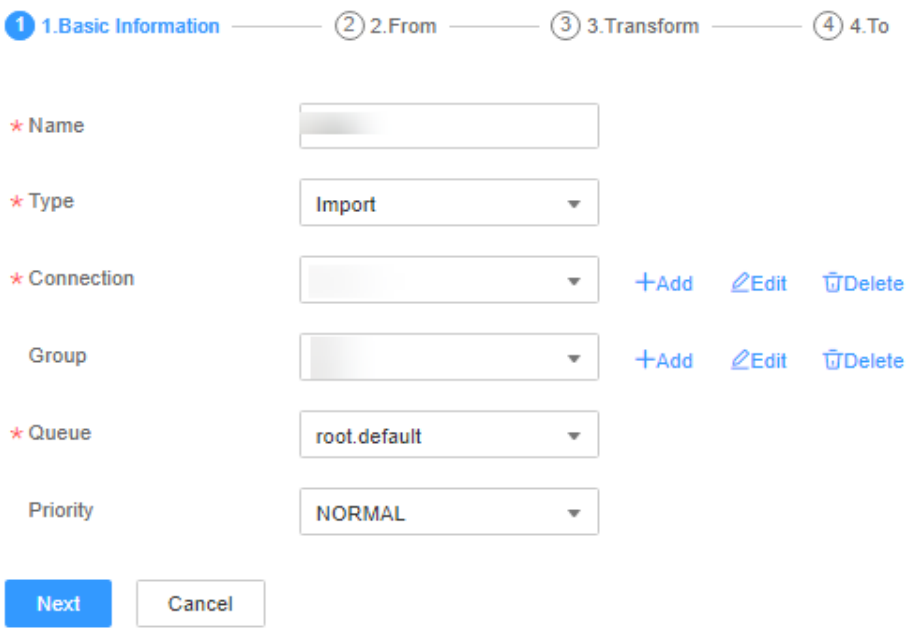
1. Log in to FusionInsight Manager.
2. Choose **Cluster** > **Services** > **Loader**.
3. Click **LoaderServer(***Node name***, Active)**. The Loader web UI is displayed.

Figure 16-4 Loader web UI



Step 2 Click **New Job** to go to the **Basic Information** page and set basic job information.

Figure 16-5 Basic Information page



1. Set **Name** to the name of the job.
2. Set **Type** to **Import**.
3. Set **Group** to the group to which the job belongs. No group is created by default. You need to click **Add** to create a group and click **OK** to save the created group.
4. Set **Queue** to the Yarn queue that executes the job. The default value is **root.default**.
5. Set **Priority** to the priority of the Yarn queue that executes the job. The default value is **NORMAL**. The options are **VERY_LOW**, **LOW**, **NORMAL**, **HIGH**, and **VERY_HIGH**.

Step 3 In the **Connection** area, click **Add** to create a connection, set **Connector** to **sftp-connector**, click **Add**, set connection parameters, and click **Test** to verify whether the connection is available. When "Test Success" is displayed, click **OK**. Loader allows multiple SFTP servers to be configured. Click **Add** to add the configuration information of multiple SFTP servers.

Table 16-15 Connection parameters

Parameter	Description	Example Value
Name	Name of the SFTP server connection	sftpName
SFTP Server IP Address	IP address of the SFTP server	10.16.0.1
SFTP Server Port	Port number of the SFTP server	22
SFTP Username	Username for accessing the SFTP server	root

Parameter	Description	Example Value
SFTP Password	Password for accessing the SFTP server	xxxx
SFTP Public Key	Public key of the SFTP server	OdDt/yn...etM

NOTE

When multiple SFTP servers are configured, the data in the specified directories of the SFTP servers is imported to the same directory in HDFS or OBS.

Configure data source information.

Step 4 Click **Next**. On the displayed **From** page, set the data source information.

Table 16-16 Parameter description

Parameter	Description	Example Value
Input Path	Input path or name of the source file on an SFTP server. If multiple SFTP server IP addresses are configured for the connector, you can set this parameter to multiple input paths separated with semicolons (;). Ensure that the number of input paths is the same as that of SFTP servers configured for the connector. **NOTE** You can use macros to define path parameters. For details, see **Using Macro Definitions in Configuration Items** .	/opt/tempfile;/opt
File Split Type	Indicates whether to split source files by file name or size. The files obtained after the splitting are used as the input files of each Map in the MapReduce task for data import. • **FILE**: indicates that the source file is split by file. That is, each Map processes one or multiple complete files, the same source file cannot be allocated to different Maps, and the source file directory structure is retained after data import. • **SIZE**: indicates that the source file is split by size. That is, each Map processes input files of a certain size, and a source file can be divided and processed by multiple Maps. After data is stored in the output directory, the number of saved files is the same as that of Maps. The file name format is **import_part**_*xxxx*, where *xxxx* is a unique random number generated by the system.	FILE

Parameter	Description	Example Value
Filter Type	File filter condition. This parameter is used when **Path Filter** or **File Filter** is set. ● **WILDCARD**: indicates using a wildcard. ● **REGEX**: indicates using a regular expression. ● If the parameter is not set, a wildcard is used by default.	WILDCARD
Path Filter	Wildcard or regular expression for filtering the directories in the input path of the source files. This parameter is used when **Filter Type** is set. **Input Path** is not used for filtering. Use semicolons (;) to separate the path filters on multiple servers and use commas (,) to separate the filter conditions of each server. If this parameter is left empty, directories are not filtered. ● **?** matches a single character. ● ***** indicates multiple characters. ● Adding **^** before the condition indicates negated filtering, that is, file filtering. For example, when **Filter type** is set to **WILDCARD**, set the parameter to *****; when **Filter type** is set to **REGEX**, set the parameter to **\\.***.	1*,2*;1*
File Filter	Wildcard or regular expression for filtering the file names of the source files. This parameter is used when **Filter Type** is set. Use semicolons (;) to separate the path filters on multiple servers and use commas (,) to separate the filter conditions of each server. This parameter cannot be left blank. ● **?** matches a single character. ● ***** indicates multiple characters. ● Adding **^** before the condition indicates negated filtering, that is, file filtering. For example, when **Filter type** is set to **WILDCARD**, set the parameter to *****; when **Filter type** is set to **REGEX**, set the parameter to **\\.***.	*.txt,*.csv; *.txt
Encoding Type	Source file encoding format, for example, UTF-8 and GBK. This parameter can be set only in text file import.	UTF-8

Parameter	Description	Example Value
Suffix	File name extension added to a source file after the source file is imported. If this parameter is empty, no file name extension is added to the source file. This parameter is valid only when the data source is a file system. You are advised to set this parameter in incremental data import. For example, if the parameter is set to **.txt** and the source file is **test-loader.csv**, the source file name is **test-loader.csv.txt** after export.	.log
Compression	Indicates whether to enable compressed transmission when SFTP is used to export data. • The value **true** indicates that compression is enabled. • The value **false** indicates that compression is disabled.	true

Configure data transformation.

Step 5 Click **Next**. On the displayed **Transform** page, set the transformation operations in the data transformation process. For details about how to select operators and set parameters, see **Operator Help** and **Table 16-17**.

Table 16-17 Input and output parameters of the operator

Input Type	Output Type
CSV File Input	File Output
HTML File Input	File Output
Fixed File Input	File Output

In **input**, drag **CSV File Input**, **HTML File Input**, or **Fixed File Input** to the grid. In **output**, drag **File Output** to the grid. Use an arrow to connect **CSV File Input**, **HTML File Input**, or **Fixed File Input** to **File Output**.

Set data storage information and execute the job.

Step 6 Click **Next**. On the displayed **To** page, set **Storage type** to **HDFS**.

Table 16-18 Parameter description

Parameter	Description	Example Value
File Type	Type of the file to be saved after being imported. The options are as follows: • **TEXT_FILE**: imports a text file and saves it as a text file. • **SEQUENCE_FILE**: imports a text file and saves it as a sequence file. • **BINARY_FILE**: imports files of any format using binary streams.	TEXT_FILE
Compression Format	Compression format of files imported to HDFS or OBS. Select a format from the drop-down list. If you select **NONE** or do not set this parameter, data is not compressed.	NONE
Output Directory	Directory for storing data imported to HDFS or OBS. **NOTE** You can use macros to define path parameters. For details, see **Using Macro Definitions in Configuration Items** .	/user/test

Parameter	Description	Example Value
Operation	Action during data import. When all data is imported from the input path to the destination path, the data is stored in a temporary directory and then copied from the temporary directory to the destination path. After data import is complete, the data in the temporary directory is deleted. One of the following actions can be taken when there are duplicate file names during data transfer: ● **OVERRIDE**: overrides the old file. ● **RENAME**: renames the new file. For a file without a file name extension, a string is added to the file name as the extension; for a file with a file name extension, a string is added to the extension. The string is unique. ● **APPEND**: adds the content of the new file to the end of the old file. This action only adds content regardless of whether the file can be used. For example, a text file can be used after this action, while a compressed file cannot. ● **IGNORE**: reserves the old file and does not copy the new file. ● **ERROR**: stops the task and reports an error if there are duplicate file names. Transferred files are imported successfully, while files that have duplicate names and files that are not transferred fail to import.	OVERRIDE
Extractors	Number of Maps that are started at the same time in a MapReduce task of a data configuration operation. This parameter cannot be set when **Extractor Size** is set. The value must be less than or equal to 3000. You are advised to set the parameter to the number of CPU cores on the SFTP server. **NOTE** To improve the data import speed, ensure that the following conditions are met: ● Each Map connection is equivalent to a client connection. Therefore, you must ensure that the maximum number of connections of the SFTP server is greater than the number of Maps. ● Ensure that the disk I/O or network bandwidth on the SFTP server does not reach the upper limit.	20

Parameter	Description	Example Value
Extractor Size	Size of data processed by Maps that are started in a MapReduce task of a data configuration operation. The unit is MB. The value must be greater than or equal to 100. The recommended value is 1000. This parameter cannot be set when **Extractors** is set.	1000

Step 7 Click **Save and Run** to save and run the job.

View the job execution result.

Step 8 Go to the Loader web UI. When **Status** is **Succeeded**, the job is complete.

Figure 16-6 Viewing job details

----End

16.5.4 Typical Scenario: Importing Data from an SFTP Server to HBase

Scenario

Use Loader to import data from an SFTP server to HBase.

Prerequisites

- You have obtained the service username and password for creating a Loader job.
- You have had the permission to access the HBase tables or phoenix tables that are used during job execution.
- You have obtained the username and password of the SFTP server as well as the read permission for the source files on the SFTP server. If file name extension needs to be added after a source file is imported, the user must have the write permission of the source file.
- No disk space alarm is reported, and the available disk space is sufficient for importing and exporting data.
- When using Loader to import data from the SFTP server, the input paths and input path subdirectories of the SFTP server and the name of the files in these directories do not contain any of the special characters /"':;.
- If a configured task requires the Yarn queue function, the user must be authorized with related Yarn queue permission.
- The user who configures a task must obtain execution permission on the task and obtain usage permission on the related connection of the task.

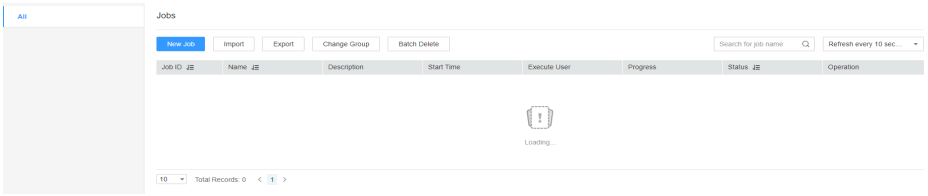
Procedure

Configure basic job information.

Step 1 Access the Loader web UI.

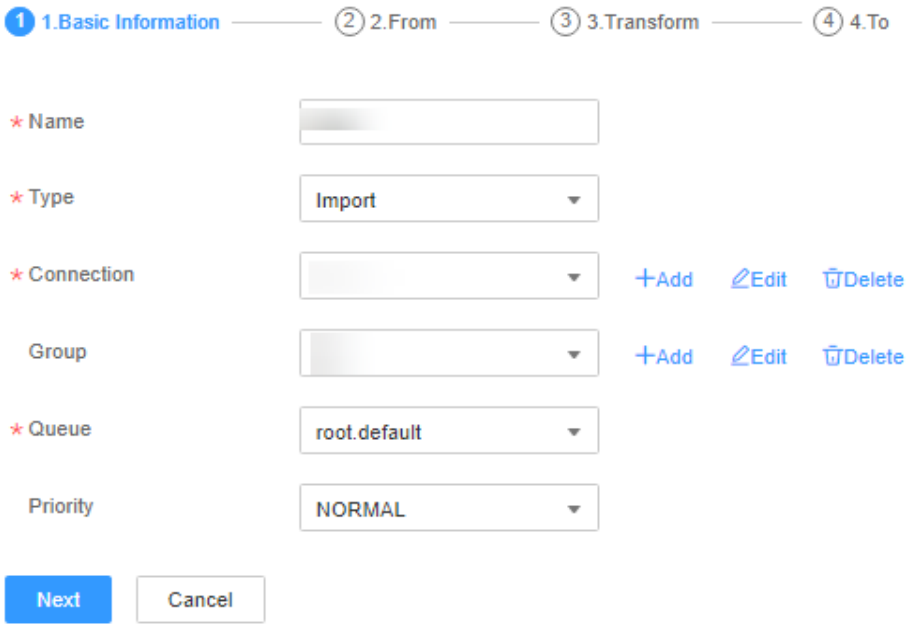
1. Log in to FusionInsight Manager.
2. Choose **Cluster** > **Services** > **Loader**.
3. Click **LoaderServer(***Node name***, Active)**. The Loader web UI is displayed.

Figure 16-7 Loader web UI



Step 2 Click **New Job** to go to the **Basic Information** page and set basic job information.

Figure 16-8 Basic Information page



1. Set **Name** to the name of the job.
2. Set **Type** to **Import**.
3. Set **Group** to the group to which the job belongs. No group is created by default. You need to click **Add** to create a group and click **OK** to save the created group.
4. Set **Queue** to the Yarn queue that executes the job. The default value is **root.default**.
5. Set **Priority** to the priority of the Yarn queue that executes the job. The default value is **NORMAL**. The options are **VERY_LOW**, **LOW**, **NORMAL**, **HIGH**, and **VERY_HIGH**.

Step 3 In the **Connection** area, click **Add** to create a connection, set **Connector** to **sftp-connector**, click **Add**, set connection parameters, and click **Test** to verify whether the connection is available. When "Test Success" is displayed, click **OK**. Loader allows multiple SFTP servers to be configured. Click **Add** to add the configuration information of multiple SFTP servers.

Table 16-19 Connection parameters

Parameter	Description	Example Value
Name	Name of the SFTP server connection	sftpName
SFTP Server IP Address	IP address of the SFTP server	10.16.0.1
SFTP Server Port	Port number of the SFTP server	22
SFTP Username	Username for accessing the SFTP server	root
SFTP Password	Password for accessing the SFTP server	xxxx
SFTP Public Key	Public key of the SFTP server	OdDt/yn...etM

NOTE

When multiple SFTP servers are configured, the data in the specified directories of the servers is imported to HBase.

Configure data source information.

Step 4 Click **Next**. On the displayed **From** page, set the data source information.

Table 16-20 Parameter description

Parameter	Description	Example Value
Input Path	Input path or name of the source file on an SFTP server. If multiple SFTP server IP addresses are configured for the connector, you can set this parameter to multiple input paths separated with semicolons (;). Ensure that the number of input paths is the same as that of SFTP servers configured for the connector. **NOTE** You can use macros to define path parameters. For details, see **Using Macro Definitions in Configuration Items** .	/opt/tempfile;/opt

Parameter	Description	Example Value
File Split Type	Indicates whether to split source files by file name or size. The files obtained after the splitting are used as the input files of each Map in the MapReduce task for data import. ● **FILE**: indicates that the source file is split by file. That is, each Map processes one or multiple complete files, the same source file cannot be allocated to different Maps, and the source file directory structure is retained after data import. ● **SIZE**: indicates that the source file is split by size. That is, each Map processes input files of a certain size, and a source file can be divided and processed by multiple Maps. After data is stored in the output directory, the number of saved files is the same as that of Maps. The file name format is **import_part**_*xxxx*, where *xxxx* is a unique random number generated by the system.	FILE
Filter Type	File filter condition. This parameter is used when **Path Filter** or **File Filter** is set. ● **WILDCARD**: indicates using a wildcard. ● **REGEX**: indicates using a regular expression. ● If the parameter is not set, a wildcard is used by default.	WILDCARD
Path Filter	Wildcard or regular expression for filtering the directories in the input path of the source files. This parameter is used when **Filter Type** is set. **Input Path** is not used for filtering. Use semicolons (;) to separate the path filters on multiple servers and use commas (,) to separate the filter conditions of each server. If this parameter is left empty, directories are not filtered. ● **?** matches a single character. ● ***** indicates multiple characters. ● Adding **^** before the condition indicates negated filtering, that is, file filtering. For example, when **Filter type** is set to **WILDCARD**, set the parameter to *****; when **Filter type** is set to **REGEX**, set the parameter to **\\.***.	1*,2*;1*

Parameter	Description	Example Value
File Filter	Wildcard or regular expression for filtering the file names of the source files. This parameter is used when **Filter Type** is set. Use semicolons (;) to separate the path filters on multiple servers and use commas (,) to separate the filter conditions of each server. This parameter cannot be left blank. • **?** matches a single character. • ***** indicates multiple characters. • Adding ^ before the condition indicates negated filtering, that is, file filtering. For example, when **Filter type** is set to **WILDCARD**, set the parameter to *****; when **Filter type** is set to **REGEX**, set the parameter to **\\.***.	*.txt,*.csv;*.txt
Encoding Type	Source file encoding format, for example, UTF-8 and GBK. This parameter can be set only in text file import.	UTF-8
Suffix	File name extension added to a source file after the source file is imported. If this parameter is empty, no file name extension is added to the source file. This parameter is valid only when the data source is a file system. You are advised to set this parameter in incremental data import. For example, if the parameter is set to **.txt** and the source file is **test-loader.csv**, the source file name is **test-loader.csv.txt** after export.	.log
Compression	Indicates whether to enable compressed transmission when SFTP is used to export data. • The value **true** indicates that compression is enabled. • The value **false** indicates that compression is disabled.	true

Configure data transformation.

Step 5 Click **Next**. On the displayed **Transform** page, set the transformation operations in the data transformation process. For details about how to select operators and set parameters, see **Operator Help** and **Table 16-21**.

Table 16-21 Input and output parameters of the operator

Input Type	Output Type
CSV File Input	HBase Output
HTML File Input	HBase Output
Fixed File Input	HBase Output

In **input**, drag **CSV File Input**, **HTML File Input**, or **Fixed File Input** to the grid. In **output**, drag **HBase Output** to the grid. Use an arrow to connect **CSV File Input**, **HTML File Input**, or **Fixed File Input** to **HBase Output**.

Set data storage information and execute the job.

Step 6 Click **Next**. On the displayed **To** page, set **Storage type** to **HBASE_BULKLOAD** or **HBASE_PUTLIST** based on the actual situation.

Table 16-22 Parameter description

Storage Type	Applicable Scenario	Parameter	Description	Example Value
HBASE_BULKLOAD	Large data volume	HBase Instance	HBase service instance that Loader selects from all available HBase service instances in the cluster. If the selected HBase service instance is not added to the cluster, the HBase job cannot be run properly.	HBase

Storage Type	Applicable Scenario	Parameter	Description	Example Value
		Clear data before import	Indicates whether to clear data in the original table before importing data. The value **true** indicates that the data is cleared, and the value **false** indicates that the data is not cleared. If you do not set this parameter, the original table is not cleared by default.	true
		Extractors	Number of Maps that are started at the same time in a MapReduce task of a data configuration operation. The value must be less than or equal to 3000. You are advised to set the parameter to the maximum number of connections on the SFTP server.	20
		Extractor Size	HBase does not support this parameter. Please set **Extractors**.	-

Storage Type	Applicable Scenario	Parameter	Description	Example Value
HBASE_PUTLIST	Small data volume	HBase Instance	HBase service instance that Loader selects from all available HBase service instances in the cluster. If the selected HBase service instance is not added to the cluster, the HBase job cannot be run properly.	HBase
		Extractors	Number of Maps that are started at the same time in a MapReduce task of a data configuration operation. The value must be less than or equal to 3000.	20
		Extractor Size	HBase does not support this parameter. Please set **Extractors**.	-

Step 7 Click **Save and Run** to save and run the job.

View the job execution result.

Step 8 Go to the Loader web UI. When **Status** is **Succeeded**, the job is complete.

Figure 16-9 Viewing job details

----End

16.5.5 Typical Scenario: Importing Data from an SFTP Server to Hive

Scenario

Use Loader to import data from an SFTP server to Hive.

Prerequisites

- You have obtained the service username and password for creating a Loader job.
- You have had the permission to access the Hive table specified in the job.
- You have obtained the username and password of the SFTP server as well as the read permission for the source files on the SFTP server. If file name extension needs to be added after a source file is imported, the user must have the write permission of the source file.
- No disk space alarm is reported, and the available disk space is sufficient for importing and exporting data.
- When using Loader to import data from the SFTP server, the input paths and input path subdirectories of the SFTP server and the name of the files in these directories do not contain any of the special characters /"':;.
- If a configured task requires the Yarn queue function, the user must be authorized with related Yarn queue permission.
- The user who configures a task must obtain execution permission on the task and obtain usage permission on the related connection of the task.

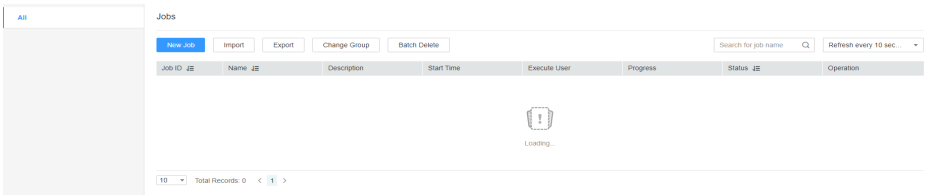
Procedure

Configure basic job information.

Step 1 Access the Loader web UI.

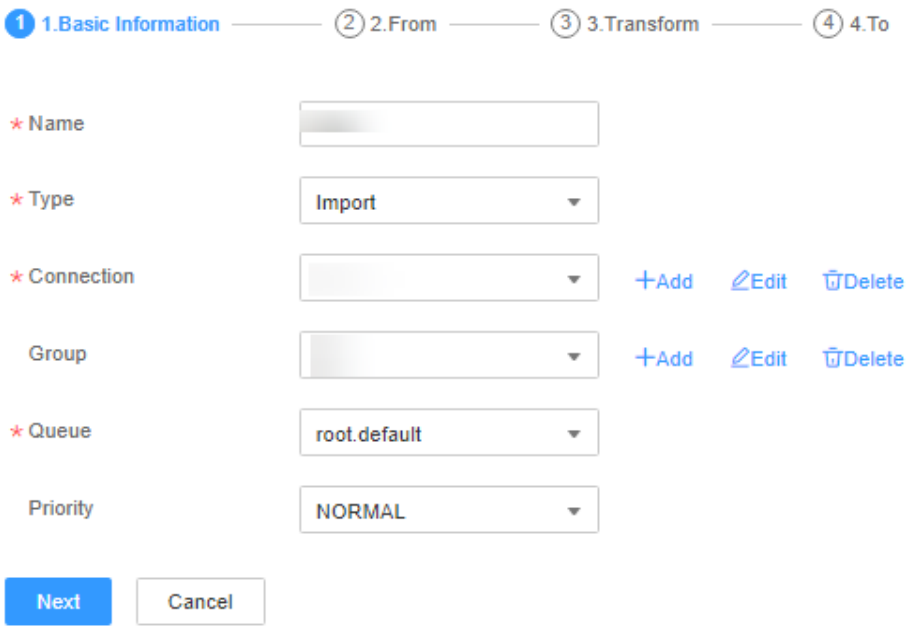
1. Log in to FusionInsight Manager.
2. Choose **Cluster** > **Services** > **Loader**.
3. Click **LoaderServer(***Node name***, Active)**. The Loader web UI is displayed.

Figure 16-10 Loader web UI



Step 2 Click **New Job** to go to the **Basic Information** page and set basic job information.

Figure 16-11 Basic Information page



1. Set **Name** to the name of the job.
2. Set **Type** to **Import**.
3. Set **Group** to the group to which the job belongs. No group is created by default. You need to click **Add** to create a group and click **OK** to save the created group.
4. Set **Queue** to the Yarn queue that executes the job. The default value is **root.default**.
5. Set **Priority** to the priority of the Yarn queue that executes the job. The default value is **NORMAL**. The options are **VERY_LOW**, **LOW**, **NORMAL**, **HIGH**, and **VERY_HIGH**.

Step 3 In the **Connection** area, click **Add** to create a connection, set **Connector** to **sftp-connector**, click **Add**, set connection parameters, and click **Test** to verify whether the connection is available. When "Test Success" is displayed, click **OK**. Loader allows multiple SFTP servers to be configured. Click **Add** to add the configuration information of multiple SFTP servers.

Table 16-23 Connection parameters

Parameter	Description	Example Value
Name	Name of the SFTP server connection	sftpName
SFTP Server IP Address	IP address of the SFTP server	10.16.0.1
SFTP Server Port	Port number of the SFTP server	22
SFTP Username	Username for accessing the SFTP server	root
SFTP Password	Password for accessing the SFTP server	xxxx

Parameter	Description	Example Value
SFTP Public Key	Public key of the SFTP server	OdDt/yn...etM

NOTE

When multiple SFTP servers are configured, the data in the specified directories of the servers is imported to Hive.

Configure data source information.

Step 4 Click **Next**. On the displayed **From** page, set the data source information.

Table 16-24 Parameter description

Parameter	Description	Example Value
Input Path	Input path or name of the source file on an SFTP server. If multiple SFTP server IP addresses are configured for the connector, you can set this parameter to multiple input paths separated with semicolons (;). Ensure that the number of input paths is the same as that of SFTP servers configured for the connector. **NOTE** You can use macros to define path parameters. For details, see **Using Macro Definitions in Configuration Items** .	/opt/tempfile;/opt
File Split Type	Indicates whether to split source files by file name or size. The files obtained after the splitting are used as the input files of each Map in the MapReduce task for data import. • **FILE**: indicates that the source file is split by file. That is, each Map processes one or multiple complete files, the same source file cannot be allocated to different Maps, and the source file directory structure is retained after data import. • **SIZE**: indicates that the source file is split by size. That is, each Map processes input files of a certain size, and a source file can be divided and processed by multiple Maps. After data is stored in the output directory, the number of saved files is the same as that of Maps. The file name format is **import_part**_*xxxx*, where *xxxx* is a unique random number generated by the system.	FILE

Parameter	Description	Example Value
Filter Type	File filter condition. This parameter is used when **Path Filter** or **File Filter** is set. ● **WILDCARD**: indicates using a wildcard. ● **REGEX**: indicates using a regular expression. ● If the parameter is not set, a wildcard is used by default.	WILDCARD
Path Filter	Wildcard or regular expression for filtering the directories in the input path of the source files. This parameter is used when **Filter Type** is set. **Input Path** is not used for filtering. Use semicolons (;) to separate the path filters on multiple servers and use commas (,) to separate the filter conditions of each server. If this parameter is left empty, directories are not filtered. ● **?** matches a single character. ● ***** indicates multiple characters. ● Adding ^ before the condition indicates negated filtering, that is, file filtering. For example, when **Filter type** is set to **WILDCARD**, set the parameter to *****; when **Filter type** is set to **REGEX**, set the parameter to **\\.***.	1*,2*;1*
File Filter	Wildcard or regular expression for filtering the file names of the source files. This parameter is used when **Filter Type** is set. Use semicolons (;) to separate the path filters on multiple servers and use commas (,) to separate the filter conditions of each server. This parameter cannot be left blank. ● **?** matches a single character. ● ***** indicates multiple characters. ● Adding ^ before the condition indicates negated filtering, that is, file filtering. For example, when **Filter type** is set to **WILDCARD**, set the parameter to *****; when **Filter type** is set to **REGEX**, set the parameter to **\\.***.	*.txt,*.csv;*.txt
Encoding Type	Source file encoding format, for example, UTF-8 and GBK. This parameter can be set only in text file import.	UTF-8

Parameter	Description	Example Value
Suffix	File name extension added to a source file after the source file is imported. If this parameter is empty, no file name extension is added to the source file. This parameter is valid only when the data source is a file system. You are advised to set this parameter in incremental data import. For example, if the parameter is set to **.txt** and the source file is **test-loader.csv**, the source file name is **test-loader.csv.txt** after export.	.log
Compression	Indicates whether to enable compressed transmission when SFTP is used to export data. • The value **true** indicates that compression is enabled. • The value **false** indicates that compression is disabled.	true

Configure data transformation.

Step 5 Click **Next**. On the displayed **Transform** page, set the transformation operations in the data transformation process. For details about how to select operators and set parameters, see **Operator Help** and **Table 16-25**.

Table 16-25 Input and output parameters of the operator

Input Type	Output Type
CSV File Input	Hive Output
HTML File Input	Hive Output
Fixed File Input	Hive Output

In **input**, drag **CSV File Input**, **HTML File Input**, or **Fixed File Input** to the grid. In **output**, drag **Hive Output** to the grid. Use an arrow to connect **CSV File Input**, **HTML File Input**, or **Fixed File Input** to **Hive Output**.

Set data storage information and execute the job.

Step 6 Click **Next**. On the displayed **To** page, set **Storage type** to **HIVE**.

Table 16-26 Parameter description

Parameter	Description	Example Value
Output Directory	Directory for storing data imported to Hive. **NOTE** You can use macros to define path parameters. For details, see **Using Macro Definitions in Configuration Items** .	/opt/tempfile
Extractors	Number of Maps that are started at the same time in a MapReduce task of a data configuration operation. The value must be less than or equal to 3000. You are advised to set the parameter to the maximum number of connections on the SFTP server.	20
Extractor Size	Hive does not support this parameter. Please set **Extractors**.	-

Step 7 Click **Save and Run** to save and run the job.

View the job execution result.

Step 8 Go to the Loader web UI. When **Status** is **Succeeded**, the job is complete.

Figure 16-12 Viewing job details

----End

16.5.6 Typical Scenario: Importing Data from an FTP Server to HBase

Scenario

Use Loader to import data from an FTP server to HBase.

Prerequisites

- You have obtained the service username and password for creating a Loader job.

- You have obtained the username and password of the FTP server and the user has the read permission of the source files on the FTP server. If file name extension needs to be added after a source file is imported, the user must have the write permission of the source file.
- No disk space alarm is reported, and the available disk space is sufficient for importing and exporting data.
- When using Loader to import data from the FTP server, the input paths and input path subdirectories of the FTP server and the name of the files in these directories do not contain any of the special characters /"':;.
- If a configured task requires the Yarn queue function, the user must be authorized with related Yarn queue permission.
- The user who configures a task must obtain execution permission on the task and obtain usage permission on the related connection of the task.

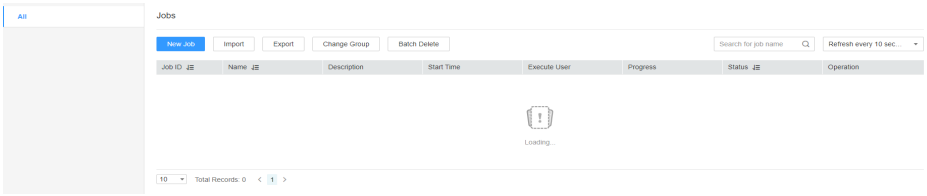
Procedure

Configure basic job information.

Step 1 Access the Loader web UI.

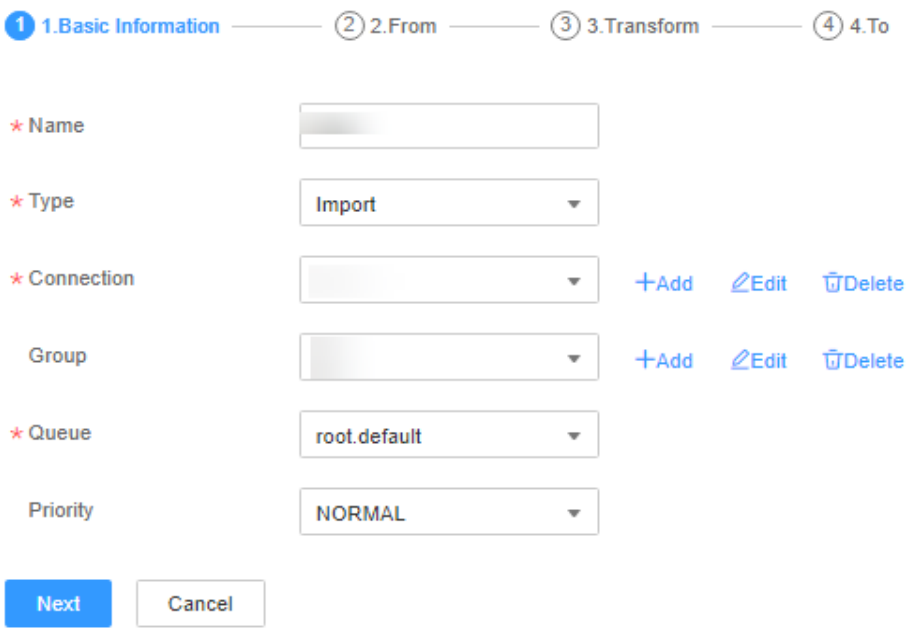
1. Log in to FusionInsight Manager.
2. Choose **Cluster** > **Services** > **Loader**.
3. Click **LoaderServer(***Node name***, Active)**. The Loader web UI is displayed.

Figure 16-13 Loader web UI



Step 2 Click **New Job** to go to the **Basic Information** page and set basic job information.

Figure 16-14 Basic Information page



1. Set **Name** to the name of the job.
2. Set **Type** to **Import**.
3. Set **Group** to the group to which the job belongs. No group is created by default. You need to click **Add** to create a group and click **OK** to save the created group.
4. Set **Queue** to the Yarn queue that executes the job. The default value is **root.default**.
5. Set **Priority** to the priority of the Yarn queue that executes the job. The default value is **NORMAL**. The options are **VERY_LOW**, **LOW**, **NORMAL**, **HIGH**, and **VERY_HIGH**.

Step 3 In the **Connection** area, click **Add** to create a connection, set **Connector** to **ftp-connector**, click **Add**, set connection parameters, and click **Test** to verify whether the connection is available. When "Test Success" is displayed, click **OK**. Loader allows multiple FTP servers to be configured. Click **Add** to add the configuration information of multiple FTP servers.

Table 16-27 Connection parameters

Parameter	Description	Example Value
FTP Server IP Address	IP address of the FTP server	ftpName
FTP Server Port	Port number of the FTP server	22
FTP Username	Username for accessing the FTP server	root

Parameter	Description	Example Value
FTP Password	Password for accessing the FTP server	xxxx
FTP Mode	FTP access mode. Possible values are **ACTIVE** and **PASSIVE**. If this parameter is not set, FTP access is in passive mode by default.	PASSIVE
FTP Protocol	FTP protocol. • **FTP**: indicates the FTP protocol. • **SSL_EXPLICIT**: indicates the explicit SSL protocol. • **SSL_IMPLICIT**: indicates the implicit SSL protocol. • **TLS_EXPLICIT**: indicates the explicit TLS protocol. • **TLS_IMPLICIT**: indicates the implicit TLS protocol. If this parameter is not set, the FTP protocol is used by default.	FTP
File Name Encoding Type	File name and file path encoding format supported by the FTP server. If this parameter is not set, the default format UTF-8 is used.	UTF-8

NOTE

When multiple FTP servers are configured, the data in the specified directories of the servers is imported to HBase.

Configure data source information.

Step 4 Click **Next**. On the displayed **From** page, set the data source information.

Table 16-28 Parameter description

Parameter	Description	Example Value
Input Path	Input path or name of the source file on an FTP server. If multiple FTP server IP addresses are configured for the connector, you can set this parameter to multiple input paths separated with semicolons (**;**). Ensure that the number of input paths is the same as that of FTP servers configured for the connector. **NOTE** You can use macros to define path parameters. For details, see **Using Macro Definitions in Configuration Items** .	/opt/tempfile;/opt
File Split Type	Indicates whether to split source files by file name or size. The files obtained after the splitting are used as the input files of each Map in the MapReduce task for data import. ● **FILE**: indicates that the source file is split by file. That is, each Map processes one or multiple complete files, the same source file cannot be allocated to different Maps, and the source file directory structure is retained after data import. ● **SIZE**: indicates that the source file is split by size. That is, each Map processes input files of a certain size, and a source file can be divided and processed by multiple Maps. After data is stored in the output directory, the number of saved files is the same as that of Maps. The file name format is **import_part**_*xxxx*, where *xxxx* is a unique random number generated by the system.	FILE
Filter Type	File filter condition. This parameter is used when **Path Filter** or **File Filter** is set. ● **WILDCARD**: indicates using a wildcard. ● **REGEX**: indicates using a regular expression. ● If the parameter is not set, a wildcard is used by default.	WILDCARD

Parameter	Description	Example Value
Path Filter	Wildcard or regular expression for filtering the directories in the input path of the source files. This parameter is used when **Filter Type** is set. **Input Path** is not used for filtering. Use semicolons (;) to separate the path filters on multiple servers and use commas (,) to separate the filter conditions of each server. If this parameter is left empty, directories are not filtered. ● **?** matches a single character. ● ***** indicates multiple characters. ● Adding **^** before the condition indicates negated filtering, that is, file filtering. For example, when **Filter type** is set to **WILDCARD**, set the parameter to *****; when **Filter type** is set to **REGEX**, set the parameter to **\\.***.	1*,2*;1*
File Filter	Wildcard or regular expression for filtering the file names of the source files. This parameter is used when **Filter Type** is set. Use semicolons (;) to separate the path filters on multiple servers and use commas (,) to separate the filter conditions of each server. This parameter cannot be left blank. ● **?** matches a single character. ● ***** indicates multiple characters. ● Adding **^** before the condition indicates negated filtering, that is, file filtering. For example, when **Filter type** is set to **WILDCARD**, set the parameter to *****; when **Filter type** is set to **REGEX**, set the parameter to **\\.***.	*.txt,*.csv;*.txt
Encoding Type	Source file encoding format, for example, UTF-8 and GBK. This parameter can be set only in text file import.	UTF-8

Parameter	Description	Example Value
Suffix	File name extension added to a source file after the source file is imported. If this parameter is empty, no file name extension is added to the source file. This parameter is valid only when the data source is a file system. You are advised to set this parameter in incremental data import. For example, if the parameter is set to **.txt** and the source file is **test-loader.csv**, the source file name is **test-loader.csv.txt** after export.	.log
Compression	Indicates whether to enable compressed transmission when FTP is used to export data. • The value **true** indicates that compression is enabled. • The value **false** indicates that compression is disabled.	true

Configure data transformation.

Step 5 Click **Next**. On the displayed **Transform** page, set the transformation operations in the data transformation process. For details about how to select operators and set parameters, see **Operator Help** and **Table 16-29**.

Table 16-29 Input and output parameters of the operator

Input Type	Output Type
CSV File Input	HBase Output
HTML File Input	HBase Output
Fixed File Input	HBase Output

In **input**, drag **CSV File Input**, **HTML File Input**, or **Fixed File Input** to the grid. In **output**, drag **HBase Output** to the grid. Use an arrow to connect **CSV File Input**, **HTML File Input**, or **Fixed File Input** to **HBase Output**.

Set data storage information and execute the job.

Step 6 Click **Next**. On the displayed **To** page, set **Storage type** to **HBASE_BULKLOAD** or **HBASE_PUTLIST** based on the actual situation.

Table 16-30 Parameter description

Storage Type	Applicable Scenario	Parameter	Description	Example Value
HBASE_BULKLOAD	Large data volume	HBase Instance	HBase service instance that Loader selects from all available HBase service instances in the cluster. If the selected HBase service instance is not added to the cluster, the HBase job cannot be run properly.	HBase
		Clear data before import	Indicates whether to clear data in the original table before importing data. **True** indicates clearing data and **False** indicates not to clear data. If you do not set this parameter, the original table is not cleared by default.	true
		Extractors	Number of Maps that are started at the same time in a MapReduce task of a data configuration operation. The value must be less than or equal to 3000. You are advised to set the parameter to the maximum number of connections on the FTP server.	20
		Extractor Size	HBase does not support this parameter. Please set **Extractors**.	-
HBASE_PUTLIST	Small data volume	HBase Instance	HBase service instance that Loader selects from all available HBase service instances in the cluster. If the selected HBase service instance is not added to the cluster, the HBase job cannot be run properly.	HBase
		Extractors	Number of Maps that are started at the same time in a MapReduce task of a data configuration operation. The value must be less than or equal to 3000.	20
		Extractor Size	HBase does not support this parameter. Please set **Extractors**.	-

Step 7 Click **Save and Run** to save and run the job.

View the job execution result.

Step 8 Go to the Loader web UI. When **Status** is **Succeeded**, the job is complete.

Figure 16-15 Viewing job details

----End

16.5.7 Typical Scenario: Importing Data from a Relational Database to HDFS or OBS

Scenario

Use Loader to import data from a relational database to HDFS or OBS.

Prerequisites

- You have obtained the service username and password for creating a Loader job.
- You have had the permission to access the HDFS or OBS directories and data involved in job execution.
- You have obtained the username and password of the relational database.
- No disk space alarm is reported, and the available disk space is sufficient for importing and exporting data.
- If a configured task requires the Yarn queue function, the user must be authorized with related Yarn queue permission.
- The user who configures a task must obtain execution permission on the task and obtain usage permission on the related connection of the task.
- Before the operation, perform the following steps:

  a. Obtain the JAR file of the relational database driver and save it to the following directory on the active and standby Loader nodes: **${BIGDATA_HOME}/FusionInsight_Porter_*/install/FusionInsight-Sqoop-1.99.3/FusionInsight-Sqoop-1.99.3/server/webapps/loader/WEB-INF/ext-lib**.

  b. Run the following command on the active and standby nodes as user **root** to modify the permission:

  cd ${BIGDATA_HOME}/FusionInsight_Porter_*/install/FusionInsight-Sqoop-1.99.3/FusionInsight-Sqoop-1.99.3/server/webapps/loader/WEB-INF/ext-lib

  chown omm:wheel *JAR file name*

  chmod 600 *JAR file name*

  c. Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Loader**. On the **Dashboard** tab page that is displayed, click **More** and select **Restart Service**. In the displayed dialog box, enter the administrator password to restart the Loader service.

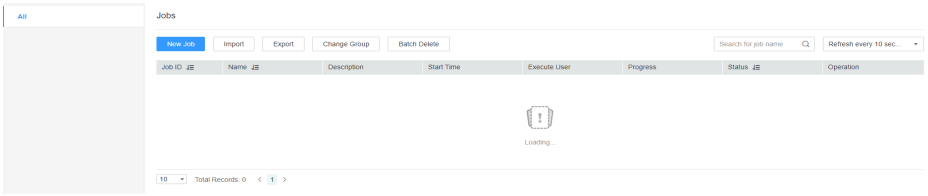
Procedure

Configure basic job information.

Step 1 Access the Loader web UI.

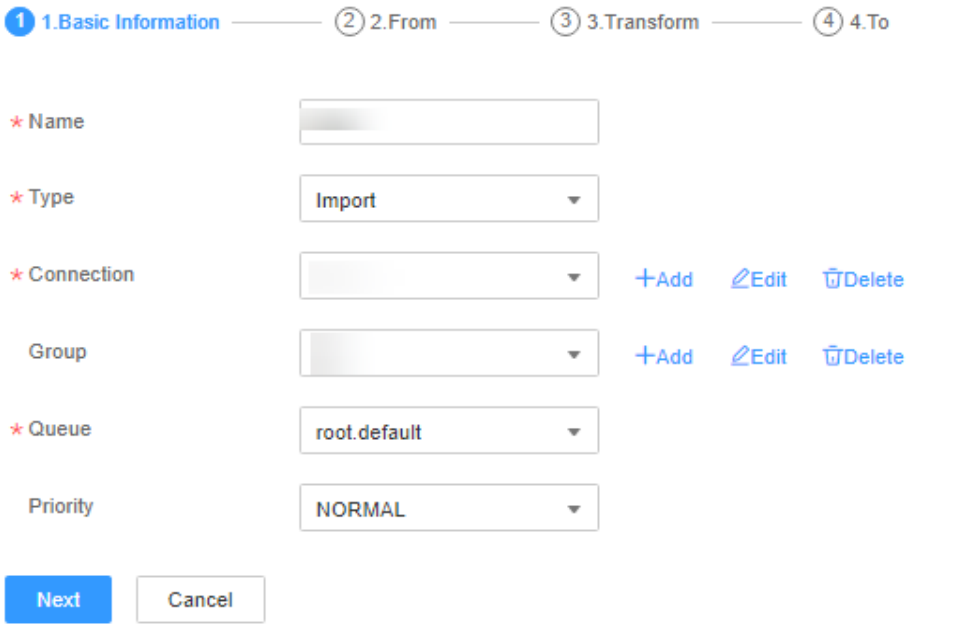
1. Log in to FusionInsight Manager.
2. Choose **Cluster** > **Services** > **Loader**.
3. Click **LoaderServer(***Node name***, Active)**. The Loader web UI is displayed.

Figure 16-16 Loader web UI



Step 2 Click **New Job** to go to the **Basic Information** page and set basic job information.

Figure 16-17 Basic Information page



1. Set **Name** to the name of the job.
2. Set **Type** to **Import**.
3. Set **Group** to the group to which the job belongs. No group is created by default. You need to click **Add** to create a group and click **OK** to save the created group.
4. Set **Queue** to the Yarn queue that executes the job. The default value is **root.default**.
5. Set **Priority** to the priority of the Yarn queue that executes the job. The default value is **NORMAL**. The options are **VERY_LOW**, **LOW**, **NORMAL**, **HIGH**, and **VERY_HIGH**.

Step 3 In the **Connection** area, click **Add** to create a connection, set **Connector** to **generic-jdbc-connector** or a dedicated database connector (oracle-connector, oracle-partition-connector, or mysql-fastpath-connector), set connection parameters, and click **Test** to verify whether the connection is available. When "Test Success" is displayed, click **OK**.

NOTE

- For connection to relational databases, general database connectors (generic-jdbc-connector) or dedicated database connectors (oracle-connector, oracle-partition-connector, and mysql-fastpath-connector) are available. However, compared with general database connectors, dedicated database connectors perform better in data import and export because they are optimized for specific database types.
- When mysql-fastpath-connector is used, the **mysqldump** and **mysqlimport** commands of MySQL must be available on NodeManager nodes, and the MySQL client version to which the two commands belong must be compatible with the MySQL server version. If the two commands are unavailable or the versions are incompatible, install the MySQL client applications and tools following the instructions at **http://dev.mysql.com/doc/refman/5.7/en/linux-installation-rpm.html**.

Table 16-31 generic-jdbc-connector connection parameters

Parameter	Description	Example Value
Name	Name of a relational database connection	dbName
JDBC Driver Class	Name of a Java database connectivity (JDBC) driver class	oracle.jdbc.driver.OracleDriver
JDBC Connection String	JDBC connection string, in the format of **jdbc:oracle:thin:@***Database IP address*:*Database port number*:*Database name*	jdbc:oracle:thin:@10.16.0.1:1521:oradb
Username	Username for connecting to the database	omm
Password	Password for connecting to the database	xxxx
JDBC Connection Properties	JDBC connection attribute. Click **Add** to manually add the attribute. • Name: connection attribute name • Value: connection attribute value	• Name: **socketTimeout** • Value: **20**

Configure data source information.

Step 4 Click **Next**. On the displayed **From** page, set the data source information.

Table 16-32 Parameter description

Parameter	Description	Example Value
Schema name	Database schema name. This parameter exists in the **Table name** schema.	public
Table name	Database table name. This parameter exists in the **Table name** schema.	test
Table SQL statement	SQL statement for Loader to query data to be imported in **Table SQL statement** mode. The SQL statement requires the query condition **WHERE ${CONDITIONS}**. Without this condition, the SQL statement cannot be run properly. An example SQL statement is as follows: **select * from TABLE WHERE A>B and ${CONDITIONS}**. If **Table column names** is set, the column specified by **Table column names** will replace the column queried in the SQL statement. This parameter cannot be set when **Schema name** or **Table name** is set. **NOTE** You can use macros to define SQL Where statements. For details, see **Using Macro Definitions in Configuration Items** .	select * from TABLE WHERE A>B and ${CONDITIONS}
Table column names	Table columns whose content is to be imported by Loader. Use commas (**,**) to separate multiple fields. If the parameter is not set, all the columns are imported and the **Select *** order is used as the column location.	id,name

Parameter	Description	Example Value
Partition column name	Database table column based on which to-be-imported data is determined. This parameter is used for partitioning in a Map job. You are advised to configure the primary key field. **NOTE** • A partition column must have an index. If no index exists, do not specify a partition column. If a partition column without an index is specified, the database server disk I/O will be busy, the access of other services to the database will be affected, and the import will take a long period. • In multiple fields with indexes, select the field that has the most discrete value as the partition column. A partition column that is not discrete may result in load imbalance when multiple MapReduce jobs are imported. • The sorting rules of partition columns must be case-sensitive. Otherwise, data may be lost during data import. • You are not advised to select fields of the float or double type for the partition column. Otherwise, the records containing the minimum and maximum values of the partition column may fail to be imported due to precision issues.	id
Nulls in partition column	Indicates whether to process records whose values are null in database table columns. • **true**: Records whose values are null are processed. • **false**: Records whose values are not null are processed.	true
Need partition column	Indicates whether to specify a partition column.	true

Configure data transformation.

Step 5 Click **Next**. On the displayed **Transform** page, set the transformation operations in the data transformation process. For details about how to select operators and set parameters, see **Operator Help** and **Table 16-33**.

Table 16-33 Input and output parameters of the operator

Input Type	Output Type
Table Input	File Output

In **input**, drag **Table Input** to the grid. In **output**, drag **File Output** to the grid. Use an arrow to connect **Table Input** to **File Output**.

Set data storage information and execute the job.

Step 6 Click **Next**. On the displayed **To** page, set **Storage type** to **HDFS**.

Table 16-34 Parameter description

Parameter	Description	Example Value
File Type	Type of the file to be saved after being imported. The options are as follows: • **TEXT_FILE**: imports a text file and saves it as a text file. • **SEQUENCE_FILE**: imports a text file and saves it as a sequence file. • **BINARY_FILE**: imports files of any format using binary streams.	TEXT_FILE
Compression Format	Compression format of files imported to HDFS or OBS. Select a format from the drop-down list. If you select **NONE** or leave this parameter blank, data is not compressed.	NONE
Output Directory	Directory for storing data imported to HDFS or OBS. **NOTE** You can use macros to define path parameters. For details, see **Using Macro Definitions in Configuration Items** .	/user/test

Parameter	Description	Example Value
Operation	Action during data import. When all data is imported from the input path to the destination path, the data is stored in a temporary directory and then copied from the temporary directory to the destination path. After data import is complete, the data in the temporary directory is deleted. One of the following actions can be taken when there are duplicate file names during data transfer: ● **OVERRIDE**: overrides the old file. ● **RENAME**: renames the new file. For a file without a file name extension, a string is added to the file name as the extension; for a file with a file name extension, a string is added to the extension. The string is unique. ● **APPEND**: adds the content of the new file to the end of the old file. This action only adds content regardless of whether the file can be used. For example, a text file can be used after this action, while a compressed file cannot. ● **IGNORE**: reserves the old file and does not copy the new file. ● **ERROR**: stops the task and reports an error if there are duplicate file names. Transferred files are imported successfully, while files that have duplicate names and files that are not transferred fail to import.	OVERRIDE
Extractors	Number of Maps that are started at the same time in a MapReduce task of a data configuration operation. This parameter cannot be set when **Extractor Size** is set. The value must be less than or equal to 3000.	-
Extractor Size	Size of data processed by Maps that are started in a MapReduce task of a data configuration operation. The unit is MB. The value must be greater than or equal to 100. The recommended value is 1000. This parameter cannot be set when **Extractors** is set. When a relational database connector is used, **Extractor Size** is unavailable. You need to set **Extractors**.	1000

Step 7 Click **Save and Run** to save and run the job.

View the job execution result.

Step 8 Go to the Loader web UI. When **Status** is **Succeeded**, the job is complete.

Figure 16-18 Viewing job details

----End

16.5.8 Typical Scenario: Importing Data from a Relational Database to HBase

Scenario

Use Loader to import data from a relational database to HBase.

Prerequisites

- You have obtained the service username and password for creating a Loader job.
- You have had the permission to access the HBase tables or phoenix tables that are used during job execution.
- You have obtained the username and password of the relational database.
- No disk space alarm is reported, and the available disk space is sufficient for importing and exporting data.
- If a configured task requires the Yarn queue function, the user must be authorized with related Yarn queue permission.
- The user who configures a task must obtain execution permission on the task and obtain usage permission on the related connection of the task.
- Before the operation, perform the following steps:
  a. Obtain the JAR file of the relational database driver and save it to the following directory on the active and standby Loader nodes: **${BIGDATA_HOME}/FusionInsight_Porter_*/install/FusionInsight-Sqoop-1.99.3/FusionInsight-Sqoop-1.99.3/server/webapps/loader/WEB-INF/ext-lib**.
  b. Run the following command on the active and standby nodes as user **root** to modify the permission:

     cd ${BIGDATA_HOME}/FusionInsight_Porter_*/install/FusionInsight-Sqoop-1.99.3/FusionInsight-Sqoop-1.99.3/server/webapps/loader/WEB-INF/ext-lib

     chown omm:wheel *JAR file name*

     chmod 600 *JAR file name*
  c. Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Loader**. On the **Dashboard** tab page that is displayed, click **More** and select **Restart Service**. In the displayed dialog box, enter the administrator password to restart the Loader service.

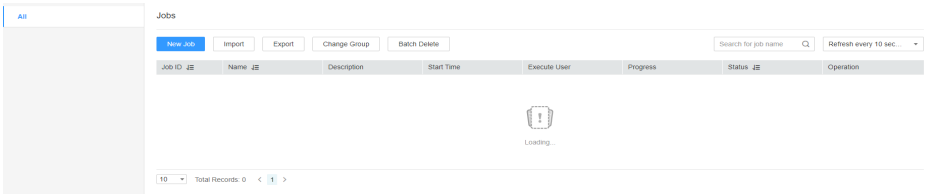
Procedure

Configure basic job information.

Step 1 Access the Loader web UI.

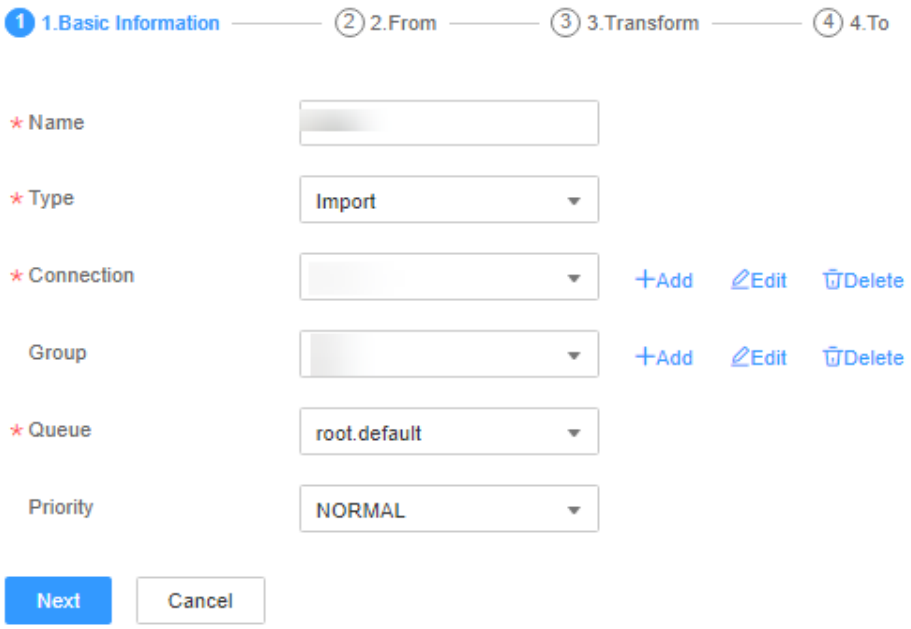
1. Log in to FusionInsight Manager.
2. Choose **Cluster** > **Services** > **Loader**.
3. Click **LoaderServer(***Node name***, Active)**. The Loader web UI is displayed.

Figure 16-19 Loader web UI



Step 2 Click **New Job** to go to the **Basic Information** page and set basic job information.

Figure 16-20 Basic Information page



1. Set **Name** to the name of the job.
2. Set **Type** to **Import**.
3. Set **Group** to the group to which the job belongs. No group is created by default. You need to click **Add** to create a group and click **OK** to save the created group.
4. Set **Queue** to the Yarn queue that executes the job. The default value is **root.default**.
5. Set **Priority** to the priority of the Yarn queue that executes the job. The default value is **NORMAL**. The options are **VERY_LOW**, **LOW**, **NORMAL**, **HIGH**, and **VERY_HIGH**.

Step 3 In the **Connection** area, click **Add** to create a connection, set **Connector** to **generic-jdbc-connector** or a dedicated database connector (oracle-connector, oracle-partition-connector, or mysql-fastpath-connector), set connection

parameters, and click **Test** to verify whether the connection is available. When "Test Success" is displayed, click **OK**.

NOTE

- For connection to relational databases, general database connectors (generic-jdbc-connector) or dedicated database connectors (oracle-connector, oracle-partition-connector, and mysql-fastpath-connector) are available. However, compared with general database connectors, dedicated database connectors perform better in data import and export because they are optimized for specific database types.
- When mysql-fastpath-connector is used, the **mysqldump** and **mysqlimport** commands of MySQL must be available on NodeManager nodes, and the MySQL client version to which the two commands belong must be compatible with the MySQL server version. If the two commands are unavailable or the versions are incompatible, install the MySQL client applications and tools following the instructions at **http://dev.mysql.com/doc/refman/5.7/en/linux-installation-rpm.html**.

Table 16-35 generic-jdbc-connector connection parameters

Parameter	Description	Example Value
Name	Name of a relational database connection	dbName
JDBC Driver Class	Name of a Java database connectivity (JDBC) driver class	oracle.jdbc.driver.OracleDriver
JDBC Connection String	JDBC connection string, in the format of **jdbc:oracle:thin:@***Database IP address*:*Database port number*:*Database name*	jdbc:oracle:thin:@10.16.0.1:1521:oradb
Username	Username for connecting to the database	omm
Password	Password for connecting to the database	xxxx
JDBC Connection Properties	JDBC connection attribute. Click **Add** to manually add the attribute. • Name: connection attribute name • Value: connection attribute value	• Name: **socketTimeout** • Value: **20**

Configure data source information.

Step 4 Click **Next**. On the displayed **From** page, set the data source information.

Table 16-36 Parameter description

Parameter	Description	Example Value
Schema name	Database schema name. This parameter exists in the **Table name** schema.	dbo
Table name	Database table name. This parameter exists in the **Table name** schema.	test
Table SQL statement	SQL statement for Loader to query data to be imported in **Table SQL statement** mode. The SQL statement requires the query condition **WHERE ${CONDITIONS}**. Without this condition, the SQL statement cannot be run properly. An example SQL statement is as follows: **select * from TABLE WHERE A>B and ${CONDITIONS}**. If **Table column names** is set, the column specified by **Table column names** will replace the column queried in the SQL statement. This parameter cannot be set when **Schema name** or **Table name** is set. **NOTE** You can use macros to define SQL Where statements. For details, see **Using Macro Definitions in Configuration Items** .	select * from test where ${CONDITIONS}
Table column names	Table columns whose content is to be imported by Loader. Use commas (,) to separate multiple fields. If the parameter is not set, all the columns are imported and the **Select *** order is used as the column location.	-

Parameter	Description	Example Value
Partition column name	Database table column based on which to-be-imported data is determined. This parameter is used for partitioning in a Map job. You are advised to configure the primary key field. **NOTE** • A partition column must have an index. If no index exists, do not specify a partition column. If a partition column without an index is specified, the database server disk I/O will be busy, the access of other services to the database will be affected, and the import will take a long period. • In multiple fields with indexes, select the field that has the most discrete value as the partition column. A partition column that is not discrete may result in load imbalance when multiple MapReduce jobs are imported. • The sorting rules of partition columns must be case-sensitive. Otherwise, data may be lost during data import. • You are not advised to select fields of the float or double type for the partition column. Otherwise, the records containing the minimum and maximum values of the partition column may fail to be imported due to precision issues.	id
Nulls in partition column	Indicates whether to process records whose values are null in database table columns. • **true**: Records whose values are null are processed. • **false**: Records whose values are not null are processed.	true
Need partition column	Indicates whether to specify a partition column.	true

Configure data transformation.

Step 5 Click **Next**. On the displayed **Transform** page, set the transformation operations in the data transformation process. For details about how to select operators and set parameters, see **Operator Help** and **Table 16-37**.

Table 16-37 Input and output parameters of the operator

Input Type	Output Type
Table Input	HBase Output

In **input**, drag **Table Input** to the grid. In **output**, drag **HBase Output** to the grid. Use an arrow to connect **Table Input** to **HBase Output**.

Set data storage information and execute the job.

Step 6 Click **Next**. On the displayed **To** page, set **Storage type** to **HBASE_BULKLOAD** or **HBASE_PUTLIST** based on the actual situation.

Table 16-38 Parameter description

Storage Type	Applicable Scenario	Parameter	Description	Example Value
HBASE_BULKLOAD	Large data volume	HBase Instance	HBase service instance that Loader selects from all available HBase service instances in the cluster. If the selected HBase service instance is not added to the cluster, the HBase job cannot be run properly.	HBase
		Clear data before import	Indicates whether to clear data in the original table before importing data. **True** indicates clearing data and **False** indicates not to clear data. If you do not set this parameter, the original table is not cleared by default.	true
		Extractors	Number of Maps that are started at the same time in a MapReduce task of a data configuration operation. The value must be less than or equal to 3000.	20
		Extractor Size	HBase does not support this parameter. Please set **Extractors**.	-

Storage Type	Applicable Scenario	Parameter	Description	Example Value
HBASE_PUTLIST	Small data volume	HBase Instance	HBase service instance that Loader selects from all available HBase service instances in the cluster. If the selected HBase service instance is not added to the cluster, the HBase job cannot be run properly.	HBase
		Extractors	Number of Maps that are started at the same time in a MapReduce task of a data configuration operation. The value must be less than or equal to 3000.	true
		Extractor Size	HBase does not support this parameter. Please set **Extractors**.	-

Step 7 Click **Save and Run** to save and run the job.

View the job execution result.

Step 8 Go to the Loader web UI. When **Status** is **Succeeded**, the job is complete.

Figure 16-21 Viewing job details

----End

16.5.9 Typical Scenario: Importing Data from a Relational Database to Hive

Scenario

Use Loader to import data from a relational database to Hive.

Prerequisites

- You have obtained the service username and password for creating a Loader job.
- You have had the permission to access the Hive tables that are used during job execution.
- You have obtained the username and password of the relational database.
- No disk space alarm is reported, and the available disk space is sufficient for importing and exporting data.

- If a configured task requires the Yarn queue function, the user must be authorized with related Yarn queue permission.
- The user who configures a task must obtain execution permission on the task and obtain usage permission on the related connection of the task.
- Before the operation, perform the following steps:
  a. Obtain the JAR file of the relational database driver and save it to the following directory on the active and standby Loader nodes: **${BIGDATA_HOME}/FusionInsight_Porter_*/install/FusionInsight-Sqoop-1.99.3/FusionInsight-Sqoop-1.99.3/server/webapps/loader/WEB-INF/ext-lib**.
  b. Run the following command on the active and standby nodes as user **root** to modify the permission:

     cd ${BIGDATA_HOME}/FusionInsight_Porter_*/install/FusionInsight-Sqoop-1.99.3/FusionInsight-Sqoop-1.99.3/server/webapps/loader/WEB-INF/ext-lib

     chown omm:wheel *JAR file name*

     chmod 600 *JAR file name*
  c. Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Loader**. On the **Dashboard** tab page that is displayed, click **More** and select **Restart Service**. In the displayed dialog box, enter the administrator password to restart the Loader service.

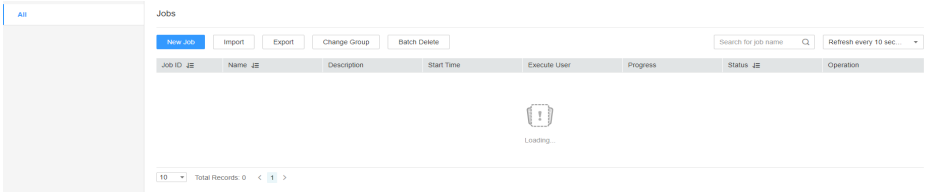
Procedure

Configure basic job information.

Step 1 Access the Loader web UI.

1. Log in to FusionInsight Manager.
2. Choose **Cluster** > **Services** > **Loader**.
3. Click **LoaderServer(***Node name***, Active)**. The Loader web UI is displayed.

Figure 16-22 Loader web UI



Step 2 Go to the Loader web UI. When **Status** is **Succeeded**, the job is complete.

Figure 16-23 Viewing job details

Step 3 In the **Connection** area, click **Add** to create a connection, set **Connector** to **generic-jdbc-connector** or a dedicated database connector (oracle-connector, oracle-partition-connector, or mysql-fastpath-connector), set connection parameters, and click **Test** to verify whether the connection is available. When "Test Success" is displayed, click **OK**.

NOTE

- For connection to relational databases, general database connectors (generic-jdbc-connector) or dedicated database connectors (oracle-connector, oracle-partition-connector, and mysql-fastpath-connector) are available. However, compared with general database connectors, dedicated database connectors perform better in data import and export because they are optimized for specific database types.
- When mysql-fastpath-connector is used, the **mysqldump** and **mysqlimport** commands of MySQL must be available on NodeManager nodes, and the MySQL client version to which the two commands belong must be compatible with the MySQL server version. If the two commands are unavailable or the versions are incompatible, install the MySQL client applications and tools following the instructions at **http://dev.mysql.com/doc/refman/5.7/en/linux-installation-rpm.html**.

Table 16-39 generic-jdbc-connector connection parameters

Parameter	Description	Example Value
Name	Name of a relational database connection	dbName
JDBC Driver Class	Name of a Java database connectivity (JDBC) driver class	oracle.jdbc.driver.OracleDriver
JDBC Connection String	JDBC connection string, in the format of **jdbc:oracle:thin:@***Database IP address*:*Database port number*:*Database name*	jdbc:oracle:thin:@10.16.0.1:1521:oradb
Username	Username for connecting to the database	omm
Password	Password for connecting to the database	xxxx
JDBC Connection Properties	JDBC connection attribute. Click **Add** to manually add the attribute. • Name: connection attribute name • Value: connection attribute value	• Name: **socketTimeout** • Value: **20**

Configure data source information.

Step 4 Click **Next**. On the displayed **From** page, set the data source information.

Table 16-40 Parameter description

Parameter	Description	Example Value
Schema name	Database schema name. This parameter exists in the **Table name** schema.	dbo
Table name	Database table name. This parameter exists in the **Table name** schema.	test
Table SQL statement	SQL statement for Loader to query data to be imported in **Table SQL statement** mode. The SQL statement requires the query condition **WHERE ${CONDITIONS}**. Without this condition, the SQL statement cannot be run properly. An example SQL statement is as follows: **select * from TABLE WHERE A>B and ${CONDITIONS}**. If **Table column names** is set, the column specified by **Table column names** will replace the column queried in the SQL statement. This parameter cannot be set when **Schema name** or **Table name** is set. **NOTE** You can use macros to define SQL Where statements. For details, see **Using Macro Definitions in Configuration Items** .	select * from test where ${CONDITIONS}
Table column names	Table columns whose content is to be imported by Loader. Use commas (,) to separate multiple fields. If the parameter is not set, all the columns are imported and the **Select *** order is used as the column location.	-

Parameter	Description	Example Value
Partition column name	Database table column based on which to-be-imported data is determined. This parameter is used for partitioning in a Map job. You are advised to configure the primary key field. **NOTE** • A partition column must have an index. If no index exists, do not specify a partition column. If a partition column without an index is specified, the database server disk I/O will be busy, the access of other services to the database will be affected, and the import will take a long period. • In multiple fields with indexes, select the field that has the most discrete value as the partition column. A partition column that is not discrete may result in load imbalance when multiple MapReduce jobs are imported. • The sorting rules of partition columns must be case-sensitive. Otherwise, data may be lost during data import. • You are not advised to select fields of the float or double type for the partition column. Otherwise, the records containing the minimum and maximum values of the partition column may fail to be imported due to precision issues.	id
Nulls in partition column	Indicates whether to process records whose values are null in database table columns. • **true**: Records whose values are null are processed. • **false**: Records whose values are not null are processed.	true
Need partition column	Indicates whether to specify a partition column.	true

Configure data transformation.

Step 5 Click **Next**. On the displayed **Transform** page, set the transformation operations in the data transformation process. For details about how to select operators and set parameters, see **Operator Help** and **Table 16-41**.

Table 16-41 Input and output parameters of the operator

Input Type	Output Type
Table Input	Hive Output

In **input**, drag **Table Input** to the grid. In **output**, drag **Hive Output** to the grid. Use an arrow to connect **Table Input** to **Hive Output**.

Set data storage information and execute the job.

Step 6 Click **Next**. On the displayed **To** page, set **Storage type** to **HIVE**.

Table 16-42 Parameter description

Parameter	Description	Example Value
Output Directory	Directory for storing data imported to Hive. **NOTE** You can use macros to define path parameters. For details, see **Using Macro Definitions in Configuration Items** .	/opt/tempfile
Extractors	Number of Maps that are started at the same time in a MapReduce task of a data configuration operation. The value must be less than or equal to 3000. You are advised to set the parameter to the maximum number of connections on the SFTP server.	20
Extractor Size	Hive does not support this parameter. Please set **Extractors**.	-

Step 7 Click **Save and Run** to save and run the job.

View the job execution result.

Step 8 Go to the Loader web UI. When **Status** is **Succeeded**, the job is complete.

Figure 16-24 Viewing job details

----End

16.5.10 Typical Scenario: Importing Data from HDFS or OBS to HBase

Scenario

Use Loader to import data from HDFS or OBS to HBase.

Prerequisites

- You have obtained the service username and password for creating a Loader job.
- You have had the permission to access the HDFS or OBS directories and data involved in job execution.
- You have had the permission to access the HBase tables or phoenix tables that are used during job execution.
- No disk space alarm is reported, and the available disk space is sufficient for importing and exporting data.
- When using Loader to import data from HDFS or OBS, the input paths and input path subdirectories of HDFS or OBS and the name of the files in these directories do not contain any of the special characters /"'\:;.
- If a configured task requires the Yarn queue function, the user must be authorized with related Yarn queue permission.
- The user who configures a task must obtain execution permission on the task and obtain usage permission on the related connection of the task.

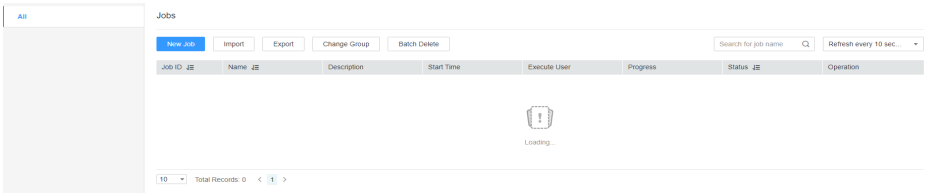
Procedure

Configure basic job information.

Step 1 Access the Loader web UI.

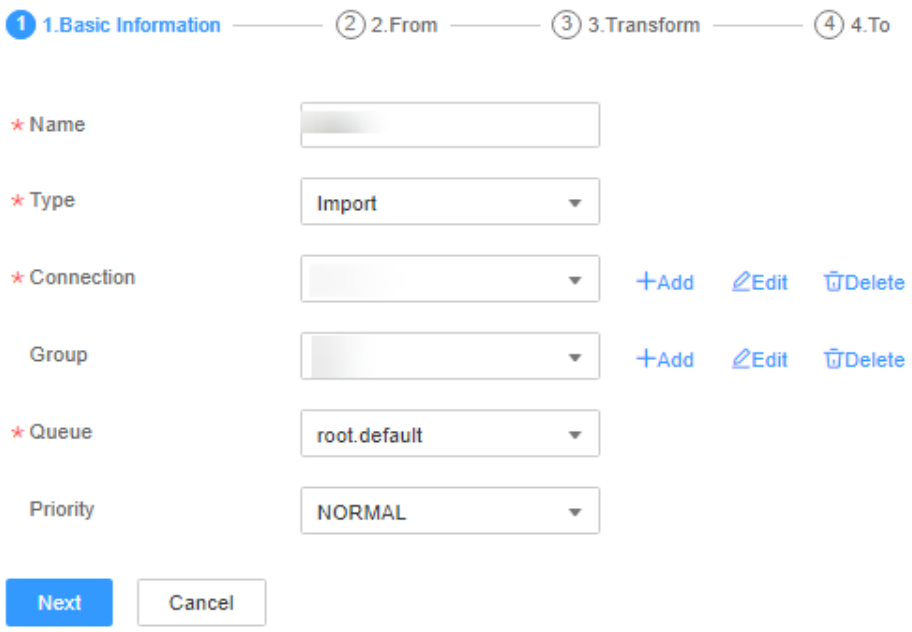
1. Log in to FusionInsight Manager.
2. Choose **Cluster** > **Services** > **Loader**.
3. Click **LoaderServer(***Node name***, Active)**. The Loader web UI is displayed.

Figure 16-25 Loader web UI



Step 2 Click **New Job** to go to the **Basic Information** page and set basic job information.

Figure 16-26 Basic Information page



1. Set **Name** to the name of the job.
2. Set **Type** to **Import**.
3. Set **Group** to the group to which the job belongs. No group is created by default. You need to click **Add** to create a group and click **OK** to save the created group.
4. Set **Queue** to the Yarn queue that executes the job. The default value is **root.default**.
5. Set **Priority** to the priority of the Yarn queue that executes the job. The default value is **NORMAL**. The options are **VERY_LOW**, **LOW**, **NORMAL**, **HIGH**, and **VERY_HIGH**.

Step 3 In the **Connection** area, click **Add** to create a connection, set **Connector** to **hdfs-connector**, set connection parameters, and click **Test** to verify whether the connection is available. When "Test Success" is displayed, click **OK**.

Configure data source information.

Step 4 Click **Next**. On the displayed **From** page, set the data source information.

Table 16-43 Parameter description

Parameter	Description	Example Value
Input Path	Input path of source files in HDFS or OBS **NOTE** You can use macros to define path parameters. For details, see **Using Macro Definitions in Configuration Items** .	/user/test
Path Filter	Wildcard for filtering the directories in the input paths of the source files. **Input Path** is not used for filtering. If there are multiple filter conditions, use commas (,) to separate them. If the parameter is empty, the directories are not filtered. The regular expression filtering is not supported.	*
File Filter	Wildcard for filtering the file names of the source files. If there are multiple filter conditions, use commas (,) to separate them. The value cannot be left blank. The regular expression filtering is not supported.	*
Encoding Type	Source file encoding format, for example, UTF-8. This parameter can be set only in text file import.	UTF-8
Suffix	File name extension added to a source file after the source file is imported. If this parameter is empty, no file name extension is added to the source file.	.log

Configure data transformation.

Step 5 Click **Next**. On the displayed **Transform** page, set the transformation operations in the data transformation process. For details about how to select operators and set parameters, see **Operator Help** and **Table 16-44**.

Table 16-44 Input and output parameters of the operator

Input Type	Output Type
CSV File Input	HBase Output
HTML File Input	HBase Output
Fixed File Input	HBase Output

In **input**, drag **CSV File Input**, **HTML File Input**, or **Fixed File Input** to the grid. In **output**, drag **HBase Output** to the grid. Use an arrow to connect **CSV File Input**, **HTML File Input**, or **Fixed File Input** to **HBase Output**.

Set data storage information and execute the job.

Step 6 Click **Next**. On the displayed **To** page, set **Storage type** to **HBASE_BULKLOAD** or **HBASE_PUTLIST** based on the actual situation.

Table 16-45 Parameter description

Storage Type	Applicable Scenario	Parameter	Description	Example Value
HBASE_BULKLOAD	Large data volume	HBase Instance	HBase service instance that Loader selects from all available HBase service instances in the cluster. If the selected HBase service instance is not added to the cluster, the HBase job cannot be run properly.	HBase
		Clear data before import	Indicates whether to clear data in the original table before importing data. **True** indicates clearing data and **False** indicates not to clear data. If you do not set this parameter, the original table is not cleared by default.	true
		Extractors	Number of Maps that are started at the same time in a MapReduce task of a data configuration operation. The value must be less than or equal to 3000.	20
		Extractor Size	HBase does not support this parameter. Please set **Extractors**.	-
HBASE_PUTLIST	Small data volume	HBase Instance	HBase service instance that Loader selects from all available HBase service instances in the cluster. If the selected HBase service instance is not added to the cluster, the HBase job cannot be run properly.	HBase
		Extractors	Number of Maps that are started at the same time in a MapReduce task of a data configuration operation. The value must be less than or equal to 3000.	20
		Extractor Size	HBase does not support this parameter. Please set **Extractors**.	-

Step 7 Click **Save and Run** to save and run the job.

View the job execution result.

Step 8 Go to the Loader web UI. When **Status** is **Succeeded**, the job is complete.

Figure 16-27 Viewing job details

----End

16.5.11 Typical Scenario: Importing Data from a Relational Database to ClickHouse

Scenario

Use Loader to import data from a relational database to ClickHouse. This section uses MySQL as an example.

Prerequisites

- A role has been created on FusionInsight Manager and granted the management permission on ClickHouse logical clusters and Loader job grouping permission. A service user for Loader jobs has been created, associated with the role, and added the user group **yarnviewgroup**.
- A replicated table and a distributed table have been created by referring to **Creating a ClickHouse Table** and a user has been assigned the permission to perform operations on the tables during job execution. The replicated table has been selected when data is imported.
- You have obtained the user name and password of the MySQL database.
- No ClickHouse alarm is generated.

Procedure

Make preparations.

Step 1 Obtain the MySQL client JAR file (for example, **mysqlclient-5.8.1.jar**) from the MySQL database installation path and save it to **${BIGDATA_HOME}/FusionInsight_Porter_*/install/FusionInsight-Sqoop-1.99.3/FusionInsight-Sqoop-1.99.3/server/webapps/loader/WEB-INF/ext-lib** on the active and standby Loader nodes.

Step 2 Obtain the **clickhouse-jdbc-*.jar** file from the ClickHouse installation directory and save it to **${BIGDATA_HOME}/FusionInsight_Porter_*/install/FusionInsight-Sqoop-1.99.3/FusionInsight-Sqoop-1.99.3/server/webapps/loader/WEB-INF/ext-lib** on the active and standby Loader nodes.

Step 3 Run the following command on the active and standby nodes as user **root** to modify the permission:

cd ${BIGDATA_HOME}/FusionInsight_Porter_*/install/FusionInsight-Sqoop-1.99.3/FusionInsight-Sqoop-1.99.3/server/webapps/loader/WEB-INF/ext-lib

chown omm:wheel *JAR file name*

chmod 600 *JAR file name*

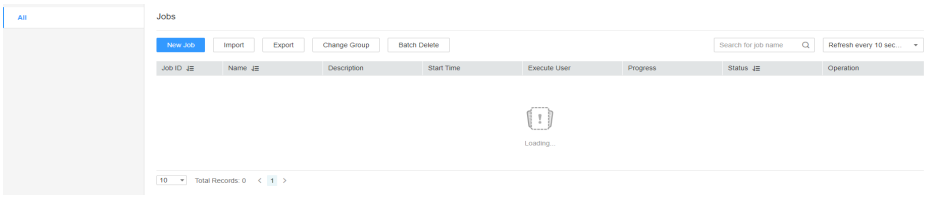
Step 4 Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Loader**. On the **Dashboard** tab page that is displayed, click **More** and select **Restart Service**. In the displayed dialog box, enter the administrator password to restart the Loader service.

Configure basic job information.

Step 5 Access the Loader web UI.

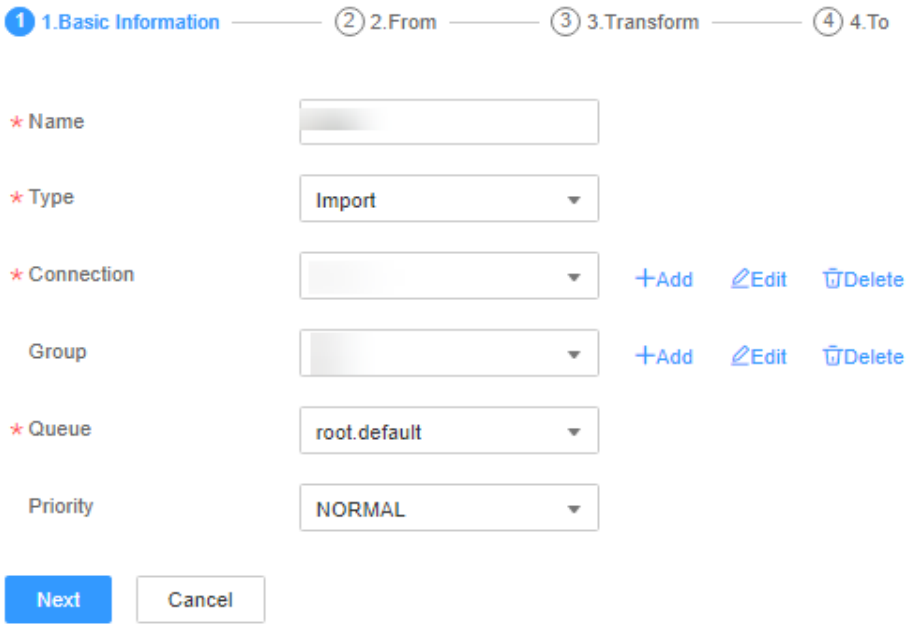
1. Log in to FusionInsight Manager.
2. Choose **Cluster** > **Services** > **Loader**.
3. Click **LoaderServer(***Node name***, Active)**. The Loader web UI is displayed.

Figure 16-28 Loader web UI



Step 6 Click **New Job** to go to the **Basic Information** page and set basic job information.

Figure 16-29 Basic Information page



1. Set **Name** to the name of the job.
2. Set **Type** to **Import**.
3. Set **Group** to the group to which the job belongs. No group is created by default. You need to click **Add** to create a group and click **OK** to save the created group.

4. Set **Queue** to the Yarn queue that executes the job. The default value is **root.default**.
5. Set **Priority** to the priority of the Yarn queue that executes the job. The default value is **NORMAL**. The options are **VERY_LOW**, **LOW**, **NORMAL**, **HIGH**, and **VERY_HIGH**.

Step 7 In the **Connection** area, click **Add** to create a connection, set **Connector** to **generic-jdbc-connector**, configure connection parameters according to **Table 16-46**, and click **Test** to verify whether the connection is available. When "Test Success" is displayed, click **OK**. Use the same method to select **clickhouse-connector** (ClickHouse dedicated database connector) for **connector**. For details about parameter settings, see **Table 16-47**.

NOTE

For connection to relational databases, general database connectors (generic-jdbc-connector) or dedicated database connectors (clickhouse-connector, oracle-connector, oracle-partition-connector, and mysql-fastpath-connector) are available. However, compared with general database connectors, dedicated database connectors perform better in data import and export because they are optimized for specific database types.

Table 16-46 generic-jdbc-connector connection parameters

Parameter	Description	Example Value
Name	Name of a relational database connection	mysql_test
JDBC Driver Class	Name of a JDBC driver class	com.mysql.jdbc.Driver
JDBC Connection String	JDBC connection string, in the following format: **jdbc:mysql://*Database IP address*/*Database name*?&useUnicode=true&characterEncoding=GBK**	jdbc:mysql://10.10.10.10/test?&useUnicode=true&characterEncoding=GBK
Username	Username for connecting to the database	root
Password	Password for connecting to the database	xxxx

Table 16-47 clickhouse-connector connection parameters

Parameter	Description	Example Value
Name	Name of a relational database connection	clickhouse_jdbc_test

Parameter	Description	Example Value
JDBC Connection String	• Kerberos authentication has been enabled for the cluster. The JDBC connection string format is **jdbc:clickhouse://** *Database IP address*:*Database port number*/*Database name*?**ssl=true&sslmode=none**. • Kerberos authentication is disabled for the cluster. The JDBC connection string format is **jdbc:clickhouse://** *Database IP address*:*Database port number*/*Database name*.	• Kerberos authentication has been enabled for the cluster: **jdbc:clickhouse://10.10.10.10:21426/test?ssl=true&sslmode=none** • Kerberos authentication is disabled for the cluster: **jdbc:clickhouse://10.10.10.10:21423/test?ssl=true&sslmode=none**

Parameter	Description	Example Value
	NOTE • *Database IP address*: To obtain the IP address of the ClickHouseBalancer instance, log in to FusionInsight Manager, choose **Cluster** > **Services** > **ClickHouse**, and click **Instance**. • Database port number: – To obtain the port number of a cluster with Kerberos authentication enabled, log in to FusionInsight Manager, choose **Cluster** > **Services**, click **Logical Cluster**, view the logical cluster, and obtain the value of **Ssl Port** in **HTTP Balancer Port**. – To obtain the port number of a cluster with Kerberos authentication disabled, log in to FusionInsight Manager, choose **Cluster** > **Services**, click **Logical Cluster**, view the logical cluster, and obtain the value of **Port** in **HTTP Balancer Port**.	
Username	Username for connecting to the database	root
Password	Password for connecting to the database	xxxx

Configure data source information.

Step 8 Click **Next**. On the displayed **From** page, configure the data source information. Currently, only **Table name** is supported.

Table 16-48 Input parameters

Parameter	Description	Example Value
Schema name	Schema name of the specified database	public

Parameter	Description	Example Value
Table name	Table name	test
Table column names	Names of the columns to be imported	id,name
Need partition column	The partition may not be specified.	false

Configure data transformation.

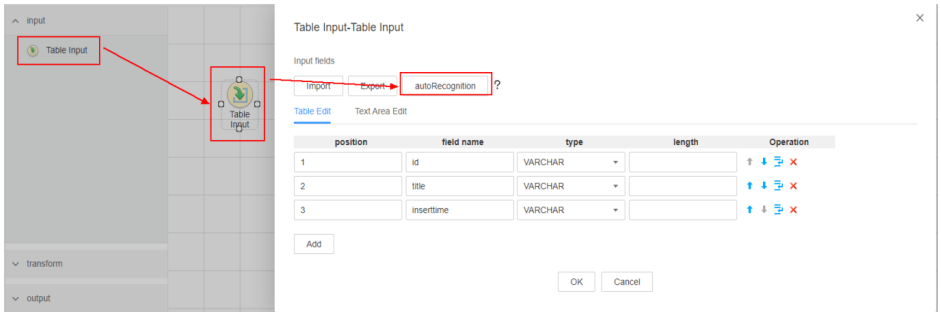
Step 9 Click **Next**. On the displayed **Transform** page, set the transformation operations in the data transformation process. For details about how to select operators and set parameters, see **Operator Help** and **Table 16-49**.

Table 16-49 Input and output parameters of the operator

Input Type	Output Type
Table Input	ClickHouse Output

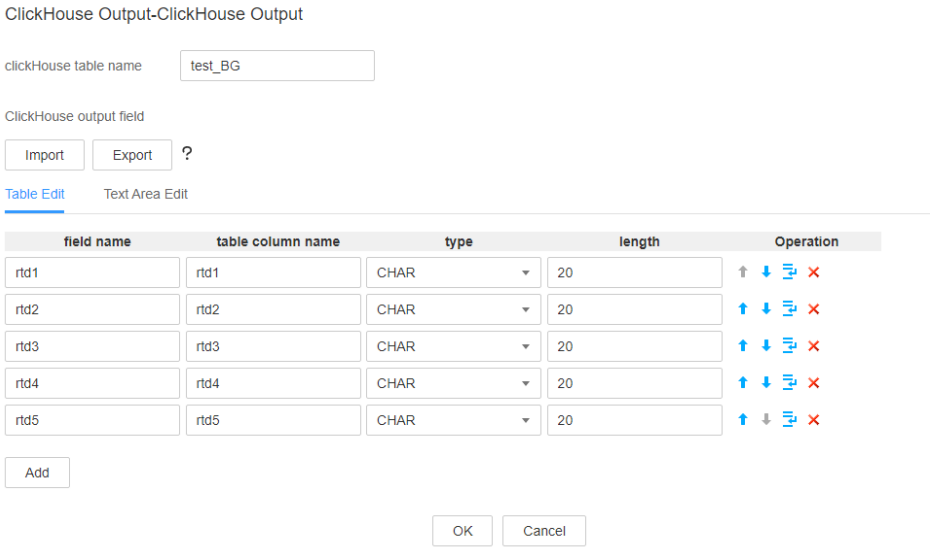
Drag **Table Input** to the grid, double-click **Table Input**, and select **autoRecognition**.

Figure 16-30 Operator input



Drag **ClickHouse Output** to the grid, double-click **ClickHouse Output**, and select **associate** or manually edit the table to correspond to the input table.

Figure 16-31 Operator output



Set data storage information and execute the job.

Step 10 Click **Next**. On the displayed **To** page, set **Storage type** to **CLICKHOUSE**.

Table 16-50 Output parameters

Parameter	Description	Example Value
Storage type	Select **CLICKHOUSE**.	-
Connection	Select the ClickHouse dedicated connector configured in **Step 7**.	clickhouse_jdbc_test
Clear data before import	Select **true** or **false**. **NOTE** If you select **true** and the table to be imported is a ClickHouse distributed table, you need to manually delete the data from the local table corresponding to the ClickHouse distributed table before your import.	true
BatchSize	Row data written in a batch when data is written to the ClickHouse table in batches.	10000
Number	The value cannot be changed. The default value is **1**.	-

Step 11 Click **Save and Run** to save and run the job.

View the job execution result.

Step 12 Go to the Loader web UI. When **Status** is **Succeeded**, the job is complete.

Figure 16-32 Viewing job details

Step 13 On the ClickHouse client, check whether the data in the ClickHouse table is the same as that in the MySQL table.

----End

16.6 Exporting Data

16.6.1 Overview

Description

Loader is an extract, transform, and load (ETL) tool for exchanging data and files between MRS and relational databases and file systems. You can use the Loader to export data or files from MRS to the relational databases or file systems.

Loader supports the following data export modes:

- Exporting data from HDFS or OBS to an SFTP server
- Exporting data from HDFS or OBS to a relational database
- Exporting data from HBase to an SFTP server
- Exporting data from HBase to a relational database
- Exporting data from Phoenix tables to an SFTP server
- Exporting data from Phoenix tables to a relational database
- Exporting data from Hive to an SFTP server
- Exporting Data from Hive to a Relational Database
- Exporting data from HBase to HDFS or OBS in the same cluster

The MRS needs to connect to the data source to exchange data and files with the external data source. The following connectors are used to configure connection parameters for different types of data sources:

- **generic-jdbc-connector**: relational database connector
- **hdfs-connector**: HDFS data source connector
- **oracle-connector**: specifies a dedicated connector for Oracle databases. **row_id** serves as partition columns. Compared with generic-jdbc-connector, Map tasks are more evenly distributed on oracle-connector, and whether the partition columns have created indexes does not affect oracle-connector.
- **mysql-fastpath-connector**: specifies a dedicated connector for MySQL databases. Data is imported and exported by using the mysqldump and mysqlimport tools of MySQL. Compared with generic-jdbc-connector, the data import and export speed is faster.
- sftp-connector: SFTP data source connector
- oracle-partition-connector: connector that supports the Oracle partition feature, which is used to optimize the import and export of Oracle partition tables.

NOTE

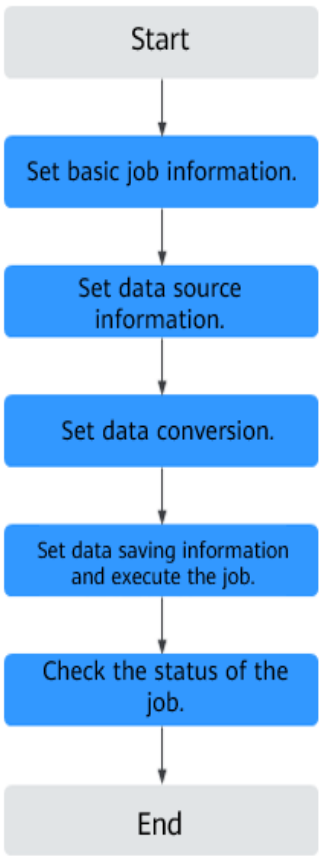
- You are advised to deploy the SFTP server, database server, and Loader into separate subnets to ensure secure data export.
- For connection to relational databases, general database connectors (generic-jdbc-connector) or dedicated database connectors (oracle-connector, oracle-partition-connector, and mysql-fastpath-connector) are available. However, compared with general database connectors, dedicated database connectors perform better in data import and export because it is optimized for specific database types.
- When **mysql-fastpath-connector** is used, the **mysqldump** and **mysqlimport** commands of MySQL must be available on NodeManagers, and the MySQL client version to which the two commands belong must be compatible with the MySQL server version. If the two commands are unavailable or the versions are incompatible, see **http://dev.mysql.com/doc/refman/5.7/en/linux-installation-rpm.html**. Install the MySQL client applications and tools.
- When oracle-connector is used, the connection user must be granted the select permission on the following system catalogs or views:

  dba_tab_partitions, dba_constraints, dba_tables, dba_segments, v$version, dba_objects, v$instance, dba_extents, dba_tab_partitions and dba_tab_subpartitions.
- When oracle-partition-connector is used, the connection user must be granted the select permission on the following system catalogs: dba_objects and dba_extents.

Export Process

A data export job can be executed in the Loader WebUI. **Figure 16-33** shows the export process.

Figure 16-33 Export process



Loader jobs can also be updated and executed using shell scripts. In this mode, the Loader client that has been installed needs to be configured.

16.6.2 Using Loader to Export Data

Scenario

This task enables you to export data from MRS to external data sources.

Generally, users can manually manage data import and export jobs on the Loader UI. To use shell scripts to update and run Loader jobs, configure the installed Loader client.

Prerequisites

- You have obtained the service username and password for creating a Loader job.
- You have had the permission to access the HDFS directories, HBase tables, and data involved in job execution.
- You have obtained the user name and password used by an external data source (SFTP server or relational database).
- No disk space alarm is reported, and the available disk space is sufficient for importing and exporting data.

- When using Loader to export data from HDFS or OBS, the input paths and input path subdirectories of the HDFSor OBS data source and the name of the files in these directories do not contain any of the following special characters: **/\'":;,**.
- If the job requires the Yarn queue function, the user must be authorized with related Yarn queue permission.
- The user who configures a task must obtain execution permission on the task and obtain usage permission on the related connection of the task.

Procedure

Step 1 Check whether data is exported from Loader to a relational database for the first time.

- If yes, go to **Step 2**.
- If no, go to **Step 3**.

Step 2 Modify the permission on the JAR package of the RDS driver.

1. Obtain the JAR file of the relational database driver and save it to the following directory on the active and standby Loader nodes: **${BIGDATA_HOME}/FusionInsight_Porter_*install/FusionInsight-Sqoop-1.99.3/FusionInsight-Sqoop-1.99.3/server/webapps/loader/WEB-INF/ext-lib**.
2. Run the following command on the active and standby nodes as user **root** to modify the permission:

   cd ${BIGDATA_HOME}/FusionInsight_Porter_*/install/FusionInsight-Sqoop-1.99.3/FusionInsight-Sqoop-1.99.3/server/webapps/loader/WEB-INF/ext-lib

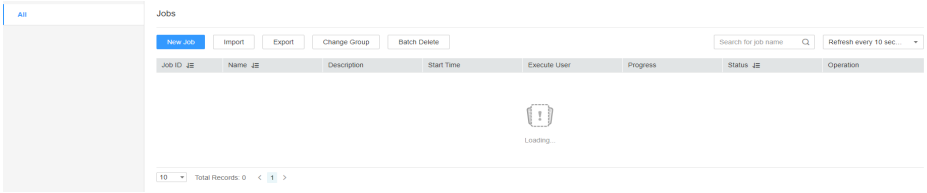
   chown omm:wheel *JAR package name*

   chmod 600 *JAR package name*
3. Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Loader**. On the **Dashboard** tab page that is displayed, click **More** and select **Restart Service**. In the displayed dialog box, enter the administrator password to restart the Loader service.

Step 3 Access the Loader web UI.

1. Log in to FusionInsight Manager.
2. Choose **Cluster** > **Services** > **Loader**.
3. Click **LoaderServer(***Node name***, Active)**. The Loader web UI is displayed.

   Figure 16-34 Loader web UI



Step 4 Create a Loader data export job. Click **New Job**. Select the required job type on the **Basic Information** page and click **Next**.

1. Set **Name** to the job name and **Type** to **Export**.
2. Select a connection for **Connection**. By default, no connection is created. Click **Add** to create a connection, and then click **Test** to test whether the connection is available. Click **OK** when the system displays a message indicates that the test is successful.

Table 16-51 Connection configuration parameters

Connector Type	Parameter	Description
generic-jdbc-connector	JDBC Driver Class	Specifies the name of a JDBC driver class.
	JDBC Connection String	Specifies the JDBC connection string.
	Username	Specifies the username for connecting to the database.
	Password	Specifies the password for connecting to the database.
	JDBC Connection Properties	Specifies JDBC connection attributes. Click **Add** to manually add connection attributes. – **Name**: connection attribute name – **Value**: connection attribute value
hdfs-connector	-	-
oracle-connector	JDBC Connection String	Specifies connection string for a user to connect to the database.
	Username	Specifies the username for connecting to the database.
	Password	Specifies the password for connecting to the database.
	Connection Properties	Specifies connection attributes. Click **Add** to manually add connection attributes. – **Name**: connection attribute name – **Value**: connection attribute value
mysql-fastpath-connector	JDBC Connection String	Specifies the JDBC connection string.
	Username	Specifies the username for connecting to the database.

Connector Type	Parameter	Description
	Password	Specifies the password for connecting to the database.
	Connection Properties	Specifies connection attributes. Click **Add** to manually add connection attributes. – **Name**: connection attribute name – **Value**: connection attribute value
sftp-connector	SFTP Server IP	Specifies the IP address of the SFTP server.
	SFTP Server Port	Specifies the port number of the SFTP server.
	SFTP Username	Specifies the username for accessing the SFTP server.
	SFTP Password	Specifies the password for accessing the SFTP server.
	SFTP Public Key	Specifies public key of the SFTP server.
oracle-partition-connector	JDBC Driver Class	Specifies the name of a Java database connectivity (JDBC) driver class.
	JDBC Connection String	Specifies the JDBC connection string.
	Username	Specifies the username for connecting to the database.
	Password	Specifies the password for connecting to the database.
	Connection Properties	Specifies connection attributes. Click **Add** to manually add connection attributes. – **Name**: connection attribute name – **Value**: connection attribute value

3. Set **Group** to the group to which the job belongs. By default, there is no created group. Click **Add** to create a group and click **OK**.
4. **Queue** indicates that Loader tasks are executed in a specified Yarn queue. The default value is **root.default**, which indicates that the tasks are executed in the **default** queue.
5. Set **Priority** to the priority of Loader tasks in the specified Yarn queue. The options are **VERY_LOW**, **LOW**, **NORMAL**, **HIGH**, and **VERY_HIGH**. The default value is **NORMAL**.

Step 5 On the **From** page, set the data source and click **Next**.

NOTE

When creating or editing a Loader job, you can use macro definitions when configuring parameters such as the SFTP path, HDFS/OBS path, and Where condition of SQL. For details, see **Using Macro Definitions in Configuration Items** .

Table 16-52 List of input configuration parameters

Source File Type	Parameter	Description
HDFS/OBS	Input Directory	Specifies the input path when data is exported from HDFS or OBS.
	Path Filter	Specifies the wildcard for filtering the directories in the input paths of the source files. **Input Directory** is not used in filtering. If there are multiple filter conditions, use commas (,) to separate them. If the value is empty, the directory is not filtered. The regular expression filtering is not supported.
	File Filter	Specifies the wildcard for filtering the file names of the source files. If there are multiple filter conditions, use commas (,) to separate them. The value cannot be left blank. The regular expression filtering is not supported.
	File Type	Specifies the file import type. • **TEXT_FILE**: imports a text file and saves it as a text file. • **SEQUENCE_FILE**: imports a text file and saves it as a sequence file. • **BINARY_FILE**: imports files of any format using binary streams.
	File Split Type	Specifies whether to split source files by file name or size. The files obtained after the splitting are used as the input files of each map in the MapReduce task for data export.
	Extractors	Number of Maps that are started at the same time in a MapReduce task of a data configuration operation. This parameter cannot be set when **Extractor Size** is set. The value must be less than or equal to 3000.

Source File Type	Parameter	Description
	Extractor size	Specifies the size of data processed by maps that are started in a MapReduce job of a data configuration operation. The unit is MB. The value must be greater than or equal to 100. The recommended value is **1000**. This parameter cannot be set when **Extractors** is set. When a relational database connector is used, **Extractor size** is unavailable. You need to set **Extractors**.
HBASE	HBase Instance	Specifies the HBase service instance that Loader selects from all available HBase service instances in the cluster. If the selected HBase service instance is not added to the cluster, the HBase job cannot be run properly.
	Quantity	Number of Maps that are started at the same time in a MapReduce task of a data configuration operation. The value must be less than or equal to 3000.
HIVE	Hive instance	Specifies the Hive service instance that Loader selects from all available Hive service instances in the cluster. If the selected Hive service instance is not added to the cluster, the Hive job cannot run properly.
	Quantity	Number of Maps that are started at the same time in a MapReduce task of a data configuration operation. The value must be less than or equal to 3000.
SPARK	Spark instance	Only SparkSQL can access Hive data. Specifies the SparkSQL service instance that Loader selects from all available SparkSQL service instances in the cluster. If the selected Spark service instance is not added to the cluster, the Spark job cannot be run properly.
	Quantity	Number of Maps that are started at the same time in a MapReduce task of a data configuration operation. The value must be less than or equal to 3000.

Step 6 On the **Transform** page, configure the transform operations during data transmission.

Check whether source data values in the data operation job created by the Loader can be directly used without conversion, including upper and lower case conversion, cutting, merging, and separation.

- If yes, click **Next**.
- If no, perform **Step 6.1** to **Step 6.4**.

1. No created conversion step exists by default. Drag an example conversion step on the left to the edit box to create a new conversion step.
2. Conversion step types must be selected based on service requirements. A complete conversion process includes the following types:
   a. Input type. Only one conversion step can be added. This parameter is mandatory if the task involves HBase or relational databases.
   b. Conversion type, which is an intermediate conversion step. You can add one or more conversion types or do not add any conversion type.
   c. Output type. Only one output type can be added in the last conversion step. This parameter is mandatory if the task involves HBase or relational databases.

Table 16-53 Example list

Type	Description
Input Type	▪ **CSV File Input**: CSV file input step for configuring separators to generate multiple fields. ▪ **Fixed File Input**: Text file input step for configuring the length of characters or bytes to be truncated to generate multiple fields. ▪ **Table Input**: relational data input step for configuring specified columns in the database as input fields. ▪ **HBase Input**: HBase table input step for configuring the column definition of an HBase table to a specified field. ▪ **HTML File Input**: HTML web page data input step for obtaining the target data of the HTML web page file to the specified field. ▪ **Hive Input**: Hive table input step for defining columns in a Hive table to specified fields. ▪ **Spark Input**: Spark SQL table input step for defining columns in the SparkSQL table to specified fields. Only Hive data can be stored and accessed.

Type	Description
Conversion type	▪ **Long Integer Time Conversion**: Configure the conversion between a long integer value and a date. ▪ **Null Value Conversion**: Configure a specified value to replace the null value. ▪ **Random Value Conversion**: Configure new value-added fields as random data fields. ▪ **Adding a Constant Field**: Add a constant to directly generate a constant field. ▪ **Concatenation and Conversion**: Concatenate fields, connect generated fields using connection characters, and convert new fields. ▪ **Separator Conversion**: Configure the generated fields to be separated by separators and convert new fields. ▪ **Modulo Conversion**: Configure the generated fields to be converted into new fields through modulo operation. ▪ **Cutting Character String**: Truncate a generated field based on a specified position to generate a new field. ▪ **EL Operation Conversion**: Calculate field values. Currently, the following operators are supported: md5sum, sha1sum, sha256sum, and sha512sum. ▪ **Character String Case Conversion:** Configure the generated fields to be converted to new fields through case conversion. ▪ **Reverse String Conversion**: Reverse the generated fields to generate new fields. ▪ **Character String Space Clearing Conversion**: Configure the generated fields to clear spaces and convert them to new fields. ▪ **Row Filtering Conversion**: Configure logical conditions to filter out rows that contain triggering conditions. ▪ **Update Fields**: Update the value of a specified field when certain conditions are met.

Type	Description
Output type	■ **File Output**: Configure generated fields to be connected by separators and exported to a file. ■ **Table Output**: Configure the mapping between output fields and specified columns in the database. ■ **HBase Output**: Configure the generated fields to the columns of the HBase table. ■ **Hive Output**: Configure generated fields to a column of a Hive table. ■ **Spark Output**: Configure generated fields to the columns of SparkSQL tables. Only SparkSQL can access Hive data.

The edit box allows you to perform the following tasks:

- Re-command: Rename an example.
- Edit: Edit the step conversion by referring to **Step 6.3**.
- Delete: Delete an example.

  NOTE

  You can also use the shortcut key Del to delete the file.

3. Click **Edit** to edit the step conversion information and configure fields and data.

   For details about how to set parameters in the step conversion information, see **Operator Help**.

   If the conversion step is incorrectly configured, the source data cannot be converted and become dirty data. The dirty data marking rules are as follows:

   - In any input type step, the number of fields contained in the original data is less than the number of configured fields or the field values in the original data do not match the configured field type.
   - In the **CSV File Input** step, **Validate input field** checks whether the input field matches the value type. If the input field and value type of a line do not match, the line is skipped and becomes dirty data.
   - In the **Fixed Width File Input** step, **Fixed Length** specifies the field splitting length. If the length is greater than the length of the original field value, data splitting fails and the current line becomes dirty data.
   - In the **HBase Input** step, if the HBase table name specified by **HBase Table Name** is incorrect, or no primary key column is configured for Primary Key, all data becomes dirty data.
   - In any conversion step, lines whose conversion fails becomes dirty data. For example, in the **Split Conversion** step, the number of generated fields is less than the number of configured fields, or the original data

cannot be converted to the String type, and the current row becomes dirty data.

- In the **Filter Row Conversion** step, rows filtered by filter criteria become dirty data.
- In the **Modulo Conversion** step, if the original field value is NULL, the current row becomes dirty data.

4. Click **Next**.

Step 7 On the **To** page, set the destination location for saving data and click **Save** to save the job or click **Save and Run** to save and run the job.

Table 16-54 List of output configuration parameters

Data Connection Type	Parameter	Description
sftp-connector	Output Path	Path or name of the export file on an SFTP server. If multiple SFTP server IP addresses are configured for the connector, you can set this parameter to multiple paths or file names separated with semicolons (;). Ensure that the number of input paths or file names is the same as the number of SFTP servers configured for the connector.

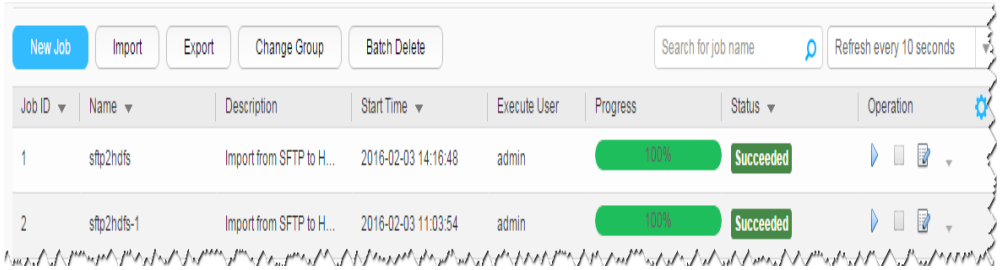
Data Connection Type	Parameter	Description
	Operation	Specifies the action during data import. When all data is imported from the input path to the destination path, the data is stored in a temporary directory and then copied from the temporary directory to the destination path. After data import is complete, the data in the temporary directory is deleted. One of the following actions can be taken when there are duplicate file names during data transfer: ● **OVERRIDE**: overrides the old file. ● **RENAME**: renames the new file. For a file without a file name extension, a string is added to the file name as the extension; for a file with a file name extension, a string is added to the extension. The string is unique. ● **APPEND**: adds the content of the new file to the end of the old file. This action only adds content regardless of whether the file can be used. For example, a text file can be used after this action, while a compressed file cannot. ● **IGNORE**: reserves the old file and does not copy the new file. ● **ERROR**: stops the task and reports an error if there are duplicate file names. Transferred files are imported successfully, while files that have duplicate names and files that are not transferred fail to import.
	Encode type	Specifies the exported file encoding format, for example, UTF-8. This parameter can be set only in text file export.
	Compression	Indicates whether to enable the compressed transmission function when SFTP is used to export data. **true** indicates that compression is enabled, and **false** indicates that compression is disabled.
hdfs-connector	Output Path	Specifies the output directory or file name of the export file in HDFS or OBS.

Data Connection Type	Parameter	Description
	File Format	Specifies the file export type. • **TEXT_FILE**: imports a text file and saves it as a text file. • **SEQUENCE_FILE**: imports a text file and saves it as a sequence file. • **BINARY_FILE**: imports files of any format using binary streams.
	Compression codec	Specifies the compression format of files exported to HDFS or OBS. Select a format from the drop-down list. If you select **NONE** or do not set this parameter, data is not compressed.
	User-defined compression format	Name of a user-defined compression format type.
generic-jdbc-connector	Schema name	Specifies the database schema name.
	Table name	Specifies the name of a database table that is used to save the final data of the transmission.
	Temporary table	Specifies the name of a temporary database table that is used to save temporary data during the transmission. The fields in the table must be the same as those in the database specified by **Table name**.
oracle-partition-connector	Schema Name	Specifies the database schema name.
	Table Name	Specifies the name of a database table that is used to save the final data of the transmission.
	Temporary Table	Specifies the name of a temporary database table that is used to save temporary data during the transmission. The fields in the table must be the same as those in the database specified by **Table name**.
oracle-connector	Table Name	Destination table name to store data.
	Column Name	Specifies the name of the column to be written. Columns that are not specified can be set to null or the default value.
mysql-fastpath-connector	Schema Name	Specifies the database schema name.

Data Connection Type	Parameter	Description
	Table Name	Specifies the name of a database table that is used to save the final data of the transmission.
	Temporary Table Name	Name of the temporary table, which is used to store data. After the job is successfully executed, data is transferred to the formal table.

Step 8 On the Loader WebUI page, you can view, start, stop, copy, delete, edit, and view historical information about created jobs.

Figure 16-35 Viewing Loader Jobs



----End

16.6.3 Typical Scenario: Exporting Data from HDFS or OBS to an SFTP Server

Scenario

This section describes how to use Loader to export data from HDFS or OBS to an SFTP server.

Prerequisites

- You have obtained the service username and password for creating a Loader job.
- You have had the permission to access the HDFS or OBS directories and data involved in job execution.
- You have obtained the username and password of the SFTP server and the user has the write permission of the data export directory on the SFTP server.
- No disk space alarm is reported, and the available disk space is sufficient for importing and exporting data.
- When using Loader to export data from HDFS or OBS, the input paths and input path subdirectories of the HDFS or OBS data source and the name of the files in these directories do not contain any of the following special characters: /\"':;,.

- If a configured task requires the Yarn queue function, the user must be authorized with related Yarn queue permission.
- The user who configures a task must obtain execution permission on the task and obtain usage permission on the related connection of the task.

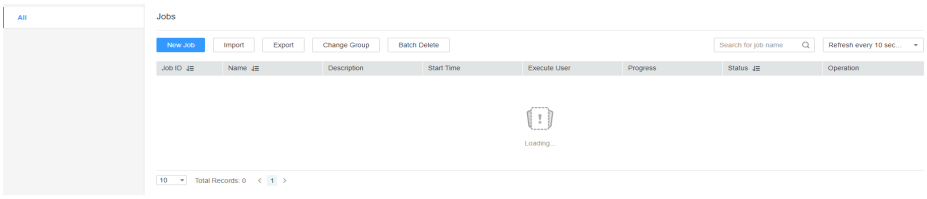
Procedure

Configure basic job information.

Step 1 Access the Loader web UI.

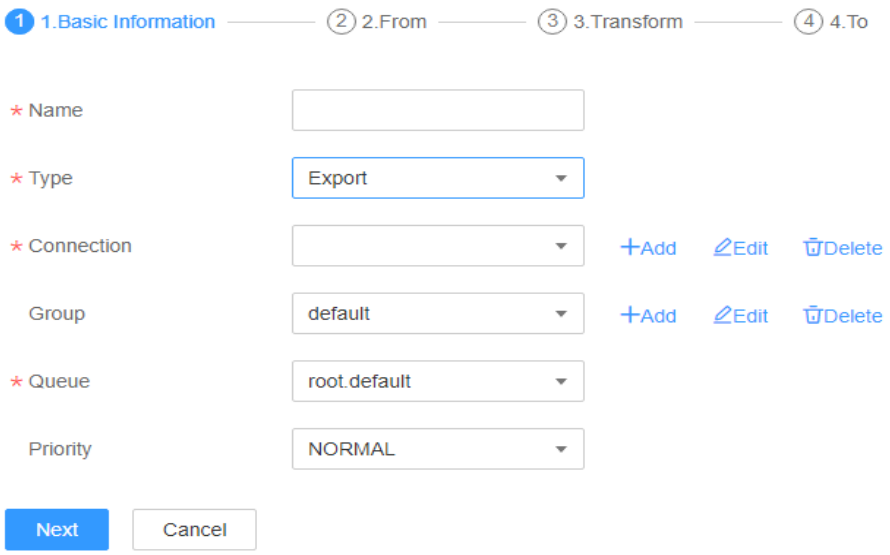
1. Log in to FusionInsight Manager.
2. Choose **Cluster** > **Services** > **Loader**.
3. Click **LoaderServer(***Node name***, Active)**. The Loader web UI is displayed.

Figure 16-36 Loader web UI



Step 2 Click **New Job**. Configure basic job parameters on the **Basic Information** page displayed.

Figure 16-37 Basic Information page



1. Enter a job name in **Name**.
2. Set **Type** to **Export**.
3. Set **Group** to the group to which the job belongs. There is no group created by default. Click **Add**, enter the group name, and click **OK**.
4. Set **Queue** to the Yarn queue that executes the job. The default value is **root.default**.

5. Set **Priority** to the priority of the Yarn queue that executes the job. The default value is **NORMAL**. The options are **VERY_LOW**, **LOW**, **NORMAL**, **HIGH**, and **VERY_HIGH**.

Step 3 In the **Connection** area, click **Add** to create a connection, set **Connector** to **sftp-connector**, click **Add**, set connection parameters, and click **Test** to verify whether the connection is available. When "**Test Success**" is displayed, click **OK**. Loader allows multiple SFTP servers to be configured. Click **Add** to add the configuration information of multiple SFTP servers.

Table 16-55 Connection parameters

Parameter	Description	Example Value
Name	Specifies the name of the SFTP server connection.	sftpName
SFTP Server IP	Specifies the IP address of the SFTP server.	10.16.0.1
SFTP Server Port	Specifies the port number of the SFTP server.	22
SFTP Username	Specifies the user name for accessing the SFTP server.	root
SFTP Password	Specifies the password for accessing the SFTP server.	xxxx
SFTP Public Key	Specifies public key of the SFTP server.	OdDt/yn...etM

NOTE

When multiple SFTP servers are configured, the data of HDFSor OBS will be divided into multiple parts and exported to the SFTP servers randomly.

Configure data source information.

Step 4 Click **Next**. On the displayed **From** page, set **Source type** to **HDFS**.

Table 16-56 Data source parameters

Parameter	Description	Example Value
Input directory	Specifies the input path when data is exported from HDFS or OBS. **NOTE** You can use macros to define path parameters. For details, see **Using Macro Definitions in Configuration Items** .	/user/test

Parameter	Description	Example Value
Path filter	Specifies the wildcard for filtering the directories in the input paths of the source files. **Input directory** is not used in filtering. If there are multiple filter conditions, use commas (**,**) to separate them. If the parameter is empty, the directory is not filtered. The regular expression filtering is not supported. ● **?** matches a single character. ● ***** indicates multiple characters. ● Adding **^** before the condition indicates negated filtering, that is, file filtering.	*
File filter	Specifies the wildcard for filtering the file names of the source files. If there are multiple filter conditions, use commas (**,**) to separate them. The value cannot be left blank. The regular expression filtering is not supported. ● **?** matches a single character. ● ***** indicates multiple characters. ● Adding **^** before the condition indicates negated filtering, that is, file filtering.	*
File Type	Specifies the file import type. ● **TEXT_FILE**: imports a text file and saves it as a text file. ● **SEQUENCE_FILE**: imports a text file and saves it as a sequence file. ● **BINARY_FILE**: imports files of any format using binary streams but not to process the files. **NOTE** When the file import type to **TEXT_FILE** or **SEQUENCE_FILE**, Loader automatically selects a decompression method based on the file name extension to decompress a file.	TEXT_FILE

Parameter	Description	Example Value
File Split Type	Indicates whether to split source files by file name or size. The files obtained after the splitting are used as the input files of each map in the MapReduce task for data export. • **FILE**: indicates that the source file is split by file. That is, each map processes one or multiple complete files, the same source file cannot be allocated to different maps, and the source file directory structure is retained after data import. • **SIZE**: indicates that the source file is split by size. That is, each map processes input files of a certain size, and a source file can be divided and processed by multiple maps. After data is stored in the output directory, the number of saved files is the same as the number of maps. The file name format is **import_part_xxxx**, where **xxxx** is a unique random number generated by the system.	FILE
Extractors	Number of Maps that are started at the same time in a MapReduce task of a data configuration operation. This parameter cannot be set when **Extractor Size** is set. The value must be less than or equal to 3000. You are advised to set the parameter to the number of CPU cores on the SFTP server. **NOTE** To improve the data import speed, ensure that the following conditions are met: • Each map connection is equivalent to a client connection. Therefore, you must ensure that the maximum number of connections of the SFTP server is greater than the number of maps. • Ensure that the disk I/O or network bandwidth on the SFTP server does not reach the upper limit.	20
Extractor size	Specifies the size of data processed by maps that are started in a MapReduce job of a data configuration operation. The unit is MB. The value must be greater than or equal to 100. The recommended value is 1000. This parameter cannot be set when **Extractors** is set.	-

Configure data transformation.

Step 5 Click **Next**. On the displayed **Transform** page, set the transformation operations in the data transformation process. For details about how to select operators and set parameters, see **Operator Help** and **Table 16-57**.

Table 16-57 Input and output parameters of the operator

Input Type	Output Type
CSV File Input	File Output
HTML File Input	File Output
Fixed File Input	File Output

In **input**, drag **CSV File Input**, **HTML File Input**, or **Fixed File Input** to the grid. In **output**, drag **File Output** to the grid. Use an arrow to connect **CSV File Input**, **HTML File Input**, or **Fixed File Input** to **File Output**.

Set data storage information and execute the job.

Step 6 Click **Next**. On the displayed **To** page, set the data storage mode.

Table 16-58 Parameter description

Parameter	Description	Example Value
Output path	Specifies the path or file name of the exported file on an SFTP server. If multiple SFTP server IP addresses are configured for the connector, you can set this parameter to multiple paths or file names separated with semicolons (;). Ensure that the number of paths or file names is the same as the number of SFTP servers configured for the connector. **NOTE** You can use macros to define path parameters. For details, see **Using Macro Definitions in Configuration Items** .	/opt/tempfile

Parameter	Description	Example Value
Operation	Specifies the action during data import. When all data is imported from the input path to the destination path, the data is stored in a temporary directory and then copied from the temporary directory to the destination path. After data import is complete, the data in the temporary directory is deleted. One of the following actions can be taken when there are duplicate file names during data transfer: ● **OVERRIDE**: overrides the old file. ● **RENAME**: renames the new file. For a file without a file name extension, a string is added to the file name as the extension; for a file with a file name extension, a string is added to the extension. The string is unique. ● **APPEND**: adds the content of the new file to the end of the old file. This action only adds content regardless of whether the file can be used. For example, a text file can be used after this action, while a compressed file cannot. ● **IGNORE**: reserves the old file and does not copy the new file. ● **ERROR**: stops the task and reports an error if there are duplicate file names. Transferred files are imported successfully, while files that have duplicate names and files that are not transferred fail to import.	OVERRIDE
Encode type	Specifies the exported file encoding format, for example, UTF-8. This parameter can be set only in text file export.	UTF-8
Compression	Indicates whether to enable the compressed transmission function when SFTP is used to export data. ● The value **true** indicates that compression is enabled. ● The value **false** indicates that compression is disabled.	true

Step 7 Click **Save and Run** to save and run the job.

View the job execution result.

Step 8 Go to the Loader web UI. When **Status** is **Succeeded**, the job is complete.

Figure 16-38 Viewing a job

----End

16.6.4 Typical Scenario: Exporting Data from HBase to an SFTP Server

Scenario

Use Loader to export data from HBase to an SFTP server.

Prerequisites

- You have obtained the service username and password for creating a Loader job.
- You have had the permission to access the HBase tables or phoenix tables that are used during job execution.
- You have obtained the username and password of the SFTP server and the user has the write permission of the data export directory on the SFTP server.
- No disk space alarm is reported, and the available disk space is sufficient for importing and exporting data.
- If a configured task requires the Yarn queue function, the user must be authorized with related Yarn queue permission.
- The user who configures a task must obtain execution permission on the task and obtain usage permission on the related connection of the task.

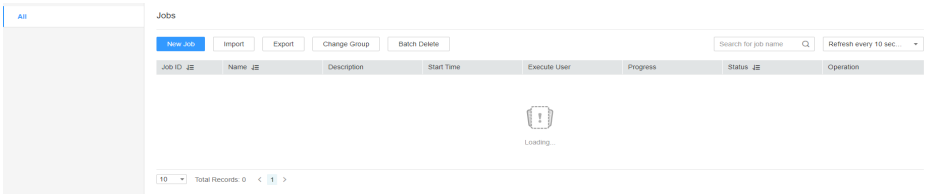
Procedure

Configure basic job information.

Step 1 Access the Loader web UI.

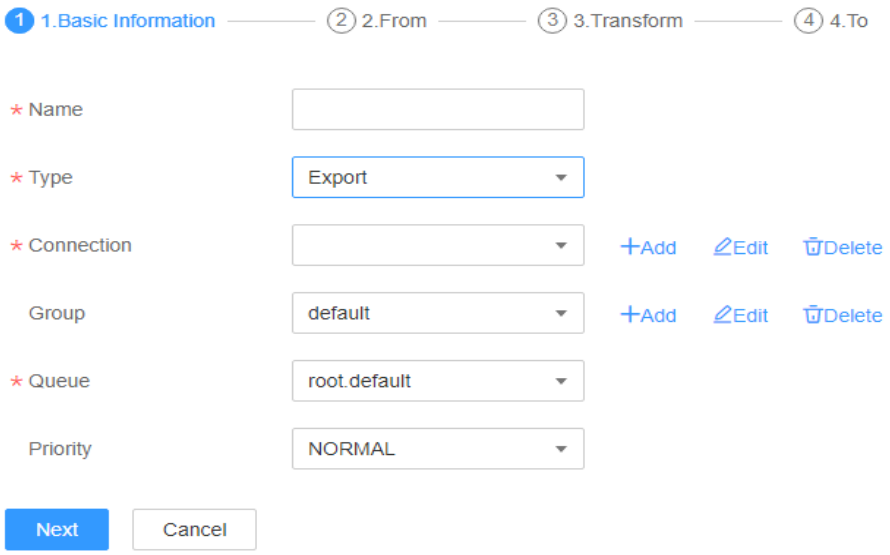
1. Log in to FusionInsight Manager.
2. Choose **Cluster** > **Services** > **Loader**.
3. Click **LoaderServer(***Node name***, Active)**. The Loader web UI is displayed.

Figure 16-39 Loader web UI



Step 2 Click **New Job**. Configure basic job parameters on the **Basic Information** page displayed.

Figure 16-40 Basic Information page



1. Enter a job name in **Name**.
2. Set **Type** to **Export**.
3. Set **Group** to the group to which the job belongs. There is no group created by default. Click **Add**, enter the group name, and click **OK**.
4. Set **Queue** to the Yarn queue that executes the job. The default value is **root.default**.
5. Set **Priority** to the priority of the Yarn queue that executes the job. The default value is **NORMAL**. The options are **VERY_LOW**, **LOW**, **NORMAL**, **HIGH**, and **VERY_HIGH**.

Step 3 In the **Connection** area, click **Add** to create a connection, set **Connector** to **sftp-connector**, click **Add**, set connection parameters, and click **Test** to verify whether the connection is available. When "**Test Success**" is displayed, click **OK**. Loader allows multiple SFTP servers to be configured. Click **Add** to add the configuration information of multiple SFTP servers.

Table 16-59 Connection parameters

Parameter	Description	Example Value
Name	Specifies the name of the SFTP server connection.	sftpName
SFTP server IP	Specifies the IP address of the SFTP server.	10.16.0.1
SFTP server port	Specifies the port number of the SFTP server.	22
SFTP username	Specifies the user name for accessing the SFTP server.	root

Parameter	Description	Example Value
SFTP password	Specifies the password for accessing the SFTP server.	xxxx
SFTP public key	Specifies public key of the SFTP server.	OdDt/yn...etM

NOTE

When multiple SFTP servers are configured, the data of HBase tables or phoenix tables will be divided into multiple parts and saved to the SFTP servers randomly.

Configure data source information.

Step 4 Click **Next**. On the displayed **From** page, set **Source type** to **HBASE**.

Table 16-60 Data source parameters

Parameter	Description	Example Value
HBase instance	Specifies the HBase service instance that Loader selects from all available HBase service instances in the cluster. If the selected HBase service instance is not added to the cluster, the HBase job cannot be run properly.	HBase
Quantity	Number of Maps that are started at the same time in a MapReduce task of a data configuration operation. The value must be less than or equal to 3000. You are advised to set the parameter to the maximum number of connections on the SFTP server.	20

Configure data transformation.

Step 5 Click **Next**. On the displayed **Transform** page, set the transformation operations in the data transformation process. For details about how to select operators and set parameters, see **Operator Help** and **Table 16-61**.

Table 16-61 Input and output parameters of the operator

Input Type	Output Type
HBase Input	File Output

In **input**, drag **HBase Input** to the grid. In **output**, drag **File Output** to the grid. Use an arrow to connect **HBase Input** to **File Output**.

Set data storage information and execute the job.

Step 6 Click **Next**. On the displayed **To** page, set the data storage mode.

Table 16-62 Parameter description

Parameter	Description	Example Value
Output path	Specifies the path or file name of the exported file on an SFTP server. If multiple SFTP server IP addresses are configured for the connector, you can set this parameter to multiple paths or file names separated with semicolons (;). Ensure that the number of paths or file names is the same as the number of SFTP servers configured for the connector. **NOTE** You can use macros to define path parameters. For details, see **Using Macro Definitions in Configuration Items** .	/opt/tempfile
Operation	Specifies the action during data import. When all data is imported from the input path to the destination path, the data is stored in a temporary directory and then copied from the temporary directory to the destination path. After data import is complete, the data in the temporary directory is deleted. One of the following actions can be taken when there are duplicate file names during data transfer: • **OVERRIDE**: overrides the old file. • **RENAME**: renames the new file. For a file without a file name extension, a string is added to the file name as the extension; for a file with a file name extension, a string is added to the extension. The string is unique. • **APPEND**: adds the content of the new file to the end of the old file. This action only adds content regardless of whether the file can be used. For example, a text file can be used after this action, while a compressed file cannot. • **IGNORE**: reserves the old file and does not copy the new file. • **ERROR**: stops the task and reports an error if there are duplicate file names. Transferred files are imported successfully, while files that have duplicate names and files that are not transferred fail to import.	OVERRIDE

Parameter	Description	Example Value
Encode type	Specifies the exported file encoding format, for example, UTF-8. This parameter can be set only in text file export.	UTF-8
Compression	Indicates whether to enable the compressed transmission function when SFTP is used to export data. • The value **true** indicates that compression is enabled. • The value **false** indicates that compression is disabled.	true

Step 7 Click **Save and Run** to save and run the job.

View the job execution result.

Step 8 Go to the Loader web UI. When **Status** is **Succeeded**, the job is complete.

Figure 16-41 Viewing a job

----End

16.6.5 Typical Scenario: Exporting Data from Hive to an SFTP Server

Scenario

Use Loader to export data from Hive to an SFTP server.

Prerequisites

- You have obtained the service username and password for creating a Loader job.
- You have had the permission to access the Hive table specified in the job.
- You have obtained the username and password of the SFTP server and the user has the write permission of the data export directory on the SFTP server.
- No disk space alarm is reported, and the available disk space is sufficient for importing and exporting data.
- If a configured task requires the Yarn queue function, the user must be authorized with related Yarn queue permission.
- The user who configures a task must obtain execution permission on the task and obtain usage permission on the related connection of the task.

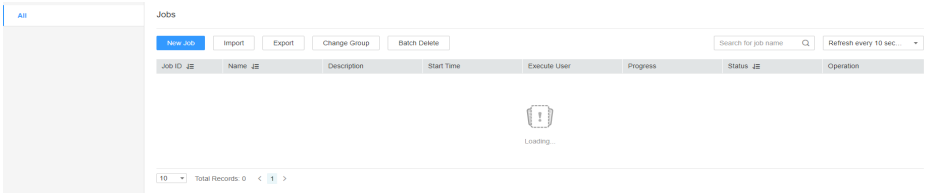
Procedure

Configure basic job information.

Step 1 Access the Loader web UI.

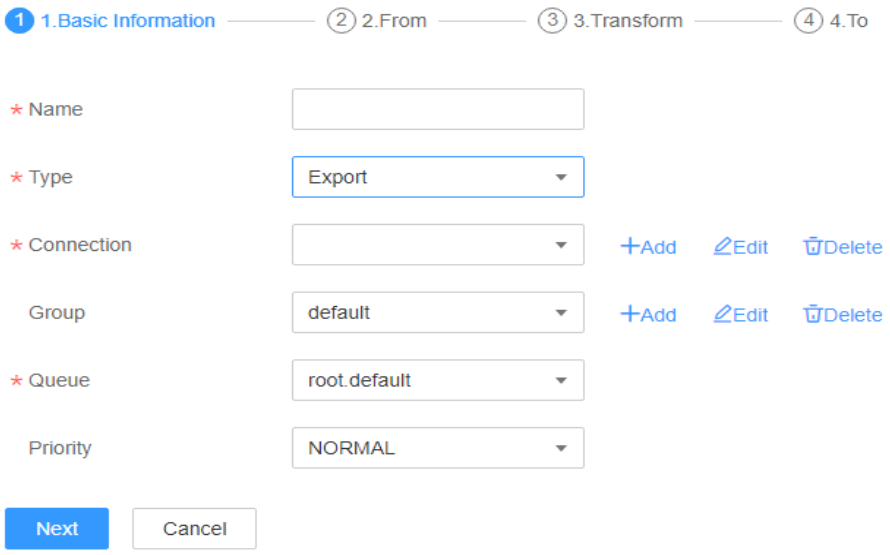
1. Log in to FusionInsight Manager.
2. Choose **Cluster** > **Services** > **Loader**.
3. Click **LoaderServer(***Node name***, Active)**. The Loader web UI is displayed.

Figure 16-42 Loader web UI



Step 2 Click **New Job**. Configure basic job parameters on the **Basic Information** page displayed.

Figure 16-43 Basic Information page



1. Enter a job name in **Name**.
2. Set **Type** to **Export**.
3. Set **Group** to the group to which the job belongs. There is no group created by default. Click **Add**, enter the group name, and click **OK**.
4. Set **Queue** to the Yarn queue that executes the job. The default value is **root.default**.
5. Set **Priority** to the priority of the Yarn queue that executes the job. The default value is **NORMAL**. The options are **VERY_LOW**, **LOW**, **NORMAL**, **HIGH**, and **VERY_HIGH**.

Step 3 In the **Connection** area, click **Add** to create a connection, set **Connector** to **sftp-connector**, click **Add**, set connection parameters, and click **Test** to verify whether

the connection is available. When "**Test Success**" is displayed, click **OK**. Loader allows multiple SFTP servers to be configured. Click **Add** to add the configuration information of multiple SFTP servers.

Table 16-63 Connection parameters

Parameter	Description	Example Value
Name	Specifies the name of the SFTP server connection.	sftpName
SFTP server IP	Specifies the IP address of the SFTP server.	10.16.0.1
SFTP server port	Specifies the port number of the SFTP server.	22
SFTP username	Specifies the user name for accessing the SFTP server.	root
SFTP password	Specifies the password for accessing the SFTP server.	xxxx
SFTP public key	Specifies public key of the SFTP server.	OdDt/yn...etM

NOTE

When multiple SFTP servers are configured, the data of Hive tables will be divided into multiple parts and saved to the SFTP servers randomly.

Configure data source information.

Step 4 Click **Next**. On the displayed **From** page, set **Source type** to **HIVE**.

Table 16-64 Data source parameters

Parameter	Description	Example Value
Hive instance	Specifies the Hive service instance that Loader selects from all available Hive service instances in the cluster. If the selected Hive service instance is not added to the cluster, the Hive job cannot run properly.	hive
Quantity	Number of Maps that are started at the same time in a MapReduce task of a data configuration operation. The value must be less than or equal to 3000. You are advised to set the parameter to the maximum number of connections on the SFTP server.	20

Configure data transformation.

Step 5 Click **Next**. On the displayed **Transform** page, set the transformation operations in the data transformation process. For details about how to select operators and set parameters, see **Operator Help** and **Table 16-65**.

Table 16-65 Input and output parameters of the operator

Input Type	Output Type
Hive Input	File Output

In **input**, drag **Hive Input** to the grid. In **output**, drag **File Output** to the grid. Use an arrow to connect **Hive Input** to **File Output**.

Set data storage information and execute the job.

Step 6 Click **Next**. On the displayed **To** page, set the data storage mode.

Table 16-66 Parameter description

Parameter	Description	Example Value
Output path	Specifies the path or file name of the exported file on an SFTP server. If multiple SFTP server IP addresses are configured for the connector, you can set this parameter to multiple paths or file names separated with semicolons (;). Ensure that the number of paths or file names is the same as the number of SFTP servers configured for the connector. **NOTE** You can use macros to define path parameters. For details, see **Using Macro Definitions in Configuration Items** .	/opt/tempfile

Parameter	Description	Example Value
Operation	Specifies the action during data import. When all data is imported from the input path to the destination path, the data is stored in a temporary directory and then copied from the temporary directory to the destination path. After data import is complete, the data in the temporary directory is deleted. One of the following actions can be taken when there are duplicate file names during data transfer: ● **OVERRIDE**: overrides the old file. ● **RENAME**: renames the new file. For a file without a file name extension, a string is added to the file name as the extension; for a file with a file name extension, a string is added to the extension. The string is unique. ● **APPEND**: adds the content of the new file to the end of the old file. This action only adds content regardless of whether the file can be used. For example, a text file can be used after this action, while a compressed file cannot. ● **IGNORE**: reserves the old file and does not copy the new file. ● **ERROR**: stops the task and reports an error if there are duplicate file names. Transferred files are imported successfully, while files that have duplicate names and files that are not transferred fail to import.	OVERRIDE
Encode type	Specifies the exported file encoding format, for example, UTF-8. This parameter can be set only in text file export.	UTF-8
Compression	Indicates whether to enable the compressed transmission function when SFTP is used to export data. ● The value **true** indicates that compression is enabled. ● The value **false** indicates that compression is disabled.	true

Step 7 Click **Save and Run** to save and run the job.

View the job execution result.

Step 8 Go to the Loader web UI. When **Status** is **Succeeded**, the job is complete.

Figure 16-44 Viewing job details

----End

16.6.6 Typical Scenario: Exporting Data from HDFS or OBS to a Relational Database

Scenario

This section describes how to use Loader to export data from HDFS or OBS to a relational database.

Prerequisites

- You have obtained the service username and password for creating a Loader job.
- You have had the permission to access the HDFS or OBS directories and data involved in job execution.
- You have obtained the username and password of the relational database.
- No disk space alarm is reported, and the available disk space is sufficient for importing and exporting data.
- If a configured task requires the Yarn queue function, the user must be authorized with related Yarn queue permission.
- The user who configures a task must obtain execution permission on the task and obtain usage permission on the related connection of the task.
- Before the operation, perform the following steps:

  a. Obtain the JAR file of the relational database driver and save it to the following directory on the active and standby Loader nodes: **${BIGDATA_HOME}/FusionInsight_Porter_*/install/FusionInsight-Sqoop-1.99.3/FusionInsight-Sqoop-1.99.3/server/webapps/loader/WEB-INF/ext-lib**.

  b. Run the following command on the active and standby nodes as user root to modify the permission:

  cd ${BIGDATA_HOME}/FusionInsight_Porter_*/install/FusionInsight-Sqoop-1.99.3/FusionInsight-Sqoop-1.99.3/server/webapps/loader/WEB-INF/ext-lib

  chown omm:wheel *JAR file name*

  chmod 600 *JAR file name*

  c. Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Loader**. On the **Dashboard** tab page that is displayed, click **More** and select **Restart Service**. In the displayed dialog box, enter the administrator password to restart the Loader service.

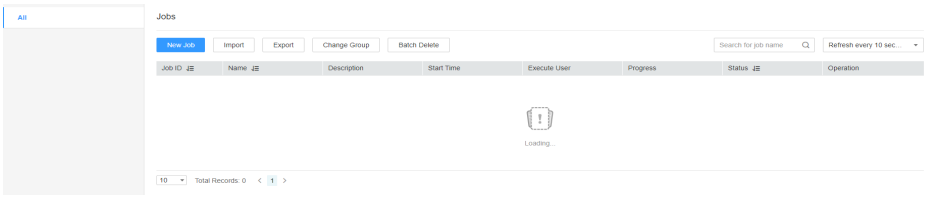
Procedure

Configure basic job information.

Step 1 Access the Loader web UI.

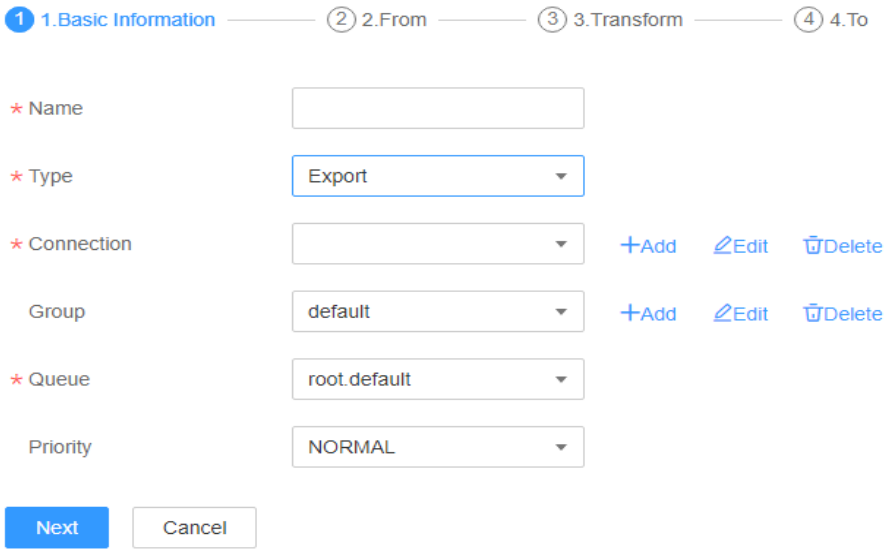
1. Log in to FusionInsight Manager.
2. Choose **Cluster** > **Services** > **Loader**.
3. Click **LoaderServer(***Node name***, Active)**. The Loader web UI is displayed.

Figure 16-45 Loader web UI



Step 2 Click **New Job**. Configure basic job parameters on the **Basic Information** page displayed.

Figure 16-46 Basic Information page



1. Enter a job name in **Name**.
2. Set **Type** to **Export**.
3. Set **Group** to the group to which the job belongs. There is no group created by default. Click **Add**, enter the group name, and click **OK**.
4. Set **Queue** to the Yarn queue that executes the job. The default value is **root.default**.
5. Set **Priority** to the priority of the Yarn queue that executes the job. The default value is **NORMAL**. The options are **VERY_LOW**, **LOW**, **NORMAL**, **HIGH**, and **VERY_HIGH**.

Step 3 In the **Connection** area, click **Add** to create a connection, set **Connector** to **generic-jdbc-connector** or a dedicated database connector (oracle-connector, oracle-partition-connector, or mysql-fastpath-connector), set connection parameters, and click **Test** to verify whether the connection is available. When "Test Success" is displayed, click **OK**.

NOTE

- For connection to relational databases, general database connectors (generic-jdbc-connector) or dedicated database connectors (oracle-connector, oracle-partition-connector, and mysql-fastpath-connector) are available. However, compared with general database connectors, dedicated database connectors perform better in data import and export because they are optimized for specific database types.
- When **mysql-fastpath-connector** is used, the **mysqldump** and **mysqlimport** commands of MySQL must be available on NodeManagers, and the MySQL client version to which the two commands belong must be compatible with the MySQL server version. If the two commands are unavailable or the versions are incompatible, visit **http://dev.mysql.com/doc/refman/5.7/en/linux-installation-rpm.html**. Install the MySQL client applications and tools.

Table 16-67 generic-jdbc-connector connection parameters

Parameter	Description	Example Value
Name	Name of a relational database connection	dbName
JDBC Driver Class	Name of a Java database connectivity (JDBC) driver class	oracle.jdbc.driver.OracleDriver
JDBC Connection String	JDBC connection string, in the format of **jdbc:oracle:thin:@***Database IP address***:***Database port number***:***Database name*	jdbc:oracle:thin:@10.16.0.1:1521:oradb
Username	Username for connecting to the database	omm
Password	Password for connecting to the database	xxxx
JDBC Connection Properties	JDBC connection attribute. Click **Add** to manually add the attribute. • Name: connection attribute name • Value: connection attribute value	• Name: **socketTimeout** • Value: **20**

Configure data source information.

Step 4 Click **Next**. On the displayed **From** page, set **Source type** to **HDFS**.

Table 16-68 Data source parameters

Parameter	Description	Example Value
Input directory	Specifies the input path when data is exported from HDFS or OBS. **NOTE** You can use macros to define path parameters. For details, see **Using Macro Definitions in Configuration Items** .	/user/test
Path filter	Specifies the wildcard for filtering the directories in the input paths of the source files. **Input directory** is not used in filtering. If there are multiple filter conditions, use commas (**,**) to separate them. If the parameter is empty, the directory is not filtered. The regular expression filtering is not supported. ● **?** matches a single character. ● ***** indicates multiple characters. ● Adding ^ before the condition indicates negated filtering, that is, file filtering.	*
File filter	Specifies the wildcard for filtering the file names of the source files. If there are multiple filter conditions, use commas (**,**) to separate them. The value cannot be left blank. The regular expression filtering is not supported. ● **?** matches a single character. ● ***** indicates multiple characters. ● Adding ^ before the condition indicates negated filtering, that is, file filtering.	*
File Type	Specifies the file import type. ● **TEXT_FILE**: imports a text file and saves it as a text file. ● **SEQUENCE_FILE**: imports a text file and saves it as a sequence file. ● **BINARY_FILE**: imports files of any format using binary streams but not to process the files. **NOTE** When the file import type to **TEXT_FILE** or **SEQUENCE_FILE**, Loader automatically selects a decompression method based on the file name extension to decompress a file.	TEXT_FILE

Parameter	Description	Example Value
File split type	Indicates whether to split source files by file name or size. The files obtained after the splitting are used as the input files of each map in the MapReduce task for data export. • **FILE**: indicates that the source file is split by file. That is, each map processes one or multiple complete files, the same source file cannot be allocated to different maps, and the source file directory structure is retained after data import. • **SIZE**: indicates that the source file is split by size. That is, each map processes input files of a certain size, and a source file can be divided and processed by multiple maps. After data is stored in the output directory, the number of saved files is the same as the number of maps. The file name format is **import_part_xxxx**, where **xxxx** is a unique random number generated by the system.	FILE
Extractors	Number of Maps that are started at the same time in a MapReduce task of a data configuration operation. This parameter cannot be set when **Extractor size** is set. The value must be less than or equal to 3000.	20
Extractor size	Specifies the size of data processed by maps that are started in a MapReduce job of a data configuration operation. The unit is MB. The value must be greater than or equal to 100. The recommended value is 1000. This parameter cannot be set when **Extractors** is set. When a relational database connector is used, **Extractor size** is unavailable. You need to set **Extractors**.	-

Configure data transformation.

Step 5 Click **Next**. On the displayed **Transform** page, set the transformation operations in the data transformation process. For details about how to select operators and set parameters, see **Operator Help** and **Table 16-69**.

Table 16-69 Input and output parameters of the operator

Input Type	Output Type
CSV File Input	Table Output
HTML File Input	Table Output

Input Type	Output Type
Fixed File Input	Table Output

In **input**, drag **CSV File Input**, **HTML File Input**, or **Fixed File Input** to the grid. In **output**, drag **Table Output** to the grid. Use an arrow to connect **CSV File Input**, **HTML File Input**, or **Fixed File Input** to **Table Output**.

Set data storage information and execute the job.

Step 6 Click **Next**. On the displayed **To** page, set the data storage mode.

Table 16-70 Parameter description

Parameter	Description	Example Value
Schema name	Specifies the database schema name.	dbo
Table name	Specifies the name of a database table that is used to save the final data of the transmission. **NOTE** Table names can be defined using macros. For details, see **Using Macro Definitions in Configuration Items** .	test
Temporary table	Specifies the name of a temporary database table that is used to save temporary data during the transmission. The fields in the table must be the same as those in the database specified by **Table name**. **NOTE** A temporary table is used to prevent dirty data from being generated in the destination table when data is exported to the database. Data is migrated from the temporary table to the destination table only after all data is successfully written to the temporary table. Using temporary tables increases the job execution time.	tmp_test

Step 7 Click **Save and Run** to save and run the job.

View the job execution result.

Step 8 Go to the Loader web UI. When **Status** is **Succeeded**, the job is complete.

Figure 16-47 Viewing a job

----End

16.6.7 Typical Scenario: Exporting Data from HDFS to MOTService

Scenario

In MOTService, tables need to be updated based on the data version field in the tables. Tables outside MOTService do not support Upsert statements. You can use Loader to export these tables from HDFS to MOTService to update their data in batches.

Prerequisites

- You have obtained the username and password of the relational database.
- The input data must be in CSV format.
- You have created a human-machine user, for example, **Loaderuser**, and added the user to user groups **hive** (primary) and **hadoop**, and associated the user with the **Manager_administrator** role on FusionInsight Manager.

Procedure

Make preparations.

Step 1 Log in to the node where RTDServer is installed as user **root** and obtain the driver JAR file corresponding to the relational database, for example, **opengaussjdbc-V500R002C00.jar** in this scenario.

cd ${BIGDATA_HOME}/FusionInsight_FARMER_RTD_*/install/FusionInsight-RTD-*/RTD/rtdservice/WEB-INF/lib

Step 2 Save the JAR file obtained in **Step 1** to the **${BIGDATA_HOME}/FusionInsight_Porter_*/install/FusionInsight-Sqoop-*/FusionInsight-Sqoop-*/server/webapps/loader/WEB-INF/ext-lib** directory on the active and standby Loader nodes.

Step 3 Run the following command on the active and standby nodes as user **root** to modify the permission on the JAR file:

cd ${BIGDATA_HOME}/FusionInsight_Porter_*/install/FusionInsight-Sqoop-*/FusionInsight-Sqoop-*/server/webapps/loader/WEB-INF/ext-lib

chown omm:wheel *JAR file name*

chmod 600 *JAR file name*

Step 4 Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Loader**. On the **Dashboard** tab page that is displayed, click **More** and select **Restart Service**. In the displayed dialog box, enter the administrator password to restart the Loader service.

Step 5 Create a version control table in MOTService and add specific fields to the table for version control. If there is such a table, you do not need to create one. All MOT jobs (full or incremental) share the same table. The reference commands are as follows:

CREATE TABLE T_RTD_TBL_CUR_VER_INFO (

TBL_NAME varchar NOT NULL,

CUR_VER_FLAG tinyint DEFAULT '0' NOT NULL,

CONSTRAINT PK_T_RTD_TBL_CUR_VER_INFO PRIMARY KEY (TBL_NAME)

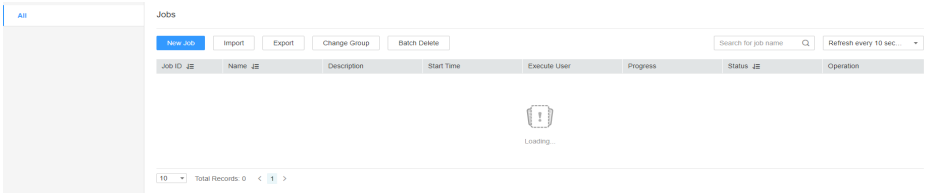
);

Configure basic job information.

Step 6 Access the Loader web UI.

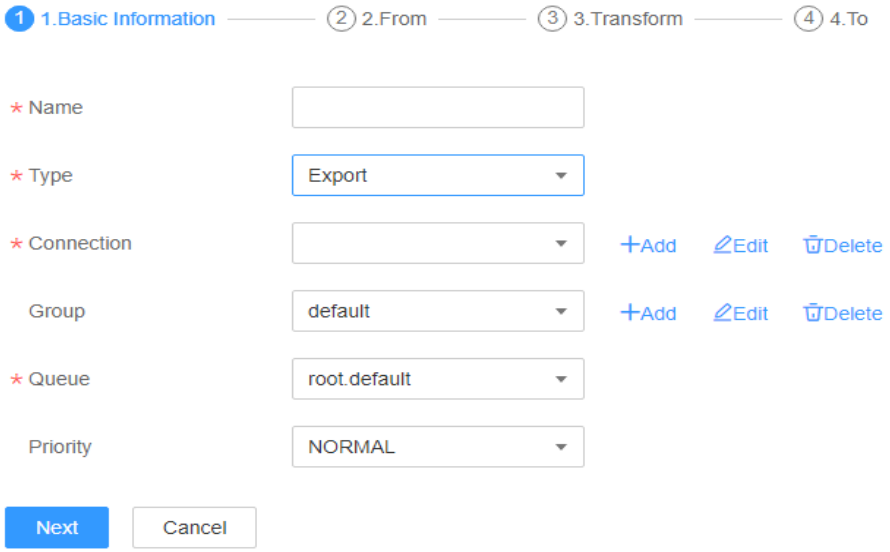
1. Log in to FusionInsight Manager.
2. Choose **Cluster** > **Services** > **Loader**.
3. Click **LoaderServer(***Node name***, Active)**. The Loader web UI is displayed.

Figure 16-48 Loader web UI



Step 7 Click **New Job**. Configure basic job parameters on the **Basic Information** page displayed.

Figure 16-49 Basic Information page



1. Enter a job name in **Name**.
2. Set **Type** to **Export**.
3. Set **Group** to the group to which the job belongs. There is no group created by default. Click **Add**, enter the group name, and click **OK**.
4. Set **Queue** to the Yarn queue that executes the job. The default value is **root.default**.

5. Set **Priority** to the priority of the Yarn queue that executes the job. The default value is **NORMAL**. The options are **VERY_LOW**, **LOW**, **NORMAL**, **HIGH**, and **VERY_HIGH**.

Step 8 In the **Connection** area, click **Add** to create a connection, set **Connector** to **generic-jdbc-connector**, set connection parameters, and click **Test** to verify whether the connection is available. When "Test Success" is displayed, click **OK**.

Table 16-71 generic-jdbc-connector connection parameters

Parameter	Description	Example Value
Name	Name of a relational database connection	dbName
JDBC Driver Class	Name of a JDBC driver class	com.xxx.opengauss.jdbc.Driver
JDBC Connection String	JDBC connection string, in the following format: **jdbc:opengauss://***Database IP address*:*Database port number*/*Database name*	jdbc:opengauss://10.10.10.10:15400/test
Username	Username for connecting to the database	omm
Password	Password for connecting to the database	xxxx

Parameter	Description	Example Value
JDBC Connection Properties	JDBC connection attribute. Click **Add** to manually add the attribute. • **Name**: connection attribute name • **Value**: connection attribute value	• Name: **socketTimeout** • Value: **20** **NOTE** Log in to FusionInsight Manager and choose **Cluster** > **Services** > **MOTService**. Click **Configurations** then **All Configurations**, and search for the **REQUIRE_SSL** parameter. If the parameter value is **true**, add a JDBC connection attribute whose name is **ssl.enable** and value is **true**. Otherwise, you do not need to add this connection attribute.

Configure data source information.

Step 9 Click **Next**. On the **From** page displayed, set **Source type** to **HDFS**.

Table 16-72 Data source parameters

Parameter	Description	Example Value
Input directory	Input path when data is exported from HDFS **NOTE** You can use macros to define path parameters. For details, see **Using Macro Definitions in Configuration Items** .	/user/test
Path filter	Wildcard for filtering the directories in the input paths of the source files. **Input directory** is not used for filtering. Use commas (,) to separate multiple filter criteria. If this parameter is left blank, directories are not filtered. Regular expression filtering is not supported. • **?** matches a single character. • ***** indicates multiple characters. • Adding ^ before the condition indicates negated filtering, that is, file filtering.	*
File filter	Wildcard for filtering the file names of the source files. Use commas (,) to separate multiple filter criteria. This parameter cannot be left blank. Regular expression filtering is not supported. • **?** matches a single character. • ***** indicates multiple characters. • Adding ^ before the condition indicates negated filtering, that is, file filtering.	*
File type	File import type. The options are as follows: • **TEXT_FILE**: imports a text file and saves it as a text file. • **SEQUENCE_FILE**: imports a text file and saves it as a sequence file. • **BINARY_FILE**: imports files of any format using binary streams but not to process the files. **NOTE** When the file import type is set to **TEXT_FILE** or **SEQUENCE_FILE**, Loader automatically selects a decompression method based on the file name extension to decompress a file.	TEXT_FILE

Parameter	Description	Example Value
File split type	Whether to split source files by file name or size. The files obtained after the splitting are used as the input files of each Map in the MapReduce task for data export. • **FILE**: indicates that the source file is split by file. That is, each Map processes one or multiple complete files, the same source file cannot be allocated to different Maps, and the source file directory structure is retained after data import. • **SIZE**: indicates that the source file is split by size. That is, each Map processes input files of a certain size, and a source file can be divided and processed by multiple Maps. After data is stored in the output directory, the number of saved files is the same as that of Maps. The file name format is **import_part**_*xxxx*, where *xxxx* is a unique random number generated by the system.	FILE
Extractors	Number of Maps that are started at the same time in a MapReduce task of a data configuration operation. This parameter cannot be set when **Extractor size** is set. The value must be less than or equal to 3000.	20
Extractor size	Size of data processed by Maps that are started in a MapReduce task of a data configuration operation. The unit is MB. The value must be greater than or equal to 100. The recommended value is 1000. This parameter cannot be set when **Extractors** is set. When a relational database connector is used, **Extractor Size** is unavailable. You need to set **Extractors**.	-

Configure data transformation.

Step 10 Click **Next**. On the displayed **Transform** page, set the transformation operations in the data transformation process. For details about how to select operators and set parameters, see **Operator Help** and **Table 16-73**.

Table 16-73 Input and output parameters of the operator

Input Type	Output Type
CSV File Input	Table Output

In **input**, drag **CSV File Input** to the grid. In **output**, drag **Table Output** to the grid. Use an arrow to connect **CSV File Input** to **Table Output**.

Set data storage information and execute the job.

Step 11 Click **Next**. Configure the parameters on the **To** page displayed.

Table 16-74 Output parameters

Parameter	Description	Example Value
Schema name	Database schema name	dbo
Table name	Name of a database table that is used to save the final data of the transmission	test
Stage table name	Name of a temporary database table that is used to temporarily store data during transmission. The fields in the temporary table must be the same as those in the table specified by **Table Name**.	db_test
DB type	Type of the database. The options are **MOT** and other databases that can be connected through JDBC.	MOT

Parameter	Description	Example Value
MOT insert type	This parameter is available only when **Database Type** is set to **MOT**. Select an import mode based on service requirements. **NOTE** • Mode of importing data to the database. The options are **TOTAL**, **INCREMENT**, and **INSERT**. **TOTAL**: full import. The data version is **0** by default. The version of newly written data is **1**. When new data is imported to the database, data with the same primary key is updated, data with different primary keys is inserted, and all original data whose version is 0 is deleted. The version of the data that is newly written next time is 0, and the data versions are updated alternately in sequence. **INCREMENT**: incremental import. Data with the same primary key is updated, data with different primary keys is inserted, and the original data is retained. **INSERT**: common import. Data is inserted. If the primary key is duplicate, the task fails. • If this parameter is set to **TOTAL** or **INCREMENT**, ensure that there is the **CUR_VER_FLAG** field available in the service data table for version control. For example: **CREATE TABLE F_ACCOUNT1 (** **ORG_NBR smallint NOT NULL,** **ACT_NBR varchar NOT NULL,** **CLT_NBR varchar NOT NULL,** **BRF_NAM varchar,** **CUR_VER_FLAG tinyint DEFAULT '0' NOT NULL,** **CONSTRAINT IDX_F_ACCOUNT1_PKEY PRIMARY KEY (CLT_NBR,ORG_NBR)** **);**	TOTAL

Step 12 Click **Save and Run** to save and run the job.

View the job execution result.

Step 13 Go to the Loader web UI. When **Status** is **Succeeded**, the job is complete.

----End

16.6.8 Typical Scenario: Exporting Data from HBase to a Relational Database

Scenario

Use Loader to export data from HBase to a relational database.

Prerequisites

- You have obtained the service username and password for creating a Loader job.
- You have had the permission to access the HBase tables or phoenix tables that are used during job execution.
- You have obtained the username and password of the relational database.
- No disk space alarm is reported, and the available disk space is sufficient for importing and exporting data.
- If a configured task requires the Yarn queue function, the user must be authorized with related Yarn queue permission.
- The user who configures a task must obtain execution permission on the task and obtain usage permission on the related connection of the task.
- Before the operation, perform the following steps:
  a. Obtain the JAR file of the relational database driver and save it to the following directory on the active and standby Loader nodes: **${BIGDATA_HOME}/FusionInsight_Porter_*/install/FusionInsight-Sqoop-1.99.3/FusionInsight-Sqoop-1.99.3/server/webapps/loader/WEB-INF/ext-lib**.
  b. Run the following command on the active and standby nodes as user root to modify the permission:

     cd ${BIGDATA_HOME}/FusionInsight_Porter_*/install/FusionInsight-Sqoop-1.99.3/FusionInsight-Sqoop-1.99.3/server/webapps/loader/WEB-INF/ext-lib

     chown omm:wheel *JAR file name*

     chmod 600 *JAR file name*
  c. Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Loader**. On the **Dashboard** tab page that is displayed, click **More** and select **Restart Service**. In the displayed dialog box, enter the administrator password to restart the Loader service.

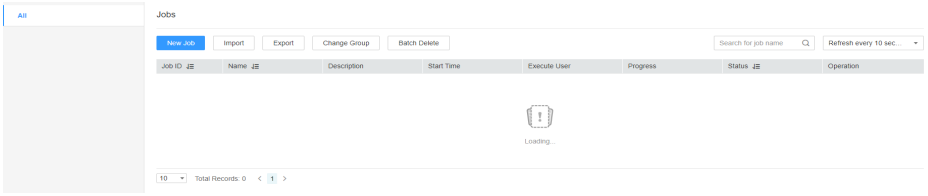
Procedure

Configure basic job information.

Step 1 Access the Loader web UI.

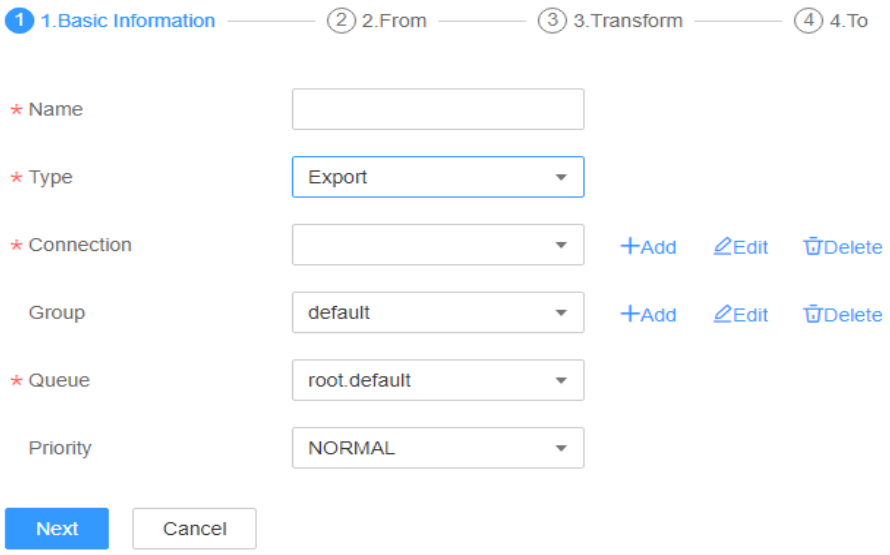
1. Log in to FusionInsight Manager.
2. Choose **Cluster** > **Services** > **Loader**.
3. Click **LoaderServer(***Node name***, Active)**. The Loader web UI is displayed.

Figure 16-50 Loader web UI



Step 2 Click **New Job**. Configure basic job parameters on the **Basic Information** page displayed.

Figure 16-51 Basic Information page



1. Enter a job name in **Name**.
2. Set **Type** to **Export**.
3. Set **Group** to the group to which the job belongs. There is no group created by default. Click **Add**, enter the group name, and click **OK**.
4. Set **Queue** to the Yarn queue that executes the job. The default value is **root.default**.
5. Set **Priority** to the priority of the Yarn queue that executes the job. The default value is **NORMAL**. The options are **VERY_LOW**, **LOW**, **NORMAL**, **HIGH**, and **VERY_HIGH**.

Step 3 In the **Connection** area, click **Add** to create a connection, set **Connector** to **generic-jdbc-connector** or a dedicated database connector (oracle-connector, oracle-partition-connector, or mysql-fastpath-connector), set connection parameters, and click **Test** to verify whether the connection is available. When "Test Success" is displayed, click **OK**.

NOTE

- For connection to relational databases, general database connectors (generic-jdbc-connector) or dedicated database connectors (oracle-connector, oracle-partition-connector, and mysql-fastpath-connector) are available. However, compared with general database connectors, dedicated database connectors perform better in data import and export because they are optimized for specific database types.
- When **mysql-fastpath-connector** is used, the **mysqldump** and **mysqlimport** commands of MySQL must be available on NodeManagers, and the MySQL client version to which the two commands belong must be compatible with the MySQL server version. If the two commands are unavailable or the versions are incompatible, visit **http://dev.mysql.com/doc/refman/5.7/en/linux-installation-rpm.html**. Install the MySQL client applications and tools.

Table 16-75 generic-jdbc-connector connection parameters

Parameter	Description	Example Value
Name	Name of a relational database connection	dbName
JDBC Driver Class	Name of a Java database connectivity (JDBC) driver class	oracle.jdbc.driver.OracleDriver
JDBC Connection String	JDBC connection string, in the format of **jdbc:oracle:thin:@***Database IP address***:***Database port number***:***Database name*	jdbc:oracle:thin:@10.16.0.1:1521:oradb
Username	Username for connecting to the database	omm
Password	Password for connecting to the database	xxxx
JDBC Connection Properties	JDBC connection attribute. Click **Add** to manually add the attribute. • Name: connection attribute name • Value: connection attribute value	• Name: **socketTimeout** • Value: **20**

Configure data source information.

Step 4 Click **Next**. On the displayed **From** page, set **Source type** to **HBASE**.

Table 16-76 Data source parameters

Parameter	Description	Example Value
HBase instance	Specifies the HBase service instance that Loader selects from all available HBase service instances in the cluster. If the selected HBase service instance is not added to the cluster, the HBase job cannot be run properly.	HBase
Quantity	Number of Maps that are started at the same time in a MapReduce task of a data configuration operation. The value must be less than or equal to 3000.	20

Configure data transformation.

Step 5 Click **Next**. On the displayed **Transform** page, set the transformation operations in the data transformation process. For details about how to select operators and set parameters, see **Operator Help** and **Table 16-77**.

Table 16-77 Input and output parameters of the operator

Input Type	Output Type
HBase Input	Table Output

In **input**, drag **HBase Input** to the grid. In **output**, drag **Table Output** to the grid. Use an arrow to connect **HBase Input** to **Table Output**.

Set data storage information and execute the job.

Step 6 Click **Next**. On the displayed **To** page, set the data storage mode.

Table 16-78 Parameter description

Parameter	Description	Example Value
Schema name	Specifies the database schema name.	dbo
Table name	Specifies the name of a database table that is used to save the final data of the transmission. **NOTE** Table names can be defined using macros. For details, see **Using Macro Definitions in Configuration Items** .	test

Parameter	Description	Example Value
Temporary table	Specifies the name of a temporary database table that is used to save temporary data during the transmission. The fields in the table must be the same as those in the database specified by **Table name**. **NOTE** A temporary table is used to prevent dirty data from being generated in the destination table when data is exported to the database. Data is migrated from the temporary table to the destination table only after all data is successfully written to the temporary table. Using temporary tables increases the job execution time.	tmp_test

Step 7 Click **Save and Run** to save and run the job.

View the job execution result.

Step 8 Go to the Loader web UI. When **Status** is **Succeeded**, the job is complete.

Figure 16-52 Viewing job details

----End

16.6.9 Typical Scenario: Exporting Data from Hive to a Relational Database

Scenario

Use Loader to export data from Hive to a relational database.

Prerequisites

- You have obtained the service username and password for creating a Loader job.
- You have had the permission to access the Hive tables that are used during job execution.
- You have obtained the username and password of the relational database.
- No disk space alarm is reported, and the available disk space is sufficient for importing and exporting data.
- If a configured task requires the Yarn queue function, the user must be authorized with related Yarn queue permission.
- The user who configures a task must obtain execution permission on the task and obtain usage permission on the related connection of the task.
- Before the operation, perform the following steps:

a. Obtain the JAR file of the relational database driver and save it to the following directory on the active and standby Loader nodes: **${BIGDATA_HOME}/FusionInsight_Porter_*/install/FusionInsight-Sqoop-1.99.3/FusionInsight-Sqoop-1.99.3/server/webapps/loader/WEB-INF/ext-lib**.

b. Run the following command on the active and standby nodes as user root to modify the permission:

cd ${BIGDATA_HOME}/FusionInsight_Porter_*/install/FusionInsight-Sqoop-1.99.3/FusionInsight-Sqoop-1.99.3/server/webapps/loader/WEB-INF/ext-lib

chown omm:wheel *JAR file name*

chmod 600 *JAR file name*

c. Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Loader**. On the **Dashboard** tab page that is displayed, click **More** and select **Restart Service**. In the displayed dialog box, enter the administrator password to restart the Loader service.

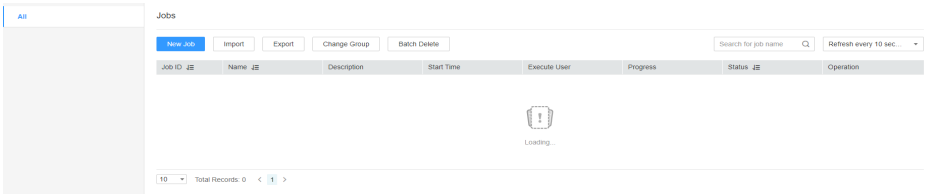
Procedure

Configure basic job information.

Step 1 Access the Loader web UI.

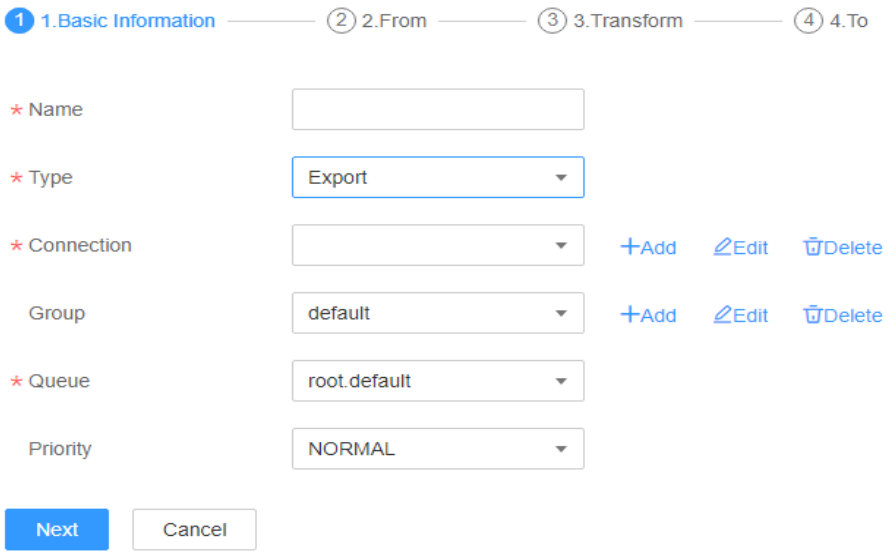
1. Log in to FusionInsight Manager.
2. Choose **Cluster** > **Services** > **Loader**.
3. Click **LoaderServer(***Node name***, Active)**. The Loader web UI is displayed.

Figure 16-53 Loader web UI



Step 2 Click **New Job**. Configure basic job parameters on the **Basic Information** page displayed.

Figure 16-54 Basic Information page



1. Enter a job name in **Name**.
2. Set **Type** to **Export**.
3. Set **Group** to the group to which the job belongs. There is no group created by default. Click **Add**, enter the group name, and click **OK**.
4. Set **Queue** to the Yarn queue that executes the job. The default value is **root.default**.
5. Set **Priority** to the priority of the Yarn queue that executes the job. The default value is **NORMAL**. The options are **VERY_LOW**, **LOW**, **NORMAL**, **HIGH**, and **VERY_HIGH**.

Step 3 In the **Connection** area, click **Add** to create a connection, set **Connector** to **generic-jdbc-connector** or a dedicated database connector (oracle-connector, oracle-partition-connector, or mysql-fastpath-connector), set connection parameters, and click **Test** to verify whether the connection is available. When "Test Success" is displayed, click **OK**.

NOTE

- For connection to relational databases, general database connectors (generic-jdbc-connector) or dedicated database connectors (oracle-connector, oracle-partition-connector, and mysql-fastpath-connector) are available. However, compared with general database connectors, dedicated database connectors perform better in data import and export because they are optimized for specific database types.
- When **mysql-fastpath-connector** is used, the **mysqldump** and **mysqlimport** commands of MySQL must be available on NodeManagers, and the MySQL client version to which the two commands belong must be compatible with the MySQL server version. If the two commands are unavailable or the versions are incompatible, visit **http://dev.mysql.com/doc/refman/5.7/en/linux-installation-rpm.html**. Install the MySQL client applications and tools.

Table 16-79 generic-jdbc-connector connection parameters

Parameter	Description	Example Value
Name	Name of a relational database connection	dbName
JDBC Driver Class	Name of a Java database connectivity (JDBC) driver class	oracle.jdbc.driver.OracleDriver
JDBC Connection String	JDBC connection string, in the format of **jdbc:oracle:thin:@***Database IP address***:***Database port number***:***Database name*	jdbc:oracle:thin:@10.16.0.1:1521:oradb
Username	Username for connecting to the database	omm
Password	Password for connecting to the database	xxxx
JDBC Connection Properties	JDBC connection attribute. Click **Add** to manually add the attribute. • Name: connection attribute name • Value: connection attribute value	• Name: **socketTimeout** • Value: **20**

Configure data source information.

Step 4 Click **Next**. On the displayed **From** page, set **Source type** to **HIVE**.

Table 16-80 Data source parameters

Parameter	Description	Example Value
Hive instance	Specifies the Hive service instance that Loader selects from all available Hive service instances in the cluster. If the selected Hive service instance is not added to the cluster, the Hive job cannot run properly.	hive
Quantity	Number of Maps that are started at the same time in a MapReduce task of a data configuration operation. The value must be less than or equal to 3000.	20

Configure data transformation.

Step 5 Click **Next**. On the displayed **Transform** page, set the transformation operations in the data transformation process. For details about how to select operators and set parameters, see **Operator Help** and **Table 16-81**.

Table 16-81 Input and output parameters of the operator

Input Type	Output Type
Hive Input	Table Output

In **input**, drag **Hive Input** to the grid. In **output**, drag **Table Output** to the grid. Use an arrow to connect **Hive Input** to **Table Output**.

Set data storage information and execute the job.

Step 6 Click **Next**. On the displayed **To** page, set the data storage mode.

Table 16-82 Parameter description

Parameter	Description	Example Value
Schema name	Specifies the database schema name.	dbo
Table name	Specifies the name of a database table that is used to save the final data of the transmission. **NOTE** Table names can be defined using macros. For details, see **Using Macro Definitions in Configuration Items** .	test
Temporary table	Specifies the name of a temporary database table that is used to save temporary data during the transmission. The fields in the table must be the same as those in the database specified by **Table name**. **NOTE** A temporary table is used to prevent dirty data from being generated in the destination table when data is exported to the database. Data is migrated from the temporary table to the destination table only after all data is successfully written to the temporary table. Using temporary tables increases the job execution time.	tmp_test

Step 7 Click **Save and Run** to save and run the job.

View the job execution result.

Step 8 Go to the Loader web UI. When **Status** is **Succeeded**, the job is complete.

Figure 16-55 Viewing job details

----End

16.6.10 Typical Scenario: Importing Data from HBase to HDFS or OBS

Scenario

This section describes how to use Loader to export data from HBase to HDFS or OBS.

Prerequisites

- You have obtained the service username and password for creating a Loader job.
- You have had the permission to access the HDFS or OBS directories and data involved in job execution.
- You have had the permission to access the HBase tables or phoenix tables that are used during job execution.
- No disk space alarm is reported, and the available disk space is sufficient for importing and exporting data.
- If a configured task requires the Yarn queue function, the user must be authorized with related Yarn queue permission.
- The user who configures a task must obtain execution permission on the task and obtain usage permission on the related connection of the task.

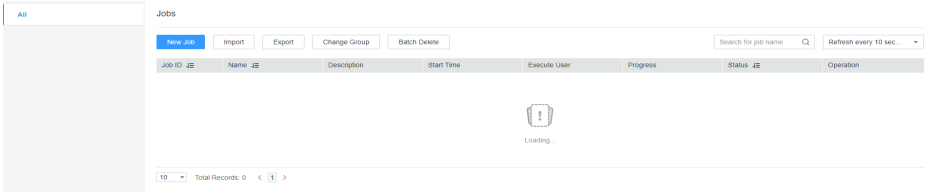
Procedure

Configure basic job information.

Step 1 Access the Loader web UI.

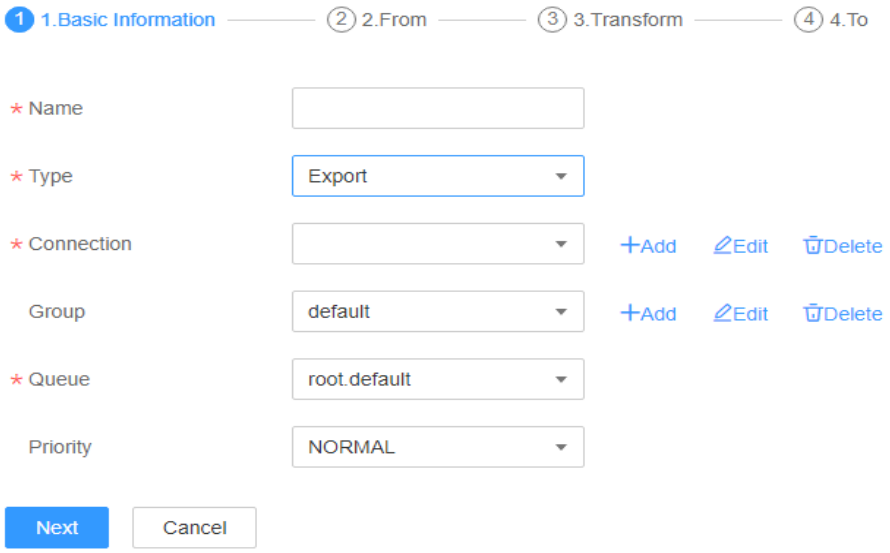
1. Log in to FusionInsight Manager.
2. Choose **Cluster** > **Services** > **Loader**.
3. Click **LoaderServer(***Node name***, Active)**. The Loader web UI is displayed.

Figure 16-56 Loader web UI



Step 2 Click **New Job**. Configure basic job parameters on the **Basic Information** page displayed.

Figure 16-57 Basic Information page



1. Enter a job name in **Name**.
2. Set **Type** to **Export**.
3. Set **Group** to the group to which the job belongs. There is no group created by default. Click **Add**, enter the group name, and click **OK**.
4. Set **Queue** to the Yarn queue that executes the job. The default value is **root.default**.
5. Set **Priority** to the priority of the Yarn queue that executes the job. The default value is **NORMAL**. The options are **VERY_LOW**, **LOW**, **NORMAL**, **HIGH**, and **VERY_HIGH**.

Step 3 In the **Connection** area, click **Add** to create a connection, set **Connector** to **hdfs-connector**, set connection parameters, and click **Test** to verify whether the connection is available. When "Test Success" is displayed, click **OK**.

Configure data source information.

Step 4 Click **Next**. On the displayed **From** page, set **Source type** to **HBASE**.

Table 16-83 Parameter description

Parameter	Description	Example Value
HBase instance	Specifies the HBase service instance that Loader selects from all available HBase service instances in the cluster. If the selected HBase service instance is not added to the cluster, the HBase job cannot be run properly.	HBase
Quantity	Number of Maps that are started at the same time in a MapReduce task of a data configuration operation. The value must be less than or equal to 3000.	20

Configure data transformation.

Step 5 Click **Next**. On the displayed **Transform** page, set the transformation operations in the data transformation process. For details about how to select operators and set parameters, see **Operator Help** and **Table 16-84**.

Table 16-84 Input and output parameters of the operator

Input Type	Output Type
HBase Input	File Output

In **input**, drag **HBase Input** to the grid. In **output**, drag **File Output** to the grid. Use an arrow to connect **HBase Input** to **File Output**.

Set data storage information and execute the job.

Step 6 Click **Next**. On the displayed **To** page, set the data storage mode.

Table 16-85 Parameter description

Parameter	Description	Example Value
Output path	Specifies the output directory or file name of the export file in the HDFS or OBS. **NOTE** You can use macros to define path parameters. For details, see **Using Macro Definitions in Configuration Items** .	/user/test
File Format	Specifies the file export type. • **TEXT_FILE**: imports a text file and saves it as a text file. • **SEQUENCE_FILE**: imports a text file and saves it as a sequence file. • **BINARY_FILE**: imports files of any format using binary streams.	TEXT_FILE
Compression codec	Specifies the compression format of files exported to HDFS or OBS. Select a format from the drop-down list. If you select **NONE** or do not set this parameter, data is not compressed.	NONE

Step 7 Click **Save and Run** to save and run the job.

View the job execution result.

Step 8 Go to the Loader web UI. When **Status** is **Succeeded**, the job is complete.

Figure 16-58 Viewing job details

----End

16.6.11 Typical Scenario: Exporting Data from HDFS to ClickHouse

Scenario

Use Loader to export data from HDFS to ClickHouse.

Prerequisites

- A role has been created on FusionInsight Manager and granted the management permission on ClickHouse logical clusters and Loader job grouping permission. A service user for Loader jobs has been created, associated with the role, and added the user group **yarnviewgroup**.
- A replicated table and a distributed table have been created by referring to **Creating a ClickHouse Table** and a user has been assigned the permission to perform operations on the tables during job execution. The replicated table has been selected when data is exported.
- No ClickHouse alarm is generated.

Procedure

Make preparations.

Step 1 Obtain the **clickhouse-jdbc-*.jar** file from the ClickHouse installation directory and save it to **${BIGDATA_HOME}/FusionInsight_Porter_*/install/FusionInsight-Sqoop-1.99.3/FusionInsight-Sqoop-1.99.3/server/webapps/loader/WEB-INF/ext-lib** on the active and standby Loader nodes.

Step 2 Run the following command on the active and standby nodes as user **root** to modify the permission:

cd ${BIGDATA_HOME}/FusionInsight_Porter_*/install/FusionInsight-Sqoop-1.99.3/FusionInsight-Sqoop-1.99.3/server/webapps/loader/WEB-INF/ext-lib

chown omm:wheel *JAR file name*

chmod 600 *JAR file name*

Step 3 Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Loader**. On the **Dashboard** tab page that is displayed, click **More** and select **Restart Service**. In the displayed dialog box, enter the administrator password to restart the Loader service.

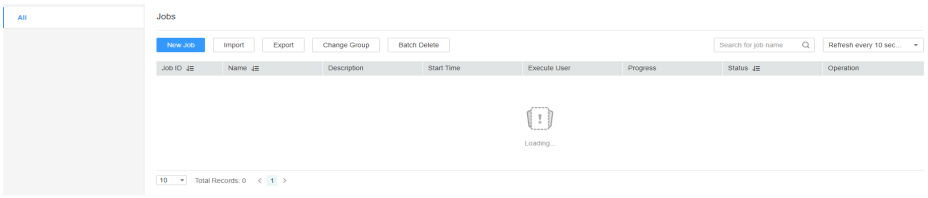
Configure basic job information.

Step 4 Access the Loader web UI.

1. Log in to FusionInsight Manager.

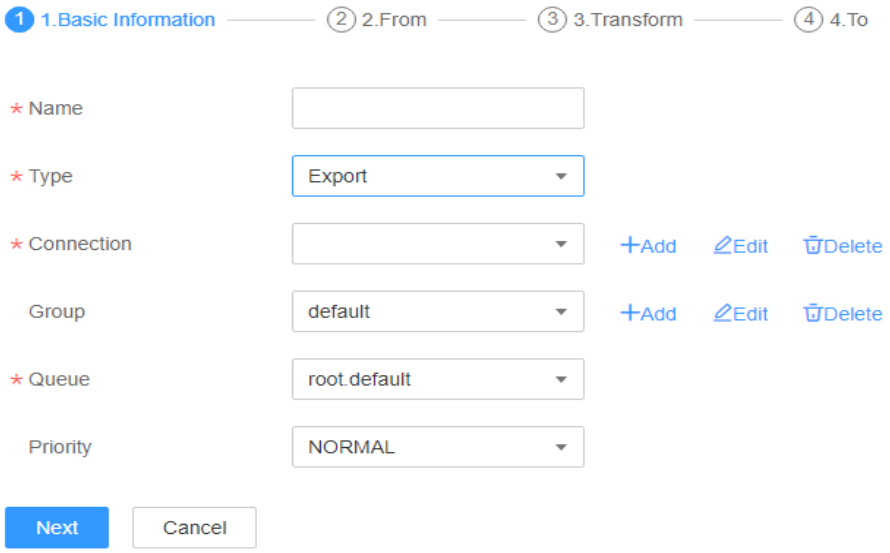
2. Choose **Cluster** > **Services** > **Loader**.
3. Click **LoaderServer(***Node name***, Active)**. The Loader web UI is displayed.

Figure 16-59 Loader web UI



Step 5 Click **New Job**. Configure basic job parameters on the **Basic Information** page displayed.

Figure 16-60 Basic Information page



1. Enter a job name in **Name**.
2. Set **Type** to **Export**.
3. Set **Group** to the group to which the job belongs. There is no group created by default. Click **Add**, enter the group name, and click **OK**.
4. Set **Queue** to the Yarn queue that executes the job. The default value is **root.default**.
5. Set **Priority** to the priority of the Yarn queue that executes the job. The default value is **NORMAL**. The options are **VERY_LOW**, **LOW**, **NORMAL**, **HIGH**, and **VERY_HIGH**.

Step 6 In the **Connection** area, click **Add** to create a connection, set **Connector** to **clickhouse-connector**, configure connection parameters, and click **Test** to verify whether the connection is available. When "Test Success" is displayed, click **OK**. For details about parameter settings, see **Table 16-86**.

Table 16-86 clickhouse-connector connection parameters

Parameter	Description	Example Value
Name	Name of a relational database connection	clickhouse_jdbc_test

Parameter	Description	Example Value
JDBC Connection String	• Kerberos authentication has been enabled for the cluster. The JDBC connection string format is **jdbc:clickhouse://** *Database IP address*:*Database port number*/*Database name*?**ssl=true&sslmode=none**. • Kerberos authentication is disabled for the cluster. The JDBC connection string format is **jdbc:clickhouse://** *Database IP address*:*Database port number*/*Database name*.	• Kerberos authentication has been enabled for the cluster: **jdbc:clickhouse://10.10.10.10:21426/test?ssl=true&sslmode=none** • Kerberos authentication is disabled for the cluster: **jdbc:clickhouse://10.10.10.10:21423/test?ssl=true&sslmode=none**

Parameter	Description	Example Value
	NOTE • *Database IP address*: To obtain the IP address of the ClickHouseBalancer instance, log in to FusionInsight Manager, choose **Cluster** > **Services** > **ClickHouse**, and click **Instance**. • Database port number: – To obtain the port number of a cluster with Kerberos authentication enabled, log in to FusionInsight Manager, choose **Cluster** > **Services**, click **Logical Cluster**, view the logical cluster, and obtain the value of **Ssl Port** in **HTTP Balancer Port**. – To obtain the port number of a cluster with Kerberos authentication disabled, log in to FusionInsight Manager, choose **Cluster** > **Services**, click **Logical Cluster**, view the logical cluster, and obtain the value of **Port** in **HTTP Balancer Port**.	
Username	Username for connecting to the database	root
Password	Password for connecting to the database	xxxx

Configure data source information.

Step 7 Click **Next**. On the **From** page displayed, set **Source type** to **HDFS**.

Table 16-87 Input parameters

Parameter	Description	Example Value
Input directory	Input path when data is exported from HDFS **NOTE** You can use macros to define path parameters. For details, see **Using Macro Definitions in Configuration Items** .	/user/test
Path filter	Wildcard for filtering the directories in the input paths of the source files. **Input directory** is not used for filtering. Use commas (,) to separate multiple filter conditions. If this parameter is left blank, directories are not filtered. Regular expression filtering is not supported. • **?** matches a single character. • ***** indicates multiple characters. • Adding ^ before the condition indicates negated filtering, that is, file filtering.	*
File filter	Wildcard for filtering the file names of the source files. Use commas (,) to separate multiple filter conditions. This parameter cannot be left blank. Regular expression filtering is not supported. • **?** matches a single character. • ***** indicates multiple characters. • Adding ^ before the condition indicates negated filtering, that is, file filtering.	*
File type	File import type. The options are as follows: • **TEXT_FILE**: imports a text file and saves it as a text file. • **SEQUENCE_FILE**: imports a text file and saves it as a sequence file. • **BINARY_FILE**: imports files of any format using binary streams but not to process the files. **NOTE** When the file import type is set to **TEXT_FILE** or **SEQUENCE_FILE**, Loader automatically selects a decompression method based on the file name extension to decompress a file.	TEXT_FILE

Parameter	Description	Example Value
File split type	Whether to split source files by file name or size. The files obtained after the splitting are used as the input files of each Map in the MapReduce task for data export. • **FILE**: indicates that the source file is split by file. That is, each Map processes one or multiple complete files, the same source file cannot be allocated to different Maps, and the source file directory structure is retained after data import. • **SIZE**: indicates that the source file is split by size. That is, each Map processes input files of a certain size, and a source file can be divided and processed by multiple Maps. After data is stored in the output directory, the number of saved files is the same as that of Maps. The file name format is **import_part**_*xxxx*, where *xxxx* is a unique random number generated by the system.	FILE
Extractors	Number of Maps that are started at the same time in a MapReduce task of a data configuration operation. This parameter cannot be set when **Extractor size** is set. The value must be less than or equal to 3000.	20
Extractor size	Size of data processed by Maps that are started in a MapReduce task of a data configuration operation. The unit is MB. The value must be greater than or equal to 100. The recommended value is 1000. This parameter cannot be set when **Extractors** is set. When a relational database connector is used, **Extractor Size** is unavailable. You need to set **Extractors**.	-

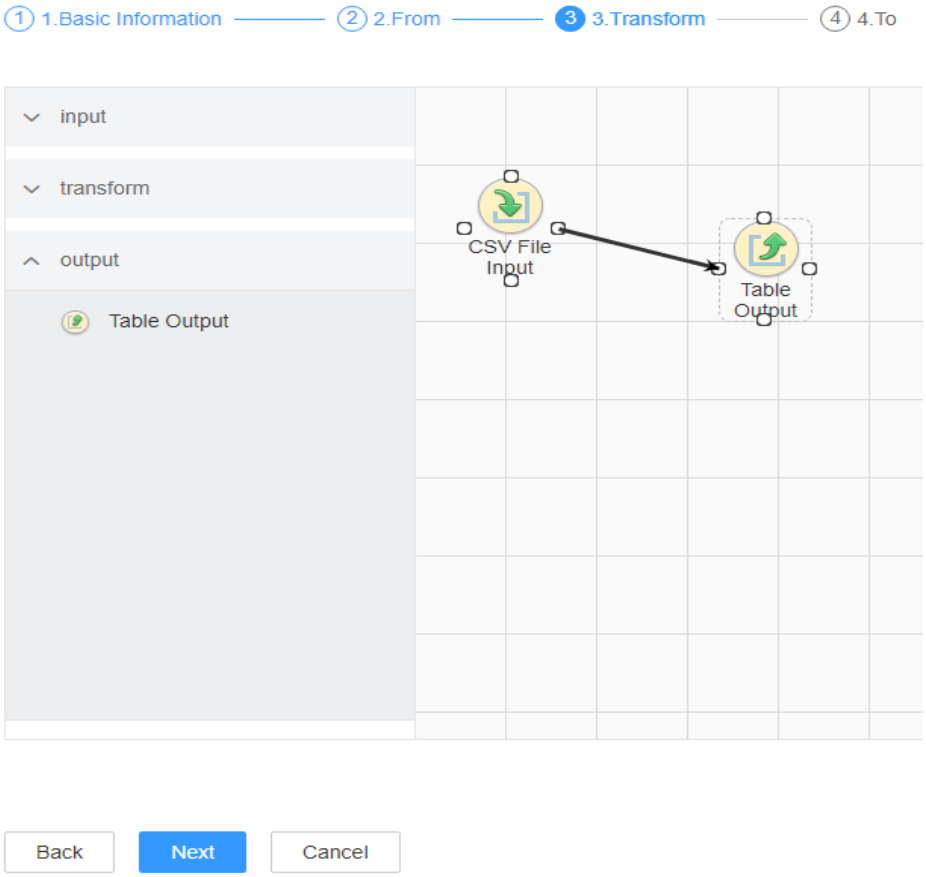
Configure data transformation.

Step 8 Click **Next**. On the displayed **Transform** page, set the transformation operations in the data transformation process. For details about how to select operators and set parameters, see **Operator Help** and **Table 16-88**.

Table 16-88 Input and output parameters of the operator

Input Type	Output Type
CSV File Input	Table Output

Figure 16-61 Operator selection



Set data storage information and execute the job.

Step 9 Click **Next**. On the displayed **To** page, set the data storage mode.

Table 16-89 Output parameters

Parameter	Description	Example Value
Table Name	Name of a database table that is used to save the final data of the transmission **NOTE** You can use macros to define table names. For details, see **Using Macro Definitions in Configuration Items** .	test

Step 10 Click **Save and Run** to save and run the job.

View the job execution result.

Step 11 Go to the Loader web UI. When **Status** is **Succeeded**, the job is complete.

Figure 16-62 Viewing a job

Step 12 On the ClickHouse client, check whether the data in the ClickHouse table is the same as that in HDFS.

----End

16.7 Managing Jobs

16.7.1 Migrating Loader Jobs in Batches

Scenario

Loader allows jobs to be migrated in batches from a group (source group) to another group (target group).

Prerequisites

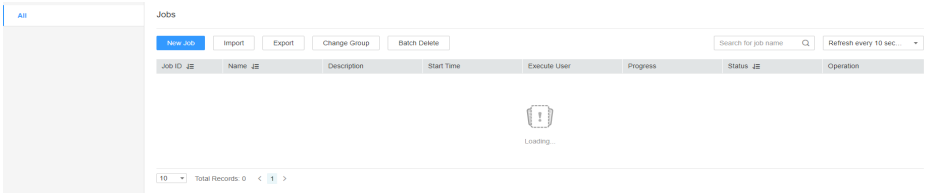
- The source group and target group exist.
- The current user has the **Group Edit** permission for the source group and target group.
- The current user has the **Jobs Edit** permission for the source group or the **Edit** permission for the jobs to be migrated.

Procedure

Step 1 Access the Loader web UI.

1. Log in to FusionInsight Manager.
2. Choose **Cluster** > **Services** > **Loader**.
3. Click **LoaderServer(***Node name***, Active)**. The Loader web UI is displayed.

Figure 16-63 Loader web UI



Step 2 Click **Change Group**. The Job Migration page is displayed.

Step 3 In **Source group**, select the group to which the jobs to be migrated belong; in **target group**, select the group to which the jobs are to be migrated.

Step 4 Set **Select Change Type** to a migration type.

- **All**: migrates all the jobs in the source group to the target group.
- **Specify Job**: migrates the specified jobs in the source group to the target group. Select **Specify Job**. In the job list, select the jobs to be migrated.

Step 5 Click **OK** to start job migration. In the displayed dialog box, if the progress bar is 100%, the job migration is complete.

----End

16.7.2 Deleting Loader Jobs in Batches

Scenario

Loader allows existing jobs to be deleted in batches.

Prerequisites

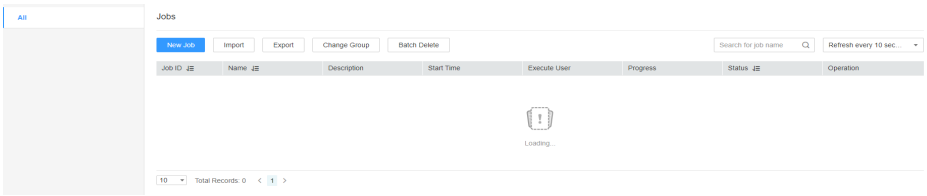
The current user has the **Edit** permission for the jobs to be deleted or the **Jobs Edit** permission for the group to which the jobs belong.

Procedure

Step 1 Access the Loader web UI.

1. Log in to FusionInsight Manager.
2. Choose **Cluster** > **Services** > **Loader**.
3. Click **LoaderServer(***Node name***, Active)**. The Loader web UI is displayed.

Figure 16-64 Loader web UI



Step 2 Click **Batch Delete**. The Batch Delete page is displayed.

Step 3 Set **Batch Delete** to a job deletion type.

- **ALL**: deletes all jobs.
- **Specify Job**: deletes specified jobs. Select **Specify Job**. In the job list, select the jobs to be deleted.

Step 4 Click **OK** to start the job deletion. In the displayed dialog box, if the progress bar is 100%, the job deletion is complete.

----End

16.7.3 Importing Loader Jobs in Batches

Scenario

Loader allows all jobs of a configuration file to be imported in batches.

Prerequisites

The current user has the **Jobs Edit** permission of the group to which the jobs to be imported belong.

NOTE

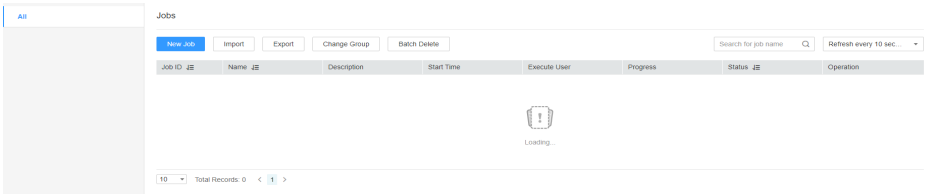
If the group to which the jobs to be imported belong does not exist, the group is automatically created first. The current user is the creator of the group and has the **Jobs Edit** permission of the group.

Procedure

Step 1 Access the Loader web UI.

1. Log in to FusionInsight Manager.
2. Choose **Cluster** > **Services** > **Loader**.
3. Click **LoaderServer(***Node name***, Active)**. The Loader web UI is displayed.

Figure 16-65 Loader web UI



Step 2 Click **Import**. The Export Job page is displayed.

Step 3 On the **Import** page, specify the path of the configuration file whose jobs are to be imported.

Step 4 Click **Upload** to start the job import. In the displayed dialog box, if the progress bar is 100%, the job import is complete.

----End

16.7.4 Exporting Loader Jobs in Batches

Scenario

Loader allows existing jobs to be exported in batches.

Prerequisites

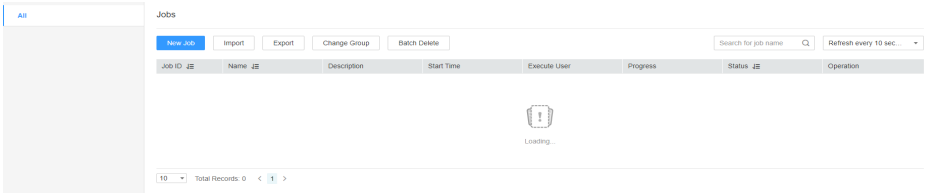
The current user has the **Edit** permission for the jobs to be exported or the **Jobs Edit** permission of the group to which the jobs belong.

Procedure

Step 1 Access the Loader web UI.

1. Log in to FusionInsight Manager.
2. Choose **Cluster** > **Services** > **Loader**.
3. Click **LoaderServer(***Node name***, Active)**. The Loader web UI is displayed.

Figure 16-66 Loader web UI



Step 2 Click **Export**. The job export page is displayed.

Step 3 Set **Batch Delete** to a job export type.

- **ALL**: exports all jobs.
- **Specify Job**: exports specified jobs. Select **Specify Job**. In the job list, select the jobs to be exported.
- **Specify Group**: exports all the jobs in a specified group. Select **Specify Group**. In the group list, select the group whose jobs are to be exported.

Export Password: exports the connector password. If this parameter is selected, the password is exported as an encrypted string.

Step 4 Click **OK** to start the job export. In the displayed dialog box, if the progress bar is 100%, the job import is complete.

----End

16.7.5 Viewing Historical Job Information

Scenario

Query the execution status and execution duration of a Loader job during routine maintenance. You can perform the following operations on the job:

- Dirty Data: Query data that fails to be processed or data that is filtered out during job execution, and check which source data does not meet transformation or cleaning rules.
- Logs: Query log information about job execution in MapReduce.

Prerequisites

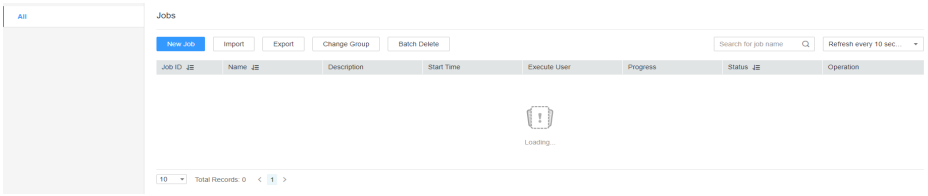
You have obtained the username and password for logging in to the Loader WebUI.

Procedure

Step 1 Access the Loader web UI.

1. Log in to FusionInsight Manager.
2. Choose **Cluster** > **Services** > **Loader**.
3. Click **LoaderServer(***Node name***, Active)**. The Loader web UI is displayed.

Figure 16-67 Loader web UI



Step 2 Query historical records of a Loader job.

1. Locate the row that contains the job to be viewed.
2. Click **More** and select **View History** to view the job execution history.

Figure 16-68 Viewing historical records

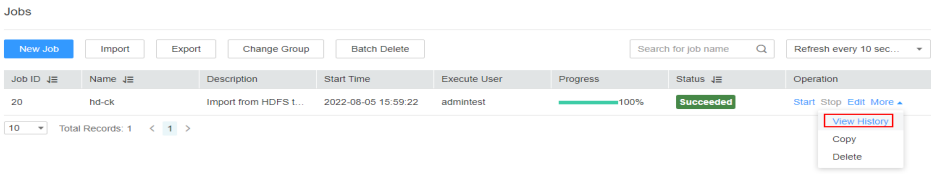


Table 16-90 Parameters

Name	Description
Rows/Files Read	Indicates the number of rows (files) read from the input source.
Rows/Files Written	Number of rows (files) written to the output source.
Rows/Files Skipped	– Indicates the number of bad rows (files) recorded during transformation. The input format is incorrect, so transformation cannot be performed. – Number of rows that are skipped after filtering conditions are configured during conversion.

----End

16.8 Operator Help

16.8.1 Overview

Conversion Process

Loader reads data at the source end, uses an input operator to convert data into fields by certain rules, use a conversion operator to clean or convert the fields, and

finally use an output operator to process the fields and export the output result to the target end.

- A job for performing data conversion can have only one input operator and one output operator.
- Data that does not meet conversion rules will become dirty data and be skipped.

NOTE

- When importing data from a relational database to HDFS or OBS, you do not need to configure data conversion. Data is separated by commas (,) and saved to HDFS or OBS.
- When exporting data from HDFS or OBS to a relational database, you do not need to configure data conversion. Data is separated by commas (,) and saved to the relational database.

Operator Description

Loader operators have three types:

- Input Operators

  First step of data conversion. This type of operator converts data into fields. Only one input operator can be used in each conversion. The input operator is mandatory in HBase or Hive data import and export.

- Conversion Operators

  Intermediate conversion step of data conversion. This type of operator is optional. The conversion operators can be used together in any combination. Conversion operators can process only fields. Therefore, an input operator must be used first to convert data into fields.

- Output Operators

  Last step of data conversion. Only one output operator can be used in each conversion for exporting processed fields. The output operator is mandatory in HBase or Hive data import and export.

Table 16-91 List of operator types

Node Type	Description
Input:	• CSV file input: Each line in the file is converted into multiple input fields based on the specified delimiter. • Fixed-width file input: Each line of the file is converted into multiple input fields based on the characters or bytes with configurable length. • Table input: converts specified columns in a relational database table into input fields of the same quantity. • HBase input: converts specified columns in an HBase table into input fields of the same quantity. • HTML input: converts elements in an HTML file into input fields. • Hive input: converts specified columns in a Hive table into input fields of the same quantity.

Node Type	Description
Convert	• Long integer to time conversion: Implements the conversion between long integer values and date types. • Null value conversion: Replaces a null value with a specified value. • Constant field adding: Generates a constant field. • Random value conversion: generates a random number field. • Concatenation and conversion: concatenates existing fields to generate new fields. • Delimiter conversion: separates existing fields with specified separators to generate new fields. • Modulo conversion: performs modulo operation on an existing field to generate a new field. • Character string cutting: cuts existing string fields by the specified start position and end position to generate new fields. • EL operation conversion: specifies a calculator to calculate field values. Currently, the following operators are supported: md5sum, sha1sum, sha256sum, and sha512sum. • Character string case conversion: converts the upper and lower cases of existing fields to generate new fields. • Character string reverse conversion: reverses existing character string fields to generate new fields. • Character string space clearing and conversion: clears the spaces on the left and right of the existing character string fields to generate new fields. • Row filtering conversion: filters rows that contain triggering conditions by configuring logic conditions. • Domain update: updates fields values when certain conditions are met.
Output:	• Hive Output: exports existing fields to a Hive table. • Table output: exports existing fields to a relational database table. • File output: uses delimiters to concatenate existing fields and exports new fields to a file. • HBase Output: exports existing fields to an HBase table.

Field Description

Fields in the job configuration are data items defined by Loader based on service requirements to match user data. Fields have specific types and the fields types must be consistent with the actual user data types.

16.8.2 Input Operators

16.8.2.1 CSV File Input

Overview

The **CSV File Input** operator imports all files that can be opened by using a text editor.

Input and Output

- Input: test files
- Output: fields

Parameter Description

Table 16-92 Operator parameter description

Parameter	Description	Type	Mandatory	Default Value
Delimiter	Delimiter in a CSV file for separating data lines.	string	Yes	,
Line Delimiter	Line delimiter, which can be any string specified by users based on the actual situation. The OS line delimiter is used by default.	string	No	\n
Filename as field	User-defined field whose value is the name of the file that stores the current data.	string	No	None
Absolute path	Indicates whether the file name used as the value of **Filename as field** contains an absolute path. Selecting the option button indicates that the file name contains an absolute path; deselecting the option button indicates that the file name does not contain a path.	boolean	No	Deselect

Parameter	Description	Type	Mandatory	Default Value
Validate input field	Checks whether the input field matches the value type. If the value is **NO**, no check is performed. If the value is **YES**, whether the input field matches the value type is checked. If the input fields do not match the value type, the line is skipped.	enum	Yes	YES
Input fields	Information about input fields: • **position**: Position of the field after data lines in the source file are separated by delimiters. The position sequence starts from 1. • **field name**: Field name. • **type**: Field type. • **date format**: If the field type is **DATE**, **TIME**, or **TIMESTAMP**, you must specify a time format. If the field type is set to other values, the time format is invalid. An example time format is **yyyyMMdd HH:mm:ss**. • **length**: Field value length. If the actual field value is excessively long, the value is cut based on the configured length. When **type** is set to **CHAR**, spaces are added to the field value for supplement if the actual field value length is less than the configured length. When **type** is set to **VARCHAR**, no space is added to the field value for supplement if the actual field value length is less than the configured length.	map	Yes	None

Data Processing Rule

- Each data line is separated into multiple fields by using delimiters and the fields are used by the subsequent conversion operator.
- If the field value does not match the actual type, the data in the line will become dirty data.

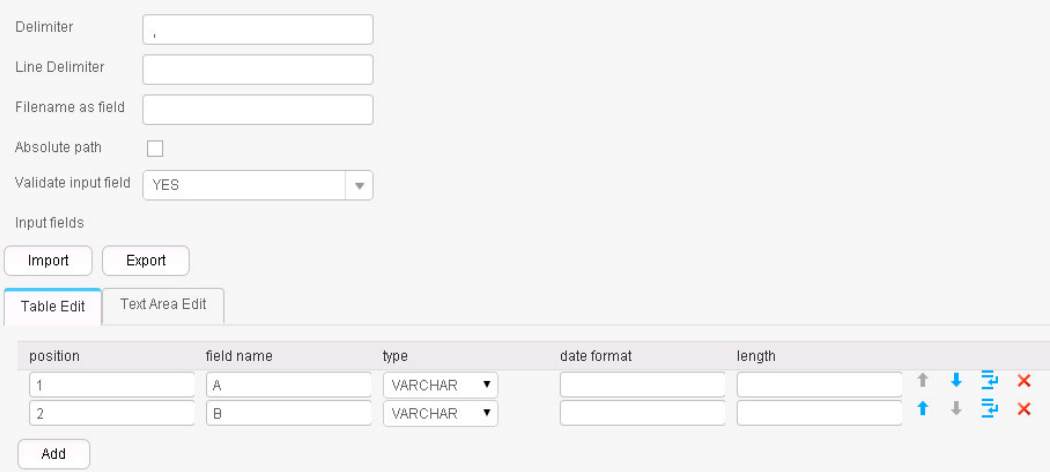
- If the number of input field columns is equal to the number of field columns actually included in the original data, the data in the line will become dirty data.

Example

The following figure shows the source file.

```
2016,year
year,2016
```

Configure the **CSV File Input** operator, set **Delimiter** to a comma (**,**), and generate fields A and B.



Fields A and B are generated, as shown in the following figure.

```
2016,year
year,2016
```

16.8.2.2 Fixed File Input

Overview

The **Fixed File Input** operator converts each line in a file into multiple fields by character or byte of a configurable length.

Input and Output

- Input: text file
- Output: fields

Parameter Description

Table 16-93 Operator parameter description

Parameter	Description	Type	Mandatory	Default Value
Line Delimiter	Line delimiter, which can be any string specified by users based on the actual situation. The OS line delimiter is used by default.	string	No	\n
Fixed length unit	Length unit. The options are **char** and **byte**.	enum	Yes	char
Input fields	Information about input fields: • **fixed length**: Field length. The ending of the first field is the starting of the second field, the ending of the second field is the starting of the third field, and so on. • **field name**: Names of input fields. • **type**: Field type. • **date format**: If the field type is **DATE**, **TIME**, or **TIMESTAMP**, you must specify a time format. If the field type is set to other values, the time format is invalid. An example time format is **yyyyMMdd HH:mm:ss**. • **length**: Field value length. If the actual field value is excessively long, the value is cut based on the configured length. When **type** is set to **CHAR**, spaces are added to the field value for supplement if the actual field value length is less than the configured length. When **type** is set to **VARCHAR**, no space is added to the field value for supplement if the actual field value length is less than the configured length.	map	Yes	None

Data Processing Rule

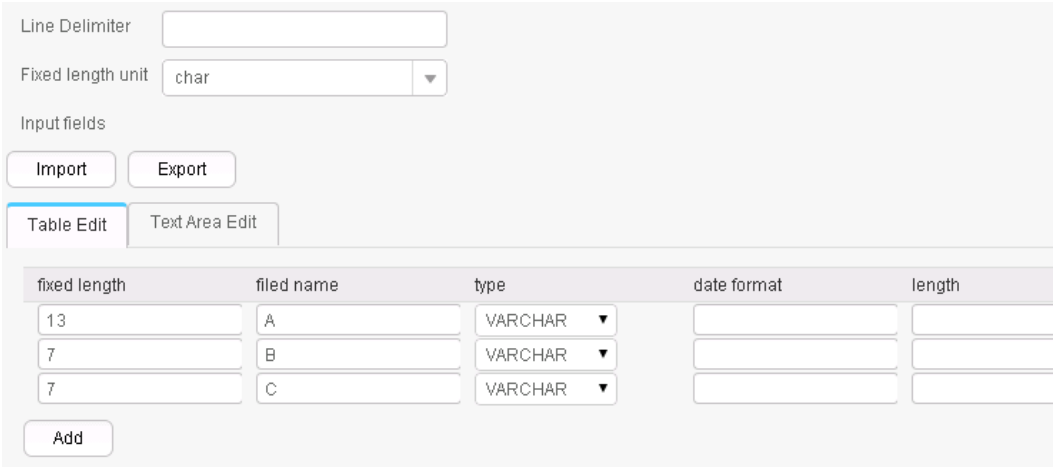
- The source file is split based on the input field length to generate fields.
- If the field value does not match the actual type, the data in the line will become dirty data.
- If the field split length is greater than the length of the original field value, the data split fails and the line becomes dirty data.

Example

The following figure shows the source file.

```
fusionInsightbigdataproduct
```

Configure the **Fixed File Input** operator to generate fields A, B, and C.



The three fields are generated, as shown in the following figure.

```
fusionInsight,bigdata,product
```

16.8.2.3 Table Input

Overview

Table Input operator converts specified columns in a relational database table into input fields of the same quantity.

Input and Output

- Input: table columns
- Output: fields

Parameter Description

Table 16-94 Operator parameters description

Parameter	Description	Type	Mandatory	Default Value
Input fields	Information about relational database input fields: ● **position**: position of input fields ● **field name**: input field name ● **type**: field type ● length: Field value length. If the actual field value is excessively long, the value is cut based on the configured length. When **type** is set to **CHAR**, spaces are added to the field value for supplement if the actual field value length is less than the configured length. When **type** is set to **VARCHAR**, no space is added to the field value for supplement if the actual field value length is less than the configured length.	map	Yes	None

Data Processing Rule

- Fields are generated in a specified order. Table columns to be converted are specified by **From** in step 2 of job configuration. If **Table column names** is set, the value is the table columns to be converted; if **Table column names** is not set, the table columns to be converted are all table columns in the table by default or the columns specified by the query conditions set by **Table SQL statement**.
- The number of input fields cannot be greater than number of specified columns; otherwise, all data becomes dirty data.
- If the field value does not match the actual type, the data in the line will become dirty data.

Example

Use SQL Server 2014 as an example. Run the following command to create a **test** table:

create table test (id int, name text, value text);

Insert three data lines to the test table:

insert into test values (1,'zhangshan','zhang');

insert into test values (2,'lisi','li');

insert into test values (3,'wangwu','wang');

Query the table:

	id	name	value
1	1	zhangshan	zhang
2	2	lisi	li
3	3	wangwu	wang

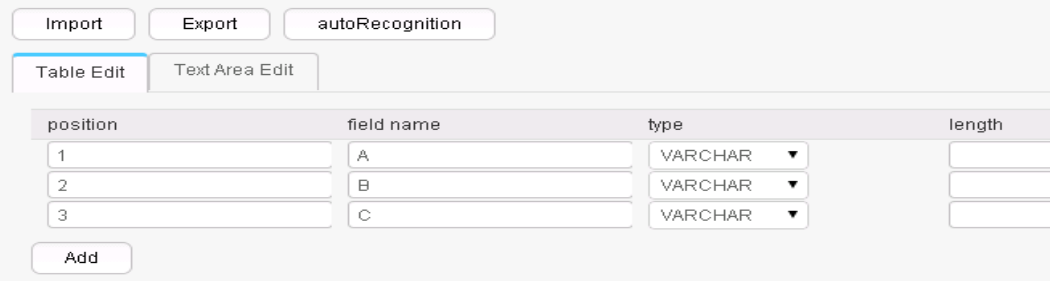
Configure the **Table Input** operator to generate the following fields:

After the data connector is set, click **Automatic Identification**. The system will automatically read fields in the database and select required fields for adding. You only need to optimize or modify the fields manually based on service scenarios.

NOTE

- This operation will overwrite existing data in the table.
- After you click **autoRecognition**, manually check the field types automatically identified by the system to ensure that they are consistent with the actual ones in the table.

  For example, the system automatically identifies the **date** type in the Oracle database as the **timestamp** type. If you do not manually change the type, an error will be reported when data is queried in the Hive table.



Configure the output operator to output data to HDFS or OBS. The result is as follows:

```
1,zhangshan,zhang
2,lisi,li
3,wangwu,wang
```

16.8.2.4 HBase Input

Overview

The **HBase Input** operator converts specified columns in an HBase table into input fields of the same quantity.

Input and Output

- Input: HBase table columns
- Output: fields

Parameter Description

Table 16-95 Operator parameter description

Parameter	Description	Type	Mandatory	Default Value
Hbase Table Type	HBase table type. The options include **normal** (common HBase table) and **phoenix**.	enum	Yes	normal
HBase table name	HBase table name. Only one HBase table is supported.	string	Yes	None
HBase input fields	HBase input information: • **family name**: HBase column family name. • **column name**: HBase column name. • **field name**: Names of input fields. • **type**: Field type. • **length**: Field value length. If the actual field value is excessively long, the value is cut based on the configured length. When **type** is set to **CHAR**, spaces are added to the field value for supplement if the actual field value length is less than the configured length. When **type** is set to **VARCHAR**, no space is added to the field value for supplement if the actual field value length is less than the configured length. • **is rowkey**: Indicates whether a column is a primary key column. A common HBase table can have only one primary key, while a phoenix table can have multiple primary keys. If multiple primary keys are configured, they are combined according to the configuration sequence. At least one primary key column must be configured.	map	Yes	None

Data Processing Rule

- If the HBase table name does not exist, the job fails to be submitted.
- If the configured column names are inconsistent with the HBase table column names, the data cannot be read and the number of imported data records is 0.
- If the number of input field columns is greater than the number of field columns actually included in the original data, all data becomes dirty data.
- If the field value does not match the actual type, the data in the line will become dirty data.

Example

Use the data export from HBase to sqlserver2014 as an example.

In sqlserver2014, run the following statement to create an empty data test_1 for storing HBase data:

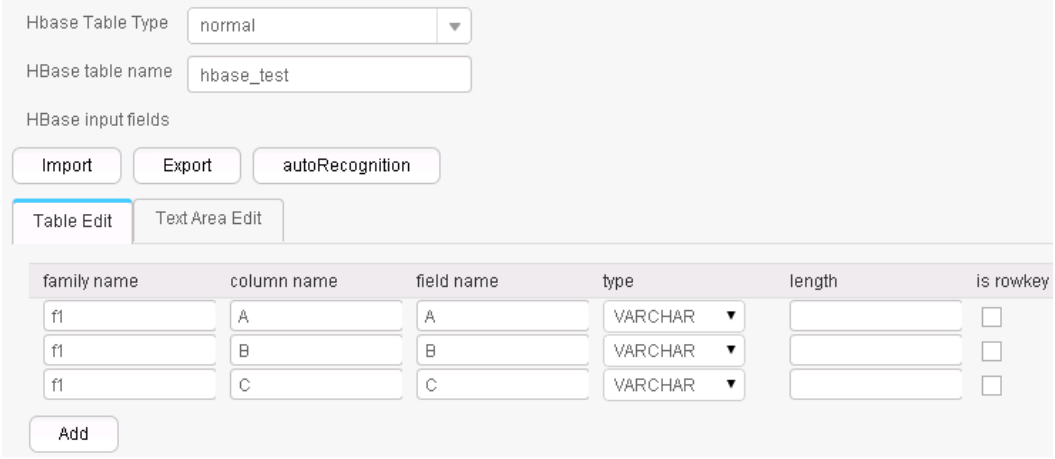
create table test_1 (id int, name text, value text);

Configure the **HBase Input** operator to generate fields A, B, and C.

After the database connection is set up, click **autoRecognition**. The system will automatically read fields in the database and select required fields for adding. You only need to optimize or modify the fields manually based on service scenarios.

NOTE

Performing this operation will overwrite existing data in the table.



Use the **Table Out** operator to export A, B, and C to the test_1 table.

select * from test_1;

	id	name	value
1	1	zhangshan	zhang
2	2	lisi	li
3	3	wangwu	wang

16.8.2.5 HTML Input

Overview

HTML Input operator imports a regular HTML file and converts elements in the HTML file into input fields.

Input and Output

Input: HTML file

Output: multiple fields

Parameter Description

Table 16-96 Operator parameters description

Parameter	Description	Type	Mandatory	Default Value
parent tag	Upper-layer HTML tag of all fields for limiting the search scope.	string	Yes	None
Filename as field	User-defined field whose value is the name of the file that stores the current data.	string	No	None
Absolute file name	Whether the file name used as the value of **Filename as field** contains an absolute path. Selecting the option button indicates that the file name contains an absolute path; deselecting the option button indicates that the file name does not contain a path.	boolean	No	No
Validate input field	Whether to check the type matching between the input field and the value. If the value is **NO**, the field is not checked. If the value is **YES**, the field will be checked. If the input field does not match the value type, the line is skipped.	enum	Yes	YES

Parameter	Description	Type	Mandatory	Default Value
Input fields	Information about input fields: • **position**: Position of the field. The position sequence starts from 1. • **field name**: field name • **field tag**: field tag • **keyword**: A keyword can be configured to match the content of the tag. Wildcards are supported. For example, if the tag content is **name**, you can configure the keyword ***name***. • **type**: field type • **date format**: If the field type is **DATE**, **TIME**, or **TIMESTAMP**, you need to specify the time format. If the field type is neither of them, the time format is invalid. The example time format is **yyyyMMdd HH:mm:ss**. • **length**: Field value length. If the actual field value is excessively long, the value is cut based on the configured length. When **type** is set to **CHAR**, spaces are added to the field value for supplement if the actual field value length is less than the configured length. When **type** is set to **VARCHAR**, no space is added to the field value for supplement if the actual field value length is less than the configured length.	map	Yes	None

Data Processing Rule

- **parent tag** is configured first to limit the search scope. The value of **parent tag** must exist; otherwise, the obtained content is empty.
- **Input fields** are configured so that the sub-tags can be used to precisely locate the tags of fields. If the tags are the same, keywords will be used for precise matching.
- The keyword is used to match the content of the field. The configuration method is similar to that of the **File filter** field in the **From** settings. The wildcard **(*)** is supported. The following three tags are provided to assist in locating the field:

  a. **#PART**: indicates the values matched by wildcard *. If there are multiple *, you can specify an order from left to right and obtain content that matches the sequence number *. For example, **#PART1** indicates to

obtain the value that matches the first * and **#PART8** indicates to obtain the value that matches the eighth *).

b. **#NEXT**: indicates that you can obtain the value next to the value that matches the tag.

c. **#ALL**: indicates that you can obtain all the values that match the tag.

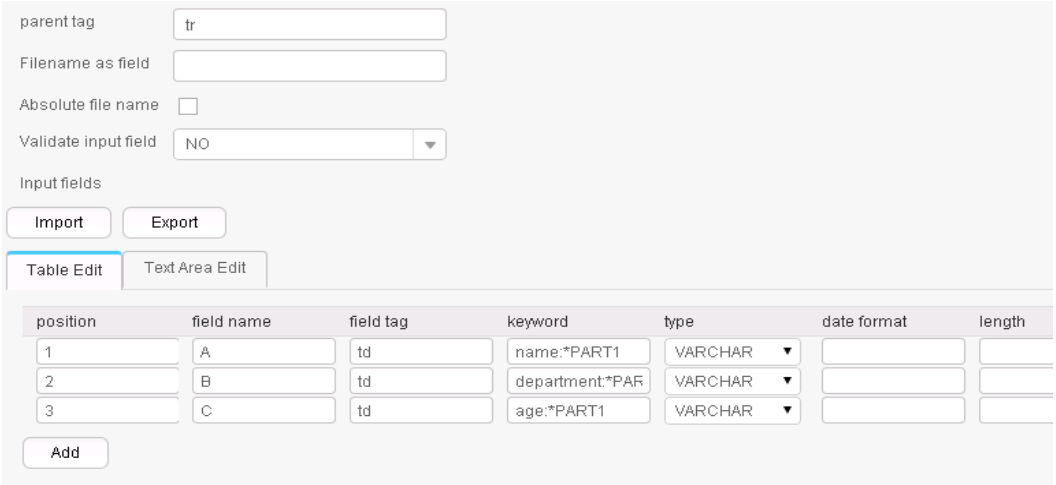
- If the tag is configured incorrectly, the obtained value is empty, but no error is reported.

Example

The following figure shows the source file.

```
<html>
<body>
<table>
<tr>
<td>name:zhangshan</td>
<td>department:FusionInght</td>
<td>age:25</td>
</tr>
</table>
</body>
</html>
```

Configure the **HTML Input** operator to generate fields A, B, and C.



Three fields are generated, as shown in the following figure.

```
zhangshan,FusionInght,25
```

16.8.2.6 Hive input

Overview

The **Hive Input** operator converts specified columns in an HBase table into input fields of the same quantity.

Input and Output

- Input: Hive table columns
- Output: fields

Parameters

Table 16-97 Operator parameters description

Parameter	Description	Node Type	Mandatory	Default Value
Hive database	Name of a Hive database	String	No	default
Hive table name	Name of the Hive table configured Only one Hive table is supported.	String	Yes	None.
Partition filter	Configures the partition filter can export data of specific partitions. The parameter is null by default and data of the whole table can be exported. For example, to export data of a table whose partition field's locale value is **CN** or **US**, the input is as follows: **locale = "CN" or locale = "US"**	String	No	-
Hive input field	Configures the input information of Hive ● column name: Hive column name. ● field name: Input field name. ● type: Field type. ● length: Field value length. If the actual field value is excessively long, the value is cut based on the configured length. When **type** is set to **CHAR**, spaces are added to the field value for supplement if the actual field value length is less than the configured length. When **type** is set to **VARCHAR**, no space is added to the field value for supplement if the actual field value length is less than the configured length.	map	Yes	-

Data Processing Rule

- If the Hive table name does not exist, the job fails to be submitted.
- If the configured column names are inconsistent with the Hive table column names, the data cannot be read and the number of imported data records is 0.
- If the field value does not match the actual type, the data in the line will become dirty data.

Example

Use the data export from Hive to SQL Server 2014 as an example.

In SQL Server 2014, run the following statement to create an empty table **test_1** for storing Hive data. Run the following statement:

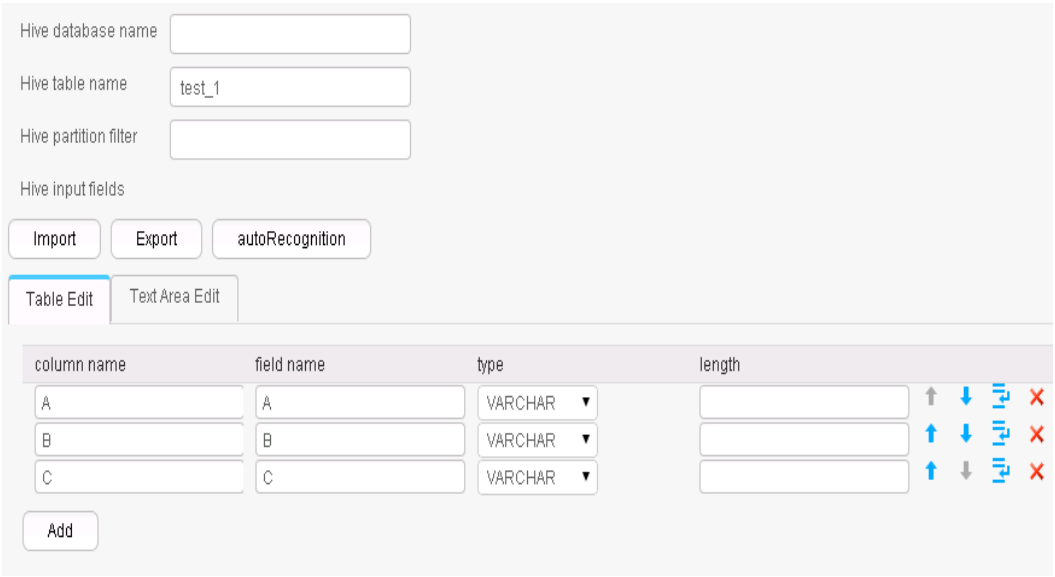
create table test_1 (id int, name text, value text);

Configure the **Hive Input** operator to generate fields A, B, and C.

After the data connector is set, click **Automatic Identification**. The system will automatically read fields in the database and select required fields for adding. You only need to optimize or modify the fields manually based on service scenarios.

NOTE

Performing this operation will overwrite existing data in the table.



Use the **Table Out** operator to export A, B, and C to the **test_1** table.

select * from test_1;

	id	name	value
1	1	zhangshan	zhang
2	2	lisi	li
3	3	wangwu	wang

16.8.2.7 Spark Input

Overview

The **Spark Input** operator converts specified columns in an SparkSQL table into input fields of the same quantity.

Input and Output

- Input: SparkSQL table column
- Output: fields

Parameters

Table 16-98 Operator parameters description

Parameter	Description	Type	Mandatory	Default Value
Spark database	Name of a Spark SQL database	String	No	default
Spark table name	Configures the SparkSQL table name. Only one SparkSQL table is supported.	String	Yes	None
Partition filter	Configures the partition filter can export data of specific partitions. The parameter is null by default and data of the whole table can be exported. For example, to export data of a table whose partition field's locale value is **CN** or **US**, the input is as follows: **locale = "CN" or locale = "US"**	String	No	-

Parameter	Description	Type	Mandatory	Default Value
Input fields of Spark	Configures the input information of SparkSQL ● column name: SparkSQL column name. ● field name: Input field name. ● type: Field type. ● length: Field value length. If the actual field value is excessively long, the value is cut based on the configured length. When **type** is set to **CHAR**, spaces are added to the field value for supplement if the actual field value length is less than the configured length. When **type** is set to **VARCHAR**, no space is added to the field value for supplement if the actual field value length is less than the configured length.	map	Yes	-

Data Processing Rule

- If the SparkSQL table name does not exist, the job fails to be submitted.
- If the configured column names are inconsistent with the SparkSQL table column names, the data cannot be read and the number of imported data records is 0.
- If the field value does not match the actual type, the data in the line will become dirty data.

Example

Use the data export from Spark to SQL Server 2014 as an example.

In SQL Server 2014, run the following statement to create an empty table **test_1** for storing SparkSQL data. Run the following statement:

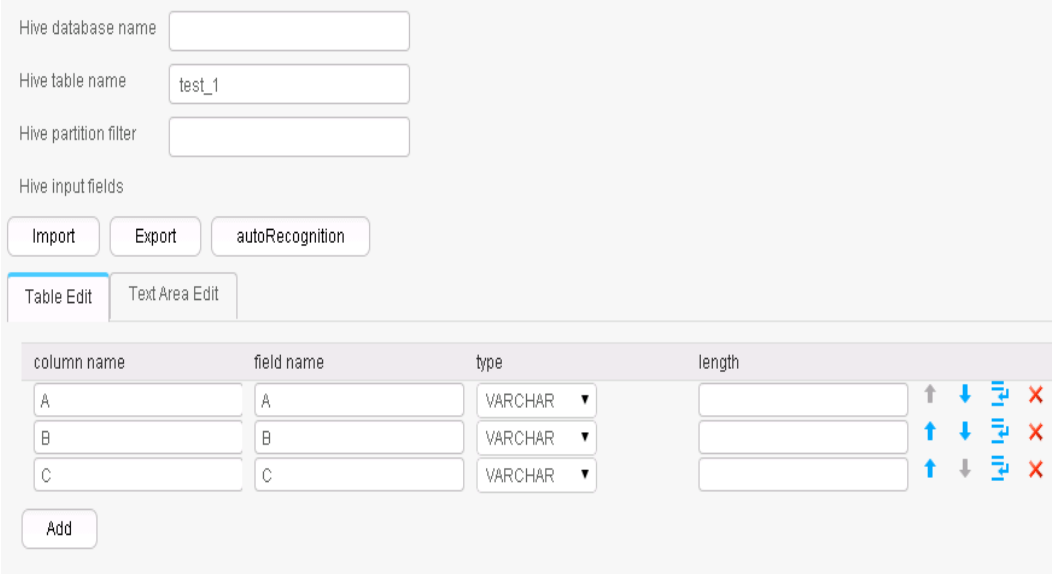
create table test_1 (id int, name text, value text);

Configure the **Spark Input** operator to generate fields A, B, and C.

After the data connector is set, click **Automatic Identification**. The system will automatically read fields in the database and select required fields for adding. You only need to optimize or modify the fields manually based on service scenarios.

NOTE

Performing this operation will overwrite existing data in the table.



Use the **Table Out** operator to export A, B, and C to the **test_1** table.

select * from test_1;

	id	name	value
1	1	zhangshan	zhang
2	2	lisi	li
3	3	wangwu	wang

16.8.3 Conversion Operators

16.8.3.1 Long Date Conversion

Overview

The **Long Date Conversion** operator performs long integer and date conversion.

Input and Output

- Input: fields to be converted
- Output: new fields

Parameter Description

Table 16-99 Operator parameter description

Parameter	Description	Type	Mandatory	Default Value
convert type	Types of long integer and date conversion: • **long to date**: converts long integers to date. • **long to time**: converts long integers to time. • **long to timestamp**: converts long integers to timestamp. • **date to long**: converts date to long integers. • **time to long**: converts time to long integers. • **timestamp to long**: converts timestamp to long integers.	enum	Yes	long to date
input field name	Name of input fields to be converted. Set this parameter to the names of fields generated in the previous conversion step.	string	Yes	None
output field name	Names of output fields.	string	Yes	None
field unit	Unit of a long integer field. According to **convert type**, the value is an input field or generated field. The options are **second** and **millisecond**.	enum	Yes	second
output field type	Output field type. The options are **BIGINT**, **DATE**, **TIME**, and **TIMESTAMP**.	enum	Yes	BIGINT
date format	Time field format, for example, **yyyyMMdd HH:mm:ss**.	string	No	None

Data Processing Rule

- If the original data includes null values, no conversion is performed.
- If the number of input field columns is greater than the number of field columns actually included in the original data, all data becomes dirty data.
- If a type conversion error occurs, the current data is saved as dirty data.

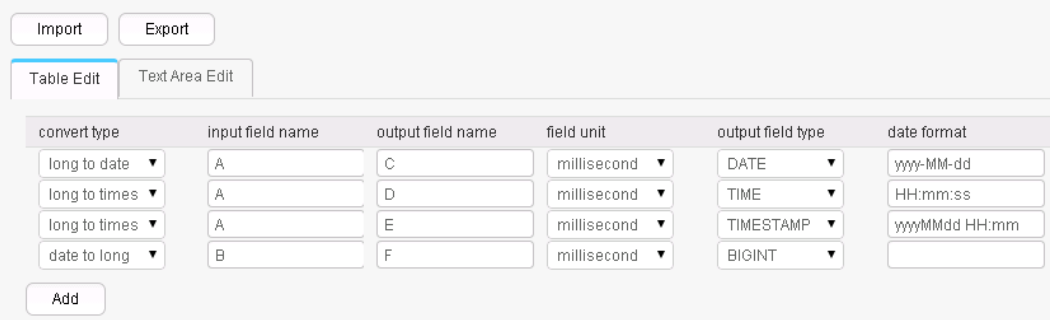
Example

Use the **CSV File Input** operator to generate fields A and B.

The following figure shows the source file.

```
1453431755874,2016-01-22 10:40:00
```

Configure the **Long Date Conversion** operator to generate four new fields C, D, E, and F. Their types are DATE, TIME, TIMESTAMP, and BIGINT, respectively.



The following figure shows the output of the conversion.

```
1453431755874,2016-01-22,2016-01-22,11:02:35,20160122 11:02:35,1453430400000
```

16.8.3.2 Null Value Conversion

Overview

The **null value conversion** operator replaces null values with specified values.

Input and Output

- Input: fields with null values
- Output: original fields with new values

Parameter Description

Table 16-100 Operator parameters description

Parameter	Description	Node Type	Mandatory	Default Value
Input field name	Names of fields that may have null values. Set this parameter to the names of existing fields.	string	Yes	None
Replace by this value	Specified values for replacing null values.	string	Yes	None

Data Processing Rule

When field values are empty, specified values are added.

Example

Use the **CSV File Input** operator to generate two fields A and B.

The following figure shows the source file.

```
,value1
key2,value2
key3,
```

Configure the **null value conversion** operator, as shown in the following figure.

After replacement, the values of fields A and B are as follows:

```
newKey,value1
key2,value2
key3,newValue
```

16.8.3.3 Constant Field Addition

Overview

The **Add Constants** operator generates constant fields.

Input and Output

- Input: none
- Output: constant fields

Parameter Description

Table 16-101 Operator parameters description

Parameter	Description	Type	Mandatory	Default Value
Constant fields	Information about constant fields: • **output field name**: Names of the configured fields. • **type**: field type • **date format**: If the field type is **DATE**, **TIME**, or **TIMESTAMP**, you need to specify the time format. If the field type is neither of them, the time format is invalid. The example time format is **yyyyMMdd HH:mm:ss**. • **length**: Field value length. If the actual field value is excessively long, the value is cut based on the configured length. When **type** is set to **CHAR**, spaces are added to the field value for supplement if the actual field value length is less than the configured length. When **type** is set to **VARCHAR**, no space is added to the field value for supplement if the actual field value length is less than the configured length. • **constant value**: Constant value of the correct type.	map	Yes	None

Data Processing Rule

This operator generates constant fields of the specified type.

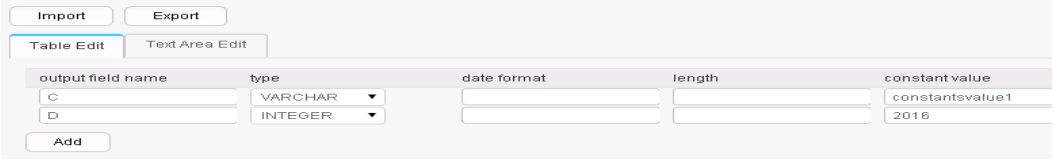
Example

Use the **CSV File Input** operator to generate two fields A and B.

The following figure shows the source file.

```
,value1
key2,value2
key3,
```

Configure the **Add Constants** operator to add fields C and D.



After adding the constants, fields A, B, C, and D are generated, as shown in the following figure.

```
,value1,constantsvalue1,2016
key2,value2,constantsvalue1,2016
key3,,constantsvalue1,2016
```

16.8.3.4 Random Value Conversion

Overview

Generate Random operator configures new values as random value fields.

Input and Output

- Input: none
- Output: random value fields

Parameter Description

Table 16-102 Operator parameters description

Parameter	Description	Type	Mandatory	Default Value
output field name	Names of generated random value fields.	string	Yes	None
length	Field length.	map	Yes	None
type	Field type. The options are **VARCHAR**, **INTEGER**, and **BIGINT**.	enum	Yes	VARCHAR

Data Processing Rule

The operator generates random value fields of specified type.

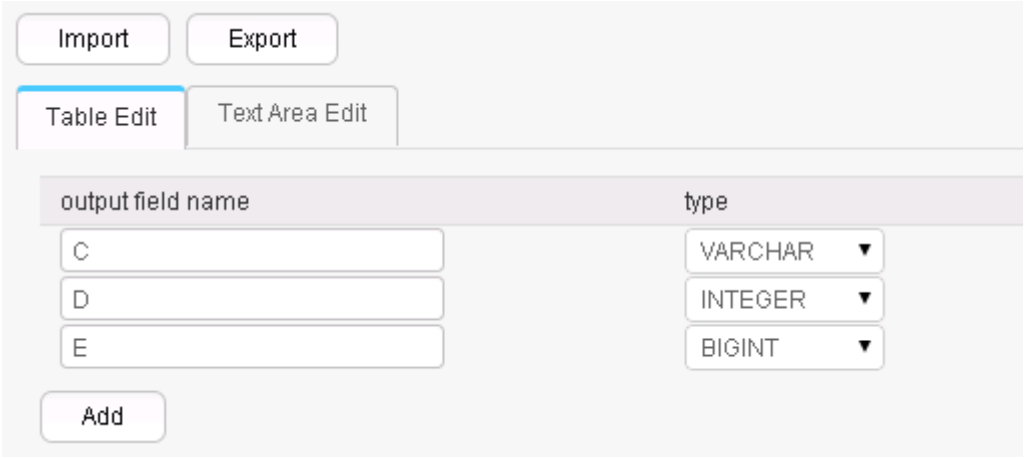
Example

Use the **CSV File Input** operator to generate two fields A and B.

The following figure shows the source file.

```
,value1
key2,value2
key3,
```

Configure the random value conversion operator to generate fields C, D, and E.



Five fields are generated.

```
,value1,2druceak69ril,769974975,8452014577467885098
key2,value2,7oq2dku93q9cg,1631427868,867914116689501757
key3,,2jg5e7b1m17kq,654806209,2477823020516316030
```

The random value fields generated each time are different.

16.8.3.5 Concat Fields

Overview

The **Concat Fields** operator concatenates existing fields by using delimiters to generate new fields.

Input and Output

- Input: fields to be concatenated
- Output: new fields

Parameter Description

Table 16-103 Operator parameter description

Parameter	Description	Type	Mandatory	Default Value
Output field name	Name of a field generated after concatenation.	string	Yes	None
Delimiter	Concatenation character. The value can be blank.	string	No	Empty string
Fields to be merged	Names of fields to be concatenated. **field name** must be set to the names of fields generated in the previous conversion step. Multiple field names can be added.	map	Yes	None

Data Processing Rule

- Use delimiters to concatenate the fields specified by **Fields to be merged** in order and assign the output to **Output field name**.
- If the value of a field is null, the value is changed to an empty string and then concatenated with other field values.

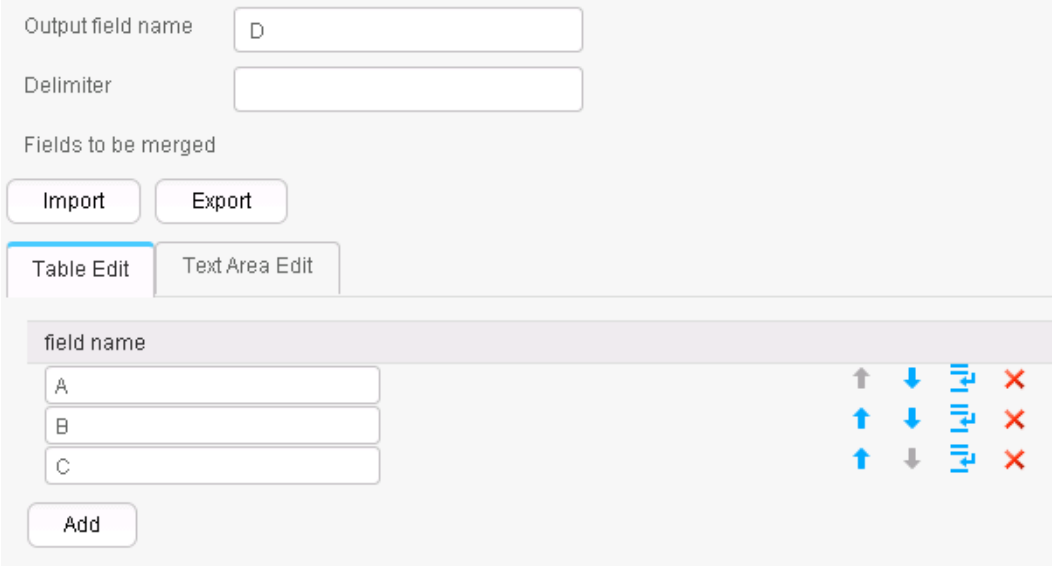
Example

Use the **CSV File Input** operator to generate fields A, B, and C.

The following figure shows the source file.

```
happy,new,year
welcome,to,2016
```

Configure the **Concat Fields** operator, set **Delimiter** to blank space, and generate field D.



After concatenation, fields A, B, C, and D are generated, as shown in the following figure.

```
happy,new,year,happy new year
welcome,to,2016,welcome to 2016
```

16.8.3.6 Extract Fields

Overview

The **Extract Fields** separates an existing field by using delimiters to generate new fields.

Input and Output

- Input: field to be separated
- Output: new fields

Parameter Description

Table 16-104 Operator parameter description

Parameter	Description	Type	Mandatory	Default Value
Input field name	Name of a field to be separated. Set this parameter to the name of a field generated in the previous conversion step.	string	Yes	None
Delimiter	Delimiter.	string	Yes	None

Parameter	Description	Type	Mandatory	Default Value
Fields extracted	Fields generated after field separation. Multiple fields can be generated after field separation. • **position**: Position of fields generated after field separation. • **output field name**: Names of output fields.	map	Yes	None

Data Processing Rule

- The value of the input field is separated by specified delimiters and the segments are assigned to the new fields.
- If the number of field columns after separation is greater than the actual number allowed by the original data, the line will become dirty data.

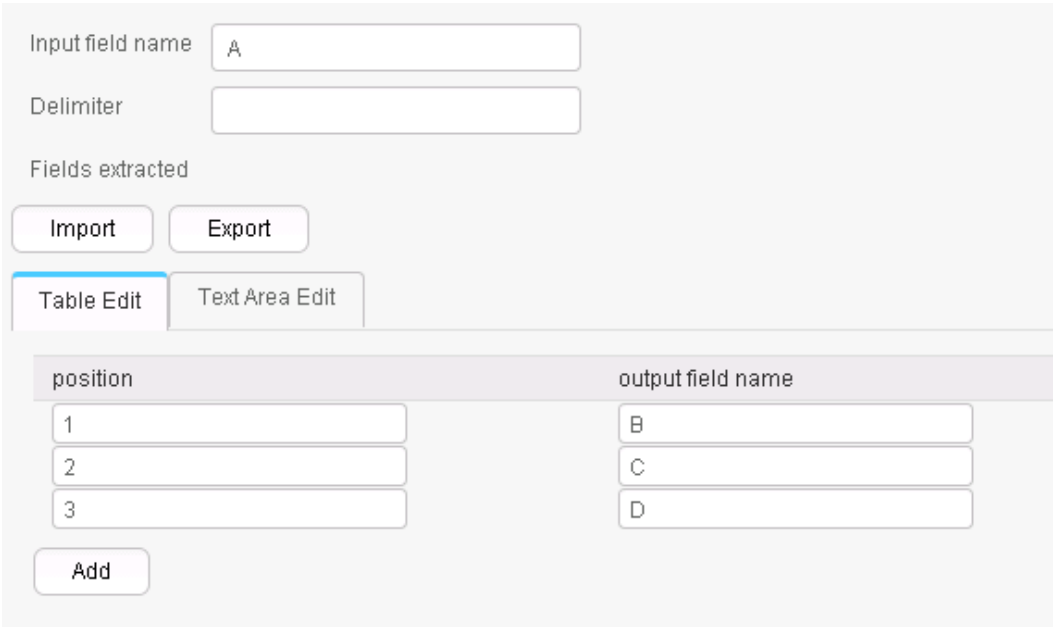
Example

Use the **CSV File Input** operator to generate field A.

The following figure shows the source file.

```
happy new year
welcome to 2016
```

Configure the **Extract Fields** operator, set **Delimiter** to blank space, and generate three fields B, C, and D.



After conversion, fields A, B, C, and D are generated, as shown in the following figure.

```
happy new year,happy,new,year
welcome to 2016,welcome,to,2016
```

16.8.3.7 Modulo Integer

Overview

The **Modulo Integer** operator performs modulo operations on integer fields to generate new fields.

Input and Output

- Input: integer fields
- Output: new fields

Parameter Description

Table 16-105 Operator parameter description

Parameter	Description	Type	Mandatory	Default Value
Modulo fields	Modulo operation information: • **input field name**: Names of input fields. Set this parameter to the names of fields generated in the previous conversion step. • **output field name**: Names of output fields. • **modulus**: Values used for a modulo operation.	map	Yes	None

Data Processing Rule

- The operator generates new fields and the values are those after the modulo operation.
- The field values must be integers; otherwise, the current line becomes dirty data.

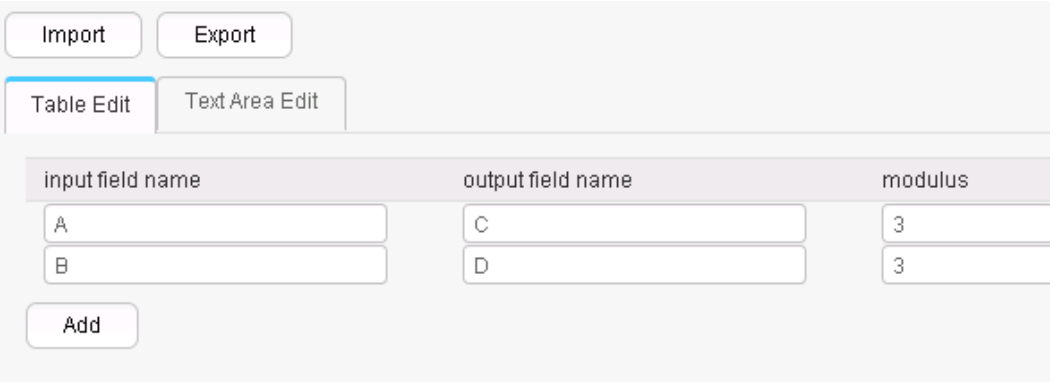
Example

Use the **CSV File Input** operator to generate fields A and B.

The following figure shows the source file.

```
10,12
2015,2016
```

Configure the **Modulo Integer** operator to generate two new fields C and D.



After the modulo operation, fields A, B, C, and D are generated, as shown in the following figure.

```
10,12,1,0
2015,2016,2,0
```

16.8.3.8 String Cut

Overview

String Cut: cuts existing fields to generate new fields.

Input and Output

- Input: fields to be truncated
- Output: new fields generated after truncation

Description

Table 16-106 Operator parameters

Parameter	Description	Type	Mandatory	Default Value
Fields to be cut	Information about a cut field: • **input field name**: Names of the input fields. Set this parameter to the names of the fields generated in the previous conversion step. • **output field name**: Names of the configured output fields. • **start position**: start position of the cut, starting from No. 1. • **end position**: end position of the field to be cut. If the length of the string cannot be determined, set this parameter to **-1**, indicating the end of a field to be cut. • **output field type**: type of an output field. • **output field length**: field length. If the actual field value is excessively long, the value is cut based on the configured length. If **output field type** is **CHAR**, spaces are added to the field value for supplement if the actual length actual field value length is less than the configured length. If **output field type** is **VARCHAR**, no space is added to the field value for supplement if the actual field value length is less than the configured length.	map	Yes	None

Data Processing Rule

- Use the start position and end position to cut the original field value and generate a new field.
- If the end position is **-1**, it indicates the end of a field. In other cases, the end position cannot be smaller than the start position.
- If the start or end position of the string to be cut is greater than the length of the input field, the current line becomes dirty data.

Example

Use the **CSV File Input** operator to generate two fields: A and B.

The source file is as follows:

```
abcd,product
FusionInsight,Bigdata
```

After **String Cut** operator is configured, fields C and D are generated.

After the conversion, the following fields are generated:

```
abcd,product,abc,prod
FusionInsight,Bigdata,Fus,Bigd
```

16.8.3.9 EL Operation

Overview

The **EL Operation** operator calculates field values and generates new fields. The algorithms that are currently supported include md5sum, sha1sum, sha256sum, and sha512sum.

Input and Output

- Input: fields to be converted
- Output: fields generated after the EL expression conversion

Parameter Description

Table 16-107 Operator parameter description

Parameter	Description	Type	Mandatory	Default Value
Field generated by el operation	EL expression configuration: • **name**: Name of the expression output result. • **el expression**: Expression. The format is *expression name(input field name,value indicating whether to use lower case letters to indicate the output result)*, for example, md5sum(fieldname,true). – md5sum: generates md5 values. – sha1sum: generates sha1 values. – sha256sum: generates sha256 values. – sha512sum: generates sha512 values. • **type**: Type of the expression output result. **VARCHAR** is recommended. • **date format**: Format of the expression output result. • **length**: Length of the expression output result.	map	Yes	None

Data Processing Rule

- The operator calculates fields values and generates new fields.
- The type of the new fields can only be VARCHAR.

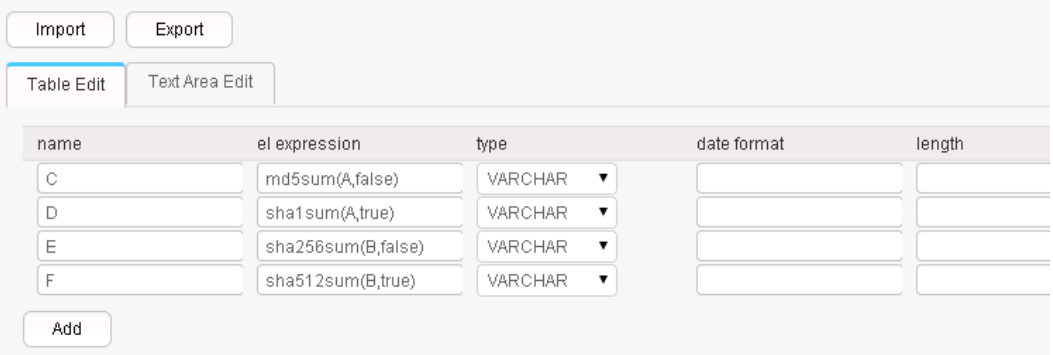
Example

Use the **CSV File Input** operator to generate fields A and B.

The following figure shows the source file.

```
2016,year
year,2016
```

Configure the **EL Operation** operator to generate fields C, D, E, and F.



Six fields are generated, as shown in the following figure.

```
2016,year,95192C98732387165BF8E396C0F2DAD2,ab39c54239118a4b086b878b7878100f769dd1
97,4CB4EA25583C25647247AE96FC90225D99AD7A6FABC3E2C2FD13C502E323CD9E,779edfe0463b2
596e7a83e4c59083e19242e8c51eace8e2ec57704643be5e15ba80f79af227cf3ea2e2362b4081377
96a1d82cb0535652b99844bb9a62019563
year,2016,84CDC76CABF41BD7C961F6AB12F117D8,4ff0b1538469338a0073e2cdaab6a517801b6a
b4,DA6E2F539726FABD1F8CD7C9469A22B36769137975B28ABC65FE2DC29E659B77,da0ae9104086a
1c58f89f82766ac55a02c8ab44277ce39f959ec0e73391bef651c6f9793657396ce47fbd846068465
ccbf3056764424bed9be7789bd1101ace7
```

16.8.3.10 String Operations

Overview

String Operations: configures generated fields to generate new fields through case conversion.

Input and Output

- Input: fields whose case needs to be converted
- Output: converted fields

Description

Table 16-108 Operator parameters

Parameter	Description	Type	Mandatory	Default Value
Fields to be processed	Information about fields for string case conversion: • **input field name**: Names of the input fields. Set this parameter to the names of the fields generated in the previous conversion step. • **output field name**: Names of the configured output fields. • **Lower/Upper**: Indicates whether to convert data to uppercase or lowercase characters.	map	Yes	None

Data Processing Rule

- Converts the case of a string value.
- If the input data is null, no conversion is required.

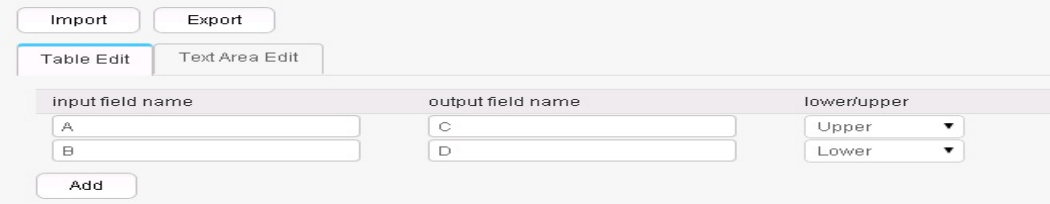
Example

Use the **CSV File Input** operator to generate two fields: A and B.

The source file is as follows:

```
abcd,product
FusionInsight,Bigdata
```

After the **String Operations** operator is configured, two new fields C and D are generated.



After the conversion, four fields are generated in sequence:

```
abcd,product,ABCD,product
FusionInsight,Bigdata,FUSIONINSIGHT,bigdata
```

16.8.3.11 String Reverse

Overview

String Reverse: converts generated fields into new fields in reverse order.

Input and Output

- Input: fields to be reversed
- Output: reversed fields

Description

Table 16-109 Operator parameters

Parameter	Description	Type	Mandatory	Default Value
Fields to be reversed	Information about the fields to be reversed • **input field name**: Names of the input fields. Set this parameter to the names of the fields generated in the previous conversion step. • **output field name**: Names of the configured output fields. • **type**: field type • **output field length**: Field value length. If the actual field value is excessively long, the value is cut based on the configured length. If **type** is **CHAR**, spaces are added to the field value for supplement if the actual field value length is less than the configured length. If **type** is **VARCHAR**, no space is added to the field value for supplement if the actual field value length is less than the configured length.	map	Yes	None

Data Processing Rules

- Reverse the values of fields.
- If the input data is null, no conversion is required.
- It can be configured that all data becomes dirty data when the number of input field columns is greater than the number of field columns actually included in the original data.

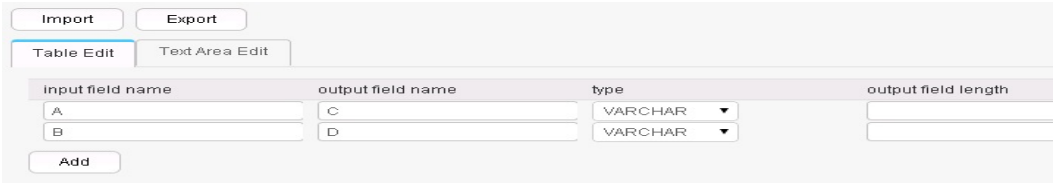
Example

Use the **CSV File Input** operator to generate two fields: A and B.

The source file is as follows:

```
abcd,product
FusionInsight,Bigdata
```

After the **String Reverse** operator is configured, two new fields C and D are generated.



After the conversion, four fields are generated in sequence:

```
abcd,product,dcba,tcudorp
FusionInsight,Bigdata,thgisnInoisuF,atadgiB
```

16.8.3.12 String Trim

Overview

The **String Trim** operator clears spaces contained in existing fields to generate new fields.

Input and Output

- Input: fields whose spaces are to be cleared
- Output: new fields

Parameter Description

Table 16-110 Operator parameter description

Parameter	Description	Type	Mandatory	Default Value
Fields to be trimmed	Information about fields for clearing spaces contained in strings: • **input field name**: Names of input fields. Set this parameter to the names of fields generated in the previous conversion step. • **output field name**: Names of output fields. • **trim type**: Space clearing mode (clearing starting spaces, ending spaces, or starting and ending spaces).	map	Yes	None

Data Processing Rule

- Clearing spaces at both ends of a value supports clearing spaces at the left end, at the right end, and at both ends.
- If the input data is null, no conversion is performed.
- If the number of input field columns is greater than the number of field columns actually included in the original data, all data becomes dirty data.

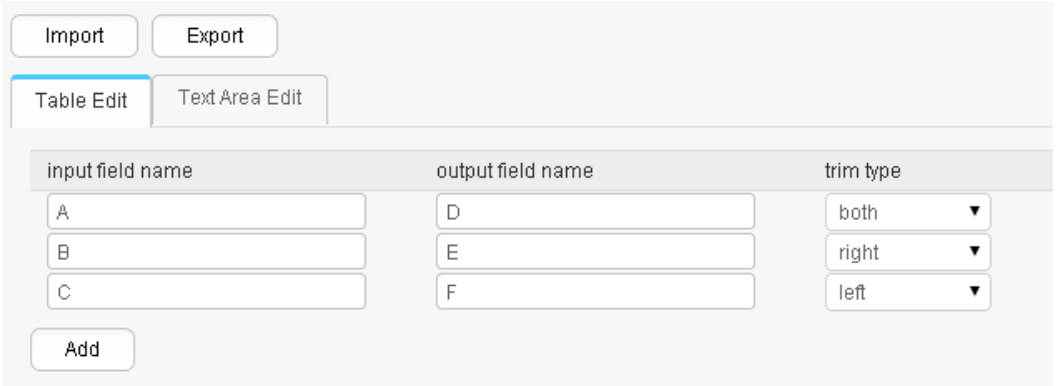
Example

Use the **CSV File Input** operator to generate fields A, B, and C.

The following figure shows the source file.

```
  welcome   ,to  ,  2016
happy  ,new , year
```

Configure the **String Trim** operator to generate three new fields D, E, and F.



Six fields are generated, as shown in the following figure.

```
  welcome   ,to  ,  2016,welcome,to,2016
happy  ,new , year,happy,new,year
```

16.8.3.13 Filter Rows

Overview

This **Filter Rows** operator filters rows that contain triggering conditions by configuring logic conditions.

Input and Output

- Input: fields used to create filter conditions
- Output: none

Parameter Description

Table 16-111 Operator parameters description

Parameter	Description	Type	Mandatory	Default Value
Condition logic connector	Condition logic connector. The options include **AND** and **OR**.	enum	Yes	AND
Conditions	Filter condition information: • **input field name**: Names of the input fields. Set this parameter to the names of the fields generated in the previous conversion step. • **operator**: Operator • **comparative value**. You can directly enter the value of a field referenced in the **#{Existing field name}** format.	map	Yes	None

Data Processing Rule

- When the condition logic is **AND**, if no filtering condition is added, all data becomes dirty data; if the original data meets all the added filtering conditions, the current line becomes dirty data.
- When the condition logic is **OR**, if no filter condition is added, all data becomes dirty data; if the original data meets any of the added filter conditions, the current line becomes dirty data.

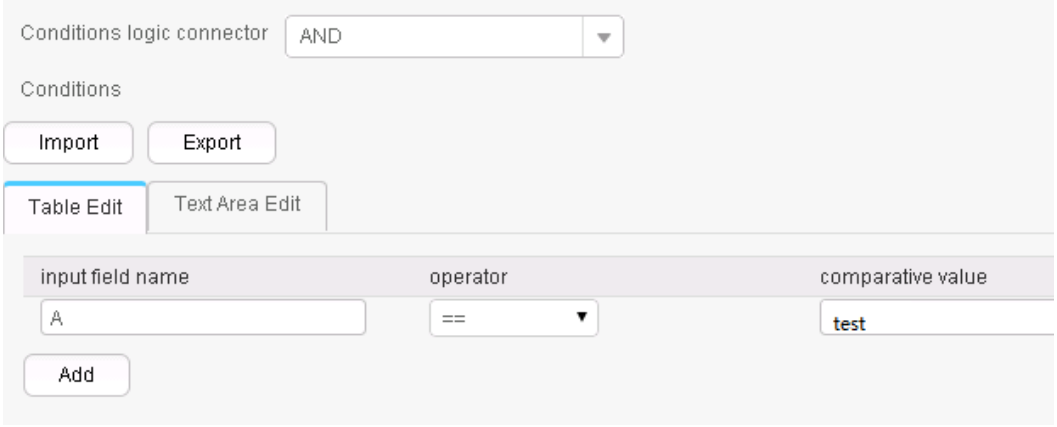
Example

Use the **CSV File Input** operator to generate two fields A and B.

The following figure shows the source file.

```
test, product
FusionInsight,Bigdata
```

Configure the **Filter Rows** operator to filter out lines that contain **test**.



After the conversion, enter the original fields. The result is as follows:

```
FusionInsight,Bigdata
```

16.8.3.14 Update Fields Operator

Overview

The **Update Fields** operator updates fields values when certain conditions are met.

The types supported at present include **BIGINT**, **DECIMAL**, **DOUBLE**, **FLOAT**, **INTEGER**, **SMALLINT**, and **VARCHAR**. When the type is **VARCHAR** and the operator is **+**, strings will be added to the end of field values. The operator **-** is not supported. For other types, **+** and **-** indicate addition and subtraction of values. For all types, **=** indicates new value assignment.

Input and Output

Input: field

Output: input field

Parameter Description

Table 16-112 Operator parameters description

Parameter	Description	Type	Mandatory	Default Value
update field name	Fields to be updated	string	Yes	None
update operator	Operator, which can be **+**, **-**, or **=**.	enum	Yes	+
update value	Values to be updated	The type is the same as the field type.	No	None
Condition logic connector	Condition logic connector. The options include **AND** and **OR.**	enum	Yes	AND
Conditions	Filter condition information: ● **input field name**: Names of the input fields. Set this parameter to the names of the fields generated in the previous conversion step. ● **operator**: Operator ● **comparative value**. You can directly enter the value of a field referenced in the **#{Existing field name}** format.	map	Yes	None

Data Processing Rule

- The operator checks whether conditions are met. If yes, the operator updates the field values. If no, the operator does not update the field values.
- If the field values are digits, the updated values are digits.
- If the fields are of the string type, the operator **-** cannot be used.

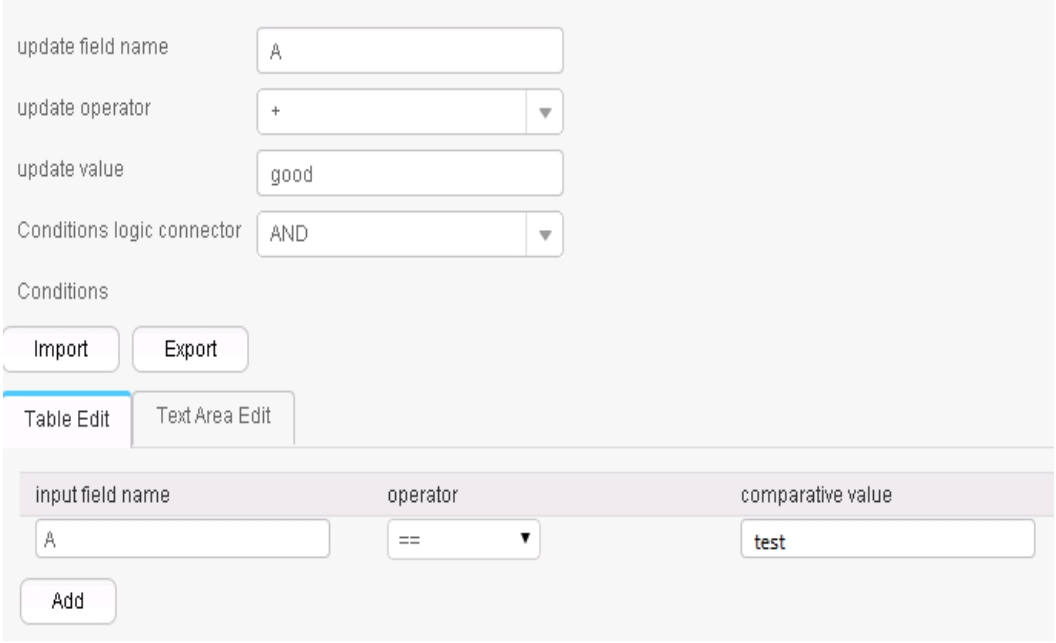
Example

Use the **CSV File Input** operator to generate two fields A and B.

The following figure shows the source file.

```
test, product
FusionInsight,Bigdata
```

Configure the **Update Fields** operator to update a value by adding **good** to the end of the value if the value is **test**.



The following figure shows the output result.

16.8.4 Output Operators

16.8.4.1 Hive output

Overview

The **Hive Output** operator exports existing fields to specified columns of a Hive table.

Input and Output

- Input: fields to be exported
- Output: Hive table

Parameters

Table 16-113 Operator parameters description

Parameter	Description	Node Type	Mandatory	Default Value
Hive file storage format	Hive configuration file storage format. CSV, ORC, and RC are supported at present. **NOTE** • Parquet is a column-based storage format. In this format, the output field names of Loader be the same as the field names in Hive tables. • For Hive of versions later than 1.2.0, a field name, instead of field number, is used to parse ORC files. Therefore, the output field names of Loader must be the same as those in Hive tables.	enum	Yes	CSV
Hive file compression format	Hive table file compression format. Select a format from the drop-down list. If you select **NONE** or do not set this parameter, data is not compressed.	enum	Yes	NONE
Hive ORC file version	Version of the ORC file (when the storage format of the Hive table file is ORC).	enum	Yes	0.12
Output delimiter	Delimiter.	string	Yes	None.

Parameter	Description	Node Type	Mandatory	Default Value
Output fields	Information about output fields: ● position: Position of output fields. ● field name: Names of output fields. ● type: Field type. If type is set to **DATE**, **TIME**, or **TIMESTAMP**, you must specify a time format. If type is set to other values, the time format is invalid. An example time format is **yyyyMMdd HH:mm:ss**. ● decimal format: scale and precision of the decimal. ● length: Field value length. If the actual field value is excessively long, the value is cut based on the configured length. When **type** is set to **CHAR**, spaces are added to the field value for supplement if the actual field value length is less than the configured length. When **type** is set to **VARCHAR**, no space is added to the field value for supplement if the actual field value length is less than the configured length. ● partition key: indicates whether a column is a partition column. You can specify zero or multiple partition columns. If multiple primary keys are configured, they are combined according to the configuration sequence.	map	Yes	None

Data Processing Rule

- The field values are exported to the Hive table.
- If one or more columns are specified as partition columns, the **Partition Handlers** feature is displayed on the **To** page in Step 4 of the job configuration. **Partition Handlers** specifies the number of handlers for processing data partitioning.
- If no column is designated as partition columns, input data does not need to be partitioned, and **Partition Handlers** is hidden by default.

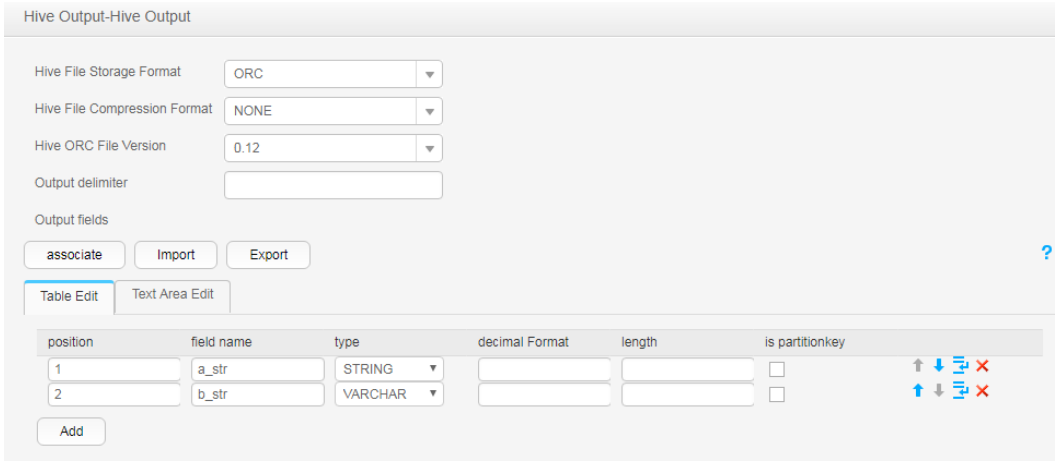
Example

Use the **CSV File Input** operator to generate two fields A and B.

The following figure shows the source file.

```
2016,year
year,2016
```

Configure the **Hive Output** operator to export a_str and b_str to the Hive table.



After the execution is complete, view the table data.

```
0: jdbc:hive2://10.52.0.97:21066/> select * from hive_test;
+------------------+------------------+--+
| hive_test.a_str  | hive_test.b_str  |
+------------------+------------------+--+
| 2016             | year             |
| year             | 2016             |
+------------------+------------------+--+
2 rows selected (1.6 seconds)
```

16.8.4.2 Spark Output

Overview

The **Spark Output** operator exports existing fields to specified columns of a Spark SQL table.

Input and Output

- Input: fields to be exported
- Output: SparkSQL table

Parameter Description

Table 16-114 Operator parameters description

Parameter	Description	Node Type	Mandatory	Default Value
Spark file storage format	SparkSQL configuration file storage format. CSV, ORC, RC and PARQUET are supported at present. **NOTE** • PARQUET is a column-based storage format. In this format, the output field names of Loader be the same as the field names in the SparkSQL table. • For Hive of versions later than 1.2.0, a field name, instead of field number, is used to parse ORC files. Therefore, the output field names of Loader must be the same as those in the SparkSQL table.	enum	Yes	CSV
Spark file compression format	SparkSQL table file compression format. Select a format from the drop-down list. If you select **NONE** or do not set this parameter, data is not compressed.	enum	Yes	NONE
Spark ORC file version	Version of the ORC file (when the storage format of the SparkSQL table file is ORC).	enum	Yes	0.12
Output delimiter	Delimiter.	string	Yes	None

Parameter	Description	Node Type	Mandatory	Default Value
Output fields	Information about output fields: ● position: Position of output fields. ● field name: Names of output fields. ● type: Field type. If type is set to **DATE**, **TIME**, or **TIMESTAMP**, you must specify a time format. If type is set to other values, the time format is invalid. An example time format is **yyyyMMdd HH:mm:ss**. ● decimal format: scale and precision of the decimal. ● length: Field value length. If the actual field value is excessively long, the value is cut based on the configured length. When **type** is set to **CHAR**, spaces are added to the field value for supplement if the actual field value length is less than the configured length. When **type** is set to **VARCHAR**, no space is added to the field value for supplement if the actual field value length is less than the configured length. ● partition key: indicates whether a column is a partition column. You can specify zero or multiple partition columns. If multiple primary keys are configured, they are combined according to the configuration sequence.	map	Yes	None

Data Processing Rule

- The field values are exported to the SparkSQL table.
- If one or more columns are specified as partition columns, the **Partition Handlers** feature is displayed on the **To** page in Step 4 of the job configuration. **Partition Handlers** specifies the number of handlers for processing data partitioning.
- If no column is designated as partition columns, input data does not need to be partitioned, and **Partition Handlers** is hidden by default.

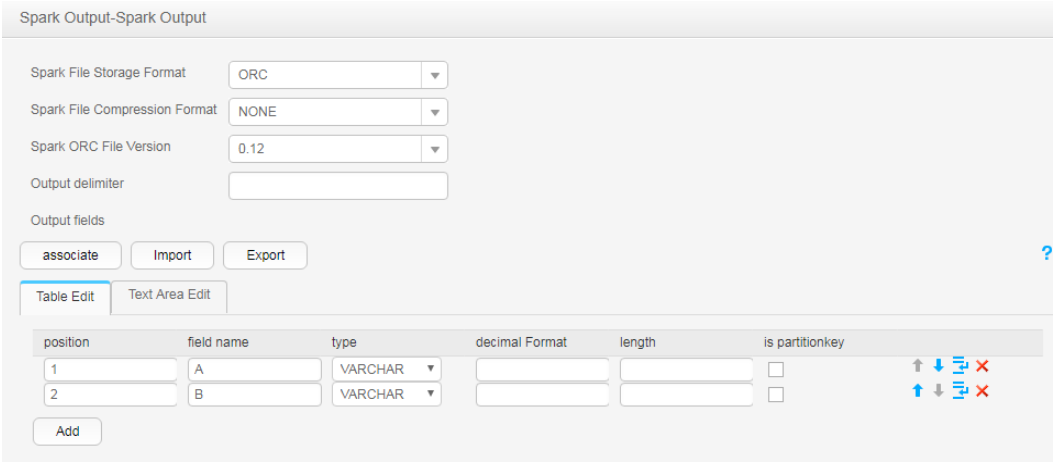
Example

Use the **CSV File Input** operator to generate two fields A and B.

The following figure shows the source file.

```
2016,year
year,2016
```

Configure the **Spark Output** operator to export A and B to the SparkSQL table.



16.8.4.3 Table Output

Overview

The **Table Output** operator exports output fields to specified columns in a relational database table.

Input and Output

- Input: fields to be exported
- Output: relational database table

Parameters

Table 16-115 Operator parameters description

Parameter	Description	Node Type	Mandatory	Default Value
Output delimiter	Delimiter. **NOTE** This configuration applies only to the MySQL dedicated connector. If the data column content contains the default delimiter, you need to set a user-defined delimiter. Otherwise, data disorder may occur.	string	No	,

Parameter	Description	Node Type	Mandatory	Default Value
Line delimiter	Line delimiter, which can be any string specified by users based on the actual situation. Any character string is supported. The OS line delimiter is used by default. **NOTE** This configuration applies only to the MySQL dedicated connector. If the data column content contains the default delimiter, you need to set a user-defined delimiter. Otherwise, data disorder may occur.	string	No	\n
Output fields	Information about relational database output fields: ● field name: Names of output fields. ● table column name: Names of database table columns. ● type: Field type. The value must be consistent with the field type configured in the database. ● length: Field value length. If the actual field value is excessively long, the value is cut based on the configured length. When **type** is set to **CHAR**, spaces are added to the field value for supplement if the actual field value length is less than the configured length. When **type** is set to **VARCHAR**, no space is added to the field value for supplement if the actual field value length is less than the configured length.	map	Yes	None

Data Processing Rule

The field values are exported to the table.

Example

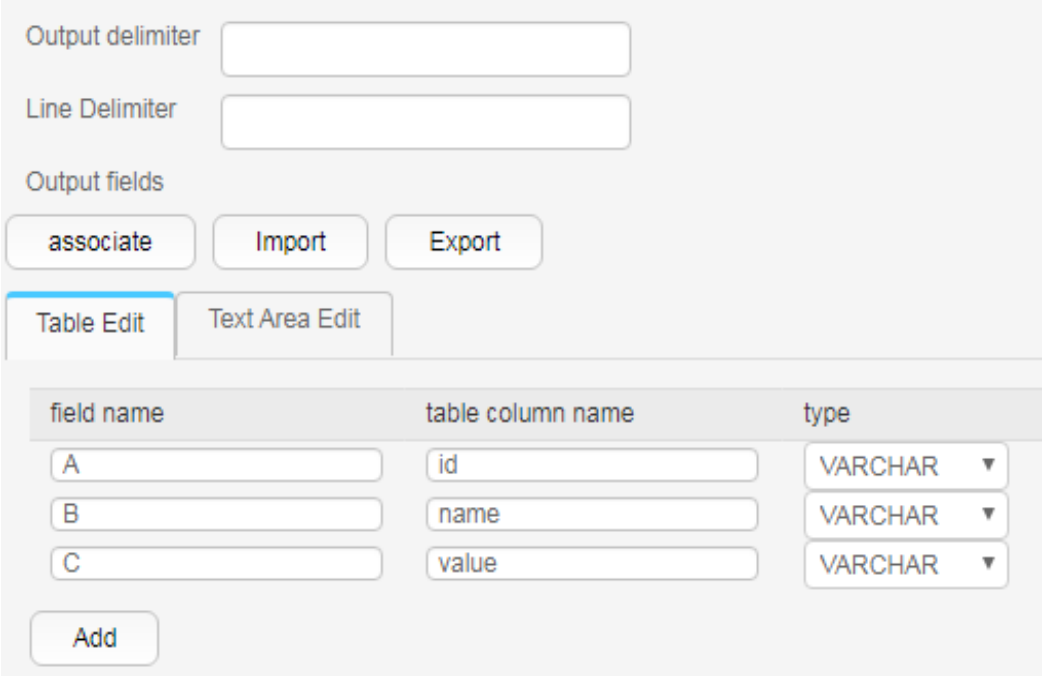
Use the data export from HBase to sqlserver2014 as an example.

In sqlserver2014, run the following statement to create an empty data test_1 for storing HBase data. Run the following statement:

create table test_1 (id int, name text, value text);

Use the HBase Input operator to generated three fields A, B, and C.

Use the **Table Output** operator to export A, B, and C to the test_1 table.



The command output is as follows:

	id	name	value
1	1	zhangshan	zhang
2	2	lisi	li
3	3	wangwu	wang

16.8.4.4 File Output

Overview

The **File Output** operator uses delimiters to concatenate existing fields and exports new fields to a file.

Input and Output

- Input: fields to be exported
- Output: files

Parameter Description

Table 16-116 Operator parameters description

Parameter	Description	Type	Mandatory	Default Value
Output delimiter	Set a delimiter.	string	Yes	None

Parameter	Description	Type	Mandatory	Default Value
Line breaker	Line delimiter, which can be any string specified by users based on the actual situation. Any character string is supported. The OS line delimiter is used by default.	string	No	\n
Output fields	Information about output fields: ● **position**: Position of output fields. ● **field name**: Names of output fields. ● **type**: Field type. If type is set to **DATE**, **TIME**, or **TIMESTAMP**, you must specify a time format. If type is set to other values, the time format is invalid. The example time format is **yyyyMMdd HH:mm:ss**. ● **length**: Field value length. If the actual field value is excessively long, the value is cut based on the configured length. When **type** is set to **CHAR**, spaces are added to the field value for supplement if the actual field value length is less than the configured length. When **type** is set to **VARCHAR**, no space is added to the field value for supplement if the actual field value length is less than the configured length.	map	No	None

Data Processing Rule

The field is exported to a file.

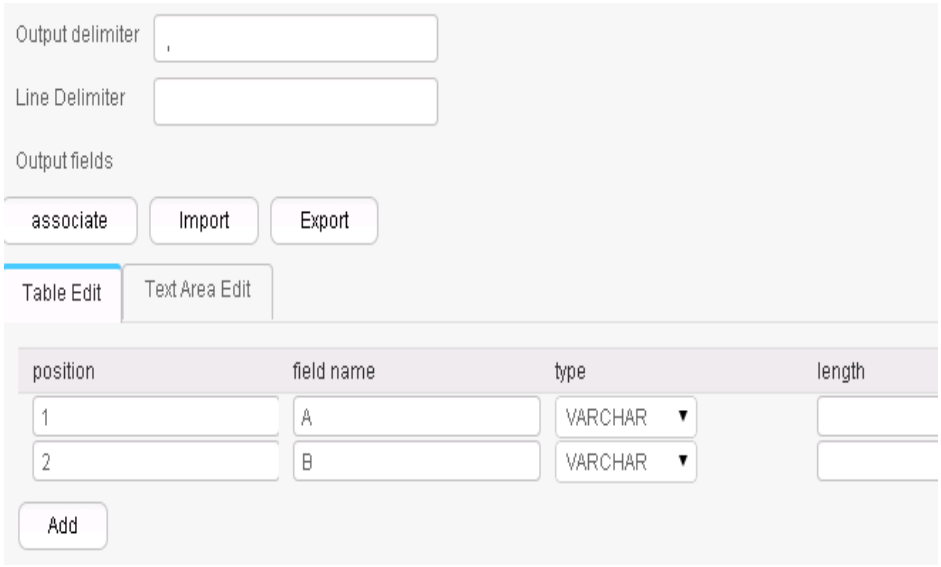
Example

Use the **CSV File Input** operator to generate two fields A and B.

The following figure shows the source file.

```
aaa,product
bbb,Bigdata
```

Configure the **File Output** operator, set **Output delimiter** to a comma (,), and export A and B to a file, as shown in the following figure.



The following figure shows the result.

```
aaa,product
bbb,Bigdata
```

16.8.4.5 HBase Output

Overview

The **HBase Output** operator exports existing fields to specified columns of an HBase Outputtable.

Input and Output

- Input: fields to be exported
- Output: HBase table

Parameters

Table 16-117 Operator parameters description

Parameter	Description	Node Type	Mandatory	Default Value
HBase table type	HBase table type. The options include normal (common HBase table) and phoenix.	enum	Yes	normal

Parameter	Description	Node Type	Mandatory	Default Value
NULL value processing mode	Null value processing mode. Selecting the option button indicates to convert null values to empty strings and save them. Deselecting the option button indicates the data is not saved.	boolean	No	The option button is not selected.
HBase output fields	HBase output information: ● field name: Names of output fields. ● table name: HBase table name. ● column family name: HBase column family name. If it is not configured during HBase/Phoenix table creation, the default value is **'0'**. ● column name: HBase column name. ● type: Field type. If type is set to **DATE**, **TIME**, or **TIMESTAMP**, you must specify a time format. If type is set to other values, the time format is invalid. An example time format is **yyyyMMdd HH:mm:ss**. ● length: Field value length. If the actual field value is excessively long, the value is cut based on the configured length. When **type** is set to **CHAR**, spaces are added to the field value for supplement if the actual field value length is less than the configured length. When **type** is set to **VARCHAR**, no space is added to the field value for supplement if the actual field value length is less than the configured length. ● Primary Key: Indicates whether a column is a primary key column. A common HBase table can have only one primary key, while a phoenix table can have multiple primary keys. If multiple primary keys are configured, they are combined according to the configuration sequence. At least one primary key column must be configured.	map	Yes	None

Data Processing Rule

- The field values are exported to the HBase table.
- When the original data contains NULL values, if the **NULL value processing mode** is selected, the NULL values are converted to empty strings and saved. If the **NULL value processing mode** button is not selected, the data is not saved.

Example

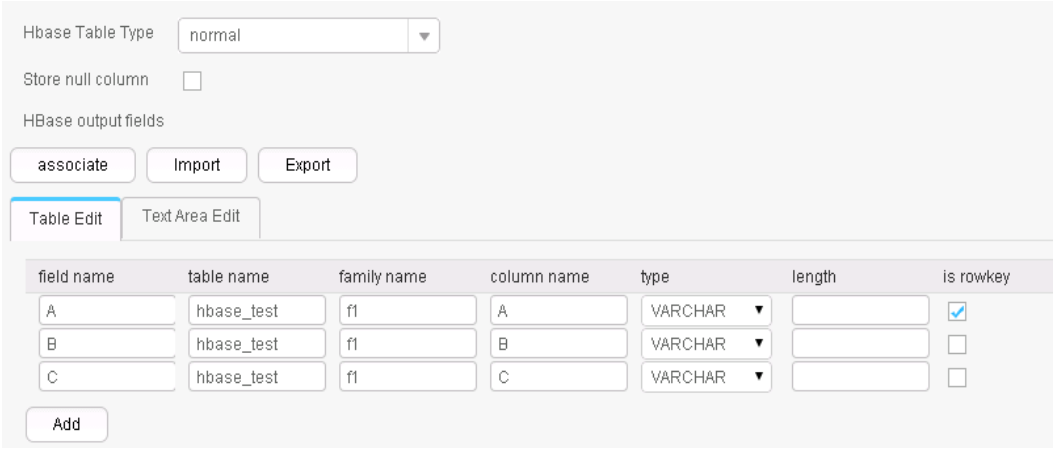
Using table input as an example, after the fields are generated, the HBase Output operator exports them to the related HBase table and stores the data in the test table, as shown in the following figure.

	id	name	value
1	1	zhangshan	zhang
2	2	lisi	li
3	3	wangwu	wang

Create an HBase table.

create 'hbase_test','f1','f2';

Configure the **HBase Output** operator, as shown in the following figure.



After the job execution is complete, view the data in the hbase_test table.

```
hbase(main):001:0> scan 'hbase_test'
ROW                                           COLUMN+CELL
 1                                            column=f1:B, timestamp=1455855645760, value=zhangshan
 1                                            column=f1:C, timestamp=1455855645760, value=zhang
 2                                            column=f1:B, timestamp=1455855645760, value=lisi
 2                                            column=f1:C, timestamp=1455855645760, value=li
 3                                            column=f1:B, timestamp=1455855645760, value=wangwu
 3                                            column=f1:C, timestamp=1455855645760, value=wang
3 row(s) in 0.2720 seconds
```

16.8.4.6 ClickHouse Output

Overview

The **ClickHouse Output** operator exports existing fields to specified columns of a ClickHouse table.

Input and Output

- Input: fields to be exported
- Output: ClickHouse table

Parameters

Table 16-118 Operator parameters

Parameter	Description	Type	Mandatory	Default Value
ClickHouse database name	Database where the ClickHouse table is located.	string	Yes	default
ClickHouse table name	Name of the ClickHouse table to which data is written.	string	Yes	None

Data Processing Rule

The field values are exported to the ClickHouse table.

Example

Use the **CSV File Input** operator to generate 12 fields.

The following figure shows the source file.

```
1,'b','abcd','2021-06-15','12:00:06','2021-06-15 12:00:06',1,12,6.8,18.6,12.8,true
2,'abc','abcd','2021-06-15','12:00:06','2021-06-15 12:00:06',1,12,6.8,18.6,12.8,true
3,'ab','abcd','2021-06-15','12:00:06','2021-06-15 12:00:06',1,12,6.8,18.6,12.8,true
4,'abcdef','abcd','2021-06-15','12:00:06','2021-06-15 12:00:06',1,12,6.8,18.6,12.8,true
5,'a','abcd','2021-06-15','12:00:06','2021-06-15 12:00:06',1,12,6.8,18.6,12.8,true
6,'bg','cde','2020-06-15','13:00:06','2021-06-15 12:00:06',1,12,6.8,18.6,12.8,true
7,'f','cde','2020-06-15','13:00:06','2021-06-15 12:00:06',1,12,6.8,18.6,12.8,true
8,'h','cde','2020-06-15','13:00:06','2021-06-15 12:00:06',1,12,6.8,18.6,12.8,true
```

Run the following statements to create a ClickHouse table:

CREATE TABLE IF NOT EXISTS testck4 ON CLUSTER default_cluster(

a Int32,

b VARCHAR(100) NOT NULL,

c char(100),

d DateTime,

e DateTime,

f DateTime,

g smallint,

h bigint,

l Float32,

j Float64,

k decimal(10,2),

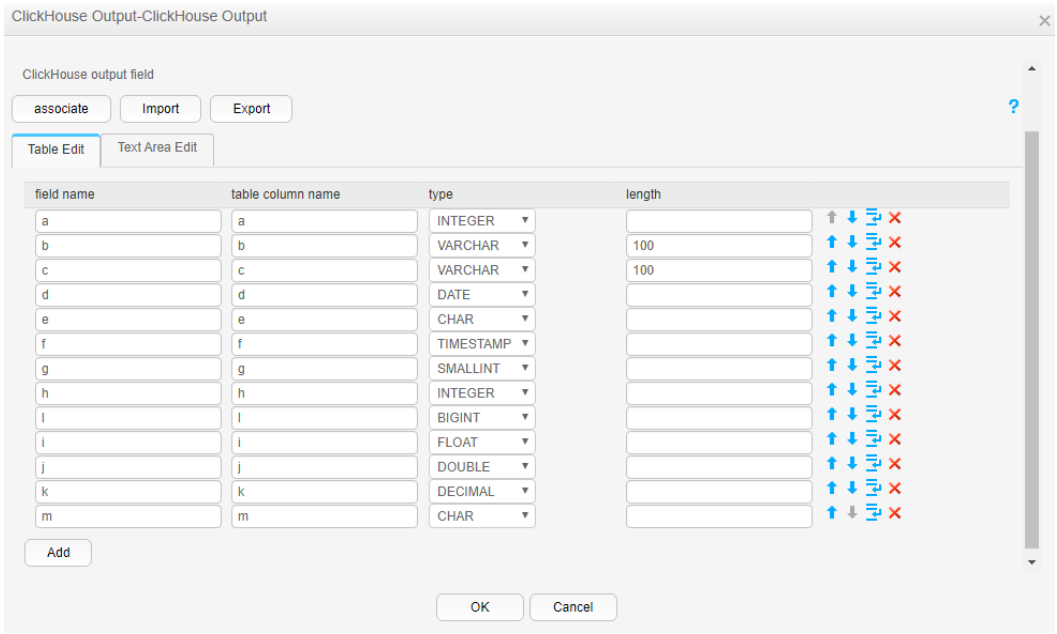
m boolean

)

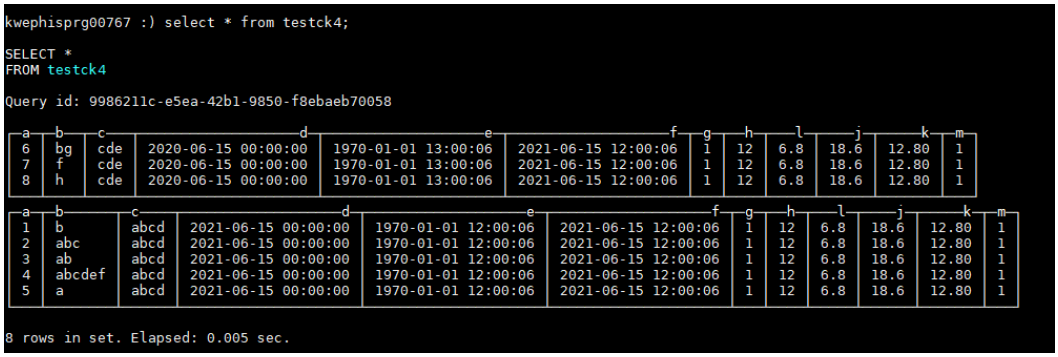
ENGINE = ReplicatedMergeTree('/clickhouse/tables/{shard}/default/testck4', '{replica}')

PARTITION BY toYYYYMM(d)ORDER BY a;

Configure the **ClickHouse Output** operator, as shown in the following figure.



After the job execution is complete, view the data in the **testck4** table.



16.8.5 Associating, Editing, Importing, or Exporting the Field Configuration of an Operator

Scenario

This section describes how to associate, import, or export the field configuration information of an operator when creating or editing a Loader job.

- Associating the field configuration of an operator

  Associate the field configuration information of an input operator with an output operator.
- Editing the field configuration of an operator

  Edit the field configuration information of an operator.
- Importing the field configuration of an operator

  Import the field configuration information to an operator by using an operator export file or operator template file.
- Exporting the field configuration of an operator

  Export the field configuration information of an operator to a JSON file and save the file to a local directory.

Prerequisites

You have obtained the username and password for logging in to the Loader web UI.

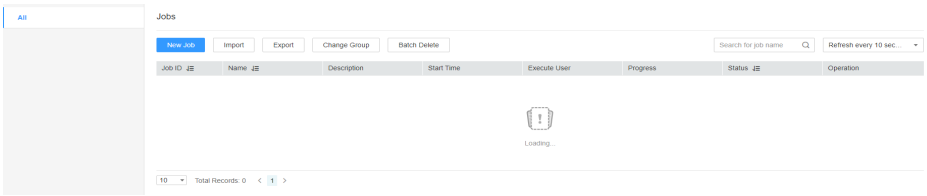
Procedure

- **Associating Field Configuration of an Operator**

Step 1 Access the Loader web UI.

1. Log in to FusionInsight Manager.
2. Choose **Cluster** > **Services** > **Loader**.
3. Click **LoaderServer(***Node name***, Active)**. The Loader web UI is displayed.

   Figure 16-69 Loader web UI

Step 2 Edit an existing job or create a new job. The **Transform** page is displayed.

Step 3 Double-click a specified input operator (such as **CSV File Input**) to go to the edit page. Add the configuration information to the parameter table of the input field.

Step 4 Double-click a specified output operator (such as **File Output**) to go to the edit page, click **associate**, and select the required field information in the displayed **associate** dialog box.

NOTE

- The field name already exists in the field table of the output operator and is not displayed in the **associate** window.
- You can also select the required field from the **field name** list. The corresponding configuration information is displayed in the parameter table of the output field.

Step 5 Click **OK**. The selected field is displayed in the parameter table of the output field.

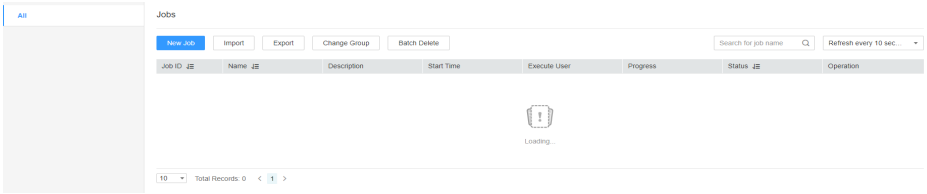
----End

- **Editing the Field Configuration of an Operator**

Step 1 Access the Loader web UI.

1. Log in to FusionInsight Manager.
2. Choose **Cluster** > **Services** > **Loader**.
3. Click **LoaderServer(***Node name***, Active)**. The Loader web UI is displayed.

Figure 16-70 Loader web UI

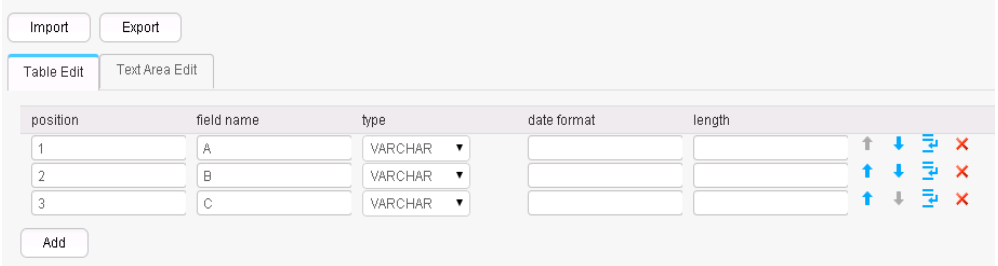


Step 2 Edit an existing job or create a new job. The **Transform** page is displayed.

Step 3 Double-click a specified operator (such as **CSV File Input**) to go to the edit page. On the **Table Edit** tab page of the input field, click **Add** and enter the field information based on the parameter requirements of the operator.

Step 4 You can move (up or down), insert a row under, and delete a field by clicking buttons corresponding to the field.

Click **Text Area Edit** to edit the field list in text format. Use commas (,) to separate field attributes.



Step 5 Click **OK**.

----End

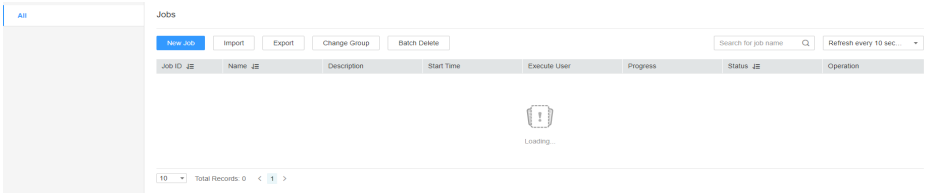
- **Importing the Field Configuration of an Operator**

Step 1 Access the Loader web UI.

1. Log in to FusionInsight Manager.

2. Choose **Cluster** > **Services** > **Loader**.
3. Click **LoaderServer(***Node name***, Active)**. The Loader web UI is displayed.

Figure 16-71 Loader web UI



Step 2 Edit an existing job or create a new job. The **Transform** page is displayed.

Step 3 Double-click a specified operator to go to the editing page and add related configuration information to the parameter table of the input or output field. Click **Import**.

Step 4 Select an import type.

- Export File

  Field configuration information is imported by using the JSON file exported by the operator.

- Specified Template

  Field configuration information is imported by using the TXT file compiled based on the operator template.

Step 5 Click  and select the upload file path.

Step 6 Click **Upload**. The field configuration information is imported to the operator.

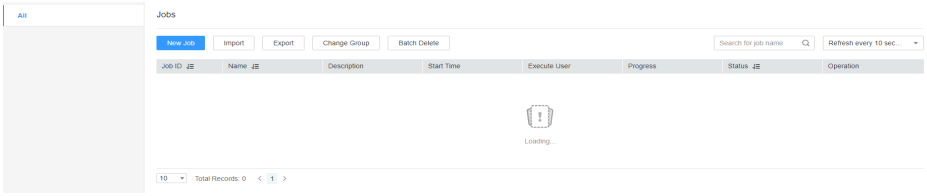
----End

- **Exporting the Field Configuration of an Operator**

Step 1 Access the Loader web UI.

1. Log in to FusionInsight Manager.
2. Choose **Cluster** > **Services** > **Loader**.
3. Click **LoaderServer(***Node name***, Active)**. The Loader web UI is displayed.

Figure 16-72 Loader web UI



Step 2 Edit an existing job or create a new job. The **Transform** page is displayed.

Step 3 Double-click a specified operator to go to the editing page, add related configuration information to the parameter table of the input or output field, and click **Export**.

Step 4 Select an export type.

- All

  All field information is exported as a JSON file and saved to a local directory.
- Specified Field Name

  Fields selected in the field list are exported as a JSON file and saved to a local directory.

Step 5 Click **OK**.

----End

16.8.6 Using Macro Definitions in Configuration Items

When creating or editing Loader jobs, users can use macro definitions during parameter configuration. Then the parameters can be automatically changed to corresponding macro values when a job is implemented.

NOTE

- The macro definitions take effect in the job only.
- Macro definitions can be imported and exported together with an import or export job. If a job uses macro definitions, the exported job includes the macro definitions. Macro definitions are imported by default when a job is imported.
- For details about the format of the first parameter in the **dateformat**time macro, see **java.text.SimpleDateFormat.java**. The restrictions of the target system must be followed. For example, HDFSor OBS directories do not support special characters.

Macro Definitions of Loader

At present, Loader supports the following time macro definitions by default:

Table 16-119 Common macro definitions of Loader

Name	Result After the Replacement	Description
@{dateformat("yyyy-MM-dd")}@	2016-05-17	Indicates the current date.
@{dateformat("yyyy-MM-dd HH:mm:ss")}@	2016-05-17 16:50:00	Indicates current date and time
@{timestamp()}@	1463476137557	Indicates milliseconds since 1970.

Name	Result After the Replacement	Description
@{dateformat("yyyy-MM-dd HH:mm:ss",-7,DAYS)}@	2016-05-10 16:50:00	Indicates the latest seven days (the present time minus seven days). The second parameter supports addition and subtraction. The third parameter is a time unit for calculation. According to definitions in the **java.util.concurrent.TimeUnit.java**, time units include DAYS, HOURS, MINUTES, and SECONDS.

In the following scenarios, parameters can be configured by using macro definitions.

- Specifying a data directory that is named by the current date

  The parameter is set to **/user/data/inputdate_@{dateformat("yyyy-MM-dd")} @**.
- Querying data in the latest seven days by using SQL

  ```
  select * from table where time between '@{dateformat("yyyy-MM-dd HH:mm:ss",-7,DAYS)}@' and '@{dateformat("yyyy-MM-dd HH:mm:ss")}@'
  ```
- Specifying a table that is named by the current date

  The parameter is set to **table_@{dateformat("yyyy-MM-dd")} @parmvalue**.

16.8.7 Operator Data Processing Rules

In Loader data import and export tasks, each operator defines different processing rules for null values and empty strings in raw data. Dirty data cannot be imported or exported.

The following table describes the operator data processing rules for each conversion procedure.

Table 16-120 Data processing rules

Procedure	Description
CSV file input	• If a delimiter appears twice consecutively in the original data, an empty string field is generated. • It can be configured that all data becomes dirty data when the number of input field columns is greater than the number of field columns actually included in the original data. • If a type conversion error occurs, the current data is saved as dirty data.
Fixed file input	• If the original data includes null values, no conversion is performed. • It can be configured that all data becomes dirty data when the number of input field columns is greater than the number of field columns actually included in the original data. • If the configured field conversion type is different from the actual type of the original data, all data becomes dirty data. For example, convert the string type to the numeric type. • If the configured field split length is greater than the length of the original field value, the data split fails and the current line becomes dirty data.
Table input	• If the original data includes null values, no conversion is performed. • It can be configured that all data becomes dirty data when the number of input field columns is greater than the number of field columns actually included in the original data. • If the configured field conversion type is different from the actual type of the original data, all data becomes dirty data. For example, convert the string type to the numeric type.

Procedure	Description
HBase input	• If the original data includes null values, no conversion is performed. • If the HBase table name is incorrect, all data becomes dirty data. • If the primary key column is not configured in **Is rowkey**, all data becomes dirty data. • It can be configured that all data becomes dirty data when the number of input field columns is greater than the number of field columns actually included in the original data. • If the configured field conversion type is different from the actual type of the original data, all data becomes dirty data. For example, convert the string type to the numeric type.
Long integer time conversion	• If the original data includes null values, no conversion is performed. • It can be configured that all data becomes dirty data when the number of input field columns is greater than the number of field columns actually included in the original data. • If a type conversion error occurs, the current data is saved as dirty data.
Null value conversion	• If the original data contains null values, data is converted to a specified value. • It can be configured that all data becomes dirty data when the number of input field columns is greater than the number of field columns actually included in the original data.
Random value conversion	Processing of null value and empty string is not involved, and dirty data is not generated.
Constant field addition	Processing of null value and empty string is not involved, and dirty data is not generated.
Concat fields	• If the original data contains null values, data is converted to empty string. • It can be configured that all data becomes dirty data when the number of input field columns is greater than the number of field columns actually included in the original data.
Extracts fields	• If the original data contains null values, the current line becomes dirty data. • If the number of field columns after separation is greater than the actual number allowed by the original data, the line will become dirty data.

Procedure	Description
Modulo integer	• If the original data contains null values, the current line becomes dirty data. • It can be configured that all data becomes dirty data when the number of input field columns is greater than the number of field columns actually included in the original data. • If data type conversion fails, the current line becomes dirty data.
String cut	• If the input data is null, no conversion is performed. • It can be configured that all data becomes dirty data when the number of input field columns is greater than the number of field columns actually included in the original data. • If the start or end position of the string to be truncated is greater than the length of the input field, the current line becomes dirty data.
EL operation	• If the input data is null, no conversion is performed. • Enter the value of one or more fields and output the calculation result. • When the input type is incompatible with the operator, the current row is dirty data.
String case conversion	• If the input data is null, no conversion is performed. • It can be configured that all data becomes dirty data when the number of input field columns is greater than the number of field columns actually included in the original data.
String reverse	• If the input data is null, no conversion is performed. • It can be configured that all data becomes dirty data when the number of input field columns is greater than the number of field columns actually included in the original data.
String trim	• If the input data is null, no conversion is performed. • It can be configured that all data becomes dirty data when the number of input field columns is greater than the number of field columns actually included in the original data.

Procedure	Description
Filter rows	• When the condition logic is **AND**, if no filter condition is added, all data becomes dirty data; if the original data meets all the added filter conditions, the current line becomes dirty data. • When the condition logic is **OR**, if no filter condition is added, all data becomes dirty data; if the original data meets all the added filter conditions, the current line becomes dirty data.
File output Table output	• If the input data is null, no conversion is performed. • It can be configured that all data becomes dirty data when the number of input field columns is greater than the number of field columns actually included in the original data. • If data type conversion fails, the current line becomes dirty data.
HBase output	• If the original data contains null values and **Store null column** is set to **true**, data is converted to empty string and saved. If **Store null column** is set to **false**, data will not be saved. • It can be configured that all data becomes dirty data when the number of input field columns is greater than the number of field columns actually included in the original data. • If data type conversion fails, the current line becomes dirty data.
Hive output	• If one or more columns are designated as partition columns, the **Partition Handlers** feature is displayed on the **To** page. **Partition Handlers** specifies the number of handlers for processing data partitioning. • If no column is designated as partition columns, input data does not need to be partitioned, and **Partition Handlers** is hidden by default. • It can be configured that all data becomes dirty data when the number of input field columns is greater than the number of field columns actually included in the original data. • If data type conversion fails, the current line becomes dirty data.

16.9 Client Tools

16.9.1 Running a Loader Job Through CLI

Scenario

Generally, users can manually manage data import and export jobs on the Loader UI. If you need to update and run Loader jobs by executing the shell script, you must configure the installed Loader client.

NOTE

Loader is incompatible with the client of an earlier version. If you reinstall the cluster or the Loader service, download and install the client again, and then use the client.

Prerequisites

- The Loader client has been installed. During the installation of the Loader client using a non-root user, if another user wants to use the client, the user needs to be authorized by the user who installs the client or a user with more rights (the Loader client installation directory needs to be granted with right 755). Please pay attention to the security problems after the authorization.
- The user for accessing the Loader service has been created. If the user is a machine-machine user, the keytab file must be downloaded..

Procedure

Step 1 Configure the Loader shell client.

1. Log in to the node where the client is located as the user who installs the client.
2. Run the following command to disable logout upon timeout:

   TMOUT=0

   NOTE

   After the operations in this section are complete, run the **TMOUT=***Timeout interval* command to restore the timeout interval in a timely manner. For example, **TMOUT=600** indicates that a user is logged out if the user does not perform any operation within 600 seconds.
3. Run the following command to go to the Loader client installation directory, for example, **/opt/client/Loader**:

   cd /opt/client/Loader
4. Run the following command to configure environment variables:

   source/opt/client/bigdata_env
5. If the cluster is in security mode, run the following command to authenticate the user. In normal mode, user authentication is not required.

   kinit *Component service user*
6. Run the following command to modify the tool authorization configuration file **login-info.xml**, save the file, and exit. For the parameters in the configuration file, see **Table 16-121**.

   vi loader-tools-1.99.3/loader-tool/job-config/login-info.xml

Table 16-121 Parameters of **login-info.xml**

Parameter	Description
hadoop.config.path	Storage directory of the **core-site.xml**, **hdfs-site.xml**, and **krb5.conf** configuration files of the MRS cluster. These three files are stored in the ***Loader Client installation directory*/Loader/loader-tools-1.99.3/loader-tool/hadoop-config/** directory by default.
authentication.type	Authentication type of the Loader service. Set this parameter based on MRS cluster authentication mode. – **kerberos** indicates the security mode. – **simple** indicates the normal mode.
user.keytab	Whether to use the keytab file for authentication. The options are **true**, and **false**.
authentication.user	User for login when the normal mode or password authentication is used. In the keytab login mode, this parameter does not need to be set.
authentication.password	Encrypted password of the user for accessing the Loader service if the keytab file authentication is not used in the security mode. **NOTE** Run the following command to encrypt the password as the user who installs the client. When the encryption tool runs for the first time, a random dynamic key is automatically generated and stored in **.loader-tools.key**. The encryption tool uses this dynamic key to encrypt passwords every time. After **.loader-tools.key** is deleted, a new random key will be generated and stored in **.loader-tools.key** when the encryption tool runs. Commands carrying authentication passwords pose security risks. Disable historical command recording before running such commands to prevent information leakage. **sh** *Loader client installation directory*/**Loader/loader-tools-1.99.3/encrypt_tool** *password*

Parameter	Description
authentication.principal	**Machine-Machine** username for accessing the Loader service when the keytab file authentication is used in the security mode.
authentication.keytab	Absolute keytab file directory of the Machine-Machine user for accessing the Loader service when the keytab file authentication is used in the security mode.
zookeeper.quorum	Service IP address and port for accessing ZooKeeper, in the format of **IP1:port,IP2:port,IP3:port**. The default port number is 2181.
sqoop.server.list	Floating IP address and port for accessing Loader. The value format is Floating IP address:Port number. The default port number is **21351**. **NOTE** – To obtain the Loader floating IP address, log in to FusionInsight Manager, choose **Cluster** > **Services** > **Loader**, and click **Configuration** > **All Configurations**. Check the value of **loader.float.ip**. – To obtain the Loader port, log in to FusionInsight Manager, choose **Cluster** > **Services** > **Loader**, and click **Configuration** > **All Configurations**. Check the value of **LOADER_HTTPS_PORT**.

Step 2 Use the Loader shell client.

1. Run the following command to go to the Loader shell client directory. For example, if the Loader client installation directory is **/opt/client/Loader**, run the following command:

   cd /opt/client/Loader/loader-tools-1.99.3/shell-client/

2. Run the following command to use the Loader shell client to run a job:

   ./submit_job.sh -n *<arg>* **-u** *<arg>* **-jobType** *<arg>* **-connectorType** *<arg>* **-frameworkType** *<arg>*

   Table 16-122 Parameters of the Loader shell client tool

Parameter	Description
-n	(Mandatory) Job name.

Parameter	Description
-u	(Mandatory) If the parameter is set to **y**, the job parameters are updated and the job is executed. In this scenario, parameters **-jobType**, **-connectorType**, and **-frameworkType** need to be set. If the parameter is set to **n**, the job is directly executed without updating parameters.
-jobType	Job type. This parameter is mandatory when **-u** is set to **y**. **import** indicates the data import job. **export** indicates the data export job.
-connectorType	Connector type. This parameter is mandatory when **-u** is set to **y**. Parameters of external data sources can be modified as required. **sftp** indicates the connector is an SFTP connector. – In a data import job, you can modify the source file input path **-inputPath**, the source file encode format **-encodeType**, and the suffix **-suffixName** added to the input file after the source file is imported. – In a data export job, you can modify the output path **-outputPath** or the name of the exported file. **rdb** indicates the connector is a relational database connector. – In a data import job, you can modify the database mode name **-schemaName**, table name **-tableName**, SQL statement **-sql**, names of columns to be imported **-columns**, and names of partition columns **-partitionColumn**. – In a data export job, you can modify the database mode name **-schemaName**, table name **-tableName**, and the temporary table name **-stageTableName**.

Parameter	Description
-frameworkType	Data storage type on MRS. This parameter is mandatory when **-u** is set to **y**. Parameters of data storage types can be modified as required. **hdfs** indicates that the HDFS is used to store data on Hadoop. – In a data import job, you can modify the number of started maps **-extractors** and the storage directory of imported data in the HDFS **-outputDirectory**. – In a data export job, you can modify the number of started maps **-extractors**, the input path of data exported from the HDFS **-inputDirectory**, and the file filter criteria of the data export job **-fileFilter**. **hbase** indicates that HBase is used to store data on MRS. In the data import and export job, you can modify the number of started maps **-extractors**.

----End

Task Examples

- Run a job whose name is **sftp-hdfs** without updating job parameters:

  ./submit_job.sh -n sftp-hdfs -u n

- Update the input path, encoding type, suffix, output path, and number of started maps of the data import job whose name is **sftp-hdfs**, and run the job:

  ./submit_job.sh -n sftp-hdfs -u y -jobType import -connectorType sftp -inputPath /opt/tempfile/1 -encodeType UTF-8 -suffixName '' -frameworkType hdfs -outputDirectory /user/user1/tttest -extractors 10

- Update the database mode, table name, and output path of the data import job whose name is **db-hdfs**, and run the job.

  ./submit_job.sh -n db-hdfs -u y -jobType import -connectorType rdb -schemaName public -tableName sq_submission -sql '' -partitionColumn sqs_id -frameworkType hdfs -outputDirectory /user/user1/dbdbt

16.9.2 loader-tool Usage Guide

Overview

loader-tool is a Loader client tool. It consists of three tools: **lt-ucc**, **lt-ucj**, **lt-ctl**.

Loader supports two modes, parameter mode and job template mode. Either mode can be used to create, update, query, and delete connectors, and to create, update, query, delete, start, and stop Loader jobs.

NOTE

loader-tool implements an asynchronous interface. After a command is submitted, the command output is not returned to the console in real time. Therefore, the results of the creation, update, query, and deletion operations on a connector and the creation, update, query, deletion, start, and stop operations on a Loader job must be confirmed on the Loader WebUI or by querying server logs.

- Parameter mode:

  Add a parameter invoking script with specific parameters.

- Job template mode:

  Change the values of all parameters in a job template and reference the job template when invoking a script.

  After a Loader client is installed, the system automatically generates job templates for various scenarios in the *Loader client installation directory*/**loader-tools-1.99.3/loader-tool/job-config/** directory. The parameters vary according to job templates. Job templates contain information about jobs and associated connectors.

  Job templates are XML files. The file name format is *original data location*-**to**-*new data location*.**xml**, for example, **sftp-to-hdfs.xml**. If a job supports conversion step, a json conversion step configuration file with the same name exists, for example, **sftp-to-hdfs.json**.

  NOTE

  Job templates contain the configuration information of connectors. During the connector creation and updating, only the connector information in job templates is invoked.

Scenarios

The parameters vary according to connectors or jobs.

- To modify some parameters, use the parameter mode.
- To create a connector or job, use the job template mode.

  NOTE

  This tool currently supports the FTP, HDFS, JDBC, MySQL, Oracle, and Oracle dedicated connectors. If other types of connectors are used, you are advised to use the open-source sqoop-shell tool.

Parameters

For example, the Loader client installation directory is **/opt/client/Loader/**.

- **lt-ucc usage description**

  lt-ucc is a connector configuration tool of loader-tool user-configuration-connection and is used to create, update, and delete connectors.

Table 16-123 lt-ucc script parameter description

Parameter	Description	Example Value
-help	Help information.	-
-a <arg>	Connector action. The values include **create**, **update** and **delete** for creating, updating, and deleting connectors respectively.	create
-at <arg>	Login authentication type. The values include **kerberos** and **simple**.	kerberos
-uk <arg>	Whether to use the keytab file.	true
-au <arg>	Login authentication username.	bar
-ap <arg>	Login authentication password. The value must be an encrypted password. The password encryption method is described as follows: **sh** *Loader client installation directory*/**Loader/loader-tools-1.99.3/encrypt_tool** *non-encrypted user password* **NOTE** If a non-encrypted password contains special characters, the special characters must be escaped. For example, the dollar sign ($) is a special character and can be escaped using single quotation marks ('). If a non-encrypted password contains single quotation marks, use double quotation marks to escape the single quotation marks. If a non-encrypted password contains double quotation marks, use backslashes (\) to escape the double quotation marks. For details, see the shell escape character rules.	-
-c <arg>	Login authentication principal.	bar
-k <arg>	Login authentication keytab file.	/opt/hadoopclient/Loader/loader-tools-1.99.3/loader-tool/hadoop-config/user.keytab
-h <arg>	Specifies the configuration file path of the MRS cluster.	-h /opt/hadoopclient/Loader/loader-tools-1.99.3/loader-tool/hadoop-config

Parameter	Description	Example Value
-l <arg>	Login template file.	/opt/hadoopclient/Loader/loader-tools-1.99.3/loader-tool/job-config/login-info.xml
-s <arg>	Floating IP address and port for Loader. Format: *floating IP address: port* The default port is **21351**.	127.0.0.1:21351
-w <arg>	Job template file path for obtaining job details.	/opt/hadoopclient/Loader/loader-tools-1.99.3/loader-tool/job-config/sftp-to-hdfs.xml
-z <arg>	Service IP address and port number of ZooKeeper quorum instances, in the format of *IP address*:*Port number*. Use commas (,) to separate multiple IP addresses and port numbers.	127.0.0.0:2181,127.0.0.1:2181
-n <arg>	Connector name	vt_sftp_test
-t <arg>	Connector type	sftp-connector
-P <arg>	Used to update the value of an attribute. The format is -Pparam1=value1. param1 indicates the attribute name of the connector in the job template. Password parameters are required for updating SFTP and FTP connector information. -Pconnection.sftpPassword=*Encrypted password*	-Pconnection.sftpServerIp=10.6.26.11

A complete example is as follows:

./bin/lt-ucc -l /opt/hadoopclient/Loader/loader-tools-1.99.3/loader-tool/job-config/login-info.xml -n vt_sftp_test -t sftp-connector -Pconnection.sftpPassword=*Password ciphertext* **-Pconnection.sftpServerIp=10.6.26.111 -a update**

Configuration description of a lt-ucc script job template:

Use the operation of saving SFTP data to HDFS as an example. Edit the **sftp-to-hdfs.xml** file in *Loader client installation directory***/loader-tools-1.99.3/loader-tool/job-config/** directory. The connector configuration is as follows:

```
<!-- Database connection information -->
<sqoop.connection name="vt_sftp_test" type="sftp-connector">
<connection.sftpServerIp>10.96.26.111</connection.sftpServerIp>
<connection.sftpServerPort>22</connection.sftpServerPort>
```

```
<connection.sftpUser>root</connection.sftpUser>
<connection.sftpPassword>Password ciphertext</connection.sftpPassword>
</sqoop.connection>
```

  - Creation command:

    ./lt-ucc -l /opt/hadoopclient/Loader/loader-tools-1.99.3/loader-tool/job-config/login-info.xml -w /opt/hadoopclient/Loader/loader-tools-1.99.3/loader-tool/job-config/ftp-to-hdfs.xml -a create

  - Update command:

    ./lt-ucc -l /opt/hadoopclient/Loader/loader-tools-1.99.3/loader-tool/job-config/login-info.xml -w /opt/hadoopclient/Loader/loader-tools-1.99.3/loader-tool/job-config/ftp-to-hdfs.xml -a update

  - Deletion command:

    ./lt-ucc -l /opt/hadoopclient/Loader/loader-tools-1.99.3/loader-tool/job-config/login-info.xml -w /opt/hadoopclient/Loader/loader-tools-1.99.3/loader-tool/job-config/ftp-to-hdfs.xml -a delete

- **lt-ucj usage description**

  lt-ucj is a job configuration tool of loader-tool user-configuration-job and is used to create, update, and delete jobs.

  Table 16-124 lt-ucj script parameter description

Parameter	Description	Example Value
-help	Help information.	-
-a <arg>	Job action. The values include **create**, **update**, and **delete** for creating, updating and deleting jobs respectively.	create
-at <arg>	Login authentication type. The values include **kerberos** and **simple**.	kerberos
-uk <arg>	Whether to use the keytab file.	true
-au <arg>	Login authentication username.	bar

Parameter	Description	Example Value
-ap <arg>	Login authentication password. The value must be an encrypted password. The password encryption method is described as follows: **sh** *Loader client installation directory*/**Loader/loader-tools-1.99.3/encrypt_tool** *non-encrypted user password* **NOTE** If a non-encrypted password contains special characters, the special characters must be escaped. For example, the dollar sign ($) is a special character and can be escaped using single quotation marks ('). If a non-encrypted password contains single quotation marks, use double quotation marks to escape the single quotation marks. If a non-encrypted password contains double quotation marks, use backslashes (\) to escape the double quotation marks. For details, see the shell escape character rules.	-
-c <arg>	Login authentication principal.	bar
-k <arg>	Login authentication keytab file.	/opt/hadoopclient/Loader/loader-tools-1.99.3/loader-tool/hadoop-config/user.keytab
-h <arg>	Specifies the configuration file path of the MRS cluster.	-h /opt/hadoopclient/Loader/loader-tools-1.99.3/loader-tool/hadoop-config
-l <arg>	Login template file.	/opt/hadoopclient/Loader/loader-tools-1.99.3/loader-tool/job-config/login-info.xml
-s <arg>	Floating IP address and port for Loader. Format: *floating IP address: port* The default port is 21351.	127.0.0.1:21351

Parameter	Description	Example Value
-w <arg>	Job template file for obtaining job details.	/opt/hadoopclient/Loader/loader-tools-1.99.3/loader-tool/job-config/sftp-to-hdfs.xml
-z <arg>	Service IP address and port number of ZooKeeper quorum instances, in the format of *IP address*:*Port number*. Use commas (,) to separate multiple IP addresses and port numbers.	127.0.0.0:2181,127.0.0.1:2181
-n <arg>	Name of the job.	Sftp.to.Hdfs
-cn <arg>	Connector name	vt_sftp_test
-ct <arg>	Connector type	sftp-connector
-t <arg>	Job type. The values include **IMPORT** and **EXPORT**.	IMPORT
-trans <arg>	Job associated conversion step file.	/opt/hadoopclient/Loader/loader-tools-1.99.3/loader-tool/job-config/sftp-to-hdfs.json
-priority <arg>	Job priority. The values include **LOW**, **NORMAL**, and **HIGH**.	NORMAL
-queue <arg>	Queues	default
-storageType <arg>	Storage type	HDFS
-P <arg>	Used to update the value of an attribute. The format is -Pparam1=value1. param1 indicates the attribute name of the connector in the job template. Password parameters are required for updating SFTP and FTP connector information. -Pconnection.sftpPassword=*Encrypted password*	-Pconnection.sftpServerIp=10.6.26.11

A complete example is as follows:

./bin/lt-ucj -l /opt/hadoopclient/Loader/loader-tools-1.99.3/loader-tool/job-config/login-info.xml -n Sftp.to.Hdfs -t IMPORT -ct sftp-connector -Poutput.outputDirectory=/user/loader/sftp-to-hdfs-test8888 -a update

Configuration description of a lt-ucj script job template:

Use the operation of saving SFTP data to HDFS as an example. Edit the file *loader client installation directory***/loader-tools-1.99.3/loader-tool/job-config/sftp-to-hdfs.xml**. The job configuration is as follows:

```
<!--Job name, globally unique.-->
<sqoop.job name="Sftp.to.Hdfs" type="IMPORT" queue="default" priority=" Priority NORMAL ">

<!-- External data source parameter configuration -->
<data.source connectionName="vt_sftp_test" connectionType="sftp-connector">
<file.inputPath>/opt/houjt/hive/all</file.inputPath>
<file.splitType>FILE</file.splitType>
<file.filterType>WILDCARD</file.filterType>
<file.pathFilter>*</file.pathFilter>
<file.fileFilter>*</file.fileFilter>
<file.encodeType>GBK</file.encodeType>
<file.suffixName></file.suffixName>
<file.isCompressive>FALSE</file.isCompressive>
</data.source>

<!-- MRS cluster, parameter configuration -->
<hadoop.source storageType="HDFS" >
<output.outputDirectory>/user/loader/sftp-to-hdfs</output.outputDirectory>
<output.fileOprType>OVERRIDE</output.fileOprType>
<throttling.extractors>3</throttling.extractors>
<output.fileType>TEXT_FILE</output.fileType>
</hadoop.source>

<!-- Job associated conversion step file -->
<sqoop.job.trans.file>/opt/hadoopclient/Loader/loader-tools-1.99.3/loader-tool/job-config/sftp-to-hdfs.json</sqoop.job.trans.file>
</sqoop.job>
```

- Creation command:

  ./bin/lt-ucj -l /opt/hadoopclient/Loader/loader-tools-1.99.3/loader-tool/job-config/login-info.xml -w /opt/hadoopclient/Loader/loader-tools-1.99.3/loader-tool/job-config/sftp-to-hdfs.xml -a create

- Update command:

  ./bin/lt-ucj -l /opt/hadoopclient/Loader/loader-tools-1.99.3/loader-tool/job-config/login-info.xml -w /opt/hadoopclient/Loader/loader-tools-1.99.3/loader-tool/job-config/sftp-to-hdfs.xml -a update

- Deletion command:

  ./bin/lt-ucj -l /opt/hadoopclient/Loader/loader-tools-1.99.3/loader-tool/job-config/login-info.xml -w /opt/hadoopclient/Loader/loader-tools-1.99.3/loader-tool/job-config/sftp-to-hdfs.xml -a delete

- **lt-ctl usage description**

  lt-ctl is a job management tool of loader-tool controller and is used to start or stop jobs, query job status and progress, and check whether jobs are running.

  Table 16-125 lt-ctl script parameter description

Parameter	Description	Example Value
-help	Help information.	-

Parameter	Description	Example Value
-a <arg>	Job action. The values include **status**, **start**, **stop**, and **is running** for querying job status, starting or stopping jobs, and checking whether jobs are running.	create
-at <arg>	Login authentication type. The values include **kerberos** and **simple**.	kerberos
-uk <arg>	Whether to use the keytab file.	true
-au <arg>	Login authentication username.	bar
-ap <arg>	Login authentication password. The value must be an encrypted password. The password encryption method is described as follows: **sh** *Loader client installation directory*/**Loader/loader-tools-1.99.3/encrypt_tool** *non-encrypted user password* **NOTE** If a non-encrypted password contains special characters, the special characters must be escaped. For example, the dollar sign ($) is a special character and can be escaped using single quotation marks ('). If a non-encrypted password contains single quotation marks, use double quotation marks to escape the single quotation marks. If a non-encrypted password contains double quotation marks, use backslashes (\) to escape the double quotation marks. For details, see the shell escape character rules.	-
-c <arg>	Login authentication principal.	bar
-k <arg>	Login authentication keytab file.	/opt/hadoopclient/Loader/loader-tools-1.99.3/loader-tool/hadoop-config/user.keytab
-h <arg>	Specifies the configuration file path of the MRS cluster.	-h /opt/hadoopclient/Loader/loader-tools-1.99.3/loader-tool/hadoop-config

Parameter	Description	Example Value
-l <arg>	Login template file.	/opt/hadoopclient/Loader/loader-tools-1.99.3/loader-tool/job-config/login-info.xml
-n <arg>	Name of the job.	Sftp.to.Hdfs
-s <arg>	Floating IP address and port for Loader. Format: *floating IP address: port* The default port is 21351.	127.0.0.1:21351
-w <arg>	Job template file for obtaining job details.	/opt/hadoopclient/Loader/loader-tools-1.99.3/loader-tool/job-config/sftp-to-hdfs.xml
-z <arg>	Service IP address and port number of ZooKeeper quorum instances, in the format of *IP address*:*Port number*. Use commas (,) to separate multiple IP addresses and port numbers.	127.0.0.0:2181,127.0.0.1:2181

- Command for starting jobs:

  ./bin/lt-ctl -l /opt/hadoopclient/Loader/loader-tools-1.99.3/loader-tool/job-config/login-info.xml -n Sftp.to.Hdfs -a start
- Command for viewing job status:

  ./bin/lt-ctl -l /opt/hadoopclient/Loader/loader-tools-1.99.3/loader-tool/job-config/login-info.xml -n Sftp.to.Hdfs -a status
- Command for checking whether jobs are running:

  ./bin/lt-ctl -l /opt/hadoopclient/Loader/loader-tools-1.99.3/loader-tool/job-config/login-info.xml -n Sftp.to.Hdfs -a isrunning
- Command for stopping jobs:

  ./bin/lt-ctl -l /opt/hadoopclient/Loader/loader-tools-1.99.3/loader-tool/job-config/login-info.xml -n Sftp.to.Hdfs -a stop

16.9.3 loader-tool Usage Example

Scenario

loader-tool can be used to create, update, query, and delete a connector or job by using a job template or setting parameters.

This section describes how to use loader-tool in the job template mode. The job of importing data from the SFTP server to HDFS is used as an example.

Prerequisites

The Loader client has been installed and configured. For details, see **Running a Loader Job Through CLI**.

Procedure

Step 1 Log in to the node where the client is located as the user who installs the client.

Step 2 Run the following command to go to the loader-tool directory on the Loader client, for example, **/opt/client/Loader/**:

cd /opt/client/Loader/loader-tools-1.99.3/loader-tool/

Step 3 Run the following command to modify the existing job template. For example, if the job template **sftp-to-hdfs.xml** already exists in the **/opt/hadoopclient/Loader/loader-tools-1.99.3/loader-tool/job-config/**, run the following command:

vi /opt/hadoopclient/Loader/loader-tools-1.99.3/loader-tool/job-config/sftp-to-hdfs.xml

```
<root>
<!-- Database connection information -->
<sqoop.connection name="vt_sftp_test" type="sftp-connector">
<connection.sftpServerIp>10.96.26.111</connection.sftpServerIp>
<connection.sftpServerPort>22</connection.sftpServerPort>
<connection.sftpUser>root</connection.sftpUser>
<connection.sftpPassword>Password ciphertext</connection.sftpPassword>
</sqoop.connection>

<!--Job name, globally unique.-->
<sqoop.job name="Sftp.to.Hdfs" type="IMPORT" queue="default" priority="NORMAL">
<data.source connectionName="vt_sftp_test" connectionType="sftp-connector">
<file.inputPath>/opt/houjt/hive/all</file.inputPath>
<file.splitType>FILE</file.splitType>
<file.filterType>WILDCARD</file.filterType>
<file.pathFilter>*</file.pathFilter>
<file.fileFilter>*</file.fileFilter>
<file.encodeType>GBK</file.encodeType>
<file.suffixName></file.suffixName>
<file.isCompressive>FALSE</file.isCompressive>
</data.source>

<hadoop.source storageType="HDFS" >
<output.outputDirectory>/user/loader/sftp-to-hdfs</output.outputDirectory>
<output.fileOprType>OVERRIDE</output.fileOprType>
<throttling.extractors>3</throttling.extractors>
<output.fileType>TEXT_FILE</output.fileType>
</hadoop.source>

<sqoop.job.trans.file></sqoop.job.trans.file>
</sqoop.job>
</root>
```

NOTE

Each Loader job needs to be associated with a connector. Connectors are used to read data from external data sources when data is imported to a cluster and used to write data into external data sources when data is exported from the cluster. In the preceding example, an SFTP data source connector is configured. To configure an SFTP and FTP data source connector, a password needs to be set and encrypted. The password encryption method is described as follows:

1. Run the following command to go to the **loader-tools-1.99.3** directory. For example, if the Loader client installation directory is **/opt/hadoopclient/Loader**, run the following command:

   cd /opt/hadoopclient/Loader/loader-tools-1.99.3

2. Run the following command to encrypt the non-encrypted password:

   ./encrypt_tool *Unencrypted password*

Step 4 Run the following command to go to the directory where loader-tool is located:

cd /opt/client/Loader/loader-tools-1.99.3/loader-tool

Step 5 Run the following command to use the lt-ucc tool to create a connector:

./bin/lt-ucc -l /opt/client/Loader/loader-tools-1.99.3/loader-tool/job-config/login-info.xml -w /opt/hadoopclient/Loader/loader-tools-1.99.3/loader-tool/job-config/sftp-to-hdfs.xml -a create

If no error is reported and the following information is displayed, the connector creation task is submitted successfully:

```
User login success. begin to execute task.
```

Step 6 Run the following command to use the lt-ucj tool to create a job:

./bin/lt-ucj -l /opt/client/Loader/loader-tools-1.99.3/loader-tool/job-config/login-info.xml -w /opt/hadoopclient/Loader/loader-tools-1.99.3/loader-tool/job-config/sftp-to-hdfs.xml -a create

If no error is reported and the following information is displayed, the job creation task is submitted successfully:

```
User login success. begin to execute task.
```

Step 7 Run the following command to use the lt-ctl tool to submit the job:

./bin/lt-ctl -l /opt/client/Loader/loader-tools-1.99.3/loader-tool/job-config/login-info.xml -n Sftp.to.Hdfs -a start

If the following information is displayed, the job is submitted successfully:

```
Start job success.
```

Step 8 Run the following command to view the job status:

./bin/lt-ctl -l /opt/client/Loader/loader-tools-1.99.3/loader-tool/job-config/login-info.xml -n Sftp.to.Hdfs -a status

```
Job:Sftp.to.Hdfs
Status:RUNNING
Progress: 0.0
```

----End

16.9.4 schedule-tool Usage Guide

Overview

schedule-tool is used to submit jobs of SFTP data sources. You can modify the input path and file filtering criteria before submitting a job. You can modify the output path if the target source is HDFS.

Parameters

Table 16-126 Configuration parameters of schedule.properties

Configuration parameters	Description	Example Value
server.url	Floating IP address and port for Loader. The default port is 21351. For compatibility, multiple IP addresses and ports can be configured and need to be separated by commas (,). The first IP address and port must be those of Loader. The others can be configured based on service requirements.	10.96.26.111:21351,127.0.0.2:21351
authentication.type	Login authentication mode. • **kerberos** indicates that the security mode is used and Kerberos authentication is performed. Kerberos authentication provides two authentication modes: the password mode and the keytab file mode. • **simple** indicates that the normal mode is used and Kerberos authentication is not performed.	kerberos
authentication.user	User for login when the normal mode or password authentication is used. In the keytab login mode, this parameter does not need to be set.	bar

Configuration parameters	Description	Example Value
authentication.password	User password for login when the password authentication mode is used. In the normal mode or keytab login mode, this parameter does not need to be set. The password needs to be encrypted. The encryption method is described as follows: 1. Go to the directory where **encrypt_tool** is located. For example, if the Loader client installation directory is **/opt/hadoopclient/Loader**, run the following command: **cd /opt/hadoopclient/Loader/loader-tools-1.99.3** 2. Run the following command to encrypt the non-encrypted password. Commands carrying authentication passwords pose security risks. Disable historical command recording before running such commands to prevent information leakage. **./encrypt_tool** *Unencrypted password* The obtained encrypted password is used as the value of **authentication.password**. **NOTE** If a non-encrypted password contains special characters, the special characters must be escaped. For example, the dollar sign ($) is a special character and can be escaped using single quotation marks ('). If a non-encrypted password contains single quotation marks, use double quotation marks to escape the single quotation marks. If a non-encrypted password contains double quotation marks, use backslashes (\) to escape the double quotation marks. For details, see the shell escape character rules.	-

Configuration parameters	Description	Example Value
use.keytab	Whether to use the keytab mode to log in. • **true** indicates using the keytab file to log in. • **false** indicates using the password to log in.	true
client.principal	User principal for accessing the Loader service when the keytab authentication mode is used. In the normal mode or password login mode, this parameter does not need to be set.	loader/hadoop.*System domain name* **NOTE** You can log in to FusionInsight Manager, choose **System** > **Permission** > **Domain and Mutual Trust**, and view the value of **Local Domain**, which is the current system domain name.
client.keytab	Directory where the used keytab file is located when the keytab authentication mode is used. In the normal mode or password login mode, this parameter does not need to be set.	/opt/client/conf/loader.keytab
krb5.conf.file	Directory where the **krb5.conf** file is located when the keytab authentication mode is used. In the normal mode or password login mode, this parameter does not need to be set.	/opt/client/conf/krb5.conf

Table 16-127 Configuration parameters of job.properties

Configuration parameters	Description	Example Value
job.jobName	Job name.	job1
file.fileName.prefix	File name prefix.	table1
file.fileName.posfix	File name suffix.	.txt

Configuration parameters	Description	Example Value
file.filter	File filter, which filters files by matching file names. • **true** indicates that the preceding prefix or suffix is used to match all files in the input path. For details, see the example. • **false** indicates that the preceding prefix or suffix is used to match a file in the input path. For details, see the example.	true
date.day	Number of delayed days, which is matched with the date in the name of an imported file. For example, if the input date is 20160202 and the number of delayed days is 3, files that contain the 20160205 date field in the input path are matched. For details, see **schedule-tool Usage Example**.	3
file.date.format	Log format included in the name of the file to be imported.	yyyyMMdd
parameter.date.format	Entered date format when a script is invoked, which is usually consistent with **file.date.format**.	yyyyMMdd
file.format.iscompressed	Whether the file to be imported is a compressed file.	false
storage.type	Storage type. The final type of the file to be imported include HDFS, HBase, and Hive.	HDFS

NOTE

schedule-tool supports the configuration of multiple jobs at the same time. When multiple jobs are configured at the same time, **job.jobName**, **file.fileName.prefix**, and **file.fileName.posfix** in Table 16-127 need to be configured with multiple values, and the values need to be separated by **commas (,)**.

Precautions

server.url must be set to a format string of two IP addresses and port numbers, and the IP addresses and ports need to be separated by **commas (,)**.

16.9.5 schedule-tool Usage Example

Scenario

After a job is created using the Loader WebUI or Loader-tool, use schedule-tool to execute the job.

Prerequisites

The Loader client has been installed and configured. For details, see **Running a Loader Job Through CLI**.

Procedure

Step 1 In the directory **/opt/houjt/test03** on the SFTP server, create multiple files with **table1** as the prefix, **.txt** as the suffix, and **yyyyMMdd** as the date format in the middle of the file name.

Figure 16-73 Example

```
[root@C12-RHEL64-ZYL111 test03]# ll
total 36
-rw-r--r--. 1 root root 54 Feb 29 19:11 table120160221.txt
-rw-r--r--. 1 root root 54 Feb 29 19:11 table120160222.txt
-rw-r--r--. 1 root root 54 Feb 29 19:11 table120160223.txt
-rw-r--r--. 1 root root 54 Feb 29 19:11 table120160224.txt
-rw-r--r--. 1 root root 54 Feb 29 19:11 table120160225.txt
-rw-r--r--. 1 root root 54 Feb 29 19:11 table120160226.txt
-rw-r--r--. 1 root root 54 Feb 29 18:43 table120160227.txt
-rw-r--r--. 1 root root 54 Feb 29 19:11 table120160228.txt
-rw-r--r--. 1 root root 54 Feb 29 19:11 table120160229.txt
```

Step 2 Create a Loader job of importing data from the SFTP server to HDFS. For details, see **Typical Scenario: Importing Data from an SFTP Server to HDFS or OBS**.

Step 3 Log in to the node where the client is located as the user who installs the client.

Step 4 Run the following command to go to the **conf** directory of schedule-tool. For example, if the Loader client installation directory is **/opt/client/Loader/**, run the following command:

cd /opt/client/Loader/loader-tools-1.99.3/schedule-tool/conf

Step 5 Run the following command to edit the schedule.properties file and configure the login mode:

vi schedule.properties

schedule-tool supports two login modes. Only one mode can be selected. For parameter details, see **schedule-tool Usage Guide**.

- When the password mode is used for login, the configuration information example is as follows:

```
[server.url = 10.10.26.187:21351,127.0.0.2:21351]
[authentication.type = kerberos]
[use.keytab = false]
[authentication.user = admin]
# Passwords stored in plaintext pose security risks. Store them in ciphertext in configuration files or
```

```
environment variables.
[authentication.password= xxx]
```

- When the keytab file mode is used for login, the configuration information example is as follows:

```
[server.url = 10.10.26.187:21351,127.0.0.2:21351]
[authentication.type = kerberos]
[use.keytab = true]
[client.principal = bar]
[client.keytab = /opt/hadoopclient/Loader/loader-tools-1.99.3/loader-tool/hadoop-config/user.keytab]
[krb5.conf.file = /opt/hadoopclient/Loader/loader-tools-1.99.3/loader-tool/hadoop-config/krb5.conf]
```

Step 6 Run the following command to edit the job.properties file and configure job information:

vi job.properties

```
#job name
job.jobName = sftp2hdfs-schedule-tool


#Whether to update the loader configuration parameters(File filter)£?This parameter is used to match the import file name.Values are true or false.
#false means update.the file name which is get by schedule tool will be updated to Loader configuration parameters (File filter).
#false means no update.the file name which is get by schedule tool will be updated to Loader configuration parameters (import path).
file.filter = false


#File name = prefix + date + suffix
#Need to import the file name prefix
file.fileName.prefix=table1

#Need to import the file name suffixes
file.fileName.posfix=.txt

#Date Days.Value is an integer.
#According to the date and number of days to get the date of the import file.
date.day = 1

#Date Format.Import file name contains the date format.Format Type£ºyyyyMMdd,yyyyMMdd HHmmss,yyyy-MM-dd,yyyy-MM-dd HH:mm:ss
file.date.format = yyyyMMdd

#Date Format.Scheduling script execution. Enter the date format.
parameter.date.format = yyyyMMdd


#Whether the import file is a compressed format.Values ??are true or false.
#true indicates that the file is a compressed format£?Execution scheduling tool will extract the files.false indicates that the file is an uncompressed.Execution scheduling tool does not unpack.
file.format.iscompressed = false

#Hadoop storage type.Values are HDFS or HBase.
storage.type = HDFS
```

According to the data provided by **Step 1**, the filtering rules are set as follows when the **table120160221.txt** file is used as an example:

- File name prefix:
  file.fileName.prefix=table1
- File name suffix:
  file.fileName.posfix=.txt
- Date format included in the file name:
  file.date.format = yyyyMMdd

- Entered date parameter for invoking the script:

  parameter.date.format = yyyyMMdd

- Number of delayed days.

  date.day = 1

  For example, if the input date parameter of the script is **20160220**, the result is **20160221** by using the addition.

  NOTE

  If the **./run.sh 20160220 /user/loader/schedule_01** command is executed, the preceding filtering rules will be combined into a string: **"table1"+"20160221"+.txt = table120160221.txt**.

Step 7 Select a filtering rule according to the value of **file.filter**.

- If a file is to be exactly matched, go to **Step 8**.
- If a series of files are to be fuzzily matched, go to **Step 9**.

Step 8 Change the value of **file.filter** in the **job.properties** file to **false**.

Run the following commands to run the job. The task is completed.

cd /opt/client/Loader/loader-tools-1.99.3/schedule-tool

./run.sh *20160220 /user/loader/schedule_01*

20160220 indicates the input date, and */user/loader/schedule_01* indicates the output path.

NOTE

The string **table120160221.txt** obtained by combining the preceding filtering rules will be used as the file name and appended to the input path of the job. Therefore, the job will only process the uniquely matched file **table120160221.txt**.

Step 9 In the **job.properties** file, change the value of **file.filter** to **true**, and set the value of **file.fileName.prefix** to *****.

Run the following commands to run the job. The task is completed.

cd /opt/client/Loader/loader-tools-1.99.3/schedule-tool

./run.sh *20160220 /user/loader/schedule_01*

20160220 indicates the input date, and */user/loader/schedule_01* indicates the output path.

NOTE

The string ***20160221.txt** obtained by combining the preceding filtering rules will be used as the fuzzy match mode of the file filter. In the input path of the job, all files matching ***20160221.txt** will be processed by the job.

----End

16.9.6 Using loader-backup to Back Up Job Data

Scenario

After a job is created using the Loader WebUI or loader-tool, use loader-backup to back up data.

NOTE

- Only Loader jobs of data export support data backup.
- This tool is an internal Loader interface and is invoked by the upper-layer component HBase. Only the data backup from HDFS to SFTP is supported.

Prerequisites

The Loader client has been installed and configured. For details, see **Running a Loader Job Through CLI**.

Procedure

Step 1 Log in to the node where the client is installed as the user who installs the client. For details, see **Running a Loader Job Through CLI**.

Step 2 Run the following command to go to the directory where the **backup.properties** file is located. For example, if the Loader client installation directory is **/opt/client/Loader/**, run the following command:

cd /opt/client/Loader/loader-tools-1.99.3/loader-backup/conf

Step 3 Run the following command to modify the configuration parameters of **backup.properties**. For details about the parameters, see **Table 16-128**.

vi backup.properties

```
server.url = 10.0.0.1:21351,10.0.0.2:12000
authentication.type = kerberos
authentication.user =
authentication.password=
job.jobId = 1
use.keytab = true
client.principal = loader/hadoop
client.keytab = /opt/client/conf/loader.keytab
```

Table 16-128 Configuration parameters

Configuration parameters	Description	Example Value
server.url	Floating IP address and port (21351) for Loader. For compatibility, multiple IP addresses and ports can be configured and need to be separated by commas (,). The first IP address and port must be those of Loader (21351). The others can be configured based on service requirements.	10.0.0.1:21351,10.0.0.2:12000
authentication.type	Login authentication mode. • **kerberos** indicates that the security mode is used and Kerberos authentication is performed. Kerberos authentication provides two authentication modes: the password mode and the keytab file mode. • **simple** indicates that the normal mode is used and Kerberos authentication is not performed.	kerberos
authentication.user	User for login when the normal mode or password authentication is used. In the keytab login mode, this parameter does not need to be set.	bar

Configuration parameters	Description	Example Value
authentication.password	User password for login when the password authentication mode is used. In the normal mode or keytab login mode, this parameter does not need to be set. The password needs to be encrypted. The encryption method is described as follows: 1. Go to the directory where **encrypt_tool** is located. For example, if the Loader client installation directory is **/opt/hadoopclient/Loader**, run the following command: **cd /opt/hadoopclient/Loader/loader-tools-1.99.3** 2. Run the following command to encrypt the non-encrypted password. Commands carrying authentication passwords pose security risks. Disable historical command recording before running such commands to prevent information leakage. **./encrypt_tool** *Unencrypted password* The obtained encrypted password is used as the value of **authentication.password**. **NOTE** If a non-encrypted password contains special characters, the special characters must be escaped. For example, the dollar sign ($) is a special character and can be escaped using single quotation marks ('). If a non-encrypted password contains single quotation marks, use double quotation marks to escape the single quotation marks. If a non-encrypted password contains double quotation marks, use backslashes (\) to escape the double quotation marks. For details, see the shell escape character rules.	-

Configuration parameters	Description	Example Value
job.jobId	ID of the job whose data is to be backed up. Job IDs can be viewed under created jobs on the Loader web UI.	1
use.keytab	Whether to use the keytab mode to log in. ● **true** indicates using the keytab file to log in. ● **false** indicates using the password to log in.	true
client.principal	User principal for accessing the Loader service when the keytab authentication mode is used. In the normal mode or password login mode, this parameter does not need to be set.	loader/hadoop
client.keytab	Directory where the used keytab file is located when the keytab authentication mode is used. In the normal mode or password login mode, this parameter does not need to be set.	/opt/client/conf/loader.keytab

Step 4 Run the following command to go to the directory where the backup script **run.sh** is located. For example, if the Loader client installation directory is **/opt/hadoopclient/Loader**, run the following command:

cd /opt/hadoopclient/Loader/loader-tools-1.99.3/loader-backup

Step 5 Run the following command to run the backup script **run.sh** to back up Loader job data. The system backs up data to a directory at the same layer of the job output directory.

./run.sh *Backup data input directory*

For example, the backup data input directory is **/user/hbase/**, and the job output directory is**/opt/client/sftp/sftp1**. **sftp1** acts as a placeholder. Run the following command to back up data to the **/opt/client/sftp/hbase** directory:

./run.sh /user/hbase/

----End

16.9.7 Open Source sqoop-shell Tool Usage Guide

Overview

Sqoop-shell is a shell tool of Loader. All its functions are implemented by executing the **sqoop2-shell** script.

The sqoop-shell tool provides the following functions:

- Creating and updating connectors
- Creating and updating jobs
- Deleting connectors and jobs
- Starting jobs in the synchronous or asynchronous mode.
- Stopping jobs
- Viewing job status
- Viewing historical execution records of jobs
- Cloning connectors and jobs
- Creating and updating conversion steps
- Specifying line and field separators

The sqoop-shell tool supports the following modes:

- Interaction mode

  Users execute the **sqoop2-shell** script without parameters to go to the particular interaction window of Loader. After the contents of the script are input, the tool returns the relevant information to the interaction window.

- Batch mode

  The **sqoop2-shell** script has a file name as a parameter and multiple commands are stored in lines in the file. The sqoop-shell tool runs all commands in the file in sequence by executing the script. Alternatively, users can execute the **sqoop2-shell** script, to the end of which a command is attached with the **-c** parameter as the bridge. In this case, the sqoop-shell tool runs one command each time.

The sqoop-shell implements functions of Loader by running the commands in **Table 16-129**.

Table 16-129 Command list

Command	Description
exit	Exits the interaction mode. This command is supported only in the interaction mode.
history	Views the executed commands. This command is supported only in the interaction mode.
help	Views the tool help information.

Command	Description
set	Sets server attributes.
show	Displays service attributes and all the metadata information of Loader.
create	Creates connectors and jobs.
update	Updates connectors and jobs.
delete	Deletes connectors and jobs.
clone	Clones connectors and jobs.
start	Starts jobs.
stop	Stops jobs.
status	Views job status.

Commands

- The sqoop2-shell tool provides two methods to obtain login authentication information. The first method is to obtain login authentication information from the configuration file. For details about the configuration items, see **Example for Using the Open-Source sqoop-shell Tool (SFTP-HDFS)** and **Example for Using the Open-Source sqoop-shell Tool (Oracle-HBase)**. The second one is to obtain the authentication information by using parameters. Two modes are available in the second method: password mode and Kerberos authentication mode.
- Command for accessing the interaction mode

  Execute the **sqoop2-shell** script without parameters to go to the sqoop tool window and run the commands one by one.

  Run the following command to obtain the authentication information by reading the configuration file:

  ./sqoop2-shell

  Run the following command to authenticate login using the password mode:

  ./sqoop2-shell -uk false -u *username* **-p** *encryptedPassword*

  Commands carrying authentication passwords pose security risks. Disable historical command recording before running such commands to prevent information leakage.

  Run the following command to authenticate login using the Kerberos mode:

  ./sqoop2-shell -uk true -k *user.keytab* **-s** *userPrincipal*

  The following information is displayed:

  ```
  Welcome to sqoop client
  Use the username and password authentication mode
  ```

```
Authentication success.
Sqoop Shell: Type 'help' or '\h' for help.

sqoop:000>
```

- Command for entering the batch mode

  Two methods are available for accessing the batch mode.

  1. Execute the **sqoop2-shell** script, in which a file name is used as a parameter and multiple commands are stored in lines in this file. The sqoop-shell tool runs all commands in the file in sequence. The script must be stored in the home directory of the current user, for example, **/root/batchCommand.sh**.

  Run the following command to authenticate login by reading configuration files:

  ./sqoop2-shell */root/batchCommand.sh*

  Run the following command to authenticate login using the password mode:

  ./sqoop2-shell -uk false -u *username* **-p** *encryptedPassword /root/batchCommand.sh*

  Run the following command to authenticate login using the Kerberos mode:

  ./sqoop2-shell -uk true -k *user.keytab* **-s** *userPrincipal /root/batchCommand.sh*

  batchCommand.sh is the user-defined name of the text file.

  2. Execute the **sqoop2-shell** script, to the end of which a command is attached with the -c parameter as the bridge. The sqoop-shell tool will execute the command.

  Run the following command to authenticate login by reading configuration files:

  ./sqoop2-shell *-c expression*

  Run the following command to authenticate login using the password mode:

  ./sqoop2-shell -uk false -u *username* **-p** *encryptedPassword -c expression*

  Run the following command to authenticate login using the Kerberos mode:

  ./sqoop2-shell -uk true -k *user.keytab* **-s** *userPrincipal -c expression*

  expression is the attached statement, whose format is the same as that in the text file in the first method.

- Exit command

  This command is used for exiting the interaction mode and supported only in the interaction mode.

  Example:

```
Welcome to sqoop client
Use the username and password authentication mode
Authentication success.
Sqoop Shell: Type 'help' or '\h' for help.

sqoop:000> exit
10-5-211-9:/opt/hadoopclient/Loader/loader-tools-1.99.3/sqoop-shell#
```

- History command

  This command is used for viewing the executed commands and supported only in the interaction mode.

  Example:

```
sqoop:000> history
  0  show connector
  1  create connection -c 4
  2  show connections;
  3  show connection;
  4  show connection -a;
  5  show connections;
  6  show connection;
  7  show connection -x 53;
  8  show connection -x 52;
  9  show connection -x 2
 10  show connection -x 53;
 11  show connection
 12  show connection -x 53
 13  create job -x 53 -t import
 14  show connector
 15  create connection -c 5
 16  show connection -x 54
 17  exit
 18  show connector
 19  create connection -c 5
 20  exit
 21  show connector
 22  create connection -c 6
 23  create job -x 20 -t import
 24  start job -j 85 -s
 25  \x
 26  exit
 27  history
sqoop:000>
```

- Help command

  This command is used for viewing the tool help information.

  Example:

```
sqoop:000> help
For information about Sqoop, visit: http://sqoop.apache.org/docs/1.99.3/index.html

Available commands:
  exit    (\x  ) Exit the shell
  history (\H  ) Display, manage and recall edit-line history
  help    (\h  ) Display this help message
  set     (\st ) Set server or option Info
  show    (\sh ) Show server, connector, framework, connection, job, submission or option Info
  create  (\cr ) Create connection or job Info
  delete  (\d  ) Delete connection or job Info
  update  (\up ) Update connection or job Info
  clone   (\cl ) Clone connection or job Info
  start   (\sta) Start job
  stop    (\stp) Stop job
  status  (\stu) Status job

For help on a specific command type: help command

sqoop:000>
```

- Set command

  The set command is used for setting attributes of clients and servers and supports the following attributes:

  – **server** indicates setting the connection attributes for servers.

    NOTE

    When attribute -u is set, attributes -h, -p, and -w can be ignored.

  – **option** indicates setting the client attributes.

NOTE

option can be set by key values. For example, **set option --name verbose --value true**.

Attribute Type	Subattribute	Description
server	-h,--host	Service IP address.
	-p,--port	Service Port
	-w,--webapp	Tomcat application name.
	-u,--url	Sqoop service URL.
option	verbose	Redundancy mode, which indicates that more information is printed.
	poll-timeout	Sets the polling timeout duration.

Example:

```
set option --name verbose --value false
set server --host 10.0.0.1 --port 21351 --webapp loader
```

- **show** command

  This command is used for displaying information, such as variable information and storage metadata information.

Attribute Type	Subattribute	Description
server	-a,--all	Displays all server attributes.
	-p,--port	Displays the service port.
	-w,--webapp	Displays the Tomcat application name.
	-h,--host	Displays the service IP address.
option	-name	Displays the attributes of the specified name.
connector	-a,--all	Displays information about all connection types.
	-c,--cid	Displays information about the connection type of a specified ID.

Attribute Type	Subattribute	Description
framework	None.	Displays metadata information about frameworks.
connection	-a,--all	Displays all connection attributes.
	-x,--xid	Displays the attributes of a specified connection.
	-n,--name	Displays the connection attributes of a specified name.
job	-a,--all	Displays information about all jobs.
	-j,--jid	Displays job information about a specified ID.
	-n,--name	Displays job information about a specified name.
submission	-j,--jid	Displays the submission record of a specified job.
	-d,--detail	Displays details.

Example:

```
show server -all
show option --name verbose
show connector -all
show framework
show connection -all
show connection -n sftp-example
show job -all
show job -j 1
show submission --jid 1
show submission --jid 1 -d
```

- Create command

  This command is used for creating connectors and jobs.

Attribute Type	Subattribute	Description
connection	-c,--cid	Specifies the ID of a connector type.
	-cn,--cname	Specifies the name of a specified connector type.
job	-x,--xid	Specifies the connector ID.

Attribute Type	Subattribute	Description
	-xn,--xname	Specifies the connector name.
	-t,--type	Specifies the job type. Possible values: ● import ● export

– In the interaction mode, enter the attribute values one by one as prompted.

  Example for creating connectors:

  ```
  create connection -c 1
  create connection -cn example
  ```

  Example for creating jobs:

  ```
  create job -x 1 -t import
  create job -xn job_example -t export
  ```

– In the batch mode, run the following command to view the specific attribute and then set a value for the attribute:

  create job -t import -x 1 --help

  You can run the above command in either of the following ways:

  Save the command to a text file and attach this file to the end of the **sqoop-shell** script, and run the following command:

  ./sqoop2-shell *batchCommand.sh*

  Attach a command with the **-c** parameter to the end of the **sqoop-shell** script and run the following command:

  ./sqoop2-shell *-c expression*

  For details about command execution, refer to previous description in this section. The following shows two complete commands:

  Example for creating connectors:

  ```
  create connection -c 4 --connector-connection-sftpPassword xxxxx --connector-connection-sftpServerIp 10.0.0.1 --connector-connection-sftpServerPort 22 --connector-connection-sftpUser root--name testConnection
  ```

  Example for creating jobs:

  ```
  create job -t import -x 1 --connector-file-inputPath /opt/tempfile --connector-file-fileFilter * --framework-output-outputDirectory /user/loader/1 --framework-output-storageType HDFS --framework-throttling-extractorSize 120 --framework-output-fileType TEXT_FILE --connector-file-splitType FILE -queue default -priority low -name newJob
  ```

– In the batch mode, you can attach a statement using the **-c** parameter as the bridge.

  Example for creating connectors:

  ```
  ./sqoop2-shell -c "create connection -c 4 --connector-connection-sftpPassword xxxxx --connector-connection-sftpServerIp 10.0.0.1 --connector-connection-sftpServerPort 22 --connector-connection-sftpUser root--name testConnection"
  ```

- **update** command

  This command is used for updating connectors and jobs.

Attribute Type	Subattribute	Description
connection	-x,--xid	Specifies the connector ID. **NOTE** When the connectors are updated, the password must be set.
job	-j,--jid	Specifies the job ID.

  - Interaction mode

    Example for updating connectors:

    ```
    update connection --xid 1
    ```

    Example for updating jobs:

    ```
    update job --jid 1
    ```

  - Batch mode

    Example for updating connectors:

    ```
    update connection -x 6 --connector-connection-sftpServerPort 21 - --name sfp_130--connector-connection-sftpPassword xxxx
    ```

    Example for updating jobs:

    Example 1:

    ```
    update job -jid 1 -name sftp2hdfs --connector-file-fileFilter *.txt
    ```

    Example 2:

    ```
    ./sqoop2-shell -uk true -k /opt/loader/user.keytab -s luser /opt/loader/testupdate.txt
    ./sqoop2-shell -uk true -k /opt/loader/user.keytab -s luser -c "update job --jid 24 --name oracle-hive --connector-table-sql 'SELECT * FROM range_example WHERE replace(datadt,\'-\',\'\')='20240801' and \${CONDITIONS}'"
    ```

    NOTE

    When updating a job, you can write the update commands in a file, for example, **/opt/loader/testupdate.txt** (the file name can be customized), or specify the commands using **--connector-table-sql**, in which the **sql** command must be enclosed in single quotation marks ('). For details, see example 2. Involved commands include **connector-table-sql**, **connector-table-columns**, **connector-table-partitionColumn**, **connector-table-conditions**, **connector-table-queryCondition**.

- **delete** command

  This command is used for deleting connectors and jobs.

Attribute Type	Subattribute	Description
connection	-x,--xid	Specifies the connector ID.
	-n,--name	Specifies the connector name.
job	-j,--jid	Specifies the job ID.
	-n,--name	Specifies the job name.

Example:

```
delete connection -x 1
delete connection --name abc
delete job -j 1
delete job -n qwerty
```

- **clone** command

  This command is used for cloning connectors and jobs.

Attribute Type	Subattribute	Description
connection	-x,--xid	Specifies the connector ID. **NOTE** The password and connector name must be entered when the connectors are cloned.
job	-j,--jid	Specifies the job ID.

  Example:

```
clone job -j 1
```

- **start** command

  This command is used for starting jobs.

Attribute Type	Subattribute	Description
job	-j,--jid	Specifies the job ID.
	-n,--name	Specifies the job name.
	-s,--synchronous	Whether to start jobs in the synchronous mode or not.

  Example for starting jobs in the asynchronous mode:

```
start job -j 1
start job -n abc
```

  Example for starting jobs in the synchronous mode:

```
start job -j 1 -s
start job --name abc --synchronous
```

- **stop** command

  This command is used for stopping jobs.

Attribute Type	Subattribute	Description
job	-j,--jid	Specifies the job ID.

Attribute Type	Subattribute	Description
	-n,--name	Specifies the job name.

Example:

```
stop job -j 1
stop job -n abc
```

- Status command

  This command is used for viewing job status.

Attribute Type	Subattribute	Description
job	-j,--jid	Specifies the job ID.

When **-s** parameter is attached to the command, the result only contains the enumerated value of job status.

Example:

```
status job -j 1
status job -j 1 -s
```

Extended Attributes of Create Command

For the scenario in which HDFS exchanges data with the SFTP server or RDB, MRS extends the create command attributes on the basis of the open source sqoop-shell tool, so as to specify line and field separators and conversion steps when jobs are created.

Table 16-130 Extended Attributes of Create Command

Property	Description
fields-terminated-by	Default field separator.
lines-terminated-by	Default line separator.
input-fields-terminated-by	Inputs the step field separator. If the step field separator is not specified, the value equals to **fields-terminated-by** by default.
input-lines-terminated-by	Inputs the step line separator. If the step line separator is not specified, the value equals to **lines-terminated-by** by default.
output-fields-terminated-by	Outputs the step field separator. If the step field separator is not specified, the value equals to **fields-terminated-by** by default.

Property	Description
output-lines-terminated-by	Outputs the step line separator. If the step line separator is not specified, the value equals to **lines-terminated-by** by default.
trans	Specifies the conversion steps. The value is the directory where the conversion step file is located. When the relative directory of file is specified, the file is by default stored in the directory where the **sqoop2-shell** script is located. When the attribute is set, the other extended attributes can be ignored.

Interconnecting Sqoop1 with MRS

Step 1 Download the open source Sqoop from **http://www.apache.org/dyn/closer.lua/sqoo:p/1.4.7**.

Step 2 Save the downloaded **sqoop-1.4.7.bin__hadoop-2.6.0.tar.gz** package to the **/opt/sqoop** directory on the Master node in the MRS cluster and decompress the package.

tar zxvf sqoop-1.4.7.bin__hadoop-2.6.0.tar.gz

Step 3 Go to the directory where the package is decompressed and modify the configuration.

cd /opt/sqoop/sqoop-1.4.7.bin__hadoop-2.6.0/conf

cp sqoop-env-template.sh sqoop-env.sh

vi sqoop-env.sh

Add the following configurations:

export HADOOP_COMMON_HOME=/opt/client/HDFS/hadoop

export HADOOP_MAPRED_HOME=/opt/client/HDFS/hadoop

export HIVE_HOME=/opt/Bigdata/MRS_1.9.X/install/FusionInsight-Hive-3.1.0/hive (Enter the actual path.)

export HIVE_CONF_DIR=/opt/client/Hive/config

export HCAT_HOME=/opt/client/Hive/HCatalog

Step 4 Add the system variable **SQOOP_HOME** to **PATH**.

vi /etc/profile

Add the following information:

export SQOOP_HOME=/opt/sqoop/sqoop-1.4.7.bin__hadoop-2.6.0

export PATH=$PATH:$SQOOP_HOME/bin

Step 5 Run the following command to copy the **jline-2.12.jar** file to the **lib** file.

cp /opt/share/jline-2.12/jline-2.12.jar /opt/sqoop/sqoop-1.4.7.bin__hadoop-2.6.0/lib

Step 6 Run the following command to add the following configuration to the file.

vim $JAVA_HOME/jre/lib/security/java.policy

permission javax.management.MBeanTrustPermission "register";

Step 7 Run the following command to interconnect sqoop1 with MRS.

source /etc/profile

----End

16.9.8 Example for Using the Open-Source sqoop-shell Tool (SFTP-HDFS)

Scenario

Taking importing data from SFTP to HDFS as an example, this section introduces how to use the sqoop-shell tool to create and start Loader jobs in the interaction mode and batch mode.

Prerequisites

The Loader client has been installed and configured. For details, see **Running a Loader Job Through CLI**.

Example for the Interaction Mode

Step 1 Log in to the node where the Loader client is installed as the user who installs the client.

Step 2 Run the following command to go to the **conf** directory of the sqoop-shell tool. For example, if the Loader client installation directory is **/opt/client/Loader/**, run the following command:

cd /opt/client/Loader/loader-tools-1.99.3/sqoop-shell/conf

Step 3 Run the following command to configure authentication information:

vi client.properties

```
server.url=10.0.0.1:21351
# simple or kerberos
authentication.type=simple
# true or false
use.keytab=true

authentication.user=
authentication.password=

client.principal=hdfs/hadoop@<system domain name>

# keytab file
client.keytab.file=./conf/login/hdfs.keytab
```

NOTE

Log in to FusionInsight Manager and choose **System** > **Permission** > **Domain and Mutual Trust**. The value of **Local Domain** is the current system domain name.

Table 16-131 Configuration parameters

Configuration parameters	Description	Example Value
server.url	Floating IP address and port (21351) for Loader. For compatibility, multiple IP addresses and ports can be configured and need to be separated by commas (,). The first IP address and port must be those of Loader (21351). The others can be configured based on service requirements.	10.0.0.1:21351
authentication.type	Login authentication mode. • **kerberos** indicates that the security mode is used and Kerberos authentication is performed. Kerberos authentication provides two authentication modes: the password mode and the keytab file mode. • **simple** indicates that the normal mode is used and Kerberos authentication is not performed.	kerberos
authentication.user	User for login when the normal mode or password authentication is used. In the keytab login mode, this parameter does not need to be set.	bar

Configuration parameters	Description	Example Value
authentication.password	User password for login when the password authentication mode is used. In the normal mode or keytab login mode, this parameter does not need to be set. The password needs to be encrypted. The encryption method is described as follows: 1. Go to the directory where **encrypt_tool** is located. For example, if the Loader client installation directory is **/opt/hadoopclient/Loader**, run the following command: **cd /opt/hadoopclient/Loader/loader-tools-1.99.3** 2. Run the following command to encrypt the non-encrypted password. Commands carrying authentication passwords pose security risks. Disable historical command recording before running such commands to prevent information leakage. **./encrypt_tool** *Unencrypted password* The obtained encrypted password is used as the value of **authentication.password**. **NOTE** If a non-encrypted password contains special characters, the special characters must be escaped. For example, the dollar sign ($) is a special character and can be escaped using single quotation marks ('). If a non-encrypted password contains single quotation marks, use double quotation marks to escape the single quotation marks. If a non-encrypted password contains double quotation marks, use backslashes (\) to escape the double quotation marks. For details, see the shell escape character rules.	-

Configuration parameters	Description	Example Value
use.keytab	Whether to use the keytab mode to log in. • **true** indicates using the keytab file to log in. • **false** indicates using the password to log in.	true
client.principal	User principal for accessing the Loader service when the keytab authentication mode is used. In the normal mode or password login mode, this parameter does not need to be set.	loader/hadoop
client.keytab.file	Directory where the used keytab file is located when the keytab authentication mode is used. In the normal mode or password login mode, this parameter does not need to be set.	/opt/client/conf/loader.keytab

Step 4 Run the following command to go to the interaction mode:

source /opt/client/bigdata_env

cd /opt/client/Loader/loader-tools-1.99.3/sqoop-shell

./sqoop2-shell

The preceding commands obtain authentication information by reading the configuration file.

Alternatively, you can also use the password or Kerberos authentication.

Run the following command to authenticate login using the password mode:

./sqoop2-shell -uk false -u *username* **-p** *encryptedPassword*

Commands carrying authentication passwords pose security risks. Disable historical command recording before running such commands to prevent information leakage.

Run the following command to authenticate login using the Kerberos mode:

./sqoop2-shell -uk true -k *user.keytab* **-s** *userPrincipal*

```
Welcome to sqoop client
Use the username and password authentication mode
Authentication success.
Sqoop Shell: Type 'help' or '\h' for help.

sqoop:000>
```

Step 5 Run the following command to view the corresponding ID of the current connector:

show connector

The following information is displayed:

```
+----+----------------------------+----------------+-----------------------------------------------------------------------+
| Id |            Name            |    Version     |                                Class                                  |
+----+----------------------------+----------------+-----------------------------------------------------------------------+
| 1  | generic-jdbc-connector     | 2.0.6-SNAPSHOT |
org.apache.sqoop.connector.jdbc.GenericJdbcConnector                 |
| 2  | ftp-connector              | 2.0.5-SNAPSHOT |
org.apache.sqoop.connector.ftp.FtpConnector                          |
| 3  | hdfs-connector             | 2.0.5-SNAPSHOT |
org.apache.sqoop.connector.hdfs.HdfsConnector                        |
| 4  | oracle-connector           | 2.0.1-SNAPSHOT |
org.apache.sqoop.connector.oracle.OracleConnector                    |
| 5  | mysql-fastpath-connector   | 2.0.1-SNAPSHOT |
org.apache.sqoop.connector.mysql.MySqlConnector                      |
| 6  | sftp-connector             | 2.0.5-SNAPSHOT |
org.apache.sqoop.connector.sftp.SftpConnector                        |
| 7  | oracle-partition-connector | 2.0.6-SNAPSHOT |
org.apache.sqoop.connector.oracle.partition.OraclePartitionConnector |
+----+----------------------------+----------------+-----------------------------------------------------------------------+
```

The preceding information indicates that the SFTP connector ID is 6.

Step 6 Run the following command to create connectors and enter the specific connector information as prompted:

create connection -c *connector ID*

For example, if the connector ID is 6, run the following command:

create connection -c 6

```
sqoop:000> create connection -c 6
Creating connection for connector with id 6
Please fill following values to create new connection object
Name: sftp14

Connection configuration

Sftp server IP: 10.0.0.1
Sftp server port: 22
Sftp user name: root
Sftp password: ************
Sftp public key:
New connection was successfully created with validation status FINE and persistent id 20
sqoop:000>
```

The preceding information indicates that the connection ID is 20.

Step 7 Based on the connection ID, run the following command to create jobs:

create job -x *connection ID* **-t import**

For example, if the connection ID is 20, run the following command:

create job -x 20 -t import

The following information is displayed:

```
Creating job for connection with id 20
Please fill following values to create new job object
Name: sftp-hdfs-test

File configuration

Input path: /opt/tempfile
```

```
File split type:
  0 : FILE
  1 : SIZE
Choose: 0
Filter type:
  0 : WILDCARD
  1 : REGEX
Choose: 0
Path filter: *
File filter: *
Encode type:
Suffix name:
Compression:

Output configuration

Storage type:
  0 : HDFS
  1 : HBASE_BULKLOAD
  2 : HBASE_PUTLIST
  3 : HIVE
Choose: 0
File type:
  0 : TEXT_FILE
  1 : SEQUENCE_FILE
  2 : BINARY_FILE
Choose: 0
Compression format:
  0 : NONE
  1 : DEFAULT
  2 : DEFLATE
  3 : GZIP
  4 : BZIP2
  5 : LZ4
  6 : SNAPPY
Choose:
Output directory: /user/loader/test
File operate type:
  0 : OVERRIDE
  1 : RENAME
  2 : APPEND
  3 : IGNORE
  4 : ERROR
Choose: 0

Throttling resources

Extractors: 2
Extractor size:
New job was successfully created with validation status FINE  and persistent id 85
sqoop:000>
```

The preceding information indicates that the job ID is 85.

Step 8 Run the following command to start the job:

start job -j *job ID* **-s**

For example, if the job ID is 85, run the following command:

start job -j 85 -s

Displaying the **SUCCEEDED** information indicates that the job is started successfully.

```
Submission details
Job ID: 85
Server URL: https://10.0.0.0:21351/loader/
Created by: admin
Creation date: 2016-07-20 16:25:38 GMT+08:00
```

```
Lastly updated by: admin
2016-07-20 16:25:38 GMT+08:00: BOOTING  - Progress is not available
2016-07-20 16:25:46 GMT+08:00: BOOTING  - 0.00 %
2016-07-20 16:25:53 GMT+08:00: BOOTING  - 0.00 %
2016-07-20 16:26:08 GMT+08:00: RUNNING  - 90.00 %
2016-07-20 16:26:08 GMT+08:00: RUNNING  - 90.00 %
2016-07-20 16:26:27 GMT+08:00: SUCCEEDED
```

----End

Example for the Batch Mode

Step 1 Log in to the node where the Loader client is installed as the user who installs the client.

Step 2 Run the following command to go to the **conf** directory of the sqoop-shell tool. For example, if the Loader client installation directory is **/opt/client/Loader/**, run the following command:

cd /opt/client/Loader/loader-tools-1.99.3/sqoop-shell/conf

Step 3 Run the following command to configure authentication information:

vi client.properties

```
server.url=10.0.0.1:21351
# simple or kerberos
authentication.type=simple
# true or false
use.keytab=true

authentication.user=
authentication.password=

client.principal=hdfs/hadoop@<system domain name>

# keytab file
client.keytab.file=./conf/login/hdfs.keytab
```

Table 16-132 Configuration parameters

Configuration parameters	Description	Example Value
server.url	Floating IP address and port (21351) for Loader. For compatibility, multiple IP addresses and ports can be configured and need to be separated by commas (**,**). The first IP address and port must be those of Loader (21351). The others can be configured based on service requirements.	10.0.0.1:21351

Configuration parameters	Description	Example Value
authentication.type	Login authentication mode. • **kerberos** indicates that the security mode is used and Kerberos authentication is performed. Kerberos authentication provides two authentication modes: the password mode and the keytab file mode. • **simple** indicates that the normal mode is used and Kerberos authentication is not performed.	kerberos
authentication.user	User for login when the normal mode or password authentication is used. In the keytab login mode, this parameter does not need to be set.	bar

Configuration parameters	Description	Example Value
authentication.password	User password for login when the password authentication mode is used. In the normal mode or keytab login mode, this parameter does not need to be set. The password needs to be encrypted. The encryption method is described as follows: 1. Go to the directory where **encrypt_tool** is located. For example, if the Loader client installation directory is **/opt/hadoopclient/Loader**, run the following command: **cd /opt/hadoopclient/Loader/loader-tools-1.99.3** 2. Run the following command to encrypt the non-encrypted password: **./encrypt_tool** *Unencrypted password* The obtained encrypted password is used as the value of **authentication.password**. **NOTE** If a non-encrypted password contains special characters, the special characters must be escaped. For example, the dollar sign ($) is a special character and can be escaped using single quotation marks ('). If a non-encrypted password contains single quotation marks, use double quotation marks to escape the single quotation marks. If a non-encrypted password contains double quotation marks, use backslashes (\) to escape the double quotation marks. For details, see the shell escape character rules.	-
use.keytab	Whether to use the keytab mode to log in. ● **true** indicates using the keytab file to log in. ● **false** indicates using the password to log in.	true

Configuration parameters	Description	Example Value
client.principal	User principal for accessing the Loader service when the keytab authentication mode is used. In the normal mode or password login mode, this parameter does not need to be set.	loader/hadoop
client.keytab.file	Directory where the used keytab file is located when the keytab authentication mode is used. In the normal mode or password login mode, this parameter does not need to be set.	/opt/client/conf/loader.keytab

Step 4 Run the following command to go to the directory where the **sqoop2-shell** script is located and create a text file in the directory, such as **batchCommand.sh**:

cd /opt/client/Loader/loader-tools-1.99.3/sqoop-shell

vi batchCommand.sh

An example of **batchCommand.sh** is displayed as follows:

```
View parameters
create connection -c 6 --help

// Create a connector
create connection -c 6 -name sftp-connection --connector-connection-sftpServerIp 10.0.0.1 --connector-connection-sftpServerPort 22 --connector-connection-sftpUser root --connector-connection-sftpPassword xxxxx

Create a job
create job -t import -x 20 --connector-file-inputPath /opt/tempfile --connector-file-fileFilter * --framework-output-outputDirectory /user/loader/1 --framework-output-storageType HDFS --framework-throttling-extractorSize 120 --framework-output-fileType TEXT_FILE --connector-file-splitType FILE -name test

Start a job
start job -j 85 -s
```

xxxxx is the password for the connector.

Step 5 Run the following command and the sqoop-shell tool will run the preceding commands in sequence:

./sqoop2-shell batchCommand.sh

The commands above authenticate login by reading configuration files. Alternatively, you can attach the authentication information to the command, that is, use the password mode or Kerberos mode to authenticate login.

Run the following command to authenticate login using the password mode:

./sqoop2-shell -uk false -u *username* **-p** *encryptedPassword* **batchCommand.sh**

Run the following command to authenticate login using the Kerberos mode:

./sqoop2-shell -uk true -k *user.keytab* **-s** *userPrincipal* **batchCommand.sh**

Displaying the **SUCCEEDED** information indicates that the job is started successfully.

```
Welcome to sqoop client
Use the username and password authentication mode
Authentication success.
sqoop:000> create connection -c 6 --help
usage: Show connection parameters:
   --connector-connection-sftpPassword <arg>
   --connector-connection-sftpServerIp <arg>
   --connector-connection-sftpServerPort <arg>
   --connector-connection-sftpUser <arg>
   --framework-security-maxConnections <arg>
   --name <arg>
===> FINE
sqoop:000> create connection -c 6 -name sftp-connection --connector-connection-sftpServerIp 10.0.0.1 --
connector-connection-sftpServerPort 22 --connector-connection-sftpUser root --connector-connection-
sftpPassword xxxxx
Creating connection for connector with id 6
New connection was successfully created with validation status FINE and persistent id 20
===> FINE
sqoop:000> create job -t import -x 20 --connector-file-inputPath /opt/tempfile --connector-file-fileFilter * --
framework-output-outputDirectory /user/loader/1 --framework-output-storageType HDFS --framework-
throttling-extractorSize 120 --framework-output-fileType TEXT_FILE --connector-file-splitType FILE -name
test
Creating job for connection with id 20
New job was successfully created with validation status FINE  and persistent id 85
===> FINE

Submission details
Job ID: 85
Server URL: https://10.0.0.0:21351/loader/
Created by: admin
Creation date: 2016-07-20 16:25:38 GMT+08:00
Lastly updated by: admin
2016-07-20 16:25:38 GMT+08:00: BOOTING  - Progress is not available
2016-07-20 16:25:46 GMT+08:00: BOOTING  - 0.00 %
2016-07-20 16:25:53 GMT+08:00: BOOTING  - 0.00 %
2016-07-20 16:26:08 GMT+08:00: RUNNING  - 90.00 %
2016-07-20 16:26:08 GMT+08:00: RUNNING  - 90.00 %
2016-07-20 16:26:27 GMT+08:00: SUCCEEDED
```

Step 6 In the batch mode, the **-c** parameter can be used to attach a command. sqoop-shell can execute only the attached command at a time.

Run the following command to create a connection:

./sqoop2-shell -c "create connection -c 6 -name sftp-connection --connector-connection-sftpServerIp 10.0.0.1 --connector-connection-sftpServerPort 22 --connector-connection-sftpUser root --connector-connection-sftpPassword xxxxx"

You can also use the password mode or Kerberos mode to attach the authentication information to the command.

Run the following command to authenticate login using the password mode:

./sqoop2-shell -uk false -u *username* **-p** *encryptedPassword* **-c "create connection -c 6 -name sftp-connection --connector-connection-sftpServerIp 10.0.0.1 --connector-connection-sftpServerPort 22 --connector-connection-sftpUser root --connector-connection-sftpPassword xxxxx"**

Run the following command to authenticate login using the Kerberos mode:

./sqoop2-shell -uk true -k *user.keytab* **-s** *userPrincipal* **-c "create connection -c 6 -name sftp-connection --connector-connection-sftpServerIp 10.0.0.1 --**

connector-connection-sftpServerPort 22 --connector-connection-sftpUser root --connector-connection-sftpPassword xxxxx"

Displaying the **FINE** information indicates the connection is created successfully.

```
Welcome to sqoop client
Use the username and password authentication mode
Authentication success.
sqoop:000> create connection -c 6 -name sftp-connection --connector-connection-sftpServerIp 10.0.0.1 --connector-connection-sftpServerPort 22 --connector-connection-sftpUser root --connector-connection-sftpPassword xxxxx
Creating connection for connector with id 6
New connection was successfully created with validation status FINE and persistent id 20
===> FINE
```

----End

16.9.9 Example for Using the Open-Source sqoop-shell Tool (Oracle-HBase)

Scenario

Taking **Importing Data from Oracle to HBase** as an example, this section introduces how to use the sqoop-shell tool to create and start Loader jobs in the interaction mode and batch mode.

Prerequisites

The Loader client has been installed and configured. For details, see **Running a Loader Job Through CLI**.

Example for the Interaction Mode

Step 1 Log in to the node where the Loader client is installed as the user who installs the client.

Step 2 Run the following command to go to the **conf** directory of the sqoop-shell tool. For example, if the Loader client installation directory is **/opt/client/Loader/**, run the following command:

cd /opt/client/Loader/loader-tools-1.99.3/sqoop-shell/conf

Step 3 Run the following command to configure authentication information:

vi client.properties

```
server.url=10.0.0.1:21351
# simple or kerberos
authentication.type=simple
# true or false
use.keytab=true
authentication.user=
authentication.password=
client.principal=oracle/hadoop@<system domain name>

# keytab file
client.keytab.file=./conf/login/oracle.keytab
```

NOTE

Log in to FusionInsight Manager and choose **System** > **Permission** > **Domain and Mutual Trust**. The value of **Local Domain** is the current system domain name.

Table 16-133 Configuration parameters

Configuration parameters	Description	Example Value
server.url	Floating IP address and port (21351) for Loader. For compatibility, multiple IP addresses and ports can be configured and need to be separated by **commas (,)**. The first IP address and port must be those of Loader (21351). The others can be configured based on service requirements.	10.0.0.1:21351
authentication.type	Login authentication mode. • **kerberos** indicates that the security mode is used and Kerberos authentication is performed. Kerberos authentication provides two authentication modes: the password mode and the keytab file mode. • **simple** indicates that the normal mode is used and Kerberos authentication is not performed.	kerberos
authentication.user	User for login when the normal mode or password authentication is used. In the keytab login mode, this parameter does not need to be set.	bar

Configuration parameters	Description	Example Value
authentication.password	User password for login when the password authentication mode is used. In the normal mode or keytab login mode, this parameter does not need to be set. The password needs to be encrypted. The encryption method is described as follows: 1. Go to the directory where **encrypt_tool** is located. For example, if the Loader client installation directory is **/opt/hadoopclient/Loader**, run the following command: **cd /opt/hadoopclient/Loader/loader-tools-1.99.3** 2. Run the following command to encrypt the non-encrypted password. Commands carrying authentication passwords pose security risks. Disable historical command recording before running such commands to prevent information leakage. **./encrypt_tool** *Unencrypted password* The obtained encrypted password is used as the value of **authentication.password**. **NOTE** If a non-encrypted password contains special characters, the special characters must be escaped. For example, the dollar sign ($) is a special character and can be escaped using single quotation marks ('). If a non-encrypted password contains single quotation marks, use double quotation marks to escape the single quotation marks. If a non-encrypted password contains double quotation marks, use backslashes (\) to escape the double quotation marks. For details, see the shell escape character rules.	-

Configuration parameters	Description	Example Value
use.keytab	Whether to use the keytab mode to log in. • **true** indicates using the keytab file to log in. • **false** indicates using the password to log in.	true
client.principal	User principal for accessing the Loader service when the keytab authentication mode is used. In the normal mode or password login mode, this parameter does not need to be set.	loader/hadoop
client.keytab.file	Directory where the used keytab file is located when the keytab authentication mode is used. In the normal mode or password login mode, this parameter does not need to be set.	/opt/client/conf/loader.keytab

Step 4 Run the following command to go to the interaction mode:

source /opt/client/bigdata_env

cd /opt/client/Loader/loader-tools-1.99.3/sqoop-shell

./sqoop2-shell

The preceding commands obtain authentication information by reading the configuration file.

Alternatively, you can also use the password or Kerberos authentication.

Run the following command to authenticate login using the password mode:

./sqoop2-shell -uk false -u *username* **-p** *encryptedPassword*

Commands carrying authentication passwords pose security risks. Disable historical command recording before running such commands to prevent information leakage.

Run the following command to authenticate login using the Kerberos mode:

./sqoop2-shell -uk true -k *user.keytab* **-s** *userPrincipal*

```
Welcome to sqoop client
Use the username and password authentication mode
Authentication success.
Sqoop Shell: Type 'help' or '\h' for help.

sqoop:000>
```

Step 5 Run the following command to view the corresponding ID of the current connector:

show connector

The following information is displayed:

```
+----+----------------------------+----------------+-----------------------------------------------------------------------+
| Id |            Name            |    Version     |                                Class                                  |
+----+----------------------------+----------------+-----------------------------------------------------------------------+
| 1  | generic-jdbc-connector     | 2.0.7-SNAPSHOT |
org.apache.sqoop.connector.jdbc.GenericJdbcConnector                |
| 2  | oracle-connector           | 2.0.1-SNAPSHOT |
org.apache.sqoop.connector.oracle.OracleConnector                   |
| 3  | ftp-connector              | 2.0.5-SNAPSHOT |
org.apache.sqoop.connector.ftp.FtpConnector                         |
| 4  | hdfs-connector             | 2.0.5-SNAPSHOT |
org.apache.sqoop.connector.hdfs.HdfsConnector                       |
| 5  | clickhouse-connector       | 1.2.0-SNAPSHOT |
org.apache.sqoop.connector.clickhouse.ClickHouseConnector           |
| 6  | mysql-fastpath-connector   | 2.0.1-SNAPSHOT |
org.apache.sqoop.connector.mysql.MySqlConnector                     |
| 7  | sftp-connector             | 2.0.6-SNAPSHOT |
org.apache.sqoop.connector.sftp.SftpConnector                       |
| 8  | oracle-partition-connector | 2.0.6-SNAPSHOT |
org.apache.sqoop.connector.oracle.partition.OraclePartitionConnector |
+----+----------------------------+----------------+-----------------------------------------------------------------------+
```

The preceding information indicates that the Oracle connector ID is 4.

Step 6 Run the following command to create connectors and enter the specific connector information as prompted:

create connection -c *connector ID*

For example, if the connector ID is 2, run the following command:

create connection -c 2

```
sqoop:000> create connection -c 2
Creating connection for connector with id 4
Please fill following values to create new connection object
Name: oracle14
Oracle connection configuration
JDBC connection string: jdbc:oracle:thin:@192.168.xxx.xxx:1521:orcl
Username: oracledba
Password: **********
JDBC connection properties:
There are currently 0 values in the map:
entry#
New connection was successfully created with validation status FINE and persistent id 3
sqoop:000>
```

The preceding information indicates that the connection ID is 3.

Step 7 Based on the connection ID, run the following command to create jobs:

create job -x *connection ID* **-t import --trans** *absolute path of job-config*/**oracle-hbase.json**

For example, if the connection ID is 3, run the following command:

create job -x 3 -t import --trans /opt/hadoopclient/Loader/loader-tools-1.99.3/loader-tool/job-config/oracle-hbase.json

The following information is displayed:

```
sqoop:000> create job -x 3 -t import --trans /opt/hadoopclient/Loader/loader-tools-1.99.3/loader-tool/job-config/oracle-to-hbase.json
Creating job for connection with id 3
```

```
Please fill following values to create new job object
Name: run
Database target
Table name: test
Columns:
Conditions:
Data split method:
  0 : ROWID
  1 : PARTITION
Choose:
Table Partitions:
Data split allocation method:
  0 : ROUNDROBIN
  1 : SEQUENTIAL
  2 : RANDOM
Choose:
JDBC fetch size:

Output configuration

Storage type:
  0 : HDFS
  1 : HBASE_BULKLOAD
  2 : HBASE_PUTLIST
  3 : HIVE
  4 : SPARK
Choose: 1
HBase instance: HBase
Clear data before import : false

Throttling resources

Extractors: 10
Extractor size:
New job was successfully created with validation status FINE  and persistent id 7
sqoop:000>
```

The preceding information indicates that the job ID is 7.

Step 8 Run the following command to start the job:

start job -j *job ID* **-s**

For example, if the job ID is 7, run the following command:

start job -j 7 -s

Displaying the **SUCCEEDED** information indicates that the job is started successfully.

```
Submission details
Job ID: 7
Server URL: https://10.0.0.0:21351/loader/
Created by: admintest
Creation date: 2019-12-04 16:37:34 CST
Lastly updated by: admintest
2019-12-04 16:37:34 CST: BOOTING  - Progress is not available
2019-12-04 16:37:42 CST: BOOTING  - 0.00 %
2019-12-04 16:37:42 CST: BOOTING  - 0.00 %
2019-12-04 16:37:57 CST: RUNNING  - 0.00 %
2019-12-04 16:38:12 CST: RUNNING  - 45.00 %
2019-12-04 16:38:12 CST: RUNNING  - 45.00 %
2019-12-04 16:38:27 CST: SUCCEEDED
```

----End

Example for the Batch Mode

Step 1 Log in to the node where the Loader client is installed as the user who installs the client.

Step 2 Run the following command to go to the **conf** directory of the sqoop-shell tool. For example, if the Loader client installation directory is **/opt/client/Loader/**, run the following command:

cd /opt/client/Loader/loader-tools-1.99.3/sqoop-shell/conf

Step 3 Run the following command to configure authentication information:

vi client.properties

```
server.url=10.0.0.1:21351
# simple or kerberos
authentication.type=simple
# true or false
use.keytab=true

authentication.user=
authentication.password=

client.principal=hdfs/hadoop.@<system domain name>@<system domain name>

# keytab file
client.keytab.file=./conf/login/hdfs.keytab
```

Table 16-134 Configuration parameters

Configuration parameters	Description	Example Value
server.url	Floating IP address and port (21351) for Loader. For compatibility, multiple IP addresses and ports can be configured and need to be separated by **commas (,)**. The first IP address and port must be those of Loader (21351). The others can be configured based on service requirements.	10.0.0.1:21351
authentication.type	Login authentication mode. • **kerberos** indicates that the security mode is used and Kerberos authentication is performed. Kerberos authentication provides two authentication modes: the password mode and the keytab file mode. • **simple** indicates that the normal mode is used and Kerberos authentication is not performed.	kerberos

Configuration parameters	Description	Example Value
authentication.user	User for login when the normal mode or password authentication is used. In the keytab login mode, this parameter does not need to be set.	bar
authentication.password	User password for login when the password authentication mode is used. In the normal mode or keytab login mode, this parameter does not need to be set. The password needs to be encrypted. The encryption method is described as follows: 1. Go to the directory where **encrypt_tool** is located. For example, if the Loader client installation directory is **/opt/hadoopclient/Loader**, run the following command: **cd /opt/hadoopclient/Loader/loader-tools-1.99.3** 2. Run the following command to encrypt the non-encrypted password: **./encrypt_tool** *Unencrypted password* The obtained encrypted password is used as the value of **authentication.password**. **NOTE** If a non-encrypted password contains special characters, the special characters must be escaped. For example, the dollar sign ($) is a special character and can be escaped using single quotation marks ('). If a non-encrypted password contains single quotation marks, use double quotation marks to escape the single quotation marks. If a non-encrypted password contains double quotation marks, use backslashes (\) to escape the double quotation marks. For details, see the shell escape character rules.	-

Configuration parameters	Description	Example Value
use.keytab	Whether to use the keytab mode to log in. • **true** indicates using the keytab file to log in. • **false** indicates using the password to log in.	true
client.principal	User principal for accessing the Loader service when the keytab authentication mode is used. In the normal mode or password login mode, this parameter does not need to be set.	loader/hadoop
client.keytab.file	Directory where the used keytab file is located when the keytab authentication mode is used. In the normal mode or password login mode, this parameter does not need to be set.	/opt/client/conf/loader.keytab

Step 4 Run the following command to go to the directory where the **sqoop2-shell** script is located and create a text file in the directory, such as **batchCommand.sh**:

cd /opt/client/Loader/loader-tools-1.99.3/sqoop-shell

vi batchCommand.sh

An example of **batchCommand.sh** is displayed as follows:

```
View parameters
create connection -c 2 --help

// Create a connector
create connection -c 2 -name oracle-connection --connector-connection-connectionString
jdbc:oracle:thin:@//10.0.0.1:1521/oradb  --connector-connection-username super --connector-connection-
password xxxxxxx--name orcale-test

Create a job

create job -t import -x 3 --trans /opt/hadoopclient/Loader/loader-tools-1.99.3/loader-tool/job-config/oracle-
hbase.json --connector-file-inputPath /opt/tempfile --connector-file-fileFilter * --framework-output-
outputDirectory /user/loader/1 --framework-output-storageType HBase --framework-throttling-
extractorSize 120 --framework-output-fileType TEXT_FILE --connector-file-splitType FILE -name test

Start a job
start job -j 7 -s
```

xxxxx is the password for the connector.

Step 5 Run the following command and the sqoop-shell tool will run the preceding commands in sequence:

./sqoop2-shell batchCommand.sh

The commands above authenticate login by reading configuration files. Alternatively, you can attach the authentication information to the command, that is, use the password mode or Kerberos mode to authenticate login.

Run the following command to authenticate login using the password mode:

./sqoop2-shell -uk false -u *username* **-p** *encryptedPassword* **batchCommand.sh**

Run the following command to authenticate login using the Kerberos mode:

./sqoop2-shell -uk true -k *user.keytab* **-s** *userPrincipal* **batchCommand.sh**

Displaying the **SUCCEEDED** information indicates that the job is started successfully.

```
Welcome to sqoop client
Use the username and password authentication mode
Authentication success.
sqoop:000> create connection -c 2 --help




usage: Show connection parameters:
   --connector-connection-connectionString <arg>
   --connector-connection-jdbcProperties <arg>
   --connector-connection-password <arg>
   --connector-connection-username <arg>
   --framework-security-maxConnections <arg>
 -n,--name <arg>
===> FINE
sqoop:000>
create connection -c 2 -name oracle-connection --connector-connection-connectionString
jdbc:oracle:thin:@//10.0.0.1:1521/oradb  --connector-connection-username super --connector-connection-
password xxxxxxx--name orcale-test
Creating connection for connector with id 4
New connection was successfully created with validation status FINE and persistent id 3
===> FINE
sqoop:000> create job -t import -x 3 --trans /opt/hadoopclient/Loader/loader-tools-1.99.3/loader-tool/job-
config/oracle-hbase.json --connector-file-inputPath /opt/tempfile --connector-file-fileFilter * --framework-
output-outputDirectory /user/loader/1 --framework-output-storageType HDFS --framework-throttling-
extractorSize 120 --framework-output-fileType TEXT_FILE --connector-file-splitType FILE -name test
Creating job for connection with id 3
New job was successfully created with validation status FINE  and persistent id 7
===> FINE
Submission details
Job ID: 7
Server URL: https://10.0.0.0:21351/loader/
Created by: admintest
Creation date: 2019-12-04 16:37:34 CST
Lastly updated by: admintest
2019-12-04 16:37:34 CST: BOOTING  - Progress is not available
2019-12-04 16:37:42 CST: BOOTING  - 0.00 %
2019-12-04 16:37:42 CST: BOOTING  - 0.00 %
2019-12-04 16:37:57 CST: RUNNING  - 0.00 %
2019-12-04 16:38:12 CST: RUNNING  - 45.00 %
2019-12-04 16:38:12 CST: RUNNING  - 45.00 %
2019-12-04 16:38:27 CST: SUCCEEDED
```

Step 6 In the batch mode, the **-c** parameter can be used to attach a command. sqoop-shell can execute only the attached command at a time.

Run the following command to create a connection:

./sqoop2-shell -c "create connection -c 4 -name oracle-connection --connector-connection-connectionString jdbc:oracle:thin:@//10.0.0.1:1521/

oradb --connector-connection-username super --connector-connection-password xxxxxxx--name orcale-test"

You can also use the password mode or Kerberos mode to attach the authentication information to the command.

Run the following command to authenticate login using the password mode:

./sqoop2-shell -uk false -u *username* **-p** *encryptedPassword* **-c "create connection -c 4 -name oracle-connection --connector-connection-connectionString jdbc:oracle:thin:@//10.0.0.1:1521/oradb --connector-connection-username super --connector-connection-password xxxxxxx--name orcale-test"**

Run the following command to authenticate login using the Kerberos mode:

./sqoop2-shell -uk true -k *user.keytab* **-s** *userPrincipal* **-c "create connection -c 4 -name oracle-connection --connector-connection-connectionString jdbc:oracle:thin:@//10.0.0.1:1521/oradb --connector-connection-username super --connector-connection-password xxxxxxx--name orcale-test"**

Displaying the **FINE** information indicates the connection is created successfully.

```
Welcome to sqoop client
Use the username and password authentication mode
Authentication success.
sqoop:000> create connection -c 2 -name oracle-connection --connector-connection-connectionString
jdbc:oracle:thin:@//10.0.0.1:1521/oradb  --connector-connection-username super --connector-connection-
password xxxxxxx--name orcale-test
Creating connection for connector with id 4
New connection was successfully created with validation status FINE and persistent id 3
===> FINE
```

----End

16.10 Loader Log Overview

Log Description

Log path: The default storage path of Loader log files is **/var/log/Bigdata/loader/Log category**.

- runlog: /var/log/Bigdata/loader/runlog (run logs)
- scriptlog: /var/log/Bigdata/loader/scriptlog/ (script execution logs)
- catalina: /var/log/Bigdata/loader/catalina (Tomcat startup and stop logs)
- audit: /var/log/Bigdata/loader/audit (audit logs)

Log archive rule:

The automatic compression and archiving function are enabled for Loader run logs and audit logs. By default, when the size of a log file exceeds 10 MB, the log file is automatically compressed into a log file named in the following rule: *<Original log file name>-<yyyy-mm-dd_hh-mm-ss>.[ID]***.log.zip**. A maximum of 20 latest compressed files are reserved. The number of compressed files can be configured on the Manager portal.

Table 16-135 Loader log list

Log Type	Log File Name	Description
Run log	loader.log	Loader system log file that records most of the logs generated when the TelcoFS system is running.
	loader-omm-***-pid***-gc.log.*.current	Loader process GC log file
	sqoopInstanceCheck.log	Loader instance health check log file
Audit log	default.audit	Loader operation audit log file that records operations such as adding, deleting, modifying, and querying jobs and user login
Tomcat log	catalina.out	Tomcat run log file.
	catalina. <yyyy-mm-dd >.log	Tomcat run log file
	host-manager. <yyyy-mm-dd >.log	Tomcat run log file
	localhost_access_log. <yyyy-mm-dd >.txt	Tomcat run log file
	manager <yyyy-mm-dd >.log	Tomcat run log file
	localhost. <yyyy-mm-dd >.log	Tomcat run log file
Script log	postInstall.log	Loader installation script log file Log file generated during the execution of the Loader installation script (**postInstall.sh**)
	preStart.log	Pre-startup script log file of the Loader service During startup of the Loader service, a series of preparation operations are first performed (by executing **preStart.sh**), such as generating the keytab file. This log file records information about these operations

Log Type	Log File Name	Description
	loader_ctl.log	Log file generated when Loader executes the service start and stop script (**sqoop.sh**)

Log Level

Table 16-136 describes the log levels provided by Loader. The priorities of log levels are ERROR, WARN, INFO, and DEBUG in descending order. Logs whose levels are higher than or equal to the specified level are printed. The number of printed logs decreases as the specified log level increases.

Table 16-136 Log levels

Level	Description
ERROR	Error information about the current event processing.
WARN	Exception information about the current event processing.
INFO	Normal running status information about the system and events.
DEBUG	System information and system debugging information.

To modify log levels, perform the following operations:

Step 1 Go to the **All Configurations** page of Loader by referring to **Modifying Cluster Service Configuration Parameters**.

Step 2 On the menu bar on the left, select the log menu of the target role.

Step 3 Select a desired log level.

Step 4 Save the configuration. In the dialog box that is displayed, click **OK**. Then restart the service for the configuration to take effect.

----End

Log Formats

The following table lists the Loader log formats.

Table 16-137 Log formats

Log Type	Format	Example
Run log	<yyyy-MM-dd HH:mm:ss,SSS>|<Log Level>|<Thread that generates the log>|<Message in the log>|<Location of the log event>	2015-06-29 14:54:35,553 | INFO | [localhost-startStop-1] | ConnectionRequestHandler initialized | org.apache.sqoop.handler.ConnectionRequestHandler.<init>(ConnectionRequestHandler.java:100)
Audit log	<yyyy-MM-dd HH:mm:ss,SSS>|<Log Level>|default|<Message in the log>|<Location of the log event>	2015-06-29 15:35:40,969 INFO default: UserName=admin, UserIP=10.52.0.111, Time=2015-06-29 15:35:40,969, Operation=submit, Resource=submission@21, Result=Failure, Detail={[reason:GET_SFTP_SESSION_FAILED:Failed to get sftp session - 10.162.0.35 (caused by: Auth cancel)]; [config:null]}

16.11 Common Issues About Loader

16.11.1 Why Can't I Save Data on Internet Explorer 10 or 11?

Question

Why an error is reported after I submit data on the Loader page using Internet Explorer 10 or 11?

Answer

- Symptom

  After data is saved and submitted, an error similar to "Invalid query parameter jobgroup id. cause: [jobgroup]" is reported.

- Cause

  The POST requests are converted into GET requests after receiving the HTTP 307 response in some Internet Explorer 11 versions. As a result, POST data cannot be delivered to the server.

- Solution

Use Google Chrome.

16.11.2 Differences Among Connectors Used During the Process of Importing Data from the Oracle Database to HDFS

Question

Three types of connectors are available for importing data from the Oracle database to HDFS using Loader. That is, generic-jdbc-connector, oracle-connector, and oracle-partition-connector. Which one should I select? What are the differences between them?

Answers

- generic-jdbc-connector

  Reads data from the Oracle database in JDBC mode. It is applicable to databases that support JDBC.

  In this mode, data loading performance of Loader is subject to data distribution in a partition column. When data skew occurs (data has only one value or several values) in a partition column, a few Maps process a significant portion of data. As a result, the index becomes invalid, causing a sharp decline in SQL query performance.

  generic-jdbc-connector supports view import and export, but oracle-partition-connector and oracle-connector do not support. Therefore, only this connector can be used to import views.

- Both **oracle-partition-connector** and **oracle-connector**

  can use the ROWID of Oracle for partitioning. oracle-partition-connector is self-developed and oracle-connector is an open-source edition. The two types of connectors share similar performance.

  oracle-connector requires more system table permissions. The following lists the read permissions required by the system tables of **oracle-connector** and **oracle-connector**.

  – **oracle-connector**: dba_tab_partitions, dba_constraints, dba_tables t, dba_segments, v$version, dba_objects, v$instance, SYS_CONTEXT function, dba_extents, and dba_tab_subpartitions

  – **oracle-partition-connector**: DBA_OBJECTS and DBA_EXTENTS

  Compared with **generic-jdbc-connector**, **oracle-partition-connector** and **oracle-connector** have the following advantages:

  a. Load balancing: Number and scope of data segments are determined by the storage structure (data blocks) of the source table rather than the data on the source table. In terms of granularity, a data block can occupy a partition.

  b. Stable performance: Invalid index faults caused by data skew and bound variable snooping can be completely eliminated.

  c. Fast query speed: Using data segmentation delivers a higher query speed than that of using index.

  d. Excellent horizontal scalability: The number of generated segments increases with the increase of data volume. In this case, ideal

performance can be delivered when you increase the number of concurrent tasks. Contrarily, decreasing concurrent tasks saves resources.

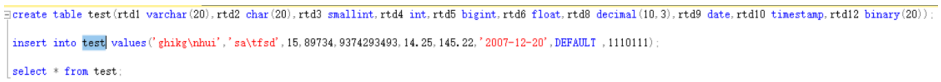
e. Simplified data segmentation logic: Problems like precision loss, type compatibility, and bound variables can be prevented.

f. Enhanced usability: Users do not need to create partition columns and tables for Loader.

16.11.3 Why Data Is Not Imported to HDFS After All Data Types of SQL Server Are Selected?

Question

After all data types of SQL Server are selected, data is not imported to HDFS.



Answer

The data contains the Timestamp data type specific to SQL Server. This data type is irrelevant to time and date and needs to be replaced with the Datetime type.

17 Using MapReduce

17.1 Configuring the Log Archiving and Clearing Mechanism

Scenario

Job and task logs are generated during execution of a MapReduce application.

- Job logs are generated by the MRApplicationMaster, which record details about the start and running time of jobs and each task, Counter value, and other information. After being analyzed by HistoryServer, the job logs are used to view job execution details.
- A task log records the log information generated by each task running in a container. By default, task logs are stored only on the local disk of each NodeManager. After the log aggregation function is enabled, the NodeManager merges local task logs and writes them into HDFS after job execution completes.

The job logs and task logs of the MapReduce are stored on HDFS (when the log aggregation function is enabled). If the mechanism for periodically archiving and deleting log files is not configured for a cluster with a large number of computation tasks, the log files will occupy large memory space of HDFS and increase the cluster load.

Log archive is implemented by Hadoop Archives. The number (number of Map tasks) of concurrent archiving tasks started by the Hadoop Archives is related to the total size of log files to be archived. The formula is as follows: Number of concurrent archive tasks = Total size of log files to be archived/Size of archive files.

Configuration

Go to the **All Configurations** page of the MapReduce service. For details, see **Modifying Cluster Service Configuration Parameters**.

Enter the parameter name in the search box, change the parameter value, and save the configuration. On the **Dashboard** tab page of the Mapreduce service,

choose **More** > **Synchronize Configuration**. After the synchronization is complete, restart the Mapreduce service.

- Job log parameters:

  Table 17-1 Parameter description

Parameter	Description	Default Value
mapreduce.jobhistory.cleaner.enable	Whether to enable the job log file deletion function.	true
mapreduce.jobhistory.cleaner.interval-ms	Period for starting a log file cleanup. Only log files whose retention period is longer than the time specified by **mapreduce.jobhistory.max-age-ms** can be deleted.	86,400,000 ms (1 day)
mapreduce.jobhistory.max-age-ms	Log files whose retention period is longer than the retention period in milliseconds specified by this parameter will be deleted.	1,296,000,000 ms (15 days)

- Task log parameters:

  Table 17-2 Parameter description

Parameter	Description	Default Value
yarn.log-aggregation.archive.files.minimum	Indicates the minimum number of archived MapReduce job log files. The archiving task starts when the number of files in the **yarn.nodemanager.remote-app-log-dir** folder is greater than or equal to the value of this parameter.	5,000
yarn.log-aggregation.archive-check-interval-seconds	Indicates the MapReduce job log archiving interval, in seconds. Log files are archived only when the number of log files reaches the value of **yarn.log-aggregation.archive.files.minimum**. The archiving function is disabled when the period is set to **0** or **-1**.	-1
yarn.log-aggregation.retain-seconds	Indicates the retention period on HDFS for archiving the MapReduce job logs. The value **-1** indicates that log files are stored permanently.	1,296,000

Parameter	Description	Default Value
yarn.log-aggregation.retain-check-interval-seconds	Indicates the check period (in seconds) of the MapReduce job log deletion task. If this parameter is set to **-1**, the check period is one tenth of the log retention period.	86400

NOTE

If task logs occupy too much HDFS storage space, modify the **mapreduce.jobhistory.max-age-ms** and **yarn.log-aggregation.retain-check-interval-seconds** configuration items to control the storage duration of task logs.

17.2 Reducing Client Application Failure Rate

Scenario

When the network is unstable or the cluster I/O and CPU are overloaded, client applications might encounter running failures.

Configuration

Adjust the following parameters in the **mapred-site.xml** configuration file on the client to reduce the client application failure rate:

NOTE

The **mapred-site.xml** configuration file is in the **conf** directory of the client installation path, for example, **/opt/client/Yarn/config**.

Table 17-3 Parameter description

Parameter	Description	Default Value
mapreduce.reduce.shuffle.max-host-failures	Indicates the number of allowed failures of an MR task to read remote shuffle data in the Reduce process. When the number is set to be over 5, the client application failure rate can be reduced.	5
mapreduce.client.submit.file.replication	Indicates the backup of job files on HDFS. MR tasks are dependent on the job files during running. When the number of backups is set to be over 10, the client application failure rate can be reduced.	10

17.3 Transmitting MapReduce Tasks from Windows to Linux

Scenarios

If you want to transmit a job from Windows to Linux, set **mapreduce.app-submission.cross-platform** to **true**. If this parameter is unavailable for a cluster or its value is **false**, the function of transmitting MapReduce tasks from Windows to Linux is not supported. In this case, perform the following operations to add this parameter or change its value to enable this function:

Configuration Description

Adjust the following parameter in the **mapred-site.xml** configuration file on the client to enable the running of MapReduce tasks: The **mapred-site.xml** configuration file is in the **config** directory of the client installation path, for example, **/opt/client/Yarn/config**.

Table 17-4 Parameters

Parameter	Description	Default Value
mapreduce.app-submission.cross-platform	Indicates whether to support running of MapReduce tasks after they are transmitted from Windows to Linux. When the parameter value is **true**, the running of MapReduce tasks is supported. When the parameter value is **false**, the running of MapReduce tasks is not supported.	true

17.4 Configuring the Distributed Cache

Scenarios

Distributed caching is useful in the following scenarios:

Rolling Upgrade

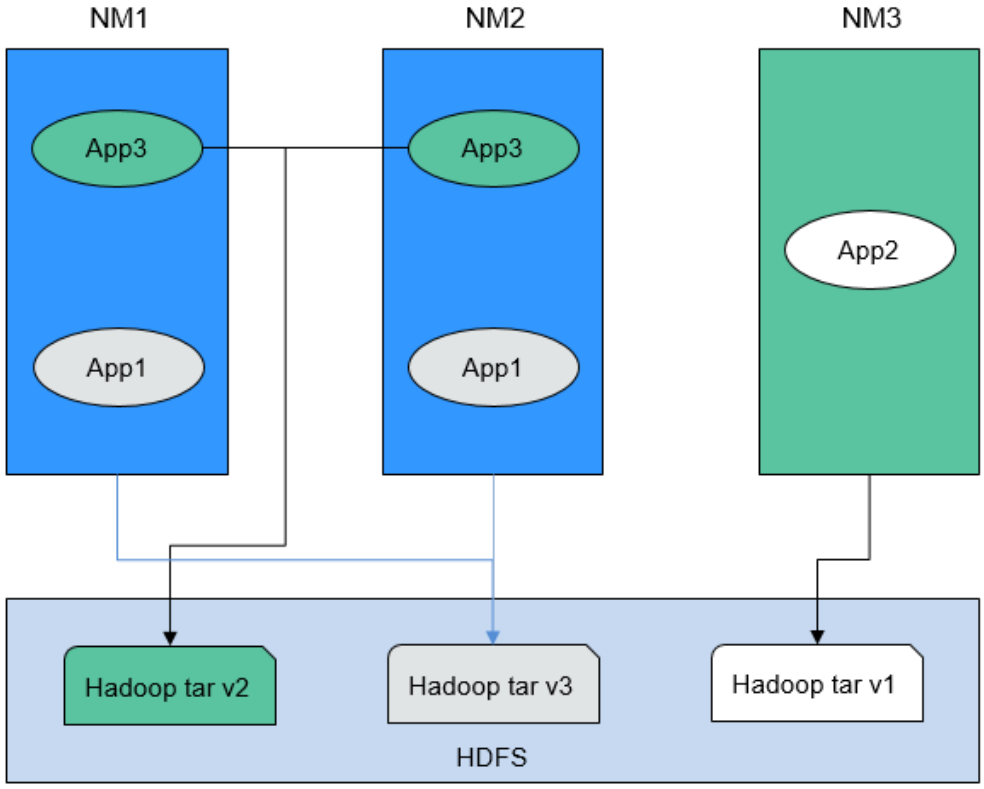
During the upgrade, applications must keep the text content (JAR file or configuration file) unchanged. The content is not based on Yarn of the current version, but on the version when it is submitted. This is a challenging issue. Generally, applications (such as MapReduce, Hive, and Tez) need to be installed locally. Libraries need to be installed on all cluster servers (clients and servers). When a rolling upgrade or downgrade starts in the cluster, the version of the locally installed library changes during application running. During the rolling upgrade, only a few NodeManagers are upgraded first. These NodeManagers obtain the software of the latest version. This leads to inconsistent behavior and can result in run-time errors.

Co-existence of Multiple Yarn Versions

Cluster administrators may run tasks that use multiple versions of Yarn and Hadoop JARs in a cluster. However, this task is difficult to be implemented because the JARs have been localized and have only one version.

The MapReduce application framework can be deployed through the distributed cache and does not depend on the static version copied during installation. Therefore, you can store multiple versions of Hadoop in HDFS and configure the **mapred-site.xml** file to specify the default version used by the task. You can run different versions of MapReduce by setting proper configuration attributes without using the versions deployed in the cluster.

Figure 17-1 Clusters with NodeManagers and Applications of multiple versions



As shown in **Figure 17-1**, the application can use Hadoop JARs in HDFS instead of the local version. Therefore, during the rolling upgrade, even if NodeManager has been upgraded, the application can still run Hadoop of the earlier version.

Configuration Description

Step 1 Save the MapReduce **.tar** package of the specified version to a directory that can be accessed by applications in HDFS, as shown in the following command.

$HADOOP_HOME/**bin/hdfs dfs -put** *hadoop-x.tar.gz /mapred/framework/*

Step 2 Set parameters in the *Client installation path*/**Yarn/config/mapred-site.xml** file based on **Table 17-5**.

Table 17-5 Distributed cache parameters

Parameter	Description	Default Value
mapreduce.application.framework.path	Indicates the URL directing to the archive location. **NOTE** This property can also create an alias for the archive if the URL fragment identity name is specified as follows. In this example, the alias is set to **mr-framework**. <property> <name>mapreduce.application.framework.path</name> <value>hdfs:/mapred/framework/hadoop-x.tar.gz#mr-framework</value> </property>	NA
mapreduce.application.classpath	Indicates the parameter property, which contains the MapReduce JARs in the class directory. **NOTE** For example, the alias **mr-framework** used in the framework path is used to match the directory. <property> <name>mapreduce.application.classpath</name> <value>$PWD/mr-framework/hadoop/share/hadoop/mapreduce/*:$PWD/mr-framework/hadoop/share/hadoop/mapreduce/lib/*:$PWD/mr-framework/hadoop/share/hadoop/common/*:$PWD/mr-framework/hadoop/share/hadoop/common/lib/*:$PWD/mr-framework/hadoop/share/hadoop/yarn/*:$PWD/mr-framework/hadoop/share/hadoop/yarn/lib/*:$PWD/mr-framework/hadoop/share/hadoop/hdfs/*:$PWD/mr-framework/hadoop/share/hadoop/hdfs/lib/*:/etc/hadoop/conf/secure</value></property>	N/A

You can upload MapReduce tarballs of multiple versions to HDFS. Different **mapred-site.xml** files indicate different locations. After that, you can run tasks for a specific **mapred-site.xml** file. The following is an example of running an MapReduce task for the MapReduce tarball of the *x* version:

hadoop jar *share/hadoop/mapreduce/hadoop-mapreduce-examples-*.jar pi* **-conf etc/hadoop-x/mapred-site.xml** *10 10*

----End

17.5 Configuring the MapReduce Shuffle Address

Scenario

When the MapReduce shuffle service is started, it attempts to bind an IP address based on local host. If the MapReduce shuffle service is required to connect to a specific IP address, no configuration is available. The following description allows you to configure a connection to a specific IP address.

Configuration

To bind a specific IP address to the MapReduce shuffle service, set the following parameters in the **mapred-site.xml** configuration file on the node where the NodeManager instance is deployed. Example path: **${BIGDATA_HOME}/FusionInsight_HD_*xxx*/*x_xx*_NodeManager/etc/mapred-site.xml**

Table 17-6 Parameter description

Parameter	Description	Default Value
mapreduce.shuffle.address	Indicates the specified address to run the shuffle service. The format is *IP:PORT*. The default value is empty. If this parameter is left empty, the local host IP address is bound. The default port number is 13562. **NOTE** If the value of *PORT* is different from that of **mapreduce.shuffle.port**, the **mapreduce.shuffle.port** value does not take effect.	-

17.6 Configuring the Cluster Administrator List

Scenario

This function is used to specify the MapReduce cluster administrator.

The cluster administrator list is specified by **mapreduce.cluster.administrators**. The cluster administrator **admin** has all operation permissions.

Configuration

On the **All Configurations** page of the MapReduce service, enter a parameter name in the search box. For details, see **Modifying Cluster Service Configuration Parameters**.

Table 17-7 Parameter description

Parameter	Description	Default Value
mapreduce.cluster.acls.enabled	Indicates whether to enable permission control on Job History Server.	true
mapreduce.cluster.administrators	Indicates the administrator list of the MapReduce cluster. You can configure both users and user groups. Multiple users or user groups are separated by commas (,), and users and user groups are separated by spaces, for example, userA,userB groupA,groupB. The value * indicates all users or user groups.	mapred supergroup,System_administrator_186

17.7 Introduction to MapReduce Logs

Log Description

Log paths:

- JobhistoryServer: **/var/log/Bigdata/mapreduce/jobhistory** (run log) and **/var/log/Bigdata/audit/mapreduce/jobhistory** (audit log)
- Container: **/srv/BigData/hadoop/data1/nm/containerlogs/application_${appid}/container_{$contid}**

NOTE

The logs of running tasks are stored in the preceding paths. After the running is complete, the system determines whether to aggregate the logs to an HDFS directory based on the YARN configuration. For details, see **Common YARN Parameters**.

Log archive rule:

The automatic compression and archive function is enabled for MapReduce logs. By default, a log file is automatically compressed when the size of the log file is greater than 50 MB. The name of the compressed log file is in the following format: *<Name of the original log>-<yyyy-mm-dd_hh-mm-ss>.[NO.]***.log.zip**. A maximum of 100 latest compressed files are reserved. The number of compressed files can be configured on the parameter configuration page.

In MapReduce, JobhistoryServer cleans the old log files stored in HDFS periodically. The default storage directory is **/mr-history/done**. **mapreduce.jobhistory.max-age-ms** is used to set the cleanup interval. The default value of this parameter is 1,296,000,000 ms, which indicates 15 days.

Table 17-8 MapReduce log list

Type	Name	Description
Run log	jhs-daemon-start-stop.log	Startup log file of the daemon process
	hadoop-<SSH_USER>-jhshadaemon-<hostname>.log	Run log file of the daemon process
	hadoop-<SSH_USER>-<process_name>-<hostname>.out	Log that records the MapReduce running environment information
	historyserver-<SSH_USER>-<DATE>-<PID>-gc.log	Log that records the garbage collection of the MapReduce service
	jhs-haCheck.log	Log that records the active and standby status of MapReduce instances

Type	Name	Description
	yarn-start-stop.log	Log that records the startup and stop of the MapReduce service
	yarn-prestart.log	Log that records cluster operations before the MapReduce service startup
	yarn-postinstall.log	Work log before the MapReduce service startup and after the installation
	yarn-cleanup.log	Log that records the cleanup logs about the uninstallation of the MapReduce service
	mapred-service-check.log	Log that records the health check details of the MapReduce service
	container_{$contid}	Container log
	hadoop-<SSH_USER>-<process_name>-<hostname>.log	MapReduce run log
	mapred-switch-jhs.log	MapReduce active/standby switchover log
	env.log	Environment information log before the instance is started or stopped
	threadDump-<process_name>-<thread pid>-<timestamp>.log	Dump log generated when MapReduce is stopped
Audit log	mapred-audit-jobhistory.log	MapReduce operation audit log
	SecurityAuth.audit	MapReduce security audit log

Log Level

Table 17-9 describes the log levels supported by MapReduce The log levels are FATAL, ERROR, WARN, INFO, and DEBUG from high priority to low. Logs whose levels are higher than or equal to the specified level are printed. The number of printed logs decreases as the specified log level increases.

Table 17-9 Log level

Level	Description
FATAL	Logs of this level record critical error information about the current event processing.
ERROR	Logs of this level record error information about the current event processing.
WARN	Logs of this level record unexpected alarm information about the current event processing.
INFO	Logs of this level record normal running status information about the system and events.
DEBUG	Logs of this level record the system information and system debugging information.

To modify log levels, perform the following operations:

Step 1 Go to the **All Configurations** page of the MapReduce service. For details, see **Modifying Cluster Service Configuration Parameters**.

Step 2 On the left menu bar, select the log menu of the target role.

Step 3 Select a desired log level.

Step 4 Save the configuration. In the displayed dialog box, click **OK** to make the configurations take effect.

NOTE

The configurations take effect immediately without restarting the service.

----End

Log Format

The following table lists the MapReduce log formats.

Table 17-10 Log format

Type	Format	Example
Run log	<*yyyy-MM-dd HH:mm:ss,SSS*>|<*Log level*>|<*Name of the thread that generates the log*>|<*Message in the log*>|<*Location where the log event occurs*>	2020-01-26 14:18:59,109 | INFO | main | Client environment:java.compiler=<NA> | org.apache.zookeeper.Environment.logEnv(Environment.java:100)

Type	Format	Example
Audit log	<*yyyy-MM-dd HH:mm:ss,SSS*>|<*Log level*>|<*Name of the thread that generates the log*>|<*Message in the log*>|<*Location where the log event occurs*>	2020-01-26 14:24:43,605 | INFO | main-EventThread | USER=omm OPERATION=refreshAdminAcls TARGET=AdminService RESULT=SUCCESS | org.apache.hadoop.yarn.server.resourcemanager.RMAuditLogger$LogLevel $6.printLog(RMAuditLogger.java:91)

17.8 MapReduce Performance Tuning

17.8.1 Optimization Configuration for Multiple CPU Cores

Scenario

Optimization can be performed when the number of CPU cores is large, for example, the number of CPU cores is three times the number of disks.

Procedure

You can set the following parameters in either of the following ways:

- Configuration on the server:

  On the **All Configurations** page of the Yarn service, enter a parameter name in the search box. For details, see **Modifying Cluster Service Configuration Parameters**.

- Configuration on the client:

  Modify the corresponding configuration file on the client.

  NOTE

  - Path of configuration files on the HDFS client: *Client installation directory*/**HDFS/hadoop/etc/hadoop/hdfs-site.xml**
  - Path of configuration files on the Yarn client: *Client installation directory*/**HDFS/hadoop/etc/hadoop/yarn-site.xml**.
  - Path of configuration files on the MapReduce client: *Client installation directory*/**HDFS/hadoop/etc/hadoop/mapred-site.xml**.

Table 17-11 Settings of multiple CPU cores

Configuration	Description	Parameter	Default Value	Server/ Client	Impact	Remarks
Number of slots in a node container	The combination of the following parameters determines the number of concurrent tasks (Map and Reduce tasks) of each node: • yarn.nodemanager.resource.memory-mb • mapreduce.map.memory.mb • mapreduce.reduce.memory.mb	yarn.nodemanager.resource.memory-mb **NOTE** You need to configure this parameter on FusionInsight Manager.	16384	Server	If data needs to be read from and written into disks for all tasks (Map/ Reduce tasks), a disk may be accessed by multiple processes at the same time, which leads to poor disk I/O performance. To ensure disk I/O performance, the number of concurrent access requests from a client to a disk cannot exceed 3.	The maximum number of concurrent containers must be [2.5 x Number of disks configured in Hadoop].
		mapreduce.map.memory.mb **NOTE** You need to set this parameter in the configuration file on the client in the *Client installation directory*/**HDFS/hadoop/etc/hadoop/mapred-site.xml** path.	4096	Client		
		mapreduce.reduce.memory.mb **NOTE** You need to set this parameter in the configuration file on the client in the *Client installation directory*/**HDFS/hadoop/etc/hadoop/mapred-site.xml** path.	4096	Client		

Configuration	Description	Parameter	Default Value	Server/ Client	Impact	Remarks
Map output and compression	The Map task output before being written into disks can be compressed. This can save disk space, offer faster data write, and reduce the data traffic delivered to Reducer. You need to configure the following parameters on the client: • **mapreduce.map.output.compress**: The Map task output can be compressed before it is transmitted over the network. It is a per-job	mapreduce.map.output.compress **NOTE** You need to set this parameter in the configuration file on the client in the *Client installation directory*/**HDFS/hadoop/etc/hadoop/mapred-site.xml** path.	true	Client	The disk I/O is the bottleneck. Therefore, use a compression algorithm with a high compression rate.	Snappy is used. The benchmark test results show that Snappy delivers high performance and efficiency.
		mapreduce.map.output.compress.codec **NOTE** You need to set this parameter in the configuration file on the client in the *Client installation directory*/**HDFS/hadoop/etc/hadoop/mapred-site.xml** path.	org.apache.hadoop.io.compress.Lz4Codec	Client		

Configuration	Description	Parameter	Default Value	Server/ Client	Impact	Remarks
	configuration. • **mapreduce.map.output.compress.codec**: the codec used for data compression					
Spills	mapreduce.map.sort.spill.percent	mapreduce.map.sort.spill.percent **NOTE** You need to set this parameter in the configuration file on the client in the *Client installation directory*/**HDFS/hadoop/etc/hadoop/mapred-site.xml** path.	0.8	Client	Disk I/Os are the bottleneck. You can set the value of **mapreduce.task.io.sort.mb** to minimize the memory spilled to the disk.	-

Configuration	Description	Parameter	Default Value	Server/ Client	Impact	Remarks
Data packet size	When the HDFS client writes data to a data node, the data will be accumulated until a packet is generated. Then, the packet is transmitted over the network. **dfs.client-write-packet-size** specifies the data packet size. It can be specified by each job.	dfs.client-write-packet-size **NOTE** You need to set this parameter in the configuration file on the client in the *Client installation directory*/**HDFS/hadoop/etc/hadoop/hdfs-site.xml/** path.	262144	Client	The data node receives data packets from the HDFS client and writes data into disks through single threads. When disks are in the concurrent write state, increasing the data packet size can reduce the disk seek time and improve the I/O performance.	dfs.client-write-packet-size = 262144

17.8.2 Determining the Job Baseline

Scenario

The performance optimization effect is verified by comparing actual values with the baseline data. Therefore, determining optimal job baseline is critical to performance optimization.

When determining the job baseline, comply with the following rules:

- Making full use of cluster resources
- Setting the number of Map and Reduce tasks appropriately
- Setting the runtime of each task appropriately

Procedure

- **Rule 1: Making full use of cluster resources**

  Enable all nodes to handle tasks as actively as they can when a job is executed. Maximizing the number of concurrent tasks helps make full use of resources. You can achieve this purpose by adjusting the data volume to be processed and the number of Map and Reduce tasks.

  You can set **mapreduce.job.reduces** to control the number of Reduce tasks.

  The number of Map tasks depends on the InputFormat type and whether the data file to be processed can be split. By default, TextFileInputFormat allocates Map tasks based on the number of blocks, that is, one Map task for each block. You can adjust the following parameters to improve resource utilization.

  Parameter portal:

  On the **All Configurations** page of the Yarn service, enter a parameter name in the search box. For details, see **Modifying Cluster Service Configuration Parameters**.

Parameter	Description	Default Value
mapreduce.input.fileinputformat.split.maxsize	Indicates the maximum size of the data block into which the Map input information is to be split. The shard size can be calculated based on its size customized by the user and the block size of each file. The formula is as follows: `splitSize = Math.max(minSize, Math.min(maxSize, blockSize))` If **maxSize** is bigger than **blockSize**, a block is a shard. If **maxSize** is smaller than **blockSize**, a block will be split into multiple shards. If the size of the remaining data in a block is smaller than **splitSize**, the remaining data will be treated as a separated shard.	-
mapreduce.input.fileinputformat.split.minsize	Indicates the minimum size of a data shard.	0

- **Principle 2: Setting Reduce tasks to be executed in one round.**

  Avoid the following scenarios:

  – Most of Reduce tasks are completed in the first round, but there is still one Reduce task left running. The execution of the last Reduce task extends the runtime of the job. Therefore, reduce the number of Reduce tasks to enable all of them to run at the same time.

  - All Map tasks are completed, but there are still Reduce tasks running on some nodes. In this case, the cluster resources are not fully utilized. You need to increase the number of Reduce tasks to enable each node to handle tasks.

- **Rule 3: Setting the runtime of each task appropriately**

  If each Map or Reduce task of a job takes only a few seconds, most time of the job is wasted on scheduling tasks and starting and stopping processes. Therefore, you need to increase the data volume to be processed in each task. The preferred processing time for each task is 1 minute.

  You can configure the following parameters to adjust the processing time in a task.

  Parameter portal:

  On the **All Configurations** page of the Yarn service, enter a parameter name in the search box. For details, see **Modifying Cluster Service Configuration Parameters**.

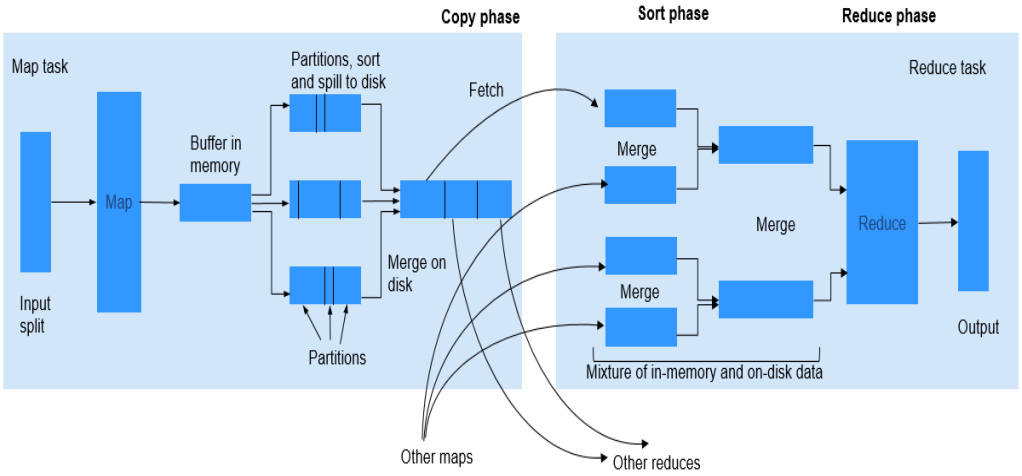
Parameter	Description	Default Value
mapreduce.input.fileinputformat.split.maxsize	Indicates the maximum size of the data block into which the Map input information is to be split. The shard size can be calculated based on its size customized by the user and the block size of each file. The formula is as follows: `splitSize = Math.max(minSize, Math.min(maxSize, blockSize))` If **maxSize** is bigger than **blockSize**, a block is a shard. If **maxSize** is smaller than **blockSize**, a block will be split into multiple shards. If the size of the remaining data in a block is smaller than **splitSize**, the remaining data will be treated as a separated shard.	-
mapreduce.input.fileinputformat.split.minsize	Indicates the minimum size of a data shard.	0

17.8.3 Streamlining Shuffle

Scenario

During the shuffle procedure of MapReduce, the Map task writes intermediate data into disks, and the Reduce task copies and adds the data to the reduce function. Hadoop provides lots of parameters for the optimization.

Figure 17-2 Shuffle process



Procedure

1. **Improving Performance in Map Phase**
   - Determine the memory used by Map.

     To determine whether Map has sufficient memory, check the number of GCs and the ratio of the GC time over the total task time in counters of completed jobs. Normally, the GC time cannot exceed 10% of the task time (that is, GC time elapsed (ms)/CPU time spent (ms) < 10%).

     You can improve Map performance by adjusting the following parameters.

     Parameter portal:

     On the **All Configurations** page of the Yarn service, enter a parameter name in the search box. For details, see **Modifying Cluster Service Configuration Parameters**.

     Table 17-12 Parameter description

Parameter	Description	Default Value
mapreduce.map.memory.mb	Memory restriction of a Map task.	4096

Parameter	Description	Default Value
mapreduce.map.java.opts	JVM parameter of the Map subtask. If this parameter is set, it will replace the **mapred.child.java.opts** parameter. If **-Xmx** is not set, the value of **Xmx** is calculated based on **mapreduce.map.memory.mb** and **mapreduce.job.heap.memory-mb.ratio**.	• Clusters with Kerberos authentication enabled: -Djava.net.preferIPv4Stack=true -Djava.net.preferIPv6Addresses=false -Djava.security.krb5.conf=*${BIGDATA_HOME}*/common/runtime/krb5.conf -Dbeetle.application.home.path=*${BIGDATA_HOME}*/common/runtime/security/config • Clusters with Kerberos authentication disabled: -Djava.net.preferIPv4Stack=true -Djava.net.preferIPv6Addresses=false -Dbeetle.application.home.path=*${BIGDATA_HOME}*/common/runtime/security/config

It is recommended that the **-Xmx** in **mapreduce.map.java.opts** is 0.8 times the value of **mapreduce.map.memory.mb**.

– Using Combiner

Combiner is an optional procedure in the Map phase, in which the intermediate results with the same key value are combined. Generally, set the reduce class to combiner. Combiner helps reduce the intermediate result output of Map, thereby consuming less network bandwidth during the shuffle process. You can use the following API to set a combiner class for a specific job.

Table 17-13 Combiner API

Class	API	Description
org.apache.hadoop.mapreduce.Job	public void setCombinerClass(Class<? extends Reducer> cls)	API used to set a combiner class for a specific job.

2. **Improving Performance in Copy Phase**
   - Compress data.

     Compress the intermediate output of Map. Data compression reduces the data to be transferred over the network. However, data compression and decompression consume more CPU. Determine whether to compress the intermediate results of Map based on site requirements. If a task is bandwidth-intensive, data compression improves processing performance. As for the bulkload optimization, compression of the intermediate output improves the performance by 60%.

     To improve copy performance, set **mapreduce.map.output.compress** to **true** and **mapreduce.map.output.compress.codec** to **org.apache.hadoop.io.compress.SnappyCodec**.
3. **Improving Performance in Merge Phase**

   To improve merge performance, configure the following parameters to reduce the number of times that Reduce writes data to disks.

   Parameter portal:

   On the **All Configurations** page of the Yarn service, enter a parameter name in the search box. For details, see **Modifying Cluster Service Configuration Parameters**.

Table 17-14 Parameter description

Parameter	Description	Default Value
mapreduce.reduce.merge.inmem.threshold	Threshold of the number of files for the in-memory merge process. When the accumulated number of files reaches the threshold, the process of in-memory merge and spilling to disks is initiated. If the value is less than or equal to **0**, the threshold does not take effect and the merge is triggered only based on the RAMFS memory usage.	1000

Parameter	Description	Default Value
mapreduce.reduce.shuffle.merge.percent	Usage threshold for initiating in-memory merge, indicating the percentage of memory allocated to the Map outputs (defined by **mapreduce.reduce.shuffle.input.buffer.percent**).	0.66
mapreduce.reduce.shuffle.input.buffer.percent	Percentage of memory to be allocated from the maximum heap size to storing Map outputs during the Shuffle.	0.70
mapreduce.reduce.input.buffer.percent	Percentage of memory (relative to the maximum heap size) to retain Map outputs during the Reduce. When the Shuffle is completed, all remaining Map outputs in memory must use less than this threshold before the Reduce begins.	0.0

17.8.4 AM Optimization for Big Tasks

Scenario

A big job containing 100,000 Map tasks fails. It is found that the failure is triggered by the slow response of ApplicationMaster (AM).

When the number of tasks increases, the number of objects managed by the AM increases, which requires much more memory for management. The default memory heap for AM is 1 GB.

Procedure

You can improve the AM performance by setting the following parameters.

Navigation path for setting parameters:

Adjust the following parameters in the **mapred-site.xml** configuration file on the client to adjust the following parameters: The **mapred-site.xml** configuration file is in the **conf** directory of the client installation path, for example, **/opt/client/Yarn/config**.

Parameter	Description	Default Value
yarn.app.mapreduce.am.resource.mb	This parameter must be greater than the heap size specified by **yarn.app.mapreduce.am.command-opts**. Unit: MB	1536
yarn.app.mapreduce.am.command-opts	Indicates the JVM startup parameters loaded to MapReduce ApplicationMaster.	-Xmx1024m -XX:+UseConcMarkSweepGC -XX:+CMSParallelRemarkEnabled -verbose:gc -Djava.security.krb5.conf=${KRB5_CONFIG} -Dhadoop.home.dir=*${BIGDATA_HOME}*/FusionInsight_HD_*xxx*/install/FusionInsight-Hadoop-*xxx*/hadoop

17.8.5 Speculative Execution

Scenario

If a cluster has hundreds or thousands of nodes, the hardware or software fault of a node may prolong the execution time of the entire task (as most tasks are already completed, the system is still waiting for the task running on the faulty node). Speculative execution allows a task to be executed on multiple machines. You can disable speculative execution for small clusters.

Procedure

Navigation path for setting parameters:

On the **All Configurations** page of the Yarn service, enter a parameter name in the search box. For details, see **Modifying Cluster Service Configuration Parameters**.

Parameter	Description	Default Value
mapreduce.map.speculative	Sets whether to execute multiple instances of some map tasks concurrently. **true** indicates that speculative execution is enabled.	false
mapreduce.reduce.speculative	Sets whether to execute multiple instances of some reduce tasks concurrently. **true** indicates that speculative execution is enabled.	false

17.8.6 Using Slow Start

Scenario

The Slow Start feature specifies the proportion of Map tasks to be completed before Reduce tasks are started. If the Reduce tasks are started too early, resources will be occupied, thereby reducing task running efficiency. However, if the Reduce tasks are started at an appropriate time, resource usage during shuffle and task running efficiency will be improved. For example, the MapReduce job includes 15 Map tasks and a cluster can start 10 Map tasks, there are 5 Map tasks remained after a round of Map tasks is completed and the cluster has available resources. In this case, you can configure the value of Slow Start to a value less than 1 (for example, 0.8), then the Reduce tasks can make use of the remaining cluster resources.

Procedure

Parameter portal:

On the **All Configurations** page of the MapReduce service, enter a parameter name in the search box. For details, see **Modifying Cluster Service Configuration Parameters**.

Parameter	Description	Default Value
mapreduce.job.reduce.slowstart.completedmaps	Fraction of the number of Maps in the job which should be completed before Reduces are scheduled for the job. By default, the Reduce tasks start when all the Map tasks are completed.	1.0

17.8.7 Optimizing Performance for Committing MR Jobs

Scenario

By default, if an MR job generates a large number of output files, it takes a long time for the job to commit the temporary outputs of a task to the final output directory in the commit phase. In large clusters, the time-consuming commit process of jobs greatly affects the performance.

In this case, you can set the **mapreduce.fileoutputcommitter.algorithm.version** to **2** to improve the performance in the commit phase of MR jobs.

Procedure

Navigation path for setting parameters:

On the **All Configurations** page of the Yarn service, enter a parameter name in the search box. For details, see **Modifying Cluster Service Configuration Parameters**.

Table 17-15 Parameter description

Parameter	Description	Default Value
mapreduce.fileoutputcommitter.algorithm.version	Indicates the algorithm version submitted by a job. The value is **1** or **2**. **NOTE** **2** is the recommended algorithm version. This algorithm enables tasks to directly commit the output results of each task to the final result output directory, reducing the time for the results of large jobs are committed.	2

17.9 Common Issues About MapReduce

17.9.1 How Do I Handle the Problem that MapReduce Task Has No Progress for a Long Time?

Symptom

The MapReduce task has no progress for a long time.

Answer

Generally, this is caused by insufficient memory. If the memory is small, it takes a long time to copy the map output.

To reduce the waiting time, increase the heap memory.

You can optimize task configuration based on the number of mappers and the data size of each mapper. Optimize the following parameters in the *Client installation path*/**Yarn/config/mapred-site.xml** file based on the size of the input data:

- **mapreduce.reduce.memory.mb**
- **mapreduce.reduce.java.opts**

For example, if the data size of 10 mappers is 5 GB, the ideal heap memory is 1.5 GB. Increase the heap memory as the data size increases.

17.9.2 Why the Client Hangs During Job Running?

Question

Why is the client unavailable when the MR ApplicationMaster or ResourceManager is moved to the D state during job running?

Answer

When a task is running, the MR ApplicationMaster or ResourceManager is moved to D state (uninterrupted sleep state) or T state (stopped state). The client waits to return the task running state, but the MR ApplicationMaster does not return. Therefore, the client remains in the waiting state.

To avoid the preceding scenario, use the **ipc.client.rpc.timeout** configuration item in the **core-site.xml** file to set the client timeout interval.

The value of this parameter is millisecond. The default value is **0**, indicating that no timeout occurs. The client timeout interval ranges from 0 ms to 2,147,483,647 ms.

NOTE

- If the Hadoop process is in the D state, restart the node where the process is located.
- The **core-site.xml** configuration file is stored in the **conf** directory of the client installation path, for example, **/opt/client/Yarn/config**.

17.9.3 Why Cannot HDFS_DELEGATION_TOKEN Be Found in the Cache?

Question

In security mode, why delegation token HDFS_DELEGATION_TOKEN is not found in the cache?

Answer

In MapReduce, by default HDFS_DELEGATION_TOKEN will be canceled after the job completion. So if the token has to be re- used for the next job then the token will not be found in the cache.

To re-use the same token in subsequent job set the below parameter for the MR job configuration. When it is false the user can re-sue the same token.

```
jobConf.setBoolean("mapreduce.job.complete.cancel.delegation.tokens", false);
```

17.9.4 How Do I Set the Task Priority When Submitting a MapReduce Task?

Question

How do I set the job priority when submitting a MapReduce task?

Answer

You can add the parameter **-Dmapreduce.job.priority=<priority>** in the command to set task priority when submitting MapReduce tasks on the client. The format is as follows:

yarn jar *<jar> [mainClass]* ***-Dmapreduce.job.priority=****<priority> [path1] [path2]*

The parameters in the command are described as follows:

- *<jar>*: specifies the name of the JAR package to be run.
- *[mainClass]*: specifies the **main** method of the class for an application project in a JAR file.
- *<priority>*: specifies the priority of a task. The value can be **VERY_HIGH**, **HIGH**, **NORMAL**, **LOW**, or **VERY_LOW**.
- *[path1]*: specifies the data input path.
- *[path2]*: specifies the data output path.

For example, set the **/opt/client/HDFS/hadoop/share/hadoop/mapreduce/hadoop-mapreduce-examples*.jar** file to a high-priority task.

yarn jar /opt/client/HDFS/hadoop/share/hadoop/mapreduce/hadoop-mapreduce-examples*.jar wordcount -Dmapreduce.job.priority=VERY_HIGH /DATA.txt /out/

17.9.5 Why Physical Memory Overflow Occurs If a MapReduce Task Fails?

Question

The HBase bulkload task has 210,000 Map tasks and 10,000 Reduce tasks. The MapReduce task fails to be executed, and the physical memory of ApplicationMaster overflows.

```
For more detailed output, check the application tracking page:https://bigdata-55:8090/cluster/app/application_1449841777199_0003
Then click on links to logs of each attempt.
Diagnostics: Container [pid=21557,containerID=container_1449841777199_0003_02_000001] is running beyond physical memory limits
Current usage: 1.0 GB of 1 GB physical memory used; 3.6 GB of 5 GB virtual memory used. Killing container.
Dump of the process-tree for container_1449841777199_0003_02_000001 :
|- PID PPID PGRPID SESSID CMD_NAME USER_MODE_TIME(MILLIS) SYSTEM_TIME(MILLIS) VMEM_USAGE(BYTES) RSSMEM_USAGE(PAGES) FULL_CMD_LINE
|- 21584 21557 21557 21557 (java) 12342 1627 3871748096 271331 ${BIGDATA_HOME}/jdk1.8.0_51//bin/java
-Djava.io.tmpdir=/srv/BigData/hadoop/data1/nm/localdir/usercache/hbase/appcache/application_1449841777199_0003/container_1449841777199_0003_02_000001/tmp -Dlog4j.configuration=container-log4j.properties
-Dyarn.app.container.log.dir=/srv/BigData/hadoop/data1/nm/containerlogs/application_1449841777199_0003/container_1449841777199_0003_02_000001 -Dyarn.app.container.log.filesize=0 -Dhadoop.root.logger=INFO,CLA
-Dhadoop.root.logfile=syslog -Xmx784m org.apache.hadoop.mapreduce.v2.app.MRAppMaster
|- 21557 21547 21557 21557 (bash) 0 0 13074432 368 /bin/bash -c ${BIGDATA_HOME}/jdk1.8.0_51//bin/java
-Djava.io.tmpdir=/srv/BigData/hadoop/data1/nm/localdir/usercache/hbase/appcache/application_1449841777199_0003/container_1449841777199_0003_02_000001/tmp -Dlog4j.configuration=container-log4j.properties
-Dyarn.app.container.log.dir=/srv/BigData/hadoop/data1/nm/containerlogs/application_1449841777199_0003/container_1449841777199_0003_02_000001 -Dyarn.app.container.log.filesize=0 -Dhadoop.root.logger=INFO,CLA
-Dhadoop.root.logfile=syslog -Xmx784m org.apache.hadoop.mapreduce.v2.app.MRAppMaster 1>/srv/BigData/hadoop/data1/nm/containerlogs/application_1449841777199_0003/container_1449841777199_0003_02_000001/stdout
2>/srv/BigData/hadoop/data1/nm/containerlogs/application_1449841777199_0003/container_1449841777199_0003_02_000001/stderr
Container killed on request. Exit code is 143
Container exited with a non-zero exit code 143
Failing this attempt. Failing the application.
```

Answer

This is a performance specification problem. The root cause of the MapReduce task execution failure is the memory overflow of ApplicationMaster, that is, the NodeManager kills the task due to the physical memory overflow.

Solutions:

Increase the memory of ApplicationMaster. Optimize configuration of the following parameters in the *Client installation path*/**Yarn/config/mapred-site.xml** configuration file on the client:

- **yarn.app.mapreduce.am.resource.mb**
- **yarn.app.mapreduce.am.command-opts**. The recommended value of **-Xmx** is 0.8 x **yarn.app.mapreduce.am.resource.mb**.

Specification:

ApplicationMaster supports 24,000 concurrent containers when the configuration is as follows:

- **yarn.app.mapreduce.am.resource.mb**=2048
- In **yarn.app.mapreduce.am.command-opts**, **-Xmx** is **1638m**.

17.9.6 After the Address of MapReduce JobHistoryServer Is Changed, Why the Wrong Page is Displayed When I Click the Tracking URL on the ResourceManager WebUI?

Question

After the address of MapReduce JobHistoryServer is changed, why the wrong page is displayed when I click the tracking URL on the ResourceManager WebUI?

Answer

JobHistoryServer address (mapreduce.jobhistory.address / mapreduce.jobhistory.webapp.<https.>address) is the parameter of MapReduce. The MapReduce client will submit the address together with jobs to ResourceManager. After ResourceManager completing the jobs, the parameter is saved in RMStateStore as the target address for viewing history job information.

If the JobHistoryServer address is changed, update the address in the configuration file of the MapReduce client in time. If the address is not updated, the page of earlier JobHistoryServer is displayed when you click the tracking URL of the new job. The target address of information about MapReduce jobs running before the change of address cannot be changed, so the wrong page is also displayed when you click the tracking URL. You can check the history information by accessing the new JobHistoryServer address.

17.9.7 MapReduce Job Failed in Multiple NameService Environment

Question

MapReduce or Yarn job fails in multiple nameService environment using viewFS.

Answer

When using viewFS only the mount directories are accessible, so the most possible cause is that the path configured is not in one of the mounted paths. For example:

```
<property>
<name>fs.defaultFS</name>
<value>viewfs://ClusterX/</value>
</property>
<property>
<name>fs.viewfs.mounttable.ClusterX.link./folder1</name>
<value>hdfs://NS1/folder1</value>
</property>
<property>
<name>fs.viewfs.mounttable.ClusterX.link./folder2</name>
<value>hdfs://NS2/folder2</value>
</property>
```

For all the MR properties which depends on HDFS, should use the paths inside mount folders.

Incorrect:

```
<property>
<name>yarn.app.mapreduce.am.staging-dir</name>
<value>/tmp/hadoop-yarn/staging</value>
</property>
```

As the root folder (/) is not accessible in viewFS.

Correct:

```
<property>
<name>yarn.app.mapreduce.am.staging-dir</name>
<value>/folder1/tmp/hadoop-yarn/staging</value>
</property>
```

17.9.8 Why a Fault MapReduce Node Is Not Blacklisted?

Question

MapReduce task fails and the ratio of fault nodes to all nodes is smaller than the blacklist threshold configured by **yarn.resourcemanager.am-scheduling.node-blacklisting-disable-threshold**. Why the fault node not be blacklisted?

Answer

If the blacklisted percentage exceeds the threshold, all blacklisted nodes are released. Traditionally, the blacklist percentage is the ratio of fault nodes to all nodes in the cluster. Currently, each node has a label expression. Therefore, the blacklist percentage needs to be calculated based on the number of nodes related to valid node label expressions. In other way, the blacklist percentage is the ratio of fault nodes related to valid node label expressions.

Assume that there are 100 nodes in the cluster, including 10 nodes (labelA) related to valid node label expressions. Assume that all nodes related to valid node label expressions are faulty and default blacklist threshold is 0.33. In traditional calculation method, 10/100 = 0.1, which is far smaller than the threshold (0.33). In this case, the 10 nodes will never get released. Therefore, MapReduce always cannot obtain nodes and applications cannot run properly. In practice, the blacklist percentage needs to be calculated based on the total number of nodes related to valid node label expressions: 10/10 = 1 is greater than the blacklist threshold and all nodes are released.

Therefore, even the ratio of fault nodes to all nodes in the cluster is below the threshold, all nodes in the blacklist are released.

18 Using MemArtsCC

18.1 Setting Typical MemArtsCC Parameters

Configuration Page

Go to the MemArtsCC configuration page by referring to **Modifying Cluster Service Configuration Parameters**.

Parameters

Table 18-1 MemArtsCC configuration parameters

Parameter	Description	Default Value
access_token_enable	Whether to enable Access token authentication If this function is enabled, token verification is required when the SDK reads the cache through the worker. When the SDK sends a read request to the worker for the first time, the worker performs Kerberos authentication, generates a key, saves the key to the local host and ZooKeeper, uses the key to generate a token, and returns the token to the SDK. When the SDK sends other read requests to the worker, the token is transferred to the worker for verification with the key, the cache can be read only after the verification is successful.	The value is **true** for a security cluster and **false** for a normal cluster.
cache_cap_max_availabe_rate	Ratio of the maximum available capacity on each disk for MemArtsCC The value ranges from 0.01 to 1.0, and the step is 0.01. This parameter determines the maximum disk capacity (percentage) can be used by MemArtsCC. The default value is **30%**. For example, if the disk capacity is 3 TB, the maximum cache space that can be used by the MemArtsCC is 900 GB. If the cache exceeds 900 GB, the MemArtsCC dynamically clears the cache.	0.3

Parameter	Description	Default Value
cache_reserved_space	Space to be dynamically reserved for each disk **cache_reserved_space** determines the reserved disk space. The default value is 512 MB. Set this parameter to a value greater than 10% of the disk capacity. For example, for a 3 TB disk, set **cache_reserved_space** to 300 GB and **cache_cap_max_available_rate** to **30%**. If the disk space is less than 300 GB, MemArtsCC dynamically clears the cache even if the cache does not reach the maximum limit (900 GB).	512MB
auto_isolate_broken_disk	Whether to automatically isolate faulty disks	true
broken_disk_list	List of faulty disks	-

18.2 Configuring the Connection Between Hive and MemArtsCC

Scenario

MemArtsCC stores hotspot data in computing clusters to reduce the required bandwidth on the OBS server. With the local storage of MemArtsCC, hotspot data does not need to be accessed across networks, improving the data read efficiency of Hive. This topic describes how to integrate Hive into HetuEngine tasks for a system where storage and compute are decoupled.

Prerequisites

- The Guardian service is running properly, and decoupled storage and compute have been used.
- Hive has been connected to OBS.

Modifying Hive Configurations

Step 1 Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Hive**, click **Configurations** and then **All Configurations**, and choose **Hive(Service)** > **OBS**.

Step 2 Set **fs.obs.readahead.policy** to **memArtsCC**.

Step 3 Click **Save**. In the displayed dialog box, click **OK** to save the configuration. Click **Dashboard** and choose **More** > **Service Rolling Restart** to restart the Hive service.

----End

Verifying the Configuration

Step 1 Log in to FusionInsight Manager and choose **Cluster** > **Services** > **MemArtsCC** > **Chart** > **Capacity**.

Step 2 View and record the number of shards in the cluster.

Step 3 Log in to the Hive client node, use Beeline to create a table, and ensure that **Location** is an OBS path.

Run the following statement in Beeline to execute MapReduce tasks:

select count(*) from *tablename;*

Step 4 Repeat **Step 1** to **Step 2**. If there are more shards in the cluster than there were in **Step 2**, the interconnection is successful.

----End

18.3 Integrating MemArtsCC into Spark Tasks

Scenario

MemArtsCC stores hotspot data in compute clusters to reduce the required bandwidth on the OBS server. With the local storage of MemArtsCC, hotspot data does not need to be accessed across networks, improving the data read efficiency of Spark. This topic describes how to integrate MemArtsCC into Spark tasks for a system where storage and compute are decoupled.

Prerequisites

- The Guardian service is running properly, and decoupled storage and compute have been used.
- Spark has been connected to OBS.

Modifying Spark Configurations

Step 1 Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Spark**. Click **Configurations**, click **All Configurations**, and click **SparkResource(Role)** > **OBS**.

Step 2 Set **fs.obs.readahead.policy** to **memArtsCC**.

Step 3 Click **Save**. In the displayed dialog box, click **OK** to save the configuration. Click **Dashboard** and choose **More** > **Service Rolling Restart** to restart the Spark service.

Step 4 Download and install the Spark service client again.

----End

Verifying the Configuration

Step 1 Log in to FusionInsight Manager and choose **Cluster** > **Services** > **MemArtsCC** > **Chart** > **Capacity**.

Step 2 View and record the number of shards in the cluster.

Step 3 Log in to the Spark client node, create a table whose **Location** is an OBS path, and query the table.

Step 4 Repeat **Step 1** and **Step 2**. If there are more shards in the cluster than there were in **Step 2**, the interconnection is successful.

----End

18.4 MemArtsCC Logs

Description

Log path: **/var/log/Bigdata/memartscc**

Archive rule: Automatic compression and archive is enabled for MemArtsCC run logs. When the size of a log file exceeds 50 MB (the size is configurable), the log file is automatically compressed. The number of compressed files can be retained is configurable.

Table 18-2 MemArtsCC logs

Log Type	Log File Name	Description
Run log	check-sidecar-instance.log	Sidecar health check log
	check-worker-instance.log	Worker health check log
	sidecarStartDetail.log	Sidecar startup log
	sidecarStopDetail.log	Sidecar stop log
	workerStartDetail.log	Worker startup log
	workerStopDetail.log	Worker stop log
Worker log	**cc-worker-console.***Log generation time*	Worker startup log
	ccworker.*Log level.Log generation time*	Worker run log
Sidecar log	cc-sidecar-zk.log	ZooKeeper operation log of sidecar
	cc-sidecar-bg-task.log	Sidecar backend task log
	cc-sidecar-cli.log	Sidecar command execution log
	cc-sidecar.log	Sidecar run log

Log levels

Table 2 describes the log levels provided by MemArtsCC.

The log levels are ERROR, WARN, INFO, and DEBUG in descending order of priority. Only logs whose levels are higher than or equal to the specified level are recorded. The higher the log level specified, the fewer the logs are recorded.

Table 18-3 Log levels

Level	Description
ERROR	Logs of this level record error information about system running
WARN	Logs of this level record exception information about the current event processing
INFO	Logs of this level record normal running status information about the system and events
DEBUG	Logs of this level record the system information and system debugging information

To modify log levels, perform the following operations:

Step 1 Log in to FusionInsight Manager.

Step 2 Choose **Cluster** > **Services** > **MemArtsCC**. Click **Configurations** and then **All Configurations**.

Step 3 On the menu bar on the left, select the log menu of the target role.

Step 4 Select a desired log level.

Step 5 Click **Save**. Then, click **OK**.

NOTE

The configurations are applied immediately without the need to restart the service.

----End

19 Using Oozie

19.1 Using Oozie from Scratch

Oozie is an open-source workflow engine that is used to schedule and coordinate Hadoop jobs.

Oozie can be used to submit a wide array of jobs, such as Hive, Spark, Loader, MapReduce, Java, DistCp, Shell, HDFS, SSH, SubWorkflow, Streaming, and scheduled jobs.

This section describes how to use the Oozie client to submit a MapReduce job.

Prerequisites

The client has been installed in a directory, for example, **/opt/client**. The client directory in the following operations is only an example. Change it based on site requirements.

Procedure

Step 1 Log in to the node where the client is installed as the client installation user.

Step 2 Run the following command to go to the client installation directory, for example, **/opt/client**:

cd /opt/client

Step 3 Run the following command to configure environment variables:

source bigdata_env

Step 4 Check the cluster authentication mode.

- If the cluster is in security mode, run the following command to authenticate the user: *UserOozie* indicates the user who submits tasks.

  kinit *UserOozie*

- If the cluster is in normal mode, go to **Step 5**.

Step 5 Upload the Oozie configuration file and JAR package to HDFS.

hdfs dfs -mkdir /user/*UserOozie*

hdfs dfs -put -f /opt/client/Oozie/oozie-client-*/examples /user/*UserOozie*/

NOTE

- /opt/client is the client installation directory. Change it based on site requirements.
- **UserOozie** indicates the name of the user who submits jobs.
- After creating the **/user/***UserOozie* directory and uploading files in **/opt/client/Oozie/oozie-client-*/examples** to the directory, ensure that the directory, all files in the directory, and subdirectories have permission 755. Otherwise, exceptions may occur when the Oozie client is used to submit tasks.

Step 6 Run the following commands to modify the job execution configuration file:

cd /opt/client/Oozie/oozie-client-*/examples/apps/map-reduce/

vi job.properties

```
nameNode=hdfs://hacluster
resourceManager=10.64.35.161:8032 (10.64.35.161 is the service plane IP address of the Yarn resourceManager (active) node, and 8032 is the port number of yarn.resourcemanager.port)
queueName=default
examplesRoot=examples
user.name=admin
oozie.wf.application.path=${nameNode}/user/${user.name}/${examplesRoot}/apps/map-reduce# HDFS upload path
outputDir=map-reduce
oozie.wf.rerun.failnodes=true
```

Step 7 Run the following command to execute the Oozie job:

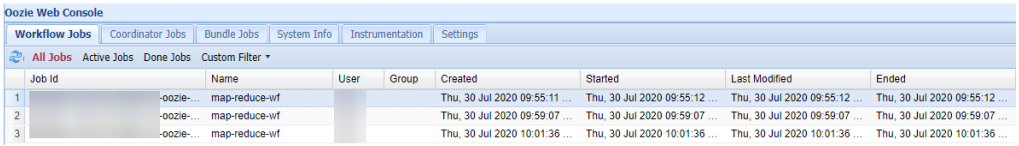
oozie job -oozie https://*Host name of the Oozie role***:21003/oozie/ -config job.properties -run**

```
[root@kwephispra44947 map-reduce]# oozie job -oozie https://kwephispra44948:21003/oozie/ -config job.properties -run
.....
job: 0000000-200730163829770-oozie-omm-W
```

Step 8 Log in to FusionInsight Manager.

Step 9 Choose **Cluster** > **Services** > **Oozie**, click the hyperlink next to **Oozie WebUI** to access the Oozie page, and view the task execution result on the Oozie web UI.

Figure 19-1 Task execution result



----End

19.2 Using the Oozie Client

Scenario

This section describes how to use the Oozie client in an O&M scenario or service scenario.

Prerequisites

- The client has been installed in a directory, for example, **/opt/client**. The client directory in the following operations is only an example. Change it based on site requirements.
- Service component users have been created by the MRS cluster administrator. In security mode, machine-machine users need to download the keytab file. A human-machine user must change the password upon the first login.

Using the Oozie Client

Step 1 Log in to the node where the client is installed as the client installation user.

Step 2 Run the following command to switch to the client installation directory (change it to the actual installation directory):

cd /opt/client

Step 3 Run the following command to configure environment variables:

source bigdata_env

Step 4 Check the cluster authentication mode.

- If the cluster is in security mode, run the following command to authenticate the user: *exampleUser* indicates the name of the user who submits tasks.

  kinit *exampleUser*
- If the cluster is in normal mode, go to **Step 5**.

Step 5 Perform the following operations to configure Hue:

1. Configure the Spark environment (skip this step if no Spark task is involved):

   hdfs dfs -put /opt/client/Spark/spark/jars/*.jar /user/oozie/share/lib/spark/

   When the JAR package in the HDFS directory **/user/oozie/share** changes, you need to restart the Oozie service.
2. Upload the Oozie configuration file and JAR package to HDFS.

   hdfs dfs -mkdir /user/*exampleUser*

   hdfs dfs -put -f /opt/client/Oozie/oozie-client-*/examples /user/*exampleUser*/

NOTE

- *exampleUser* indicates the name of the user who submits tasks.
- After creating the **/user/***exampleUser***/** directory and uploading files in **/opt/client/Oozie/oozie-client-*/examples** to the directory, ensure that the directory, all files in the directory, and subdirectories have permission 755. Otherwise, exceptions may occur when the Oozie client is used to submit tasks.
- If the user who submits the task and other files except **job.properties** are not changed, client installation directory **Oozie/oozie-client-*/examples** can be repeatedly used after being uploaded to HDFS.
- Resolve the JAR file conflict between Spark and Yarn about Jetty.

  hdfs dfs -rm -f /user/oozie/share/lib/spark/jetty-all-9.2.22.v20170606.jar
- In normal mode, if **Permission denied** is displayed during the upload, run the following commands:

  su - omm

  source /opt/client/bigdata_env

  hdfs dfs -chmod -R 777 /user/oozie

  exit

----End

19.3 Checking ShareLib

Oozie tasks require native ShareLib JAR packages to run. ShareLib is automatically uploaded to the **/user/oozie** directory of HDFS when the Oozie kernel is started. Oozie tasks may fail if ShareLib JAR packages in HDFS are damaged, missing, or conflict.

If an Oozie job submitted by a user fails to run, check ShareLib by referring to the operations provided in this section.

Prerequisites

- You have installed the HDFS and Oozie clients.
- To check Spark ShareLib, you need to install the Spark client on the node where the Oozie client is located.
- The user who performs the check must have the common user permission of Oozie and the permission to access the **/user/oozie** directory of HDFS.

Procedure

Step 1 Log in to the node where the client is installed as the client installation user.

Step 2 Run the following command to go to the client installation directory:

cd *Client installation directory*

Step 3 Run the following commands to configure environment variables and authenticate the user:

source bigdata_env

kinit *User who submits Oozie tasks* (Skip this step for normal clusters.)

Step 4 Check ShareLib by checking the client or server. Spark ShareLib can be checked only by checking the client.

- Checking the client:
  - Check Oozie ShareLib and ensure that an Oozie instance is installed on the node where the Oozie client to be checked resides.

    oozie -validatesharelib -oozie.core.path=*Oozie instance installation path*

    The following is an example:

    oozie -validatesharelib -oozie.core.path=${BIGDATA_HOME}/FusionInsight_Porter_*/install/FusionInsight-Oozie-*/oozie-*
  - Check Spark ShareLib.

    oozie -validatesharelib -spark.client.path=*Spark client installation directory*

    The following is an example:

    oozie -validatesharelib -spark.client.path=/opt/client/Spark/
- Checking the server:

  Run the following command to check Oozie ShareLib:

  oozie job -oozie https://*Host name of the Oozie role***:21003/oozie -validatesharelib**

  To view the host name of the oozie role, choose **Cluster** > **Services** > **Oozie** and click the **Instance** tab on FusionInsight Manager.

  21003 is the running port of Oozie HTTPS requests. To view the port, log in to FusionInsight Manager, choose **Cluster** > **Services** > **Oozie** and click the **Configuration** tab. Search for **OOZIE_HTTPS_PORT**.

Step 5 View check results. The following circumstances are included:

- Some ShareLib JAR packages are missing.

  If some JAR packages are missing, message "Share Lib jar file(s) not found on hdfs:" and information about the missing JAR packages are displayed.

  If no ShareLib JAR package is missing, message "All Share Lib jar file(s) found on hdfs." is displayed.
- Some JAR packages are damaged.

  If damaged JAR packages are detected, message "Share Lib jar file(s) mismatch on hdfs:" and information about the damaged JAR packages are displayed.

  If no ShareLib JAR package is damaged, message "All Share Lib jar file(s) on hdfs match." is displayed.
- Custom JAR packages are uploaded.

  If custom JAR packages are detected, message "Extra Share Lib jar file(s) found on hdfs:" and information about the custom JAR packages are displayed.

  If no custom JAR package is detected, message "No extra Share Lib jar file(s) found on hdfs." is displayed.

Step 6 Rectify the fault based on the check results.

If the detection result obtained in **Step 5** contains information indicating JAR packages are missing or damaged, perform the following operations:

- Spark ShareLib:

  Upload the Spark JAR package in the *Spark client installation directory*/**spark/jars** directory to the HDFS path in the check result.

  hdfs dfs -put -f *Local JAR package path HDFS path that Spark JAR packages are missing or damaged*

- Oozie ShareLib:

  a. Decompress the **oozie-sharelib-*.tar.gz** file under Oozie installation path **${BIGDATA_HOME}/FusionInsight_Porter_*/install/FusionInsight-Oozie-*/oozie-*/** and find the ShareLib JAR package.

  tar -zxf oozie-sharelib-*.tar.gz

  b. Upload the obtained Oozie JAR package to the HDFS path in the check result.

  hdfs dfs -put -f *Local JAR package path HDFS path that Oozie JAR packages are missing or damaged*

----End

19.4 Using Oozie Client to Submit an Oozie Job

19.4.1 Submitting a Hive Job

Scenario

This section describes how to use the Oozie client to submit a Hive job.

Hive jobs are divided into the following types:

- Hive job

  Hive job that is connected in JDBC mode

- Hive2 job

  Hive job that is connected in Beeline mode

This section describes how to submit a Hive job using the Oozie client.

NOTE

- The procedure for submitting a Hive2 job using the Oozie client is the same as that for submitting a Hive job. You only need to change **/Hive** in the procedure to **/Hive2**.

  For example, the directory of Hive jobs is **/opt/client/Oozie/oozie-client-*/examples/apps/hive/**, and that of Hive2 jobs is **/opt/client/Oozie/oozie-client-*/examples/apps/hive2/**.

- You are advised to download the latest client.

Prerequisites

- The Hive and Oozie components and clients have been installed and are running properly.
- You have created or obtained the human-machine account and password for accessing the Oozie service.

NOTE

- This user must belong to the **hadoop**, **supergroup**, and **hive** groups and be assigned with the Oozie role operation permission. If the multi-instance function is enabled for Hive, the user must belong to a specific Hive instance group, for example, **hive3**.
- This user must also be assigned the **manager_viewer** role at least.

- You have obtained the URL of the Oozie server (any instance) in the running state, for example, **https://10.1.130.10:21003/oozie**.
- You have obtained the name of the Oozie server, for example, **10-1-130-10**.
- You have obtained the IP address of the active Yarn ResourceManager, for example, **10.1.130.11**.

Procedure

Step 1 Log in to the node where the Oozie client is installed as the client installation user.

Step 2 Run the following command to obtain the installation environment. **/opt/client** is an example client installation path.

source /opt/client/bigdata_env

Step 3 Check the cluster authentication mode.

- If the cluster is in security mode, run the **kinit** command to authenticate users.

  For example, the **oozieuser** user is authenticated using the following command:

  kinit oozieuser

- If the cluster is in normal mode, go to **Step 4**.

Step 4 Run the following command to go to the example directory:

cd /opt/client/Oozie/oozie-client-*/examples/apps/hive/

Table 19-1 lists the files that you need to pay attention to in the directory.

Table 19-1 File description

File	Description
hive-site.xml	Configuration file of a Hive job
job.properties	Parameter definition file of a workflow
script.q	SQL script of a Hive job
workflow.xml	Rule definition file of a workflow

Step 5 Run the following command to edit the **job.properties** file:

vi job.properties

Perform the following modifications:

Change the value of **userName** to the name of the human-machine user who submits the job, for example, **userName=oozieuser**.

Step 6 Run the **oozie job** command to run the workflow file:

oozie job -oozie https://*Host name of the Oozie role*:**21003/oozie/ -config job.properties -run**

NOTE

- The command parameters are described as follows:

  -oozie: URL of the Oozie server that executes a job

  -config: Workflow property file

  -run: Executing a workflow

- If a job ID, for example, **job: 0000021-140222101051722-oozie-omm-W**, is displayed after the workflow file is executed, the job is successfully submitted. You can view the execution results on the Oozie management page.

  Log in to the Oozie web UI at **https**://*IP address of the Oozie role*:**21003/oozie** as user **oozieuser**.

  On the Oozie web UI, you can view the submitted workflow information based on the job ID in the table on the page.

----End

19.4.2 Submitting a Spark Job

Scenario

Submit a Spark job on the Oozie client.

NOTE

You are advised to download the latest client.

Prerequisites

- Spark and Oozie as well as their clients have been installed and are running properly.

  If the current client is an earlier version, you need to download and install the client again.

- You have created or obtained the human-machine account and password for accessing the Oozie service.

  NOTE

  - This user must belong to the **hadoop**, **supergroup**, and **hive** groups and be assigned with the Oozie role operation permission. If the multi-instance function is enabled for Hive, the user must belong to a specific Hive instance group, for example, **hive3**.
  - This user must also be assigned the **manager_viewer** role at least.

- You have obtained the URL of the Oozie server (any instance) in the running state, for example, **https://10.1.130.10:21003/oozie**.
- You have obtained the name of the Oozie server, for example, **10-1-130-10**.

- You have obtained the IP address of the active Yarn ResourceManager, for example, **10.1.130.11**.

Procedure

Step 1 Log in to the node where the Oozie client is installed as the client installation user.

Step 2 Run the following command to obtain the installation environment. **/opt/client** is an example client installation path.

source /opt/client/bigdata_env

Step 3 Check the cluster authentication mode.

- If the cluster is in security mode, run the **kinit** command to authenticate users.

  For example, the **oozieuser** user is authenticated using the following command:

  kinit oozieuser

- If the cluster is in normal mode, go to **Step 4**.

Step 4 Run the following command to go to the example directory:

cd /opt/client/Oozie/oozie-client-*/examples/apps/spark/

Table 19-2 lists the files that you need to pay attention to in the directory.

Table 19-2 File description

File	Description
job.properties	Parameter definition file of a workflow
workflow.xml	Rule definition file of a workflow
lib	Directory of the JAR file on which a workflow depends

Step 5 Run the following command to edit the **job.properties** file:

vi job.properties

Perform the following modifications:

Change the value of **userName** to the name of the human-machine user who submits the job, for example, **userName=oozieuser**.

Step 6 Run the **oozie job** command to run the workflow file:

oozie job -oozie https://*Host name of the Oozie role***:21003/oozie/ -config job.properties -run**

NOTE

- The command parameters are described as follows:

  -oozie: URL of the Oozie server that executes a job

  -config: Workflow property file

  -run: Executing a workflow
- If a job ID, for example, **job: 0000021-140222101051722-oozie-omm-W**, is displayed after the workflow file is executed, the job is successfully submitted. You can view the execution results on the Oozie management page.

  Log in to the Oozie web UI at **https**://*IP address of the Oozie role*:**21003/oozie** as user **oozieuser**.

  On the Oozie web UI, you can view the submitted workflow information based on the job ID in the table on the page.

----End

19.4.3 Submitting a Loader Job

Scenario

This section describes how to submit a Loader job using the Oozie client.

NOTE

You are advised to download the latest client.

Prerequisites

- The Hive and Oozie components and clients have been installed and are running properly.
- You have created or obtained the human-machine account and password for accessing the Oozie service.

  NOTE

  - This user must belong to the **hadoop**, **supergroup**, and **hive** groups and be assigned with the Oozie role operation permission. If the multi-instance function is enabled for Hive, the user must belong to a specific Hive instance group, for example, **hive3**.
  - This user must also be assigned the **manager_viewer** role at least.
- You have obtained the URL of the Oozie server (any instance) in the running state, for example, **https://10.1.130.10:21003/oozie**.
- You have obtained the name of the Oozie server, for example, **10-1-130-10**.
- You have obtained the IP address of the active Yarn ResourceManager, for example, **10.1.130.11**.
- You have created a Loader job to be scheduled and obtained the job ID.

Procedure

Step 1 Log in to the node where the Oozie client is installed as the client installation user.

Step 2 Run the following command to obtain the installation environment. **/opt/client** is an example client installation path.

source /opt/client/bigdata_env

Step 3 Check the cluster authentication mode.

- If the cluster is in security mode, run the **kinit** command to authenticate users.

  For example, the **oozieuser** user is authenticated using the following command:

  kinit oozieuser

- If the cluster is in normal mode, go to **Step 4**.

Step 4 Run the following command to go to the example directory:

cd /opt/client/Oozie/oozie-client-*/examples/apps/sqoop/

Table 19-3 lists the files that you need to pay attention to in the directory.

Table 19-3 File description

File	Description
job.properties	Parameter definition file of a workflow
workflow.xml	Rule definition file of a workflow

Step 5 Run the following command to edit the **job.properties** file:

vi job.properties

Perform the following modifications:

Change the value of **userName** to the name of the human-machine user who submits the job, for example, **userName=oozieuser**.

Step 6 Run the following command to edit the **workflow.xml** file:

vi workflow.xml

Perform the following modifications:

Change the value of **command** to the ID of the Loader job to be scheduled, for example, **1**.

Upload the **workflow.xml** file to the HDFS path in the **job.properties** file.

hdfs dfs -put -f workflow.xml /user/userName/examples/apps/sqoop

Step 7 Run the **oozie job** command to run the workflow file:

oozie job -oozie https://*Host name of the Oozie role***:21003/oozie/ -config job.properties -run**

NOTE

- The command parameters are described as follows:

  -oozie: URL of the Oozie server that executes a job

  -config: Workflow property file

  -run: Executing a workflow

- If a job ID, for example, **job: 0000021-140222101051722-oozie-omm-W**, is displayed after the workflow file is executed, the job is successfully submitted. You can view the execution results on the Oozie management page.

  Log in to the Oozie web UI at **https**://*IP address of the Oozie role*:**21003/oozie** as user **oozieuser**.

  On the Oozie web UI, you can view the submitted workflow information based on the job ID in the table on the page.

----End

19.4.4 Submitting a Sqoop Job

Scenario

This section outlines the procedure for submitting a Sqoop job using the Oozie client.

NOTE

- Parameters that facilitate the automatic creation and deletion of HCatalog tables, such as Sqoop's options **--create-hcatalog-table** and **--drop-and-create-hcatalog-table**, are not applicable for data imports using Sqoop. It is necessary to pre-create the required tables in Oozie. To leverage the automatic table creation feature, perform data import using the **--hive-import** method.
- If Kerberos authentication is enabled for the cluster (the cluster is in security mode), it is not possible to use the Oozie client for direct Sqoop task submissions to HBase. Instead, execute the Sqoop command for data imports or conduct operations on a normal cluster.

Prerequisites

- The Sqoop and Oozie components and clients have been installed and are running properly.
- Obtain the URL of the Oozie service and the IP address and port number of the active Yarn ResourceManager node.
  - The URL of the Oozie service is **https://***Host IP address of the Oozie instance:Port number***/oozie**. For example, you can use **https://***10.1.130.11:21003***/oozie** to specify the Oozie server that runs the Sqoop task.

    Log in to FusionInsight Manager, choose **Cluster** > **Services** > **Oozie** and click **Instances** to check the IP address of any Oozie instance. Click **Configurations** and search for **OOZIE_HTTPS_PORT** in the search box to check the port number in use.
  - The IP address and port number of the active Yarn ResourceManager node are used to modify the **resourceManager** parameter in the **job.properties** file. The format is *Active ResourceManager IP address*:*Port number*, for example, **10.1.130.11:8032**.

Log in to FusionInsight Manager, choose **Cluster** > **Services** > **Yarn** and click **Instances** to check the IP address of the active ResourceManager instance. Click **Configurations** and search for **yarn.resourcemanager.port** in the search box to check the port number in use.

- Upload the JDBC driver JAR package (for example, MySQL driver package **mysql-connector-java-5.1.47.jar**) of the corresponding relational database version to the **/user/oozie/share/lib/sqoopclient/** directory of HDFS, and change the permission and user group to be the same as those of other JAR packages in the directory, perform either of the following operations to update the JAR package dependency:
  - Refresh the dependency on the Oozie client.

    oozie admin -oozie https://*Host IP address of the Oozie instance:Port number***/oozie -sharelibupdate**
  - Restart the Oozie service to refresh the dependency.

    Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Oozie**. On the page that is displayed, choose **More** > **Restart Service** to restart the Oozie service.
- You have obtained the JDBC driver JAR package of the corresponding relational database version, for example, the MySQL driver package **mysql-connector-java-5.1.47.jar**.
- The corresponding Sqoop command has been prepared. For details, see .

Procedure

Step 1 Create a human-machine user for accessing the Oozie service. (Skip this step if a user with related permissions already exists.)

1. Log in to FusionInsight Manager and choose **System** > **Permission**.
2. Click **Role** and click **Create Role**.
   - **Role Name**: Enter a role name, for example, **oozieadmin**.
   - **Configure Resource Permission**: Click the name of the desired cluster, click **Oozie**, and select **Admin**.
3. Choose **User** in the navigation pane and click **Create** on the displayed page. Create a human-machine user.
   - **Username**: Enter the username, for example, **admin123**.
   - **User Type**: Select **Human-Machine**.
   - **Password** and **Confirm Password**: Enter a password and enter it again for confirmation.
   - **User Group**: Add the user to the **hadoop**, **supergroup**, and **hive** user groups.
   - **Role**: Click **Add** and bind **manager_viewer** and the role (for example, **oozieadmin**) that has the Oozie administrator permissions added in **Step 1.2**.
4. Log in to FusionInsight Manager as the new user and change the initial password.

Step 2 Log in to the node where the client is installed as the client installation user.

Step 3 Configure environment variables. **/opt/client** is an example client installation path.

source /opt/client/bigdata_env

Step 4 Check the cluster authentication mode.

- Kerberos authentication has been enabled for the cluster. Run the **kinit** command to authenticate users.

  For example, the **oozieuser** user is authenticated using the following command:

  kinit oozieuser

- If Kerberos authentication is not enabled for the cluster, go to **Step 5**.

Step 5 Go to the Sqoop sample directory.

cd /opt/client/Oozie/oozie-client-*/examples/apps/sqoopclient/

NOTE

- Sqoop supports two workflow compilation methods: **sqoopclient** and **sqoopclient-freeform**. The distinction between them is confined to the format of the Sqoop command parameters within the **workflow.xml** file.
- The **sqoopclient-freeform** method can be utilized identically to the **sqoopclient** method. Here are some guidelines for using **sqoopclient**.
- If the actual parameter in the Sqoop command contains spaces, use **/opt/client/Oozie/oozie-client-*/examples/apps/sqoopclient-freeform** as an example. For details, see **workflow.xml** in the path.

  For example, the Sqoop command contains the parameter **--query'select TT.I, TT.S from TT where $CONDITIONS'** , and the select statement of the command contains spaces.

Step 6 Modify the **job.properties** file.

vim job.properties

Perform the following modifications:

- Change the value of **resourceManager** to the IP address and port number of the active ResourceManager node of Yarn, for example, **resourceManager=10.1.130.11:8032**.
- Change the value of **userName** to the name of the human-machine user who submits the task, that is, the user name created in **Step 1**, for example, **userName=oozieuser**. This parameter is used to combine the HDFS user path used by Oozie Job.
- Change the value of **user.name** to the name of the human-machine user who submits the task, that is, the user name created in **Step 1**, for example, **user.name=oozieuser**. This parameter specifies the user who submits the task.
- In a multi-cluster environment, change the value of **nameNode** to the value of **fs.defaultFS** of the Oozie service in the corresponding cluster.

In the following example, the **resourceManager**, **userName**, and **user.name** parameters are modified. Retain the default values for other parameters.

```
nameNode=hdfs://hacluster
resourceManager=10.1.130.11:8032
```

```
queueName=default
examplesRoot=examples
userName=oozieuser
user.name=oozieuser
oozie.use.system.libpath=true
oozie.wf.application.path=${nameNode}/user/${userName}/${examplesRoot}/apps/sqoop
```

Step 7 Modify the **workflow.xml** file:

- Kerberos authentication is disabled for the cluster (the cluster is in normal mode)

  vim workflow.xml

  Below is an example of importing data from a MySQL database to Hive. The bolded content should be adjusted accordingly.

```
<workflow-app xmlns="uri:oozie:workflow:1.0" name="sqoopclient-wf">
   <start to="sqoopclient-node"/>

   <action name="sqoopclient-node">
      <sqoopclient xmlns="uri:oozie:sqoopclient-action:1.0">
         <resource-manager>${resourceManager}</resource-manager>
         <name-node>${nameNode}</name-node>
         <prepare>
            <delete path="${nameNode}/user/${userName}/${examplesRoot}/output-data/
sqoopclient"/>
            <mkdir path="${nameNode}/user/${userName}/${examplesRoot}/output-data"/>
         </prepare>
         <configuration>
            <property>
               <name>mapred.job.queue.name</name>
               <value>${queueName}</value>
            </property>
         </configuration>
         <!--   Specify a specific Sqoop command. Do not add sqoop at the beginning of the
command. Do not write sqoop import. Do not use single or double quotation marks to quote the
database password. -->
         <command>import --connect jdbc:mysql://mysql_host_ip:3306/database --username xxx --
password xxx --table xxx --hive-import --hive-table xxx --delete-target-dir --fields-terminated-by
"," -m 1 --as-textfile</command>
         <!--   Specify the HDFS configuration file to be used. This parameter should only be specified
if explicitly required.-->
         <file>/user/oozie/share/lib/sqoopclient/hive-site.xml#hive-site.xml</file>
      </sqoopclient>
      <ok to="end"/>
      <error to="fail"/>
   </action>

   <kill name="fail">
      <message>Sqoop client failed, error message[${wf:errorMessage(wf:lastErrorNode())}]</
message>
   </kill>
   <end name="end"/>
</workflow-app>
```

- Kerberos authentication is enabled for the cluster (the cluster is in security mode)

  cp workflow.xml.security workflow.xml

  vim workflow.xml

  Below is an example of importing data from a MySQL database to Hive. The bolded content should be adjusted accordingly.

```
<workflow-app xmlns="uri:oozie:workflow:1.0" name="sqoopclient-wf">
   <credentials>
     <credential name='hcat_auth' type='hcat'>
       <property>
         <name>hcat.metastore.uri</name>
         <!--  The value can be obtained from hive.metastore.uris in hive-site.xml. For example, you
```

```
can obtain the value from Client installation directory/Hive/config/hive-site.xml.
          <value>thrift://172.19.xxx.xxx:9083,thrift://172.xxx.xxx.xxx:9083</value>
        </property>
        <property>
          <name>hcat.metastore.principal</name>
          <!--  The value can be obtained from hive.metastore.kerberos.principal in hive-site.xml. For
example, you can obtain the value from Client installation directory/Hive/config/hive-site.xml.
          <value>hive/hadoop.xxx.com@XXX_XXX_XXX_XXX_XXX.COM</value>
        </property>
      </credential>
    </credentials>

    <start to="sqoopclient-node"/>

    <action name="sqoopclient-node" cred='hcat_auth'>
       <sqoopclient xmlns="uri:oozie:sqoopclient-action:1.0">
          <resource-manager>${resourceManager}</resource-manager>
          <name-node>${nameNode}</name-node>
          <prepare>
             <delete path="${nameNode}/user/${userName}/${examplesRoot}/output-data/
sqoopclient"/>
             <mkdir path="${nameNode}/user/${userName}/${examplesRoot}/output-data"/>
          </prepare>
          <configuration>
             <property>
                <name>mapred.job.queue.name</name>
                <value>${queueName}</value>
             </property>
          </configuration>
          <!--   Specify a specific Sqoop command. Do not add sqoop at the beginning of the
command. Do not write sqoop import. Do not use single or double quotation marks to quote the
database password. -->
          <command>import --connect jdbc:mysql://mysql_host_ip:3306/database --username xxx --
password xxx --table xxx --hive-import --hive-table xxx --delete-target-dir --fields-terminated-by
"," -m 1 --as-textfile</command>
          <!--   Specify the HDFS configuration file to be used. This parameter should only be specified
if explicitly required.-->
          <file>/user/oozie/share/lib/sqoopclient/hive-site.xml#hive-site.xml</file>
       </sqoopclient>
       <ok to="end"/>
       <error to="fail"/>
    </action>

    <kill name="fail">
       <message>Sqoop client failed, error message[${wf:errorMessage(wf:lastErrorNode())}]</
message>
    </kill>
    <end name="end"/>
</workflow-app>
```

Step 8 Upload the **workflow.xml** file to the HDFS path specified by **oozie.wf.application.path** in the job.properties file.

hadoop fs -put -f workflow.xml */user/oozieuser/examples/apps/sqoopclient*

NOTE

- If the path does not exist, run the following command to create one:

  hadoop fs -mkdir -p */user/oozieuser/examples/apps/sqoopclient*
- Each modification to the **workflow.xml** file on the client requires re-uploading the file to HDFS prior to executing the Oozie job command.

Step 9 Run the **oozie job** command to run the workflow file.

oozie job -oozie https://*Host IP address of the Oozie instance:Port number***/oozie/ -config job.properties -run**

NOTE

- The command parameters are described as follows:
  - **-oozie**: URL of the Oozie server that actually executes the Sqoop task
  - **-config**: Workflow property file
  - **-run**: Executing a workflow
- If the job ID is displayed after the workflow file is executed, the submission is successful. The following is an example.
  ```
  job: 0000021-140222101051722-oozie-omm-W
  ```
  You can view the execution results on the Oozie web UI.

  Log in to the Oozie web UI at **https**://*IP address of the Oozie role*:**21003/oozie** as user **oozieuser**.

  On the Oozie web UI, you can view the submitted workflow information based on the job ID in the table on the page.

----End

19.4.5 Submitting a DistCp Job

Scenario

This section describes how to submit a DistCp job using the Oozie client.

NOTE

You are advised to download the latest client.

Prerequisites

- The HDFS and Oozie components and clients have been installed and are running properly.

  If the current client is an earlier version, you need to download and install the client again.
- You have created or obtained the human-machine account and password for accessing the Oozie service.

  NOTE

  - This user must belong to the **hadoop**, **supergroup**, and **hive** groups and be assigned with the Oozie role operation permission. If the multi-instance function is enabled for Hive, the user must belong to a specific Hive instance group, for example, **hive3**.
  - This user must also be assigned the **manager_viewer** role at least.
- You have obtained the URL of the Oozie server (any instance) in the running state, for example, **https://10.1.130.10:21003/oozie**.
- You have obtained the name of the Oozie server, for example, **10-1-130-10**.
- You have obtained the IP address of the active Yarn ResourceManager, for example, **10.1.130.11**.

Procedure

Step 1 Log in to the node where the Oozie client is installed as the client installation user .

Step 2 Run the following command to obtain the installation environment. **/opt/client** is an example client installation path.

source /opt/client/bigdata_env

Step 3 Check the cluster authentication mode.

- If the cluster is in security mode, run the **kinit** command to authenticate users.

  For example, the **oozieuser** user is authenticated using the following command:

  kinit oozieuser

- If the cluster is in normal mode, go to **Step 4**.

Step 4 Run the following command to go to the example directory:

cd /opt/client/Oozie/oozie-client-*/examples/apps/distcp/

Table 19-4 lists the files that you need to pay attention to in the directory.

Table 19-4 File description

File	Description
job.properties	Parameter definition file of a workflow
workflow.xml	Rule definition file of a workflow

Step 5 Run the following command to edit the **job.properties** file:

vi job.properties

Perform the following modifications:

Change the value of **userName** to the name of the human-machine user who submits the job, for example, **userName=oozieuser**.

Step 6 Whether DistCp is not deployed across security clusters.

- If yes, go to **Step 7**.
- If no, go to **Step 9**.

Step 7 Establish cross-Manager mutual trust between two clusters.

Step 8 Run the following commands to back up and modify the **workflow.xml** file:

cp workflow.xml workflow.xml.bak

vi workflow.xml

Modify the following content:

```
<workflow-app xmlns="uri:oozie:workflow:1.0" name="distcp-wf">
   <start to="distcp-node"/>
   <action name="distcp-node">
      <distcp xmlns="uri:oozie:distcp-action:1.0">
         <resource-manager>${resourceManager}</resource-manager>
         <name-node>${nameNode}</name-node>
         <prepare>
            <delete path="hdfs://target_ip:target_port/user/${userName}/${examplesRoot}/output-data/$
```

```
{outputDir}"/>
            </prepare>
            <configuration>
               <property>
                  <name>mapred.job.queue.name</name>
                  <value>${queueName}</value>
               </property>
               <property>
                  <name>oozie.launcher.mapreduce.job.hdfs-servers</name>
                  <value>hdfs://source_ip:source_port,hdfs://target_ip:target_port</value>
               </property>
            </configuration>
            <arg>${nameNode}/user/${userName}/${examplesRoot}/input-data/text/data.txt</arg>
            <arg>hdfs://target_ip:target_port/user/${userName}/${examplesRoot}/output-data/${outputDir}/
data.txt</arg>
            </distcp>
         <ok to="end"/>
         <error to="fail"/>
      </action>
      <kill name="fail">
         <message>DistCP failed, error message[${wf:errorMessage(wf:lastErrorNode())}]</message>
      </kill>
      <end name="end"/>
</workflow-app>
```

target_ip:target_port is the HDFS active NameNode address of the other trusted cluster, for example, **10.10.10.233:25000**.

source_ip:source_port indicates the HDFS active NameNode address of the source cluster, for example, **10.10.10.223:25000**.

Change the two IP addresses and port numbers based on the site requirements.

Step 9 Run the **oozie job** command to run the workflow file:

oozie job -oozie https://*Host name of the Oozie role***:21003/oozie/ -config job.properties -run**

NOTE

- The command parameters are described as follows:

  -oozie: URL of the Oozie server that executes a job

  -config: Workflow property file

  -run: Executing a workflow

- If a job ID, for example, **job: 0000021-140222101051722-oozie-omm-W**, is displayed after the workflow file is executed, the job is successfully submitted. You can view the execution results on the Oozie management page.

  Log in to the Oozie web UI at **https**://*IP address of the Oozie role***:21003/oozie** as user **oozieuser**.

  On the Oozie web UI, you can view the submitted workflow information based on the job ID in the table on the page.

----End

19.4.6 Submitting Other Jobs

Scenario

In addition to Hive, Spark, and Loader tasks, the Oozie client can also be used to submit MapReduce, Java, Shell, HDFS, SSH, SubWorkflow, Streaming, and scheduled jobs.

NOTE

You are advised to download the latest client.

Prerequisites

- The Oozie component and its client have been installed and are running properly.
- You have created or obtained the human-machine account and password for accessing the Oozie service.

  NOTE

  - Shell job:

    This user must belong to the **hadoop** and **supergroup** groups and be assigned the Oozie role operation permission. The Shell script must have the execution permission on each NodeManager.
  - SSH job:

    This user must belong to the **hadoop** and **supergroup** groups and be assigned the Oozie role operation permission. The mutual trust configuration is complete.
  - Other jobs:

    This user must belong to the **hadoop** and **supergroup** groups and be assigned the Oozie role operation permission and other required permissions.
  - This user must also be assigned the **manager_viewer** role at least.
- You have obtained the URL of the Oozie server (any instance) in the running state, for example, **https://10.1.130.10:21003/oozie**.
- You have obtained the name of the Oozie server, for example, **10-1-130-10**.
- You have obtained the IP address of the active Yarn ResourceManager, for example, **10.1.130.11**.

Procedure

Step 1 Log in to the node where the Oozie client is installed as the client installation user.

Step 2 Run the following command to obtain the installation environment. **/opt/client** is an example client installation path.

source /opt/client/bigdata_env

Step 3 Check the cluster authentication mode.

- If the cluster is in security mode, run the **kinit** command to authenticate users.

  For example, the **oozieuser** user is authenticated using the following command:

  kinit oozieuser
- If the cluster is in normal mode, go to **Step 4**.

Step 4 Go to the example directory based on the type of the task you submit.

Table 19-5 List of example directories

Job Type	Example Directory
MapReduce job	*Client installation directory*/**Oozie/oozie-client-*/examples/apps/map-reduce**
Java job	*Client installation directory*/**Oozie/oozie-client-*/examples/apps/java-main**
Shell job	*Client installation directory*/**Oozie/oozie-client-*/examples/apps/shell**
Streaming job	*Client installation directory*/**Oozie/oozie-client-*/examples/apps/shell**
SubWorkflow job	*Client installation directory*/**Oozie/oozie-client-*/examples/apps/subwf**
SSH job	*Client installation directory*/**Oozie/oozie-client-*/examples/apps/ssh**
Scheduled job	*Client installation directory*/**Oozie/oozie-client-*/examples/apps/cron**

NOTE

The examples of other jobs contain HDFS job examples.

Table 19-6 lists the files that you need to pay attention to in the example directory.

Table 19-6 File description

File	Description
job.properties	Parameter definition file of a workflow
workflow.xml	Rule definition file of a workflow
lib	Directory of the JAR file on which a workflow depends
coordinator.xml	Scheduled job configuration file which can be used to set a scheduled policy. The file is in the **cron** directory.
oozie_shell.sh	Shell script file required for submitting shell jobs. The file is in the **shell** directory.

Step 5 Run the following command to edit the **job.properties** file:

vi job.properties

Perform the following modifications:

Change the value of **userName** to the name of the human-machine user who submits the job, for example, **userName=oozieuser**.

Step 6 Run the **oozie job** command to run the workflow file:

oozie job -oozie https://*Host name of the oozie role*:**21003/oozie -config** *File path of job.properties* **-run**

Example:

oozie job -oozie https://10-1-130-10:21003/oozie -config

/opt/client/Oozie/oozie-client-*/examples/apps/map-reduce/job.properties -run

NOTE

- The command parameters are described as follows:

  -oozie: URL of the Oozie server that executes a job

  -config: Workflow property file

  -run: Executing a workflow

- If a job ID, for example, **job: 0000021-140222101051722-oozie-omm-W**, is displayed after the workflow file is executed, the job is successfully submitted. You can view the execution results on the Oozie management page.

  Log in to the Oozie web UI at **https**://*IP address of the Oozie role*:**21003/oozie** as user **oozieuser**.

  On the Oozie web UI, you can view the submitted workflow information based on the job ID in the table on the page.

----End

19.5 Oozie Log Overview

Log Description

Log path: The default storage paths of Oozie log files are as follows:

- Run log: **/var/log/Bigdata/oozie**
- Audit log: **/var/log/Bigdata/audit/oozie**

Log archiving rule: Oozie logs are classified into run logs, script logs, and audit logs. The maximum size of a run log file is 20 MB, and a maximum of 20 run log files can be reserved. The maximum size of an audit log file is 20 MB, and a maximum of 20 audit log files can be reserved.

NOTE

A compressed log file is generated for **oozie.log** every hour. 720 compressed files (log files of one month) are retained by default.

Table 19-7 Oozie log list

Log Type	Log File Name	Description
Run log	jetty.log	Oozie built-in jetty server log file, which is used to process the request and response information of OozieServlet
	jetty.out	Oozie process startup log file
	oozie_db_temp.log	Oozie database connection log
	oozie-instrumentation.log	Oozie dashboard log file, which records the Oozie running status and configuration information of each component
	oozie-jpa.log	openJPa run log file
	oozie.log	Oozie run log file
	oozie-<SSH_USER>-<DATE>-<PID>-gc.log.0.current	Log file that records the garbage collection of the Oozie service
	oozie-ops.log	Oozie operation log file
	check-serviceDetail.log	Oozie health check logs
	oozie-error.log	Oozie running error logs
	threadDump-<DATE>.log	Log file that records stack information when the service process exits normally
Script logs	postinstallDetail.log	Work log file generated after the installation and before the startup
	prestartDetail.log	Pre-startup log file
	startDetail.log	Service startup log file
	stopDetail.log	Service stop log file
	upload-sharelib.log	Operation logs uploaded by **sharelib**
Audit log	oozie-audit.log	Audit log

Log Level

Table 19-8 describes the log levels provided by Oozie.

The priorities of log levels are ERROR, WARN, INFO, and DEBUG in descending order. Logs whose levels are higher than or equal to the set level are printed. The number of printed logs decreases as the configured log level increases.

Table 19-8 Log levels

Level	Description
ERROR	Logs of this level record abnormal information about events that cause process exceptions.
WARN	Logs of this level record exception information about the current event processing.
INFO	Logs of this level record normal running status information about the system and events.
DEBUG	Logs of this level record system information and information about database underlying data transmission.

To modify log levels, perform the following operations:

Step 1 Log in to FusionInsight Manager.

Step 2 Choose **Cluster** > **Services** > **Oozie** and click **Configurations**.

Step 3 Select **All Configurations**.

Step 4 On the menu bar on the left, select the log menu of the target role.

Step 5 Select a desired log level.

Step 6 Click **Save**, and then click **OK**. The settings take effect after the processing is complete.

----End

Log Formats

The following table lists the Oozie log formats.

Table 19-9 Log formats

Log Type	Format	Example
Run log	*<yyyy-MM-dd HH:mm:ss,SSS><Log level><Location where the log event occurs><Log level><Message in the log>*	2015-05-29 21:01:45,268 INFO StatusTransitService$StatusTransitRun-nable:539 - USER[-] GROUP[-] Released lock for [org.apache.oozie.service.StatusTransitService]
Script logs	*<yyyy-MM-dd HH:mm:ss,SSS><Host name > <Log level > <Message in the log>*	2015-06-01 17:18:03 001 suse11-192-168-0-111 oozie INFO Running oozie service check script

Log Type	Format	Example
Audit log	*<yyyy-MM-dd HH:mm:ss,SSS>|<Log Level>|< Thread name >	Message in the log	Location where the log event occurs*	2015-06-01 22:38:41,323 | INFO | http-bio-21003-exec-8 | IP [192.168.0.111] USER [null], GROUP [null], APP [null], JOBID [null], OPERATION [null], PARAMETER [null], RESULT [SUCCESS], HTTPCODE [200], ERRORCODE [null], ERRORMESSAGE [null] | org.apache.oozie.util.XLog.log(XLog.java:539)

19.6 Common Issues About Oozie

19.6.1 What Should I Do If Oozie Scheduled Tasks Are Not Executed on Time

Symptom

Coordinator scheduled jobs are not executed on time on the Hue or Oozie client.

Answer

Use UTC time. For example, set **start** to **2016-12-20T09:00Z** in the **job.properties** file.

19.6.2 Why Update of the share lib Directory of Oozie on HDFS Does Not Take Effect?

Symptom

A new JAR package is uploaded to the **/user/oozie/share/lib** directory on HDFS. However, an error indicating that the class cannot be found is reported during task execution.

Solution

Run the following command on the client to refresh the directory:

oozie admin -oozie https://xxx.xxx.xxx.xxx:21003/oozie -sharelibupdate

19.6.3 Common Oozie Troubleshooting Methods

1. Check the job logs on Yarn. Run the command executed through Hive SQL using beeline to ensure that Hive is running properly.
2. If error information such as "classnotfoundException" is displayed, check whether the JAR package of the faulty class exists in the **/user/oozie/**

share/lib directory of each component. If no, add the JAR package and go to **Why Update of the share lib Directory of Oozie on HDFS Does Not Take Effect?**. If the faulty class still cannot be found after the **share lib** directory is updated, check whether **sharelibDirNew** is **/user/oozie/share/lib** in the output of the command for updating the directory.

3. If "NosuchMethodError" is displayed, check whether the JAR packages of each component in the **/user/oozie/share/lib** directory have multiple versions. Note that the JAR packages uploaded by the service cannot conflict with each other. You can check whether a JAR package conflict occurs based on the loaded JAR packages in Oozie run logs on Yarn.
4. If the self-developed code is abnormal, run the Oozie sample to check whether Oozie is running properly.
5. Contact technical support personnel. By using this method, you must collect run logs of Oozie on Yarn, Oozie logs, and component run logs. For example, if an exception occurs when Hive runs on Oozie, you need to collect Hive logs.

19.6.4 What Should I Do If the User Who Submits Jobs on the Oozie Client in a Normal Cluster Is Inconsistent with the User Displayed on the Yarn Web UI?

Question

The user who submits a job on the Oozie client of a normal MRS cluster is different from the user displayed on the Yarn web UI.

1. Log in to the node where the Oozie client is installed and run the following commands:

   cd *Client installation directory*

   source bigdata_env

   export HADOOP_ USER_ NAME=*awdtest*
2. Submit an Oozie task. For details, see **Using Oozie from Scratch**.
3. Log in to the Yarn web UI and check whether the user corresponding to the submitted task is **root**.

Procedure

Step 1 Log in to the node where the Oozie client is installed and run the following command:

cd *Client installation directory*

Step 2 Run the following commands to specify the user who submits the task:

su *User who submits the task*

source bigdata_env

If the error message "Permission denied" is displayed, run the following command to change the permission on the client directory:

chmod -R 777 *Client installation directory*

Step 3 Submit the Oozie task again.

----End

20 Using Ranger

20.1 Logging In to the Ranger Web UI

Ranger provides a centralized permission management framework to implement fine-grained permission access control on components, such as HDFS, HBase, Hive, and YARN, and provides a web UI for Ranger administrators to perform operations.

Ranger User Type

Ranger users are classified into **admin**, **user**, and **auditor**. Different users have different permissions to view and operate the Ranger management interface.

- **Admin**: A Ranger security administrator who can view all page content, manage permission management plug-ins and access control policies, view audit information, and set user types.
- **Auditor**: A Ranger audit administrator who can view the permission management plug-ins and access control policies.
- **User**: A common user who can be assigned with specific permissions by the Ranger administrator.

Logging In to the Ranger Web UI

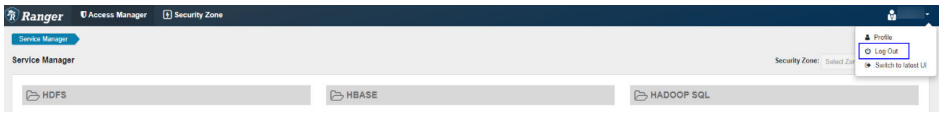
Security mode (Kerberos authentication is enabled for clusters)

Step 1 Log in to FusionInsight Manager as user **admin**. Choose **Cluster** > **Services** > **Ranger**.

Step 2 Click **RangerAdmin** in the **Basic Information** area. The Ranger web UI is displayed.

- The **admin** user in Ranger belongs to the **User** type and can only view the **Access Manager** as well as **Security Zone** pages.
- To view all management pages, switch to user **rangeradmin** or other users who have the Ranger administrator permissions.

  a. On the Ranger WebUI, click the user name in the upper right corner and choose **Log Out** to log out of the Ranger WebUI.



b. Log in to the system as user **rangeradmin** or another user who has the Ranger administrator permissions. For details about the default passwords of user **rangeradmin**, contact the MRS cluster administrator.

----End

Normal mode (Kerberos authentication is disabled for clusters)

Step 1 Log in to FusionInsight Manager as user **admin**. Choose **Cluster** > **Services** > **Ranger**. The Ranger service overview page is displayed.

Step 2 Click **RangerAdmin** in the **Basic Information** area. The Ranger web UI is displayed.

The **admin** user in Ranger belongs to the **Admin** type and can view all management pages of Ranger without switching to user **rangeradmin**.

NOTE

When a user logs in to the Ranger WebUI as user **rangeradmin** in normal mode, error 401 is reported.

----End

On the homepage of Ranger web UI, you can view the permission management plug-ins of the services integrated in Ranger. The plug-ins can be used to set more fine-grained permissions. For details about functions of main operations you can perform on the page, see **Table 20-1**.

Table 20-1 Functions of each operation portal on the Ranger page

Portal	Function
Access Manager	You can view the permission management plug-ins of each service integrated in Ranger. The plug-ins can be used to set more fine-grained permissions. For details, see **Configuring Component Permission Policies**.
Audit	You can view the audit logs related to Ranger running and permission control. For details, see **Viewing Ranger Audit Information**.
Security Zone	Ranger administrators can divide resources of each component into multiple security zones where different Ranger administrators set security policies for specified resources of services to facilitate management. For details, see **Configuring a Security Zone**.
Settings	You can view Ranger permission settings, such as users, user groups, and roles. For details, see **Viewing Ranger Permission Information**.

20.2 Enabling Ranger Authentication

Scenario

This section guides you how to enable Ranger authentication. Ranger authentication is enabled by default in security mode and disabled by default in normal mode.

Procedure

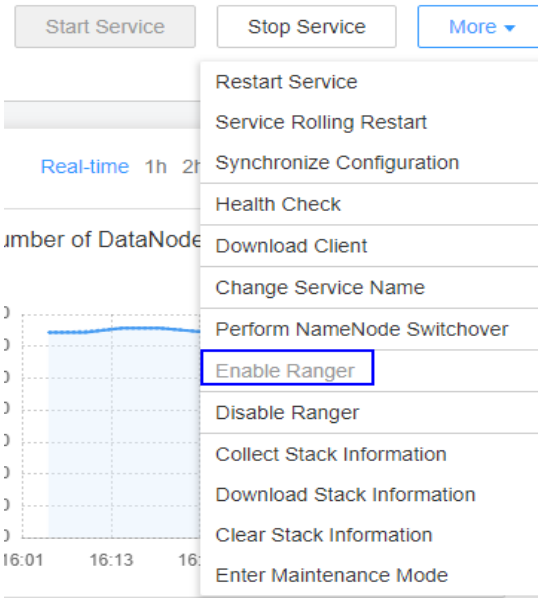
Step 1 Log in to FusionInsight Manager. Choose **Cluster** > **Services** > *Name of the service for which Ranger authentication is enabled*.

Step 2 In the upper right corner of the **Dashboard** page, click **More** and select **Enable Ranger**. In the displayed dialog box, enter the password and click **OK**. After the operation is successful, click **Finish**.

NOTE

- If **Enable Ranger** is dimmed, Ranger authentication is enabled. See **Figure 20-1**.
- For components (except HDFS and Yarn) for which Ranger authorization has been enabled, the permissions of non-default roles on Manager do not take effect. You need to configure Ranger policies to assign permissions to user groups.

Figure 20-1 Enabling Ranger Authentication



Step 3 Perform a rolling service restart or restart the service.

----End

20.3 Configuring Component Permission Policies

In the newly installed MRS cluster, Ranger is installed by default, with the Ranger authentication model enabled. The Ranger administrator can set fine-grained

security policies for accessing component resources through the component permission plug-ins.

Currently, the following components in a cluster in security mode support Ranger: HDFS, Yarn, HBase, Hive, Spark, Kafka, Storm..

Configuring User Permission Policies Using Ranger

Step 1 Log in to the Ranger web UI as the Ranger administrator **rangeradmin**. For details, see **Logging In to the Ranger Web UI**.

Step 2 In the **Service Manager** area on the Ranger homepage, click the permission plug-in name of a component. The page for security access policy list of the component is displayed.

NOTE

In the policy list of each component, many items are generated by default to ensure the permissions of some default users or user groups (such as the **supergroup** user group). Do not delete these items. Otherwise, the permissions of the default users or user groups are affected.

Step 3 Click **Add New Policy** and configure resource access policies for related users or user groups based on the service scenario plan.

The following policies are examples for different components:

- **Adding a Ranger Access Permission Policy for HDFS**
- **Adding a Ranger Access Permission Policy for HBase**
- **Adding a Ranger Access Permission Policy for Hive**
- **Adding a Ranger Access Permission Policy for Yarn**
- **Adding a Ranger Access Permission Policy for Spark**
- **Adding a Ranger Access Permission Policy for Kafka**
- **Adding a Ranger Access Permission Policy for Storm**

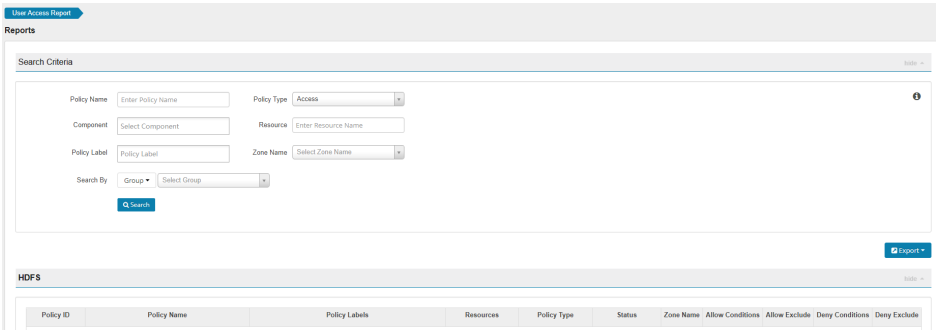
After the policies are added, wait for about 30 seconds for them to take effect.

NOTE

Each time a component is started, the system checks whether the default Ranger service of the component exists. If the service does not exist, the system creates the Ranger service and adds a default policy for it. If a service is deleted by mistake, you can restart or restart the corresponding component service in rolling mode to restore the service. If the default policy is deleted by mistake, you can manually delete the service and then restart the component service.

Step 4 Choose **Access Manager** > **Reports** to view all security access policies of each component.

If there are many system policies, filter and search for policies by the policy name, policy type, component, resource, policy label, security zone, user, or user group. Alternatively, click **Export** to export related policies.



NOTE

- Generally, only one policy can be configured for a fixed resource object. If multiple policies are configured for the same resource object, the policies cannot be saved.
- For details about the priorities of different policies, see **Condition Priorities of the Ranger Permission Policy**.

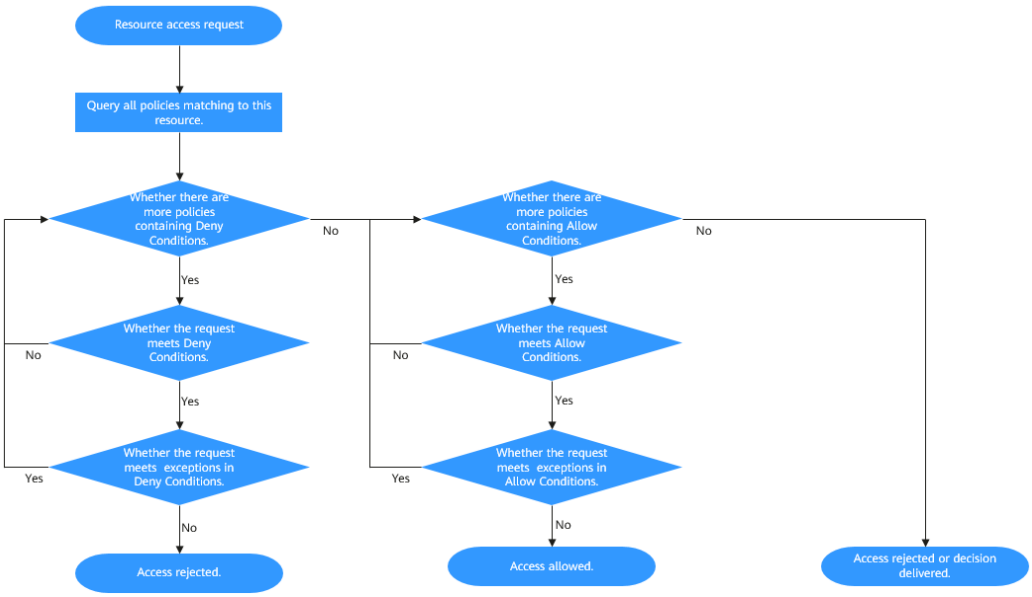
----End

Condition Priorities of the Ranger Permission Policy

When configuring a permission policy for a resource, you can configure Allow Conditions, Exclude from Allow Conditions, Deny Conditions, and Exclude from Deny Conditions for the resource, to meet unexpected requirements in different scenarios.

The priorities of different conditions are listed in descending order: Exclude from Deny Conditions > Deny Conditions > Exclude from Allow Conditions > Allow Conditions

The following figure shows the process of determining condition priorities. If the component resource request does not match the permission policy in Ranger, the system rejects the access by default. However, for HDFS and Yarn, the system delivers the decision to the access control layer of the component for determination.



For example, if you want to grant the read and write permissions of the **FileA** folder to the **groupA** user group, but the user in the group is not **UserA**, you can add an allowed condition and an exception condition.

20.4 Viewing Ranger Audit Information

Ranger administrators can view audit logs about Ranger running and permission control audit logs after Ranger is used by components for authentication.

Viewing Ranger Audit Information

Step 1 Log in to the Ranger web UI as the Ranger administrator **rangeradmin**. For details, see **Logging In to the Ranger Web UI**.

Step 2 Choose **Audit** to view the audit information. For details about each tab page, see **Table 20-2**. If there are a large number of audit records, you can filter them in the search box by keyword.

Table 20-2 Audit information

Tab	Description
Access	Currently, MRS does not support online query of audit logs of component resources. You can log in to the component installation node and access **/var/log/Bigdata/audit** to view audit logs of each component.
Admin	Audit information about operations on Ranger, such as creating, updating, and deleting security access policies, creating and deleting component permission policies, and creating, updating, and deleting roles.
Login Sessions	Session audit information about users who log in to Ranger.
Plugins	Component permission policy information in Ranger.
Plugin Status	Audit information about synchronization of the permission policy of each component node.
User Sync	Audit information about synchronization between Ranger and LDAP users.

----End

20.5 Configuring a Security Zone

Security zone can be configured using Ranger. Ranger administrators can divide resources of each component into multiple security zones where Ranger administrators set security policies for specified resources in the zones to facilitate management. Policies defined in a security zone apply only to resources in the zone. After service resources are allocated to the security zone, the access

permission policies for the resources in the non-security zone do not take effect. The administrator of a security zone can set policies only in the security zone that the administrator belongs to.

Adding a Security Zone

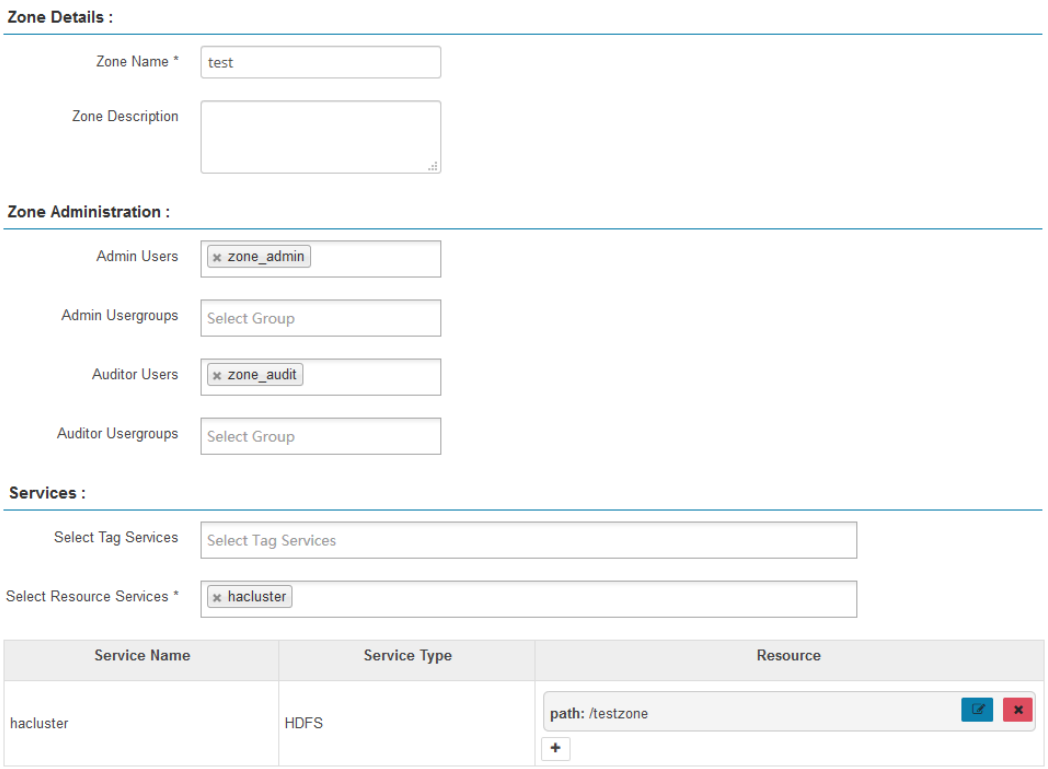
Step 1 Log in to the Ranger web UI as the Ranger administrator **rangeradmin**. For details, see **Logging In to the Ranger Web UI**.

Step 2 Click **Security Zone**. On the zone list page, click  to add a zone.

Table 20-3 Parameters for configuring a security zone

Parameter	Description	Example Value
Zone Name	Security zone	test
Zone Description	Description of the security zone	-
Admin Users/ Admin Usergroups	Management users and user groups in a security zone. You can add and modify permission policies for related resources in the security zone. At least one user or user group must be configured.	zone_admin
Auditor Users/ Auditor Usergroups	Audit users or user groups to be added. You can view the resource permission policies in the security zone. At least one user or user group must be configured.	zone_user
Select Tag Services	Tag information of a service	-
Select Resource Services	Services and resources in a security zone. After selecting a service, you need to add specific resource objects in the **Resource** column, such as the file directories of the HDFS server, Yarn queues, Hive databases and tables, and HBase tables and columns.	/testzone

For example, to create a security zone for the **/testzone** directory in HDFS, the configuration is as follows:



Step 3 Click **Save** and wait until the security zone is added successfully.

The Ranger administrator can view all security zones on the **Security Zone** page and click **Edit** to modify the attributes of a security zone. If resources do not need to be managed in a security zone, the Ranger administrator can click **Delete** to delete the security zone.

----End

Configuring Permission Policies in a Security Zone

Step 1 Log in to the Ranger management page as the Ranger administrator of a security zone.

Step 2 Select a security zone from the **Security Zone** drop-down list in the upper right corner of the Ranger home page to switch to the permission view of the security zone.

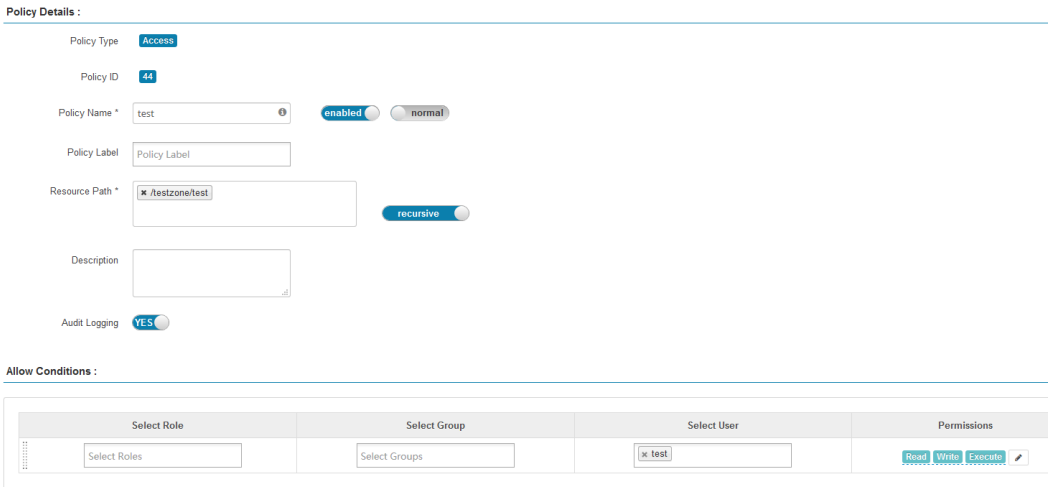
Step 3 Click the permission plug-in name of a component. The page for security access policy list of the component is displayed.

NOTE

In the policy list of each component, the default items generated by the system are automatically inherited to the security zone to ensure the permissions of some default users or user groups in the cluster.

Step 4 Click **Add New Policy** and configure resource access policies for related users or user groups based on the service scenario plan.

In this example, a policy that allows user test to access the **/testzone/test** directory is configured in the security zone.



The following access policies are examples for different components:

- **Adding a Ranger Access Permission Policy for HDFS**
- **Adding a Ranger Access Permission Policy for HBase**
- **Adding a Ranger Access Permission Policy for Hive**
- **Adding a Ranger Access Permission Policy for Yarn**
- **Adding a Ranger Access Permission Policy for Spark**
- **Adding a Ranger Access Permission Policy for Kafka**
- **Adding a Ranger Access Permission Policy for Storm**

After the policies are added, wait for about 30 seconds for them to take effect.

NOTE

- Policies defined in a security zone apply only to resources in the zone. After service resources are allocated to the security zone, the access permission policies for the resources in the non-security zone do not take effect.
- To configure access policies for resources outside the current security zone, click **Security Zone** in the upper right corner of the Ranger homepage to exit the current security zone.

----End

20.6 Changing the Ranger Data Source to LDAP for a Normal Cluster

By default, the Ranger data source of the security cluster can be accessed by FusionInsight Manager LDAP users. By default, the Ranger data source of a common cluster can be accessed by Unix users.

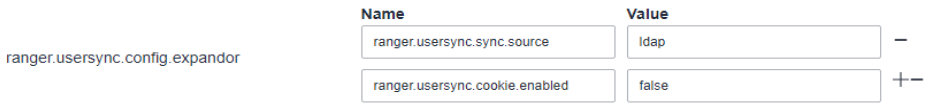
Prerequisites

- The cluster is in normal mode.
- The Ranger component has been installed.

Procedure

Step 1 Log in to FusionInsight Manager, choose **Cluster** > **Services** > **Ranger**, click **Configurations**, and click **All Configurations**. Click **UserSync(Role)** and click **Customization**.

Step 2 In the **ranger.usersync.config.expandor** area, set **ranger.usersync.sync.source** to **ldap** and **ranger.usersync.cookie.enabled** to **false**, as shown in the following figure.



Step 3 In the upper right corner of the Ranger **Dashboard** page, click **More** and choose **Synchronize Configuration**.

Step 4 On the Ranger instance page, select the **UserSync** instance and choose **More** > **Restart Instance**.

Step 5 On the **Dashboard** page of the Ranger service, click **RangerAdmin** and choose **Settings** > **Users/Groups/Roles** to check whether LDAP users exist.

----End

20.7 Viewing Ranger Permission Information

You can view Ranger permission settings, such as users, user groups, and roles.

Viewing Ranger Permission Information

Step 1 Log in to the Ranger web UI as the Ranger administrator **rangeradmin**. For details, see **Logging In to the Ranger Web UI**.

Step 2 Choose **Settings** > **Users**/**Groups**/**Roles** to view information about users, user groups, or roles in the system.

- Users: displays all user information synchronized from LDAP or OS to Ranger.
- Groups: displays information about all user groups and role information synchronized from LDAP or OS to Ranger.

- Roles: displays information about roles created in Ranger.

NOTE

- The users, roles, user groups created on FusionInsight Manager are automatically synchronized to Ranger periodically. The default period is 300,000 milliseconds (5 minutes). After roles and user groups in FusionInsight Manager are synchronized to Ranger, they become user groups. Only roles and user groups that are associated with users can be automatically synchronized to Ranger.
- The role created on the Ranger page is a set of users or user groups, which is used to flexibly set the permission access policies of components. The role is different from that on FusionInsight Manager.

----End

Adjusting Ranger User Types

Step 1 Log in to the Ranger management page.

To change the Ranger user type, you must log in as an **admin** user. For details about the user types, see **Ranger User Type**.

Step 2 Choose **Settings** > **Users**/**Groups**/**Roles**. In the list of users, click the name of the user whose type you want to change.

Step 3 Set **Select Role** to the type to be modified.

Step 4 Click **Save**.

----End

Creating a Ranger Role

Ranger administrators can flexibly configure permission access policies for components based on users, user groups, or roles. User and user group information is automatically synchronized from LDAP, and roles can be manually added.

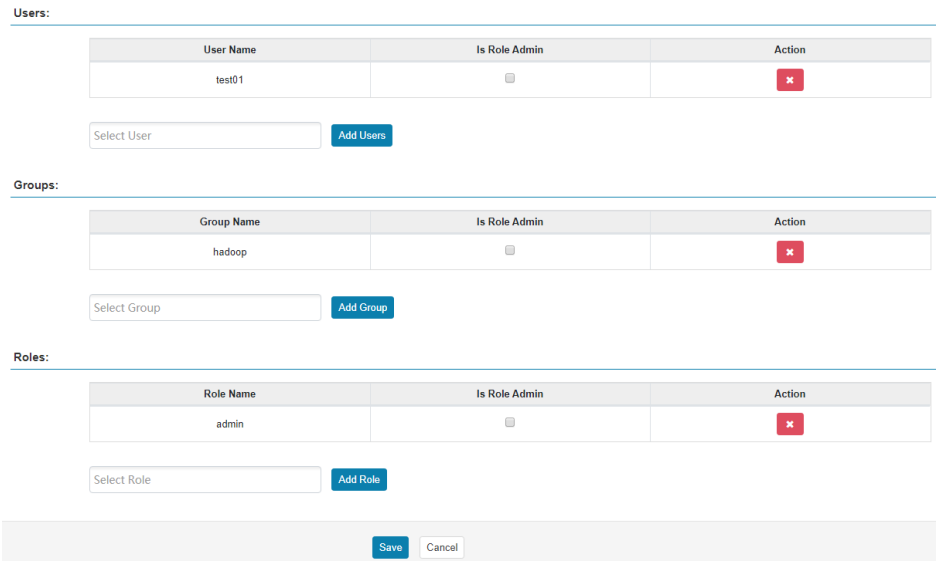
Step 1 Log in to the Ranger management page.

Step 2 Choose **Settings** > **Users**/**Groups**/**Roles** > **Roles** > **Add New Role**.

Step 3 Enter the role name and description as prompted.

Step 4 Add users, user groups, and sub-roles to the role.

- In the **Users** area, select a created user in the system and click **Add Users**.
- In the **Groups** area, select a created user group and click **Add Group**.
- In the **Roles** area, select a created role in the system and click **Add Role**.



Step 5 Click **Save**. The role is added.

NOTE

Added roles cannot be deleted but can be modified.

----End

20.8 Adding a Ranger Access Permission Policy for CDL

Scenario

Ranger administrators can use Ranger to configure creation, execution, query, and deletion permissions for CDL users.

Prerequisites

- The Ranger service has been installed and is running properly.
- You have created users, user groups, or roles for which you want to configure permissions.

Procedure

Step 1 Log in to the Ranger web UI as the Ranger administrator **rangeradmin**. For details, see **Logging In to the Ranger Web UI**.

Step 2 On the home page, click the component plug-in name in the **CDL** area, for example, **CDL**.

Step 3 Click **Add New Policy** to add a CDL permission control policy.

Step 4 Configure the parameters listed in the table below based on the service demands.

Table 20-4 CDL permission parameters

Parameter	Description
Policy Type	Access.
Policy Conditions	IP address filtering policy, which can be customized. You can enter one or more IP addresses or IP address segments. The IP address can contain the wildcard character (*), for example, **192.168.1.10**, **192.168.1.20**, or **192.168.1.***.
Policy Name	Policy name, which can be customized and must be unique in the service.
Policy Label	A label specified for the current policy. You can search for reports and filter policies based on labels.
job	Name of the job applicable to the current policy. You can enter multiple values. The value can contain wildcards, such as **test**, **test***, and *. The **Include** policy applies to the current input object, and the **Exclude** policy applies to objects other than the current input object.
Description	Policy description.
Audit Logging	Whether to audit the policy.
Allow Conditions	Permission and exception conditions allowed by a policy. The priority of an exception condition is higher than that of a normal condition. In the **Select Role**, **Select Group**, and **Select User** columns, select the role, user group, or user to which you want to assign permissions. Click **Add Conditions**, add the IP address range to which the policy applies, and click **Add Permissions** to add corresponding permissions. ● **Create** permission. ● **Execute** permission. ● **Delete** permission. ● **Update** permission. ● **Get** permission. ● **Select/Deselect All** permission. To add multiple permission control rules, click  . If users or user groups in the current condition need to manage this policy, select **Delegate Admin**. These users will become the agent administrators. The agent administrators can update and delete this policy and create sub-policies based on the original policy.

Parameter	Description
Deny Conditions	Policy rejection condition, which is used to configure the permissions and exceptions to be denied in the policy. The configuration method is the same as that of **Allow Conditions**. The priority of the rejection condition is higher than that of the allowed conditions configured in **Allow Conditions**.

Table 20-5 Setting user permissions

Scenario	Role Authorization
Setting the CDL administrator permission	1. On the home page, click the component plug-in name in the **CDL** area, for example, **CDL**. 2. Select the policies whose **Policy Name** is **all - job**, **all - link**, **all - driver** or **all - env**, and click  to edit the policies. 3. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 4. Click **Add Permissions** and select **Select/ Deselect All**.
Setting the permission to manage a CDL job	1. Select a CDL job name from the **job** drop-down list. 2. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 3. Click **Add Permissions** and select **Select/ Deselect All**.
Setting the permission to create a CDL job	1. Select a CDL job name from the **job** drop-down list. 2. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 3. Click **Add Permissions** and select **Create**.
Setting the permission to delete a CDL job	1. Select a CDL job name from the **job** drop-down list. 2. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 3. Click **Add Permissions** and select **Delete**.
Setting the permission to obtain information about a CDL job	1. Select a CDL job name from the **job** drop-down list. 2. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 3. Click **Add Permissions** and select **Get**.

Scenario	Role Authorization
Setting the permission to execute a CDL job	1. Select a CDL job name from the **job** drop-down list. 2. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 3. Click **Add Permissions** and select **Execute**.
Setting the permission to manage a CDL data link	1. Select the CDL data link name on the right of the **link** drop-down list. 2. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 3. Click **Add Permissions** and select **Select/ Deselect All**.
Setting the permission to create a CDL data link	1. Select the CDL data link name on the right of the **link** drop-down list. 2. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 3. Click **Add Permissions** and select **Create**.
Setting the permission to delete a CDL data link	1. Select the CDL data link name on the right of the **link** drop-down list. 2. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 3. Click **Add Permissions** and select **Delete**.
Setting the permission to update a CDL data link	1. Select the CDL data link name on the right of the **link** drop-down list. 2. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 3. Click **Add Permissions** and select **Update**.
Setting the permission to obtain information about a CDL data link	1. Select the CDL data link name on the right of the **link** drop-down list. 2. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 3. Click **Add Permissions** and select **Get**.
Setting the permission to manage a CDL driver	1. Select the CDL driver name on the right of the **driver** drop-down list. 2. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 3. Click **Add Permissions** and select **Select/ Deselect All**.

Scenario	Role Authorization
Setting the permission to delete a CDL driver	1. Select the CDL driver name on the right of the **driver** drop-down list. 2. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 3. Click **Add Permissions** and select **Delete**.
Setting the permission to upload a CDL driver	1. Select the CDL driver name on the right of the **driver** drop-down list. 2. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 3. Click **Add Permissions** and select **Upload**.
Setting the permission to manage a CDL environment variable	1. Select the CDL environment variable name on the right of the **env** drop-down list. 2. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 3. Click **Add Permissions** and select **Select/ Deselect All**.
Setting the permission to create a CDL environment variable	1. Select the CDL environment variable name on the right of the **env** drop-down list. 2. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 3. Click **Add Permissions** and select **Create**.
Setting the permission to delete a CDL environment variable	1. Select the CDL environment variable name on the right of the **env** drop-down list. 2. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 3. Click **Add Permissions** and select **Delete**.
Setting the permission to update a CDL environment variable	1. Select the CDL environment variable name on the right of the **env** drop-down list. 2. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 3. Click **Add Permissions** and select **Update**.
Setting the permission to obtain information about a CDL environment variable	1. Select the CDL environment variable name on the right of the **env** drop-down list. 2. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 3. Click **Add Permissions** and select **Get**.

Step 5 (Optional) Add the validity period of the policy. Click **Add Validity period** in the upper right corner of the page, set **Start Time** and **End Time**, and select **Time**

Zone. Click **Save**. To add multiple policy validity periods, click  . To delete a policy validity period, click  .

Step 6 Click **Add** to view the basic information about the policy in the policy list. After the policy takes effect, check whether the related permissions are normal.

To disable a policy, click  to edit the policy and set the policy to **Disabled**.

If a policy is no longer used, click  to delete it.

----End

20.9 Adding a Ranger Access Permission Policy for HDFS

Scenario

Ranger administrators can use Ranger to configure the read, write, and execution permissions on HDFS directories or files for HDFS users.

Prerequisites

- The Ranger service has been installed and is running properly.
- You have created users, user groups, or roles for which you want to configure permissions.

Procedure

Step 1 Log in to the Ranger web UI as the Ranger administrator **rangeradmin**. For details, see **Logging In to the Ranger Web UI**.

Step 2 On the homepage, click the component plug-in name in the **HDFS** area, for example, **hacluster**.

Step 3 Click **Add New Policy** to add an HDFS permission control policy.

Step 4 Configure the parameters listed in the table below based on the service demands.

Table 20-6 HDFS permission parameters

Parameter	Description
Policy Name	Policy name, which can be customized and must be unique in the service.
Policy Conditions	IP address filtering policy, which can be customized. You can enter one or more IP addresses or IP address segments. The IP address can contain the wildcard character (*), for example, **192.168.1.10**,**192.168.1.20**, or **192.168.1.***.

Parameter	Description
Policy Label	A label specified for the current policy. You can search for reports and filter policies based on labels.
Resource Path	Resource path, which is the HDFS path folder or file to which the current policy applies. You can enter multiple values and use the wildcard (*), for example, **/test/***. To enable a subdirectory to inherit the permission of its upper-level directory, enable the recursion function. If recursion is enabled for the parent directory and a policy is configured for the subdirectory, the subdirectory has the policies of both the parent directory and the subdirectory. If the policy of the parent directory conflicts with that of the subdirectory, the policy of the subdirectory prevails. • **non-recursive**: recursion disabled • **recursive**: recursion enabled
Description	Policy description.
Audit Logging	Whether to audit the policy.
Allow Conditions	Permission and exception conditions allowed by a policy. The priority of an exception condition is higher than that of a normal condition. In the **Select Role**, **Select Group**, and **Select User** columns, select the role, user group, or user to which the permission is to be granted, click **Add Conditions**, add the IP address range to which the policy applies, and click **Add Permissions** to add the corresponding permission. • **Read**: permission to read data • **Write**: permission to write data • **Execute**: execution permission • **Select/Deselect All**: Select or deselect all. If users or user groups in the current condition need to manage this policy, select **Delegate Admin**. These users or user groups will become the agent administrators. The agent administrators can update and delete this policy and create sub-policies based on the original policy. To add multiple permission control rules, click  . To delete a permission control rule, click  . Exclude from Allow Conditions: exception rules excluded from the allowed conditions
Deny All Other Accesses	Whether to reject all other access requests. • **True**: All other access requests are rejected. • **False**: **Deny Conditions** can be configured.

Parameter	Description
Deny Conditions	Policy rejection condition, which is used to configure the permissions and exceptions to be denied in the policy. The configuration method is the same as that of **Allow Conditions**. The priority of the rejection condition is higher than that of the allowed conditions configured in **Allow Conditions**. **Exclude from Deny Conditions**: exception rules excluded from the denied conditions

For example, to add the write permission for the **/user/test** directory of user **testuser**, the configuration is as follows:

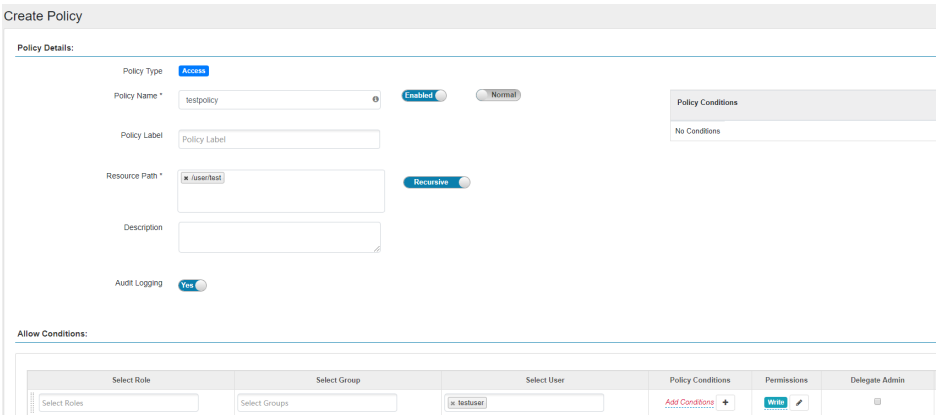


Table 20-7 Setting permissions

Task	Role Authorization
Setting the HDFS administrator permission	1. On the homepage, click the component plug-in name in the **HDFS** area, for example, **hacluster**. 2. Select the policy whose **Policy Name** is **all - path** and click  to edit the policy. 3. In the **Allow Conditions** area, select a user from the **Select User** drop-down list.
Setting the permission for users to check and recover HDFS	1. Add a folder or a file path in **Resource Path**. 2. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 3. Click **Add Permissions** and select **Read** and **Execute**.

Task	Role Authorization
Setting the permission for users to read directories or files of other users	1. Add a folder or a file path in **Resource Path**. 2. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 3. Click **Add Permissions** and select **Read** and **Execute**.
Setting the permission for users to write data to files of other users	1. Add a folder or a file path in **Resource Path**. 2. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 3. Click **Add Permissions** and select **Write** and **Execute**.
Setting the permission for users to create or delete sub-files or sub-directories in the directory of other users	1. Add a folder or a file path in **Resource Path**. 2. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 3. Click **Add Permissions** and select **Write** and **Execute**.
Setting the permission for users to execute directories or files of other users	1. Add a folder or a file path in **Resource Path**. 2. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 3. Click **Add Permissions** and select **Execute**.
Setting the permission for allowing subdirectories to inherit all permissions of their parent directories	1. Add a folder or a file path in **Resource Path**. 2. Enable the recursion function. **Recursive** indicates that recursion is enabled.

Step 5 (Optional) Add the validity period of the policy. Click **Add Validity period** in the upper right corner of the page, set **Start Time** and **End Time**, and select **Time Zone**. Click **Save**. To add multiple policy validity periods, click  . To delete a policy validity period, click  .

Step 6 Click **Add** to view the basic information about the policy in the policy list. After the policy takes effect, check whether the related permissions are normal.

To disable a policy, click  to edit the policy and set the policy to **Disabled**.

If a policy is no longer used, click  to delete it.

----End

20.10 Adding a Ranger Access Permission Policy for HBase

Scenario

Ranger administrators can use Ranger to configure permissions on HBase tables, column families, and columns for HBase users.

Prerequisites

- The Ranger service has been installed and is running properly.
- You have created users, user groups, or roles for which you want to configure permissions.

Procedure

Step 1 Log in to the Ranger web UI as the Ranger administrator **rangeradmin**. For details, see **Logging In to the Ranger Web UI**.

Step 2 On the home page, click the component plug-in name in the **HBASE** area, for example, **HBase**.

Step 3 Click **Add New Policy** to add an HBase permission control policy.

Step 4 Configure the parameters listed in the table below based on the service demands.

Table 20-8 HBase permission parameters

Parameter	Description
Policy Name	Policy name, which can be customized and must be unique in the service.
Policy Conditions	IP address filtering policy, which can be customized. You can enter one or more IP addresses or IP address segments. The IP address can contain the wildcard character (*), for example, **192.168.1.10**,**192.168.1.20**, or **192.168.1.***.
Policy Label	A label specified for the current policy. You can search for reports and filter policies based on labels.

Parameter	Description
HBase Table	Name of a table to which the policy applies. The value can contain wildcard (*). For example, **table1:*** indicates all tables in **table1**. The **Include** policy applies to the current input object, and the **Exclude** policy applies to objects other than the current input object. **NOTE** The value of **hbase.rpc.protection** of the HBase service plug-in on Ranger must be the same as that of **hbase.rpc.protection** on the HBase server. For details, see **When an HBase Policy Is Added or Modified on Ranger, Wildcard Characters Cannot Be Used to Search for Existing HBase Tables**.
HBase Column-family	Name of the column families to which the policy applies. The **Include** policy applies to the current input object, and the **Exclude** policy applies to objects other than the current input object.
HBase Column	Name of the column to which the policy applies. The **Include** policy applies to the current input object, and the **Exclude** policy applies to objects other than the current input object.
Description	Policy description.
Audit Logging	Whether to audit the policy.

Parameter	Description
Allow Conditions	Policy allowed condition. You can configure permissions and exceptions allowed by the policy. In the **Select Role**, **Select Group**, and **Select User** columns, select the role, user group, or user to which the permission is to be granted, click **Add Conditions**, add the IP address range to which the policy applies, and click **Add Permissions** to add the corresponding permission. • **Read**: permission to read data • **Write**: permission to write data • **Create**: permission to create data • **Admin**: permission to manage data • **Select/Deselect All**: Select or deselect all. If users or user groups in the current condition need to manage this policy, select **Delegate Admin**. These users or user groups will become the agent administrators. The agent administrators can update and delete this policy and create sub-policies based on the original policy. To add multiple permission control rules, click  . To delete a permission control rule, click  . Exclude from Allow Conditions: policy exception conditions
Deny All Other Accesses	Whether to reject all other access requests. • **True**: All other access requests are rejected. • **False**: **Deny Conditions** can be configured.
Deny Conditions	Policy rejection condition, which is used to configure the permissions and exceptions to be denied in the policy. The configuration method is similar to that of **Allow Conditions**. The priority of **Deny Conditions** is higher than that of allowed conditions configured in **Allow Conditions**. **Exclude from Deny Conditions**: exception rules excluded from the denied conditions

Table 20-9 Setting permissions

Task	Role Authorization
Setting the HBase administrator permission	1. On the home page, click the component plug-in name in the **HBase** area, for example, **HBase**. 2. Select the policy whose **Policy Name** is **all - table, column-family, column** and click  to edit the policy. 3. In the **Allow Conditions** area, select a user from the **Select User** drop-down list.
Setting the permission for users to create tables	1. In **HBase Table**, specify a table name. 2. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 3. Click **Add Permissions** and select **Create**. 4. This user hase the following permissions: create table drop table truncate table alter table enable table flush table flush region compact disable enable desc
Setting the permission for users to write data to tables	1. In **HBase Table**, specify a table name. 2. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 3. Click **Add Permissions** and select **Write**. 4. The user has the **put**, **delete**, **append**, and **incr** operation permissions.
Setting the permission for users to read data from tables	1. In **HBase Table**, specify a table name. 2. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 3. Click **Add Permissions** and select **Read**. 4. This user hase the **get** and **scan** permissions.

Task	Role Authorization
Setting the permission for users to manage namespaces or tables	1. In **HBase Table**, specify a table name. 2. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 3. Click **Add Permissions** and select **Admin**. 4. The user has the **rsgroup**, **peer**, **assign** and **balance** operation permissions.
Setting the permission for reading data from or writing data to columns	1. In **HBase Table**, specify a table name. 2. In **HBase Column-family**, specify the column family name. 3. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 4. Click **Add Permissions** and select **Read** and **Write**.

NOTE

If a user performs the **desc** operation in **hbase shell**, the user must be granted the read permission on the **hbase:quota** table.

Step 5 (Optional) Add the validity period of the policy. Click **Add Validity period** in the upper right corner of the page, set **Start Time** and **End Time**, and select **Time Zone**. Click **Save**. To add multiple policy validity periods, click  . To delete a policy validity period, click  .

Step 6 Click **Add** to view the basic information about the policy in the policy list. After the policy takes effect, check whether the related permissions are normal.

To disable a policy, click  to edit the policy and set the policy to **Disabled**.

If a policy is no longer used, click  to delete it.

----End

20.11 Adding a Ranger Access Permission Policy for Hive

Scenario

Ranger administrators can use Ranger to set permissions for Hive users. The default administrator account of Hive is **hive**.

Prerequisites

- The Ranger service has been installed and is running properly.

- You have created users, user groups, or roles for which you want to configure permissions.
- The users must be added to the **hive** group.

Procedure

Step 1 Log in to the Ranger web UI as the Ranger administrator **rangeradmin**. For details, see **Logging In to the Ranger Web UI**.

Step 2 On the home page, click the component plug-in name in the **HADOOP SQL** area, for example, **Hive**.

Step 3 On the **Access** tab page, click **Add New Policy** to add a Hive permission control policy.

Step 4 Configure the parameters listed in the table below based on the service demands.

Table 20-10 Hive permission parameters

Parameter	Description
Policy Name	Policy name, which can be customized and must be unique in the service.
Policy Conditions	IP address filtering policy, which can be customized. You can enter one or more IP addresses or IP address segments. The IP address can contain the wildcard character (*), for example, **192.168.1.10**, **192.168.1.20**, or **192.168.1.***.
Policy Label	A label specified for the current policy. You can search for reports and filter policies based on labels.
database	Name of the Hive database to which the policy applies. The **Include** policy applies to the current input object, and the **Exclude** policy applies to objects other than the current input object.
table	Name of the Hive table to which the policy applies. To add a UDF-based policy, switch to UDF and enter the UDF name. The **Include** policy applies to the current input object, and the **Exclude** policy applies to objects other than the current input object.
Hive Column	Name of the column to which the policy applies. The value * indicates all columns. The **Include** policy applies to the current input object, and the **Exclude** policy applies to objects other than the current input object.
Description	Policy description.
Audit Logging	Whether to audit the policy.

Parameter	Description
Allow Conditions	Policy allowed condition. You can configure permissions and exceptions allowed by the policy. In the **Select Role**, **Select Group**, and **Select User** columns, select the role, user group, or user to which the permission is to be granted, click **Add Conditions**, add the IP address range to which the policy applies, and click **Add Permissions** to add the corresponding permission. ● select: permission to query data ● update: permission to update data ● Create: permission to create data ● Drop: permission to drop data ● Alter: permission to alter data ● Index: permission to index data ● All: all permissions ● Read: permission to read data ● Write: permission to write data ● Temporary UDF Admin: temporary UDF management permission ● Select/Deselect All: Select or deselect all. To add multiple permission control rules, click . If users or user groups in the current condition need to manage this policy, select **Delegate Admin**. These users will become the agent administrators. The agent administrators can update and delete this policy and create sub-policies based on the original policy.
Deny Conditions	Policy rejection condition, which is used to configure the permissions and exceptions to be denied in the policy. The configuration method is similar to that of **Allow Conditions**.

Table 20-11 Setting permissions

Task	Role Authorization
role admin operation	1. On the home page, click **Settings** and choose **Roles**. 2. Click the role with **Role Name** set to **admin**. In the **Users** area, click **Select User** and select a username. 3. Click **Add Users**, select **Is Role Admin** in the row where the username is located, and click **Save**. **NOTE** Only user **rangeradmin** has the permission to access the **Settings** option on the Ranger page. After being bound to the Hive administrator role, perform the following operations during each maintenance operation: 1. Log in to the node where the Hive client is installed as the client installation user. 2. Run the following command to configure environment variables: For example, if the Hive client installation directory is **/opt/hiveclient**, run **source /opt/hiveclient/bigdata_env**. 3. Run the following command to authenticate the user: **kinit** *Hive service user* 4. Run the following command to log in to the client tool: **beeline** 5. Run the following command to update the administrator permissions: **set role admin;**
Creating a database table	1. Enter the policy name in **Policy Name**. 2. Enter or select the corresponding database on the right side of **database** and enter or select ***** on the right side of **column**. (To create a table, enter or select the corresponding table on the right side of **table**.) 3. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 4. Click **Add Permissions** and select **Create**.
Deleting a table	1. Enter the policy name in **Policy Name**. 2. Enter or select the corresponding database on the right side of **database** and enter and select ***** on the right side of **column**. (To delete a table, enter or select the corresponding table on the right side of **table**.) 3. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 4. Click **Add Permissions** and select **Drop**.

Task	Role Authorization
Query operation (**select**, **desc**, and **show**)	1. Enter the policy name in **Policy Name**. 2. Enter or select the corresponding database on the right side of **database** and enter or select ***** (***** indicates all columns) on the right side of **column**. (To create a table, enter or select the corresponding table on the right side of **table**.) 3. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 4. Click **Add Permissions** and select **select**.
Alter operation	1. Enter the policy name in **Policy Name**. 2. Enter and select the corresponding database on the right side of **database** and enter or select ***** on the right side of **column**. (For tables, enter or select the corresponding table on the right side of **table**.) 3. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 4. Click **Add Permissions** and select **Alter**.
LOAD operation	1. Enter the policy name in **Policy Name**. 2. On the right side of **database**, enter or select the corresponding database. On the right side of **table**, enter or select the corresponding table. On the right side of **column**, enter a column and select *****. 3. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 4. Click **Add Permissions** and select **update**.
INSERT and **DELETE** operations	1. Enter the policy name in **Policy Name**. 2. On the right side of **database**, enter or select the corresponding database. On the right side of **table**, enter or select the corresponding table. On the right side of **column**, enter a column and select *****. 3. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 4. Click **Add Permissions** and select **update**. 5. Configure the **submit** permission on the Yarn task queue. For details about how to configure the permission, see **Adding a Ranger Access Permission Policy for Yarn**.

Task	Role Authorization
GRANT/REVOKE operation	1. Enter the policy name in **Policy Name**. 2. On the right side of **database**, enter or select the corresponding database. On the right side of **table**, enter or select the corresponding table. On the right side of **column**, enter a column and select *****. 3. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 4. Select **Delegate Admin**.
ADD JAR operation	1. Enter the policy name in **Policy Name**. 2. Click **database**, and select **global** from the drop-down list. On the right of **global**, enter related information or select *****. 3. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 4. Click **Add Permissions** and select **Temporary UDF Admin**.
UDF operation	1. Enter the policy name in **Policy Name**. 2. Enter or select the corresponding database on the right of **database**, and enter the corresponding udf function name on the right of **udf**. 3. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 4. Click **Add Permissions** and select required permissions for the user (**udf** supports the **Create**, **select**, and **Drop** permissions).
VIEW operation	1. Enter the policy name in **Policy Name**. 2. On the right side of **database**, enter or select the corresponding database. On the right side of **table**, enter or select the corresponding table to be viewed. On the right side of **column**, enter a column and select *****. 3. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 4. Click **Add Permissions** and select permissions for the user as required.
dfs command operation	The **dfs** operation can be performed only after you have run the **set role admin** command.
Operations on other user database tables	1. Perform the preceding operations to add the corresponding permissions. 2. Grant the read, write, and execution permissions on the HDFS paths of other user database tables to the user. For details, see **Adding a Ranger Access Permission Policy for HDFS**.

NOTE

- If you have specified an HDFS path when running commands, you need to be assigned the read, write, and execution permissions on the HDFS path. For details, see **Adding a Ranger Access Permission Policy for HDFS**. You do not need to configure the Ranger policy of HDFS. You can use the Hive permission plug-in to add permissions to the role and assign the role to the corresponding user. If the HDFS Ranger policy can match the file or directory permission of the Hive database table, the HDFS Ranger policy is preferentially used.
- If the cascading authorization function of Hive tables has been enabled by referring to **Hive Tables Supporting Cascading Authorization**, you do not need to authorize the HDFS path where the table is located.
- The URL policy in the Ranger policy is involved in the scenario where the Hive table is stored on OBS. Set the URL to the complete path of the object on OBS. The Read and Write permissions are used together with the URL. URL policies are not involved in other scenarios.
- The global policy in the Ranger policy is used only with the **Temporary UDF Admin** permission to control the upload of UDF packages.
- The **hiveservice** policy in the Ranger policy is used only with the **Service Admin** permission to control the permission to run the **kill query <queryId>** command to end the task that is being executed.
- The **lock**, **index**, **refresh**, and **replAdmin** permissions are not supported.
- Run the **show grant** command to view the table permission. The **grantor** column of the table **owner** is displayed as user **hive**. If the Ranger page is used or the **grant** command is used to grant permissions in the background, the **grantor** column is displayed as the corresponding user. To view the result of using the Hive permission plug-in, set **hive-ext.ranger.previous.privileges.enable** to **true** and run the **show grant** command.

Step 5 Click **Add** to view the basic information about the policy in the policy list. After the policy takes effect, check whether the related permissions are normal.

To disable a policy, click  to edit the policy and set the policy to **Disabled**.

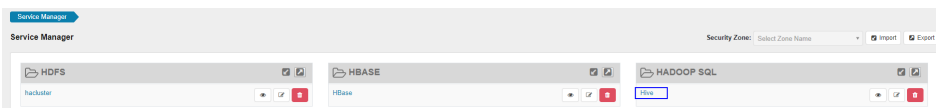
If a policy is no longer used, click  to delete it.

----End

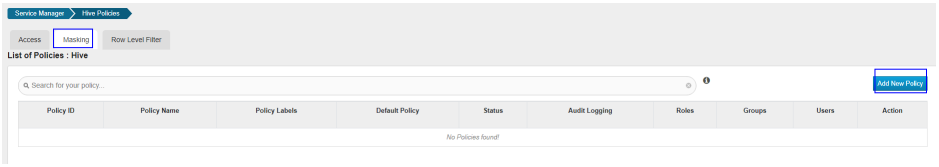
Hive Data Masking

Ranger supports data masking for Hive data. It can process the returned result of the **select** operation you performed to mask sensitive information.

Step 1 Log in to the Ranger web UI. Click **Hive** in the **HADOOP SQL** area on the homepage.



Step 2 On the **Masking** tab page, click **Add New Policy** to add a Hive permission control policy.



Step 3 Configure the parameters listed in the table below based on the service demands.

Table 20-12 Hive data masking parameters

Parameter	Description
Policy Name	Policy name, which can be customized and must be unique in the service.
Policy Conditions	IP address filtering policy, which can be customized. You can enter one or more IP addresses or IP address segments. The IP address can contain the wildcard character (*), for example, **192.168.1.10**, **192.168.1.20**, or **192.168.1.***.
Policy Label	A label specified for the current policy. You can search for reports and filter policies based on labels.
Hive Database	Name of the Hive database to which the current policy applies. Multiple database names can be configured and wildcards (*) are supported, for example, **aa**, **a***, ***b**, **a*b**, or ***.
Hive Table	Name of the Hive table to which the current policy applies. Multiple table names can be configured and wildcards (*) are supported, for example, **aa**, **a***, ***b**, **a*b**, or ***.
Hive Column	Name of the Hive column. Multiple column names can be configured and wildcards (*) are supported, for example, **aa**, **a***, ***b**, **a*b**, or ***.
Description	Policy description.
Audit Logging	Whether to audit the policy.

Parameter	Description
Mask Conditions	In the **Select Role**, **Select Group**, and **Select User** columns, select the object to which the permission is to be granted, click **Add Conditions**, add the IP address range to which the policy applies, then click **Add Permissions**, and select **select**. Click **Select Masking Option** and select a data masking policy. • Redact: Use **x** to mask all letters and **0** to mask all digits. • Partial mask: show last 4: Only the last four characters are displayed, and the rest characters are displayed using **x**. • Partial mask: show first 4: Only the first four characters are displayed, and the rest characters are displayed using **x**. • Hash: Replace the original value with the hash value. The Hive built-in function **mask_hash** is used. This is valid only for fields of the string, character, and varchar types. NULL is returned for fields of other types. • Nullify: Replace the original value with the NULL value. • Unmasked (retain original value): Keep the original value. • Date: show only year: Only the year part of the date string is displayed, and the default month and date start from January and Monday (**01/01**). • Custom: You customize policies using any valid return data type which is the same as the data type in the masked column. To add a multi-column masking policy, click  .

Step 4 Click **Add** to view the basic information about the policy in the policy list.

Step 5 After you perform the **select** operation on a table configured with a data masking policy on the Hive client, the system processes and displays the data.

NOTE

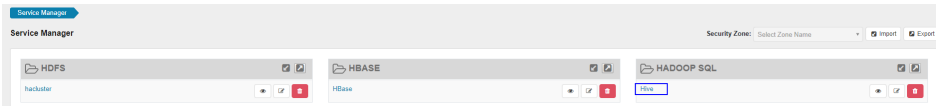
To process data, you must have the permission to submit tasks to the Yarn queue.

----End

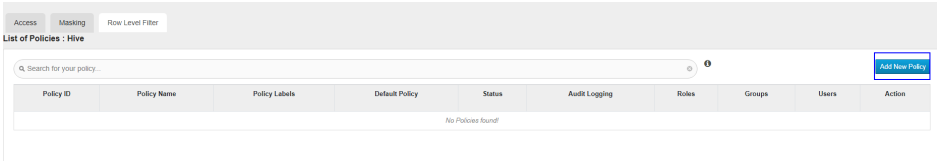
Hive Row-Level Data Filtering

Ranger allows you to filter data at the row level when you perform the **select** operation on Hive data tables.

Step 1 Log in to the Ranger web UI. Click **Hive** in the **HADOOP SQL** area on the homepage.



Step 2 On the **Row Level Filter** tab page, click **Add New Policy** to add a row data filtering policy.



Step 3 Configure the parameters listed in the table below based on the service demands.

Table 20-13 Parameters for filtering Hive row data

Parameter	Description
Policy Name	Policy name, which can be customized and must be unique in the service.
Policy Conditions	IP address filtering policy, which can be customized. You can enter one or more IP addresses or IP address segments. The IP address can contain the wildcard character (*), for example, **192.168.1.10**, **192.168.1.20**, or **192.168.1.***.
Policy Label	A label specified for the current policy. You can search for reports and filter policies based on labels.
Hive Database	Name of the Hive database to which the current policy applies.
Hive Table	Name of the Hive table to which the current policy applies.
Description	Policy description.
Audit Logging	Whether to audit the policy.
Row Filter Conditions	In the **Select Role**, **Select Group**, and **Select User** columns, select the object to which the permission is to be granted, click **Add Conditions**, add the IP address range to which the policy applies, then click **Add Permissions**, and select **Select**. Click **Row Level Filter** and enter data filtering rules. For example, if you want to filter the data in the **zhangsan** row in the **name** column of **table A**, the filtering rule is **name <>'zhangsan'**. For more information, see the official Ranger document. To add more rules, click  .

Step 4 Click **Add** to view the basic information about the policy in the policy list.

Step 5 After you perform the **select** operation on a table configured with a data masking policy on the Hive client, the system processes and displays the data.

NOTE

To process data, you must have the permission to submit tasks to the Yarn queue.

----End

20.12 Adding a Ranger Access Permission Policy for Yarn

Scenario

Ranger administrators can use Ranger to configure YARN administrator permissions for YARN users, allowing them to manage YARN queue resources.

Prerequisites

- The Ranger service has been installed and is running properly.
- You have created users, user groups, or roles for which you want to configure permissions.

Procedure

Step 1 Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Yarn**.

Step 2 On the page that is displayed, click the **Configuration** tab then the **All Configurations** sub-tab. On this sub-tab page, search for the **yarn.acl.enable** parameter, and change its value to **true**. If the value is **true**, no further action is required.

Step 3 Log in to the Ranger web UI as the Ranger administrator **rangeradmin**. For details, see **Logging In to the Ranger Web UI**.

Step 4 On the home page, click the component plug-in name in the **YARN** area, for example, **Yarn**.

Step 5 Click **Add New Policy** to add a Yarn permission control policy.

Step 6 Configure the parameters listed in the table below based on the service demands.

Table 20-14 Yarn permission parameters

Parameter	Description
Policy Name	Policy name, which can be customized and must be unique in the service.
Policy Conditions	IP address filtering policy, which can be customized. You can enter one or more IP addresses or IP address segments. The IP address can contain the wildcard character (*), for example, **192.168.1.10**,**192.168.1.20**, or **192.168.1.***.
Policy Label	A label specified for the current policy. You can search for reports and filter policies based on labels.

Parameter	Description
Queue	Queue name. The wildcard (*) is supported. To enable a sub-queue to inherit the permission of its upper-level queue, enable the recursion function. • **Non-recursive**: recursion disabled • **Recursive**: recursion enabled
Description	Policy description.
Audit Logging	Whether to audit the policy.
Allow Conditions	Policy allowed condition. You can configure permissions and exceptions allowed by the policy. In the **Select Role**, **Select Group**, and **Select User** columns, select the role, user group, or user to which the permission is to be granted, click **Add Conditions**, add the IP address range to which the policy applies, and click **Add Permissions** to add the corresponding permission. • submit-app: permission to submit queue tasks • admin-queue: permission to manage queue tasks • Select/Deselect All: Select or deselect all. If users or user groups in the current condition need to manage this policy, select **Delegate Admin**. These users will become the agent administrators. The agent administrators can update and delete this policy and create sub-policies based on the original policy. To add multiple permission control rules, click  . To delete a permission control rule, click  . Exclude from Allow Conditions: policy exception conditions
Deny All Other Accesses	Whether to reject all other access requests. • True: All other access requests are rejected. • **False**: **Deny Conditions** can be configured.
Deny Conditions	Policy rejection condition, which is used to configure the permissions and exceptions to be denied in the policy. The configuration method is similar to that of **Allow Conditions**. The priority of **Deny Conditions** is higher than that of allowed conditions configured in **Allow Conditions**. Exclude from Deny Conditions: exception rules excluded from the denied conditions

Table 20-15 Setting permissions

Task	Role Authorization
Setting the Yarn administrator permission	1. On the home page, click the component plug-in name in the **YARN** area, for example, **Yarn**. 2. Select the policy whose **Policy Name** is **all - queue** and click  to edit the policy. 3. In the **Allow Conditions** area, select a user from the **Select User** drop-down list.
Setting the permission for a user to submit tasks in a specified Yarn queue	1. In **Queue**, specify a queue name. 2. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 3. Click **Add Permissions** and select **submit-app**.
Setting the permission for a user to manage tasks in a specified Yarn queue	1. In **Queue**, specify a queue name. 2. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 3. Click **Add Permissions** and select **admin-queue**.

Step 7 (Optional) Add the validity period of the policy. Click **Add Validity period** in the upper right corner of the page, set **Start Time** and **End Time**, and select **Time Zone**. Click **Save**. To add multiple policy validity periods, click  . To delete a policy validity period, click  .

Step 8 Click **Add** to view the basic information about the policy in the policy list. After the policy takes effect, check whether the related permissions are normal.

To disable a policy, click  to edit the policy and set the policy to **Disabled**.

If a policy is no longer used, click  to delete it.

----End

NOTE

The permissions on Ranger Yarn are independent of each other. There is inclusion relationship among the permissions. Currently, the following permissions are supported:

- **submit-app**: permission to submit queue tasks
- **admin-queue**: permission to manage queue tasks

Although the **admin-queue** has the permission to submit tasks, it does not have the inclusion relationship with the **submit-app** permission.

20.13 Adding a Ranger Access Permission Policy for Spark

Scenario

Ranger administrators can use Ranger to set permissions for Spark users.

NOTE

1. After Ranger authentication is enabled or disabled on Spark, you need to restart Spark.
2. Download the client again or manually update the client configuration file *Client installation directory*/**Spark/spark/conf/spark-defaults.conf**.

   Enable Ranger: **spark.ranger.plugin.authorization.enable=true**

   Disable Ranger: **spark.ranger.plugin.authorization.enable=false**
3. In Spark, spark-beeline (applications connected to JDBCServer) supports the Ranger IP address filtering policy (**Policy Conditions** in the Ranger permission policy), while spark-submit and spark-sql do not.

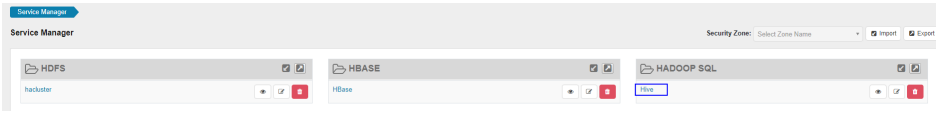
Prerequisites

- The Ranger service has been installed and is running properly.
- Ranger authentication of Hive has been enabled and Spark is restarted after Hive is restarted.
- You have created users, user groups, or roles for which you want to configure permissions.
- The created user has been added to the **hive** user group.

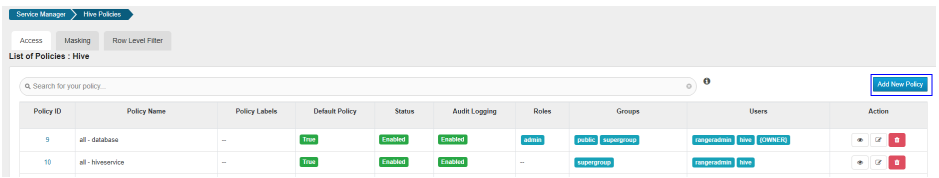
Procedure

Step 1 Log in to the Ranger web UI as the Ranger administrator **rangeradmin**. For details, see **Logging In to the Ranger Web UI**.

Step 2 On the home page, click the component plug-in name in the **HADOOP SQL** area, for example, **Hive**.



Step 3 On the **Access** tab page, click **Add New Policy** to add a Spark permission control policy.



Step 4 Configure the parameters listed in the table below based on the service demands.

Table 20-16 Spark permission parameters

Parameter	Description
Policy Name	Policy name, which can be customized and must be unique in the service.
Policy Conditions	IP address filtering policy, which can be customized. You can enter one or more IP addresses or IP address segments. The IP address can contain the wildcard character (*), for example, **192.168.1.10**,**192.168.1.20**, or **192.168.1.***.
Policy Label	A label specified for the current policy. You can search for reports and filter policies based on labels.
database	Name of the Spark database to which the policy applies. The **Include** policy applies to the current input object, and the **Exclude** policy applies to objects other than the current input object.
table	Name of the Spark table to which the policy applies. To add a UDF-based policy, switch to UDF and enter the UDF name. The **Include** policy applies to the current input object, and the **Exclude** policy applies to objects other than the current input object.
column	Name of the column to which the policy applies. The value ***** indicates all columns. The **Include** policy applies to the current input object, and the **Exclude** policy applies to objects other than the current input object.
Description	Policy description.
Audit Logging	Whether to audit the policy.

Parameter	Description
Allow Conditions	Policy allowed condition. You can configure permissions and exceptions allowed by the policy. In the **Select Role**, **Select Group**, and **Select User** columns, select the role, user group, or user to which the permission is to be granted, click **Add Conditions**, add the IP address range to which the policy applies, and click **Add Permissions** to add the corresponding permission. ● select: permission to query data ● update: permission to update data ● Create: permission to create data ● Drop: permission to drop data ● Alter: permission to alter data ● Index: permission to index data ● All: all permissions ● Read: permission to read data ● Write: permission to write data ● Temporary UDF Admin: temporary UDF management permission ● Select/Deselect All: Select or deselect all. To add multiple permission control rules, click  . If users or user groups in the current condition need to manage this policy, select **Delegate Admin**. These users will become the agent administrators. The agent administrators can update and delete this policy and create sub-policies based on the original policy.
Deny Conditions	Policy rejection condition, which is used to configure the permissions and exceptions to be denied in the policy. The configuration method is similar to that of **Allow Conditions**.

Table 20-17 Setting permissions

Task	Operation
role admin operation	1. On the home page, click **Settings** and choose **Roles** > **Add New Role**. 2. Set **Role Name** to **admin**. In the **Users** area, click **Select User** and select a username. 3. Click **Add Users**, select **Is Role Admin** in the row where the username is located, and click **Save**. **NOTE** After being bound to the Hive administrator role, perform the following operations during each maintenance operation: 1. Log in to the node where the Hive client is installed as the client installation user. 2. Run the following command to configure environment variables: For example, if the Spark client installation directory is **/opt/client**, run **source /opt/client/bigdata_env**. 3. Run the following command to perform user authentication: **kinit Spark***Service user* 4. Run the following command to log in to the client tool: **spark-beeline** 5. Run the following command to update the administrator permissions: **set role admin;**
Creating a database table	1. Enter the policy name in **Policy Name**. 2. Enter and select the corresponding database on the right of **database**. (If you want to create a database, enter the name of the database to be created or enter ***** to indicate a database with any name, and then select the name.) Enter and select the corresponding table name on the right of **table** and **column**. Wildcard characters (*) are supported. 3. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 4. Click **Add Permissions** and select **Create**.

Task	Operation
Deleting a table	1. Enter the policy name in **Policy Name**. 2. Enter and select the corresponding database on the right of **database**. (If you want to delete a database, enter the name of the database to be created or enter ***** to indicate a database with any name, and then select the name.) Enter and select the corresponding table name on the right of **table** and **column**. Wildcard characters (*) are supported. 3. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 4. Click **Add Permissions** and select **Drop**. **NOTE** For CarbonData tables, only the owner of the corresponding database or table can perform the **drop** operation.
ALTER operation	1. Enter the policy name in **Policy Name**. 2. Enter and select the corresponding database on the right of **database**, enter and select the corresponding table on the right of **table**, and enter and select the corresponding column name on the right of **column**. Wildcard characters (*) are supported. 3. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 4. Click **Add Permissions** and select **Alter**.
LOAD operation	1. Enter the policy name in **Policy Name**. 2. Enter and select the corresponding database on the right of **database**, enter and select the corresponding table on the right of **table**, and enter and select the corresponding column name on the right of **column**. Wildcard characters (*) are supported. 3. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 4. Click **Add Permissions** and select **update**.

Task	Operation
INSERT operation	1. Enter the policy name in **Policy Name**. 2. Enter and select the corresponding database on the right of **database**, enter and select the corresponding table on the right of **table**, and enter and select the corresponding column name on the right of **column**. Wildcard characters (*) are supported. 3. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 4. Click **Add Permissions** and select **update**. 5. The user also needs to have the **submit-app** permission of the Yarn task queue. By default, the Hadoop user group has the **submit-app** permission of all Yarn task queues. For details about how to load a network instance to a cloud connection, see **Adding a Ranger Access Permission Policy for Yarn**.
GRANT operation	1. Enter the policy name in **Policy Name**. 2. Enter and select the corresponding database on the right of **database**, enter and select the corresponding table on the right of **table**, and enter and select the corresponding column name on the right of **column**. Wildcard characters (*) are supported. 3. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 4. Select **Delegate Admin**.
ADD JAR operation	1. Enter the policy name in **Policy Name**. 2. Click **database**, and select **global** from the drop-down list. On the right of **global**, enter related information and select ***. 3. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 4. Click **Add Permissions** and select **Temporary UDF Admin**.

Task	Operation
VIEW and **INDEX** permissions	1. Enter the policy name in **Policy Name**. 2. On the right side of **database**, enter the database name and select the corresponding database. (If you want to delete a database, enter the database name and select *.) On the right side of **table**, enter a table name and select the view and index names. On the right side of **column**, enter a Hive column name, and select *. 3. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 4. Click **Add Permissions** and select permissions for the user as required.
Operations on other user database tables	1. Perform the preceding operations to add the corresponding permissions. 2. Grant the read, write, and execution permissions on the HDFS paths of other user database tables to the current user. For details, see **Adding a Ranger Access Permission Policy for HDFS**.

NOTE

After Spark SQL access policy is added on Ranger, you need to add the corresponding path access policies in the HDFS access policy. Otherwise, data files cannot be accessed. For details, see **Adding a Ranger Access Permission Policy for HDFS**.

- The global policy in the Ranger policy is only used to associate with the **Temporary UDF Admin** permission to control the upload of UDF packages.
- When Ranger is used to control Spark SQL permissions, the **empower** syntax is not supported.
- Ranger policies do not support local paths or HDFS paths containing spaces.

Step 5 Click **Add** to view the basic information about the policy in the policy list. After the policy takes effect, check whether the related permissions are normal.

To disable a policy, click  to edit the policy and set the policy to **Disabled**.

If a policy is no longer used, click  to delete it.

----End

Data Masking of the Spark Table

Ranger supports data masking for Spark data. It can process the returned result of the **select** operation you performed to mask sensitive information.

Step 1 Log in to the Ranger WebUI and click the component plug-in name, for example, **Hive**, in the **HADOOP SQL** area on the home page.

Step 2 On the **Masking** tab page, click **Add New Policy** to add a Spark permission control policy.

Step 3 Configure the parameters listed in the table below based on the service demands.

Table 20-18 Spark data masking parameters

Parameter	Description
Policy Name	Policy name, which can be customized and must be unique in the service.
Policy Conditions	IP address filtering policy, which can be customized. You can enter one or more IP addresses or IP address segments. The IP address can contain the wildcard character (*), for example, **192.168.1.10**,**192.168.1.20**, or **192.168.1.***.
Policy Label	A label specified for the current policy. You can search for reports and filter policies based on labels.
Hive Database	Name of the Spark database to which the current policy applies.
Hive Table	Name of the Spark table to which the current policy applies.
Hive Column	Name of the Spark column to which the current policy applies.
Description	Policy description.
Audit Logging	Whether to audit the policy.

Parameter	Description
Mask Conditions	In the **Select Group** and **Select User** columns, select the user group or user to which the permission is to be granted, click **Add Conditions**, add the IP address range to which the policy applies, then click **Add Permissions**, and select **select**. Click **Select Masking Option** and select a data masking policy. ● Redact: Use **x** to mask all letters and **0** to mask all digits. ● Partial mask: show last 4: Only the last four characters are displayed. ● Partial mask: show first 4: Only the first four characters are displayed. ● Hash: Perform hash calculation for data. ● Nullify: Replace the original value with the NULL value. ● Unmasked(retain original value): The original data is displayed. ● Date: show only year: Only the year information is displayed. ● Custom: You can use any valid Hive UDF (returns the same data type as the data type in the masked column) to customize the policy. To add a multi-column masking policy, click  .
Deny Conditions	Policy rejection condition, which is used to configure the permissions and exceptions to be denied in the policy. The configuration method is similar to that of **Allow Conditions**.

----End

Spark Row-Level Data Filtering

Ranger allows you to filter data at the row level when you perform the **select** operation on Spark data tables.

Step 1 Change the value of **spark.ranger.plugin.rowfilter.enable** to **true** on the server and client, respectively.

- Server: Log in to FusionInsight Manager, choose **Clusters** > **Services** and click the Spark component. On the displayed page, click the **Configurations** tab and click the **All Configurations** tab. Search for **spark.ranger.plugin.rowfilter.enable** and change the value to **true**. Save the modifications, and restart the service.

- Client: Log in to the Spark client node, go to the *Client installation directory*/**Spark/spark/conf/spark-defaults.conf** directory, and change the value of **spark.ranger.plugin.rowfilter.enable** to **true**.

Step 2 Log in to the Ranger WebUI and click the component plug-in name, for example, **Hive**, in the **HADOOP SQL** area on the home page.

Step 3 On the **Row Level Filter** tab page, click **Add New Policy** to add a row data filtering policy.

Step 4 Configure the parameters listed in the table below based on the service demands.

Table 20-19 Parameters for filtering Spark row data

Parameter	Description
Policy Name	Policy name, which can be customized and must be unique in the service.
Policy Conditions	IP address filtering policy, which can be customized. You can enter one or more IP addresses or IP address segments. The IP address can contain the wildcard character (*), for example, **192.168.1.10**,**192.168.1.20**, or **192.168.1.***.
Policy Label	A label specified for the current policy. You can search for reports and filter policies based on labels.
Hive Database	Name of the Spark database to which the current policy applies.
Hive Table	Name of the Spark table to which the current policy applies.
Description	Policy description.
Audit Logging	Whether to audit the policy.
Row Filter Conditions	In the **Select Role**, **Select Group**, and **Select User** columns, select the object to which the permission is to be granted, click **Add Conditions**, add the IP address range to which the policy applies, then click **Add Permissions**, and select **select**. Click **Row Level Filter** and enter data filtering rules. For example, if you want to filter the data in the **zhangsan** row in the **name** column of **table A**, the filtering rule is **name <>'zhangsan'**. For more information, see the official Ranger document. To add more rules, click  .

Step 5 Click **Add** to view the basic information about the policy in the policy list.

Step 6 After you perform the **select** operation on a table configured with a data masking policy on the Spark client, the system processes and displays the data.

----End

20.14 Adding a Ranger Access Permission Policy for Kafka

Scenario

Ranger administrators can use Ranger to configure the read, write, and management permissions of the Kafka topic and the management permission of the cluster for the Kafka user. This section describes how to add the production permission of the **test** topic for the **test** user.

Prerequisites

- The Ranger service has been installed and is running properly.
- You have created users, user groups, or roles for which you want to configure permissions.

Procedure

Step 1 Log in to the Ranger web UI as the Ranger administrator **rangeradmin**. For details, see **Logging In to the Ranger Web UI**.

Step 2 On the home page, click the component plug-in name in the **KAFKA** area, for example, **Kafka**.

Step 3 Click **Add New Policy** to add a Kafka permission control policy.

Step 4 Configure the following parameters based on the service demands.

Table 20-20 Kafka permission parameters

Parameter	Description
Policy Type	Access type.
Policy Conditions	IP address filtering policy, which can be customized. You can enter one or more IP addresses or IP address segments. The IP address can contain the wildcard character (*), for example, **192.168.1.10**,**192.168.1.20**, or **192.168.1.***.
Policy Name	Policy name, which can be customized and must be unique in the service.
Policy Label	A label specified for the current policy. You can search for reports and filter policies based on labels.
topic	Name of the topic applicable to the current policy. You can enter multiple values. The value can contain wildcards, such as **test**, **test***, and *. The **Include** policy applies to the current input object, and the **Exclude** policy applies to objects other than the current input object.

Parameter	Description
Description	Policy description.
Audit Logging	Whether to audit the policy.
Allow Conditions	Permission and exception conditions allowed by a policy. The priority of an exception condition is higher than that of a normal condition. In the **Select Role**, **Select Group**, and **Select User** columns, select the role, user group, or user to which you want to assign permissions. Click **Add Conditions**, add the IP address range to which the policy applies, and click **Add Permissions** to add corresponding permissions. ● Publish: production permission ● Consume: consumption permission ● Describe: query permission ● Create: topic creation permission ● Delete: topic deletion permission ● Describe Configs: configuration query permission ● Alter: permission to change the number of partitions of a topic. ● Alter Configs: configuration modification permission ● Select/Deselect All: Select or deselect all. To add multiple permission control rules, click  . If users or user groups in the current condition need to manage this policy, select **Delegate Admin**. These users will become the agent administrators. The agent administrators can update and delete this policy and create sub-policies based on the original policy.
Deny Conditions	Policy rejection condition, which is used to configure the permissions and exceptions to be denied in the policy. The configuration method is the same as that of **Allow Conditions**. The priority of the rejection condition is higher than that of the allowed conditions configured in **Allow Conditions**.

For example, to add the production permission for the **test** topic of user **testuser**, configure the following information:

Figure 20-2 Kafka permission parameters

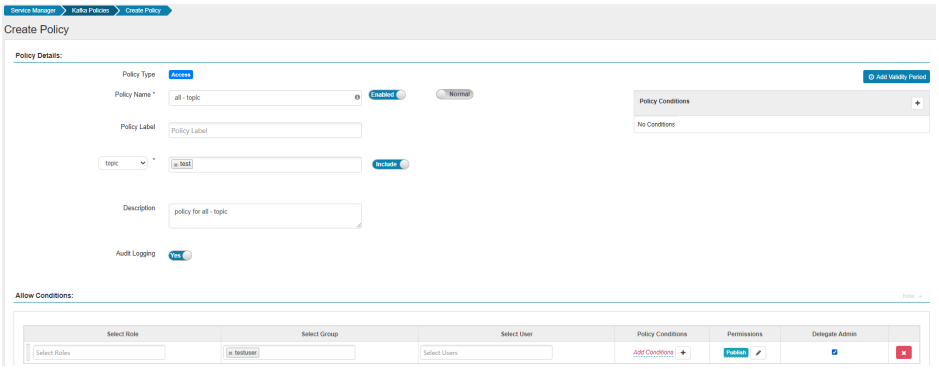


Table 20-21 Setting permissions

Scenario	Role Authorization
Setting the Kafka administrator permissions	1. On the home page, click the component plug-in name in the **KAFKA** area, for example, **Kafka**. 2. Select the policy whose **Policy Name** is **all - topic** and click  to edit the policy. 3. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 4. Click **Add Permissions** and select **Select/ Deselect All**.
Setting the permission for a user to create a topic	1. Specify a topic name in **topic**. 2. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 3. Click **Add Permissions** and select **Create**. **NOTE** Currently, the Kafka kernel supports the **--zookeeper** and **--bootstrap-server** methods to create topics. The **--zookeeper** method will be deleted from the community in later versions. Therefore, you are advised to use the **--bootstrap-server** method to create topics. Note: Currently, Kafka supports only the authentication of topic creation in **--bootstrap-server** mode and does not support that in **--zookeeper** mode.

Scenario	Role Authorization
Setting the permission for a user to delete a topic	1. Specify a topic name in **topic**. 2. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 3. Click **Add Permissions** and select **Delete**. **NOTE** Currently, the Kafka kernel supports the **--zookeeper** and **--bootstrap-server** methods to delete topics. The **--zookeeper** method will be deleted from the community in later versions. Therefore, you are advised to use the **--bootstrap-server** method to delete topics. Note: Currently, Kafka supports only the authentication of topic deletion in **--bootstrap-server** mode and does not support that in **--zookeeper** mode.
Setting the permission for a user to query a topic	1. Specify a topic name in **topic**. 2. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 3. Click **Add Permissions** and select **Describe** and **Describe Configs**. **NOTE** Currently, the Kafka kernel supports the **--zookeeper** and **--bootstrap-server** methods to query topics. The **--zookeeper** method will be deleted from the community in later versions. Therefore, you are advised to use the **--bootstrap-server** method to query topics. Note: Currently, Kafka supports only the authentication of topic query in **--bootstrap-server** mode and does not support that in **--zookeeper** mode.
Setting the production permission of a user on a topic	1. Specify a topic name in **topic**. 2. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 3. Click **Add Permissions** and select **Publish**.
Setting the consumption permission of a user on a topic	1. Specify a topic name in **topic**. 2. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 3. Click **Add Permissions** and select **Consume**. **NOTE** During topic consumption, offset management is involved. Therefore, the **Consume** permission of **ConsumerGroup** must be enabled at the same time. For details, see **Setting a User's Permission to Submit ConsumerGroup Offsets**.
Setting the permission for a user to expand a topic (by adding partitions)	1. Specify a topic name in **topic**. 2. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 3. Click **Add Permissions** and select **Alter**.

Scenario	Role Authorization
Setting the permission for a user to modify the topic configuration	Currently, the Kafka kernel does not support to modify topic parameters based on **--bootstrap-server**. Therefore, Ranger does not support authentication for this behavior.
Setting all the management permissions of a user on a cluster	1. Enter a cluster name and select the cluster on the right side of **cluster**. 2. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 3. Click **Add Permissions** and select **Kafka Admin**.
Setting the permission for a user to create a cluster	1. On the home page, click the component plug-in name in the **KAFKA** area, for example, **Kafka**. 2. Select the policy whose **Policy Name** is **all - cluster** and click  to edit the policy. 3. Enter a cluster name and select the cluster on the right side of **cluster**. 4. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 5. Click **Add Permissions** and select **Create**. **NOTE** The authentication of the **Create** operation of a cluster involves the following two scenarios: 1. After the **auto.create.topics.enable** parameter is enabled in the cluster, the client sends data to a topic that has not been created in the service. In this case, the system checks whether the user has the **Create** permission of the cluster. 2. If a user creates a large number of topics and is granted the **Cluster Create** permission, the user can create any topic in the cluster.
Setting the permission for a user to modify the cluster configuration	1. Enter a cluster name and select the cluster on the right side of **cluster**. 2. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 3. Click **Add Permissions** and select **Alter Configs**. **NOTE** The configuration modification permission allows you to modify the Broker and Broker Logger configurations. After the configuration modification permission is granted to a user, the user can query configuration details even if the user does not have the query permission. (The configuration modification permission includes the configuration query permission.)

Scenario	Role Authorization
Setting the permission for a user to query the cluster configuration	1. Enter a cluster name and select the cluster on the right side of **cluster**. 2. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 3. Click **Add Permissions** and select **Describe** and **Describe Configs**. **NOTE** You can only query Broker and Broker Logger information in the cluster, excluding topics.
Setting the Idempotent Write permission in a cluster for a user	1. Enter a cluster name and select the cluster on the right side of **cluster**. 2. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 3. Click **Add Permissions** and select **Idempotent Write**. **NOTE** This permission authenticates the **Idempotent Produce** behavior of the user's client.
Setting the permission to migrate partitions in a cluster for a user	1. Enter a cluster name and select the cluster on the right side of **cluster**. 2. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 3. Click **Add Permissions** and select **Alter**. **NOTE** The **Alter** permission of a cluster can be used to control permissions in the following scenarios: 1. In the **Partition Reassign** scenario, migrate the storage directory of replicas. 2. Elect a leader replica in each partition of the cluster. 3. Add or delete ACLs. Operations in scenarios **Step 4.1** and **Step 4.2** are between a controller and broker and between brokers in the cluster. When a cluster is created, this permission is granted to the built-in Kafka user by default. It is meaningless for a common user to be granted with this permission. Scenario **Step 4.3** involves the ACL management. ACLs are designed for authentication. Currently, Kafka authentication is hosted to Ranger. Therefore, this scenario is not involved (the configuration does not take effect).

Scenario	Role Authorization
Setting the Cluster Action permission in a cluster for a user	1. Enter a cluster name and select the cluster on the right side of **cluster**. 2. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 3. Click **Add Permissions** and select **Cluster Action**. **NOTE** This permission controls the synchronization between the leader and follower replicas in the cluster and the communication between nodes. It has been granted to the built-in Kafka user during cluster creation. It is meaningless for a common user to grant this permission.
Setting the TransactionalId permission for a user	1. On the home page, click the component plug-in name in the **KAFKA** area, for example, **Kafka**. 2. Select the policy whose **Policy Name** is **all - transactionalid** and click  to edit the policy. 1. Set **transactionalid** to a transaction ID. 2. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 3. Click **Add Permissions** and select **Publish** and **Describe**. **NOTE** The **Publish** permission is used to authenticate client requests for which the transaction feature is enabled, for example, starting and ending a transaction, submitting an offset, and generating transactional data. The **Describe** permission is used to authenticate the requests from the client and coordinator that have enabled the transaction feature. If the transaction feature is enabled, you are advised to grant both the **Publish** and **Describe** permissions to users.

Scenario	Role Authorization
Setting the DelegationToken permission for a user	1. On the home page, click the component plug-in name in the **KAFKA** area, for example, **Kafka**. 2. Select the policy whose **Policy Name** is **all - delegationtoken** and click  to edit the policy. 3. Set **delegationtoken** to a delegation token. 4. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 5. Click **Add Permissions** and select **Describe**. **NOTE** Currently, Ranger only controls the query permission of DelegationToken, but does not control its **create**, **renew**, and **expire** permissions.
Setting the permission for a user to query ConsumerGroup Offsets	1. On the home page, click the component plug-in name in the **KAFKA** area, for example, **Kafka**. 2. Select the policy whose **Policy Name** is **all - consumergroup** and click  to edit the policy. 3. In **consumergroup**, configure the consumer group to be managed. 4. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 5. Click **Add Permissions** and select **Describe**.
Set the user's submission permission on **ConsumerGroup Offsets**.	1. On the home page, click the component plug-in name in the **KAFKA** area, for example, **Kafka**. 2. Select the policy whose **Policy Name** is **all - consumergroup** and click  to edit the policy. 3. In **consumergroup**, configure the consumer group to be managed. 4. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 5. Click **Add Permissions** and select **Consume**. **NOTE** After a user is granted with the **Consume** permission of **ConsumerGroup**, the user is also granted with the **Describe** permission.

Scenario	Role Authorization
Setting the permission for a user to delete ConsumerGroup Offsets	1. On the home page, click the component plug-in name in the **KAFKA** area, for example, **Kafka**. 2. Select the policy whose **Policy Name** is **all - consumergroup** and click  to edit the policy. 3. In **consumergroup**, configure the consumer group to be managed. 4. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 5. Click **Add Permissions** and select **Delete**. **NOTE** When a user is granted with the **Delete** permission of **ConsumerGroup**, the user is also granted with the **Describe** permission.

Step 5 (Optional) Add the validity period of the policy. Click **Add Validity period** in the upper right corner of the page, set **Start Time** and **End Time**, and select **Time Zone**. Click **Save**. To add multiple policy validity periods, click  . To delete a policy validity period, click  .

Step 6 Click **Add** to view the basic information about the policy in the policy list. After the policy takes effect, check whether the related permissions are normal.

To disable a policy, click  to edit the policy and set the policy to **Disabled**.

If a policy is no longer used, click  to delete it.

----End

20.15 Adding a Ranger Access Permission Policy for HetuEngine

Scenario

Ranger administrators can use Ranger to configure management permissions on resources such as catalog, trinouser, systemproperty, function, schema, sessionproperty, table, procedure, and columns of data sources for HetuEngine users.

Prerequisites

- The Ranger service has been installed and is running properly.
- You have created users, user groups, or roles for which you want to configure permissions.

- The users have been added to the **hetuuser** group.
- Before using HetuEngine, ensure that the client operator or user in the configuration file for connecting to the data source has the expected operation permission. If the user does not have it, configure the permission by referring to the corresponding data source permission requirements.

Procedure

Step 1 Log in to the Ranger web UI as the Ranger administrator **rangeradmin**. For details, see **Logging In to the Ranger Web UI**.

Step 2 On the homepage, click **HetuEngine** in the **TRINO** area.

Step 3 On the **Access** tab page, click **Add New Policy** to add a HetuEngine permission control policy.

Step 4 Configure the parameters listed in the table below based on the service demands.

Granting the access policy to the catalog where the table is located is a basic policy and must be configured before you configure other policies. For details, see **Table 20-23**.

Table 20-22 HetuEngine permission parameters

Parameter	Description
Policy Name	Policy name, which can be customized and must be unique in the service. • **Enabled**: Enable the current policy. • **Disabled**: Disable the current policy.
Policy Conditions	IP address filtering policy, which can be customized. You can enter one or more IP addresses or IP address segments. The IP address can contain the wildcard character (*), for example, **192.168.1.10**,**192.168.1.20**, or **192.168.1.***.
Policy Label	A label specified for the current policy. You can search for reports and filter policies based on labels.
catalog	Name of the data source catalog to which the policy applies. If this parameter is set to *, the policy applies to all catalogs. • **Include**: The policy applies to the current input object. • **Exclude**: The policy applies to objects other than the current input.

Parameter	Description
trinouser	Name of the trinouser to which the policy applies. If this parameter is set to *, all trinousers are used for simulated access. ● **Include**: The policy applies to the current input object. ● **Exclude**: The policy applies to objects other than the current input.
systemproperty	Name of the system session attribute to which the policy applies. The value * indicates all system session attributes. ● **Include**: The policy applies to the current input object. ● **Exclude**: The policy applies to objects other than the current input.
function	Name of the function to which the policy applies. The value * indicates all functions. ● **Include**: The policy applies to the current input object. ● **Exclude**: The policy applies to objects other than the current input.
schema	Name of the schema to which the policy applies. The value * indicates all schemas. ● **Include**: The policy applies to the current input object. ● **Exclude**: The policy applies to objects other than the current input.
sessionproperty	Data source session attribute to which the policy applies. The value * indicates all session attributes of the data source. ● **Include**: The policy applies to the current input object. ● **Exclude**: The policy applies to objects other than the current input.
table	Name of the table or view to which the policy applies. If this parameter is set to *, the policy applies to all tables. ● **Include**: The policy applies to the current input object. ● **Exclude**: The policy applies to objects other than the current input.

Parameter	Description
procedure	Name of the procedure to which the policy applies. The value * indicates all procedures. ● **Include**: The policy applies to the current input object. ● **Exclude**: The policy applies to objects other than the current input.
column	Name of the column to which the policy applies. The value * indicates all columns.
Description	Policy description.
Audit Logging	Whether to audit the policy.

Parameter	Description
Allow Conditions	Policy allowed condition. You can configure permissions and exceptions allowed by the policy. In the **Select Role**, **Select Group**, and **Select User** columns, select the role, user group, or user to which you want to assign permissions. Click **Add Conditions**, add the IP address range to which the policy applies, and click **Add Permissions** to add corresponding permissions. ● **Select**: permission to query data ● **Insert**: permission to insert data ● **Create**: permission to create data ● **Drop**: permission to drop data ● **Delete**: permission to delete data ● **Use**: permission to use data ● **Alter**: permission to alter data ● **Grant**: Grants specific permissions to a specific user. ● **Revoke**: Revokes specific permissions from a specific user. ● **Show**: Displays the types and other attribute permissions of all authorized columns in a specified table. ● **Impersonate**: A Kerberos or LDAP authenticated user simulates Trino to query user permissions. ● **Update**: permission required for update ● **execute**: permission to execute functions ● **All**: all permissions (including the **Admin** permission) ● **Select/Deselect All**: Select or deselect all. To add multiple permission control rules, click  . If users or user groups in the current condition need to manage this policy, select **Delegate Admin**. These users will become the agent administrators. The agent administrators can update and delete this policy and create sub-policies based on the original policy.
Deny Conditions	Policy rejection condition, which is used to configure the permissions and exceptions to be denied in the policy. The configuration method is the same as that of **Allow Conditions**.

NOTICE

- The configured permission must match the level to which the permission belongs. If they do not match, the permission configuration does not take effect.
- Ranger checks the permissions of the user twice. Ranger checks whether the user has the permission to access the catalog and then checks the permissions involved in the access.

Table 20-23 Setting permissions

Task	Role Authorization
Granting the access policy to the catalog where the table is located (mandatory before other policies are configured)	1. Enter the policy name in **Policy Name**. 2. In **Catalog**, enter the catalog of the resource to be authorized, for example, **hive**. 3. **schema**: Select **none** from the drop-down list box. 4. Enter the authorized HetuEngine user in the **Select User** text box. 5. In **Permissions**, select **Select**. **NOTICE** This policy is a basic policy. Before configuring other policies, ensure that this policy has been configured.
Granting the permission to access the remote HetuEngine table	1. Enter the policy name in **Policy Name**. 2. In **Catalog**, enter the catalog of the table to be authorized, for example, **systemremote** and **svc**. 3. Select **schema** from the drop-down list box under **Catalog** and enter ***** in the text box. 4. Select **table** from the drop-down list box under **schema** and enter ***** in the text box. 5. Select **column** from the drop-down list box under **table** and enter ***** in the text box. 6. Enter the authorized remote HetuEngine user in the **Select User** text box. 7. In **Permissions**, select **Create**, **Drop**, **Select**, and **Insert**. **NOTE** This policy is a basic policy for remote HetuEngine tables. Before configuring other policies, ensure that this policy has been configured.

Task	Role Authorization
Create schemas	1. Enter the policy name in **Policy Name**. 2. In **Catalog**, enter the catalog of the target schema to be authorized, for example, **hive**. 3. **schema**: Select **none** from the drop-down list box. 4. Enter the authorized HetuEngine user in the **Select User** text box. 5. In **Permissions**, select **Create**.
Drop schemas	1. Enter the policy name in **Policy Name**. 2. In **Catalog**, enter the catalog of the target schema to be authorized, for example, **hive**. 3. Select **schema** from the drop-down list box under **Catalog** and enter the name of the target schema to be authorized in the text box. If this parameter is set to *****, all schemas under the current catalog are authorized. 4. **table**: Select **none** from the drop-down list box. 5. Enter the authorized HetuEngine user in the **Select User** text box. 6. In **Permissions**, select **Drop**.

Task	Role Authorization
Show schemas	Add permissions on the catalog to which the schema belongs. 1. Enter the policy name in **Policy Name**. 2. In **Catalog**, enter the catalog of the target schema to be authorized, for example, **hive**. 3. **schema**: Select **none** from the drop-down list box. 4. Enter the authorized HetuEngine user in the **Select User** text box. 5. In **Permissions**, select **Show** and **Select**. Add the show permission for a schema. 1. Enter the policy name in **Policy Name**. 2. In **Catalog**, enter the catalog of the target schema to be authorized, for example, **hive**. 3. Select **schema** from the drop-down list box under **Catalog** and enter the name of the target schema to be authorized in the text box. If this parameter is set to *****, all schemas under the current catalog are authorized. 4. **table**: Select **none** from the drop-down list box. 5. Enter the authorized HetuEngine user in the **Select User** text box. 6. In **Permissions**, select **Select**. **NOTE** ● When running the **show schemas** command, you need to configure the **Show** permission on the catalog. Similarly, to run the **show tables** command, configure the **Show** permission on the schema. ● After the authentication is complete, the obtained schema and table lists are filtered and only schemas and tables with the **Select** permission are displayed. So, you need to configure the **Select** permission for schemas and tables. When you run the **Show** command, only schemas and tables with the **Select** permission are displayed. ● Only when you have the **Select** permission on a catalog, the schemas and tables on which you have the permission can be displayed.

Task	Role Authorization
Create table	1. Enter the policy name in **Policy Name**. 2. In **Catalog**, enter the catalog of the target table to be authorized, for example, **hive**. 3. Select **schema** from the drop-down list box under **Catalog** and enter the name of the schema where the target table to be authorized resides in the text box, for example, **default**. 4. **table**: Select **none** from the drop-down list box. 5. Enter the authorized HetuEngine user in the **Select User** text box. 6. In **Permissions**, select **Create**.
Drop tables	1. Enter the policy name in **Policy Name**. 2. In **Catalog**, enter the catalog of the target table to be authorized, for example, **hive**. 3. Select **schema** from the drop-down list box under **Catalog** and enter the name of the schema where the target table to be authorized resides in the text box, for example, **default**. 4. Select **table** from the drop-down list box under **schema** and enter the name of the target table to be authorized in the text box. If this parameter is set to *****, all tables under the current schema are authorized. 5. **column**: Select **none** from the drop-down list box. 6. Enter the authorized HetuEngine user in the **Select User** text box. 7. In **Permissions**, select **Drop**.
Delete table	1. Enter the policy name in **Policy Name**. 2. In **Catalog**, enter the catalog of the target table to be authorized, for example, **hive**. 3. Select **schema** from the drop-down list box under **Catalog** and enter the name of the schema where the target table to be authorized resides in the text box, for example, **default**. 4. Select **table** from the drop-down list box under **schema** and enter the name of the target table to be authorized in the text box. If this parameter is set to *****, all tables under the current schema are authorized. 5. **column**: Select **none** from the drop-down list box. 6. Enter the authorized HetuEngine user in the **Select User** text box. 7. In **Permissions**, select **Delete**.

Task	Role Authorization
Alter tables	1. Enter the policy name in **Policy Name**. 2. In **Catalog**, enter the catalog of the target table to be authorized, for example, **hive**. 3. Select **schema** from the drop-down list box under **Catalog** and enter the name of the schema where the target table to be authorized resides in the text box, for example, **default**. 4. Select **table** from the drop-down list box under **schema** and enter the name of the target table to be authorized in the text box. If this parameter is set to *****, all tables under the current schema are authorized. 5. **column**: Select **none** from the drop-down list box. 6. Enter the authorized HetuEngine user in the **Select User** text box. 7. In **Permissions**, select **Alter**. **NOTE** • **ALTER TABLE table_name DROP [IF EXISTS] PARTITION partition_spec[, PARTITION partition_spec, ...];** requires the table-level **delete** and column-level **select** permissions. • **ALTER TABLE table_name DROP COLUMN column_name** and **ALTER TABLE table_name_2 EXCHANGE PARTITION** require the table-level **drop** permission.

Task	Role Authorization
Show tables	Add permissions on the schema to which the table belongs. 1. Enter the policy name in **Policy Name**. 2. In **Catalog**, enter the catalog of the target schema to be authorized, for example, **hive**. 3. Select **schema** from the drop-down list box under **Catalog** and enter the name of the target schema that allows to show table in the text box, for example, **default**. 4. **table**: Select **none** from the drop-down list box. 5. Enter the authorized HetuEngine user in the **Select User** text box. 6. In **Permissions**, select **Show**. Add the show permission for a table. 1. Enter the policy name in **Policy Name**. 2. In **Catalog**, enter the catalog of the target table to be authorized, for example, **hive**. 3. Select **schema** from the drop-down list box under **Catalog** and enter the name of the target schema that allows to show table in the text box, for example, **default**. 4. **table**: Select **none** from the drop-down list box. 5. Enter the authorized HetuEngine user in the **Select User** text box. 6. In **Permissions**, select **Select**.

Task	Role Authorization
Show partitions	1. Enter the policy name in **Policy Name**. 2. In **Catalog**, enter the catalog of the target table to be authorized, for example, **hive**. 3. Select **schema** from the drop-down list box under **Catalog** and enter the name of the target schema that allows to show table in the text box, for example, **default**. 4. Select **table** from the **schema** drop-down list and enter the target table to be authorized, for example, **hive_table**, and the internal table corresponding to the target table, for example, **hive_table$partitions**. 5. Select **column** from the drop-down list box under **table** and enter the name of the target column to be authorized in the text box. If this parameter is set to *****, all columns under the current table are authorized. 6. Enter the authorized HetuEngine user in the **Select User** text box. 7. In **Permissions**, select **Select**. **NOTE** When querying partitions of a table, HetuEngine converts the query to a query on the internal table *Name of the table to be queried*\$**partitions** during SQL parsing.
Insert	1. Enter the policy name in **Policy Name**. 2. In **Catalog**, enter the catalog of the target table to be authorized, for example, **hive**. 3. Select **schema** from the drop-down list box under **Catalog** and enter the name of the schema where the target table to be authorized resides in the text box, for example, **default**. 4. Select **table** from the drop-down list box under **schema** and enter the name of the target table to be authorized in the text box. If this parameter is set to *****, all tables under the current schema are authorized. 5. **column**: Select **none** from the drop-down list box. 6. Enter the authorized HetuEngine user in the **Select User** text box. 7. In **Permissions**, select **Insert**.

Task	Role Authorization
Delete	1. Enter the policy name in **Policy Name**. 2. In **Catalog**, enter the catalog of the target table to be authorized, for example, **hive**. 3. Select **schema** from the drop-down list box under **Catalog** and enter the name of the schema where the target table to be authorized resides in the text box, for example, **default**. 4. Select **table** from the drop-down list box under **schema** and enter the name of the target table to be authorized in the text box. If this parameter is set to *****, all tables under the current schema are authorized. 5. **column**: Select **none** from the drop-down list box. 6. Enter the authorized HetuEngine user in the **Select User** text box. 7. In **Permissions**, select **Delete**.
Select	1. Enter the policy name in **Policy Name**. 2. In **Catalog**, enter the catalog of the target table to be authorized, for example, **hive**. 3. Select **schema** from the drop-down list box under **Catalog** and enter the name of the schema where the target table to be authorized resides in the text box, for example, **default**. 4. Select **table** from the drop-down list box under **schema** and enter the name of the target table to be authorized in the text box. If this parameter is set to *****, all tables under the current schema are authorized. 5. Select **column** from the drop-down list box under **table** and enter the name of the target column to be authorized in the text box. If this parameter is set to *****, all columns under the current table are authorized. 6. Enter the authorized HetuEngine user in the **Select User** text box. 7. In **Permissions**, select **Select**.

Task	Role Authorization
Show columns	1. Enter the policy name in **Policy Name**. 2. In **Catalog**, enter the catalog of the target table to be authorized, for example, **hive**. 3. Select **schema** from the drop-down list box under **Catalog** and enter the name of the schema where the target table to be authorized resides in the text box, for example, **default**. 4. Select **table** from the drop-down list box under **schema** and enter the name of the target table to be authorized in the text box. If this parameter is set to *****, all tables under the current schema are authorized. 5. **column**: Select **none** from the drop-down list box. 6. Enter the authorized HetuEngine user in the **Select User** text box. 7. In **Permissions**, select **Select** and **Show**.
Set session	1. Enter the policy name in **Policy Name**. 2. Select **systemproperty** under **Policy Label** and enter the name of the session to be authorized in the **systemproperty** text box, for example, **implicit_conversion**. If an asterisk (*) is entered, all sessions are authorized. 3. Enter the authorized HetuEngine user in the **Select User** text box. 4. In **Permission**, select **ALTER**.
Function operation	1. Enter the policy name in **Policy Name**. 2. Select **function** under **Policy Label** and enter the name of the function to be authorized in the **systemproperty** text box, for example, **sum**. If an asterisk (*) is entered, all functions are authorized. 3. Enter the authorized HetuEngine user in the **Select User** text box. 4. In **Permission**, select **execute**.

Task	Role Authorization
Procedure operation	1. Enter the policy name in **Policy Name**. 2. In **Catalog**, enter the catalog of the target procedure to be authorized, for example, **hive**. 3. Select **schema** from the drop-down list box under **Catalog** and enter the name of the schema where the target procedure to be authorized resides in the text box, for example, **system**. 4. Select **procedure** from the drop-down list box under **schema** and enter the name of the target procedure to be authorized in the text box. If this parameter is set to *, all procedures under the current schema are authorized. 5. Enter the authorized HetuEngine user in the **Select User** text box. 6. In **Permissions**, select **execute**.
Access simulation operation	1. Enter the policy name in **Policy Name**. 2. Select **trinouser** under **Policy Label** and enter the name of the trinouser to be simulated in the **systemproperty** text box, for example, **user1**. For example, if an asterisk (*) is entered, all users are simulated. 3. Enter the authorized HetuEngine user in the **Select User** text box. 4. In **Permission**, select **Impersonate**.

NOTE

- The configuration takes effect about 30 seconds after the permission is configured.
- The current permission control is available to columns.

Step 5 (Optional) Add the validity period of the policy. Click **Add Validity period** in the upper right corner of the page, set **Start Time** and **End Time**, and select **Time Zone**. Click **Save**. To add multiple policy validity periods, click  . To delete a policy validity period, click  .

Step 6 Click **Add** to view the basic information about the policy in the policy list. After the policy takes effect, check whether the related permissions are normal.

To disable a policy, click  to edit the policy and set the policy to **Disabled**.

If a policy is no longer used, click  to delete it.

----End

HetuEngine Data Masking

Ranger supports data masking for HetuEngine data. It can process the return result of the **select** operation performed by a user to mask sensitive information.

Step 1 Log in to the Ranger web UI. Click **HetuEngine** in the **TRINO** area on the homepage.

Step 2 On the **Masking** tab page, click **Add New Policy** to add a HetuEngine data masking policy.

Step 3 Configure the parameters listed in the table below based on the service demands.

Table 20-24 HetuEngine data masking parameters

Parameter	Description
Policy Name	Policy name, which can be customized and must be unique in the service.
Policy Conditions	IP address filtering policy, which can be customized. You can enter one or more IP addresses or IP address segments. The IP address can contain the wildcard character (*), for example, **192.168.1.10**,**192.168.1.20**, or **192.168.1.***.
Policy Label	A label specified for the current policy. You can search for reports and filter policies based on labels.
Trino Catalog	Name of the catalog to which the current policy applies.
Trino Schema	• Hive, Hudi, HBase, ClickHouse, HetuEngine, and IoTDB data sources: name of the database used by the current policy. • GaussDB and MySQL data sources: name of the schema used by the current policy.
Trino Table	Name of the table to which the current policy applies.
Trino Column	Name of the column to which the current policy applies.
Description	Policy description.
Audit Logging	Whether to audit the policy.

Parameter	Description
Mask Conditions	In the **Select Role**, **Select Group**, and **Select User** columns, select the object to which the permission is to be granted, click **Add Conditions**, add the IP address range to which the policy applies, then click **Add Permissions**, and select **Select**. Click **Select Masking Option** and select a data masking policy. ● Redact: Use **x** to mask all letters and **0** to mask all digits. ● **Partial mask: show last 4**: Only the last four characters are displayed, and the rest characters are displayed using **x**. ● **Partial mask: show first 4**: Only the first four characters are displayed, and the rest characters are displayed using **x**. ● **Hash**: Replace the original value with the hash value. The built-in **to_utf8(varchar(x))** function of HetuEngine is used. This function is valid only for fields of the STRING, CHAR, and VARCHAR types. ● **Nullify**: Replace the original value with the NULL value. ● **Unmasked (retain original value)**: Keep the original value. ● **Date: show only year**: Only the year part of the date string is displayed, and the default month and date start from January and Monday (**01/01**). ● **Custom**: You customize policies using any valid return data type which is the same as the data type in the masked column. To add a multi-column masking policy, click  .

Step 4 Click **Add** to view the basic information about the policy in the policy list.

Step 5 After a user performs the **select** operation on a table for which a data masking policy has been configured on a HetuEngine client, the system processes the data and displays it.

----End

HetuEngine Row-level Data Filtering

Ranger allows you to filter data at the row level when you perform the select operation on a HetuEngine data table.

Step 1 Log in to the Ranger web UI. Click **HetuEngine** in the **TRINO** area on the homepage.

Step 2 On the **Row Level Filter** tab page, click **Add New Policy** to add a row data filtering policy.

Step 3 Configure the parameters listed in the table below based on the service demands.

Table 20-25 Parameters for filtering HetuEngine row data

Parameter	Description
Policy Name	Policy name, which can be customized and must be unique in the service.
Policy Conditions	IP address filtering policy, which can be customized. You can enter one or more IP addresses or IP address segments. The IP address can contain the wildcard character (*), for example, **192.168.1.10**,**192.168.1.20**, or **192.168.1.***.
Policy Label	A label specified for the current policy. You can search for reports and filter policies based on labels.
Trino Catalog	Name of the catalog to which the current policy applies.
Trino Schema	• Hive, Hudi, HBase, ClickHouse, HetuEngine, and IoTDB data sources: name of the database used by the current policy. • GaussDB and MySQL data sources: name of the schema used by the current policy.
Trino Table	Name of the table to which the current policy applies.
Description	Policy description.
Audit Logging	Whether to audit the policy.
Row Filter Conditions	In the **Select Role**, **Select Group**, and **Select User** columns, select the object to which the permission is to be granted, click **Add Conditions**, add the IP address range to which the policy applies, then click **Add Permissions**, and select **Select**. Click **Row Level Filter** and enter data filtering rules. For example, if you want to filter the data in the **zhangsan** row in the **name** column of **table A**, the filtering rule is **name <>'zhangsan'**. For more information, see the official Ranger document. To add more rules, click  .

Step 4 Click **Add** to view the basic information about the policy in the policy list.

Step 5 After a user performs the **select** operation on a table for which a data masking policy has been configured on a HetuEngine client, the system processes the data and displays it.

----End

20.16 Adding a Ranger Access Permission Policy for Storm

Scenario

Ranger administrators can use Ranger to set permissions for Storm users.

Prerequisites

- The Ranger service has been installed and is running properly.
- You have created users, user groups, or roles for which you want to configure permissions.
- The Ranger authentication function has been enabled on the page. The option in the following figure controls whether to enable the Ranger plug-in for permission control. If the function is enabled, the Ranger authentication is used. Otherwise, the authentication mechanism of the component is used.

Procedure

Step 1 Log in to the Ranger web UI as the Ranger administrator **rangeradmin**. For details, see **Logging In to the Ranger Web UI**.

Step 2 On the homepage, click **Storm** in the **STORM** area.

Step 3 Click **Add New Policy** to add a Storm permission control policy.

Step 4 Configure the parameters listed in the table below based on the service demands.

Table 20-26 Storm permission parameters

Parameter	Description
Policy Conditions	IP address filtering policy, which can be customized. You can enter one or more IP addresses or IP address segments. The IP address can contain the wildcard character (*), for example, **192.168.1.10**,**192.168.1.20**, or **192.168.1.***.
Policy Name	Policy name, which can be customized and must be unique in the service. The **include** policy applies to the current input object, and the **exclude** policy applies to objects other than the current input object.
Policy Label	A label specified for the current policy. You can search for reports and filter policies based on labels.
Storm Topology	Name of the topology to which the current policy applies. One or more values can be entered.

Parameter	Description
Description	Policy description.
Audit Logging	Whether to audit the policy.
Allow Conditions	Policy allowed condition. You can configure permissions and exceptions allowed by the policy. In the **Select Role**, **Select Group**, and **Select User** columns, select the role, user group, or user to which the permission is to be granted, click **Add Conditions**, add the IP address range to which the policy applies, and click **Add Permissions** to add the corresponding permissions. • **Submit Topology**: Submit a topology. **NOTE** The Submit Topology permission takes effect only when **Storm Topology** is set to *****. • **File Upload**: Upload a file. • **File Download**: Download a file. • **Kill Topology**: Delete a topology. • **Rebalance**: Perform the rebalance operation. • **Activate**: Activate the topology permission. • **Deactivate**: Deactivate the topology permission. • **Get Topology Conf**: Obtain topology configurations. • **Get Topology**: Obtain a topology. • **Get User Topology**: Obtain user's topology. • **Get Topology Info**: Obtain topology information. • **Upload New Credential**: Upload a new credential. • **Select/Deselect All**: Select or deselect all. To add multiple permission control rules, click  . If users or user groups in the current condition need to manage this policy, select **Delegate Admin**. These users will become the agent administrators. The agent administrators can update and delete this policy and create sub-policies based on the original policy.

Parameter	Description
Deny Conditions	Policy rejection condition, which is used to configure the permissions and exceptions to be denied in the policy. The configuration method is similar to that of **Allow Conditions**.

Step 5 (Optional) Add the validity period of the policy. Click **Add Validity period** in the upper right corner of the page, set **Start Time** and **End Time**, and select **Time Zone**. Click **Save**. To add multiple policy validity periods, click  . To delete a policy validity period, click  .

Step 6 Click **Add** to view the basic information about the policy in the policy list. After the policy takes effect, check whether the related permissions are normal.

To disable a policy, click  to edit the policy and set the policy to **Disabled**.

If a policy is no longer used, click  to delete it.

----End

20.17 Adding a Ranger Access Permission Policy for Elasticsearch

Scenario

Ranger administrators can use Ranger to configure the permissions on Elasticsearch index creation and deletion for Elasticsearch users.

Prerequisites

- The Ranger service has been installed and is running properly.
- You have created users, user groups, or roles for which you want to configure permissions.

Procedure

Step 1 Log in to the Ranger web UI as the Ranger administrator **rangeradmin**. For details, see **Logging In to the Ranger Web UI**.

Step 2 On the home page, click the component plug-in name in the **ELASTICSEARCH** area, for example, **Elasticsearch**.

Step 3 Click **Add New Policy** to add an Elasticsearch permission control policy.

Step 4 Configure the parameters listed in the table below based on the service demands.

Table 20-27 Elasticsearch permission parameters

Parameter	Description
Policy Name	Policy name, which can be customized and must be unique in the service.
Policy Conditions	IP address filtering policy, which can be customized. You can enter one or more IP addresses or IP address segments. The IP address can contain the wildcard character (*), for example, **192.168.1.10**,**192.168.1.20**, or **192.168.1.***.
Policy Label	A label specified for the current policy. You can search for reports and filter policies based on labels.
Index	Index name, index alias, or index template name. This parameter is used to configure the index or index template to which the current policy applies. Multiple values can be entered. The wildcard * is supported.
Description	Policy description.
Audit Logging	Whether to audit the policy.

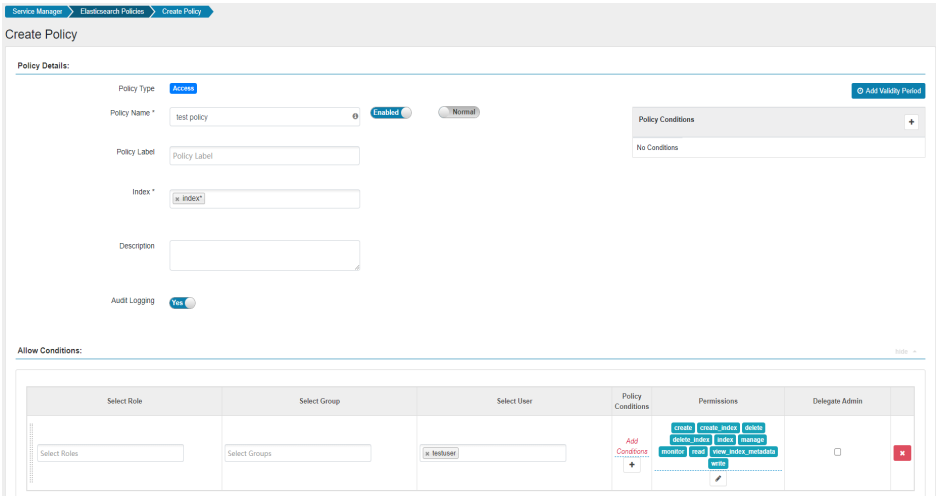
Parameter	Description
Allow Conditions	Permission and exception conditions allowed by a policy. The priority of an exception condition is higher than that of a normal condition. In the **Select Role**, **Select Group**, and **Select User** columns, select the role, user group, or user to which you want to assign permissions. **NOTICE** When setting the **Select Group** column, do not add the **elasticsearch** user group to the policy. Otherwise, the permission may be amplified. Click **Add Conditions**, add the IP address range to which the policy applies, and click **Add Permissions** to add corresponding permissions. • **all**: executing all permissions • **monitor**: index monitoring permission, including **cat_index_recovery** • **manage**: index management permission, including **monitor** and **cat_index_recovery** • **view_index_metadata**: permission to view index metadata, including **indeces_search_shards** and **cat_index_metadata** • read: index read permission, including **clear_search_scroll** • **read_cross_cluster**: cross-cluster index read permission, including **indices_search_shards** • **index**: index document write/update permission, including **indices_put**, **indices_bulk**, and **indices_index** • **create**: index write permission, including **indices_put**, **indices_bulk**, and **indices_index** • **delete**: permission to delete index documents, including **indices_bulk** • **write**: permission to write, update, and delete index documents, including the **indices_put** permission • **delete_index**: permission to delete an index • **create_index**: permission to create an index • **cluster_manage**: permission to manage clusters, including **cluster_monitor** • **cluster_monitor**: cluster monitoring permission, including **clear_search**, **cat_index_recovery** and **cat_index_metadata** • **indices_put**: permission to set index mapping • **indices_search_shards**: permission to query index shards • **indices_bulk**: batch request permission • **indices_index**: permission to write index files • **cat_index_recovery**: permission to execute the **cat recovery** API • **cat_index_metadata**: permission to execute the **cat indices** API

Parameter	Description
	• **clear_search_scroll**: permission to query indexes in rolling mode and clear the rolling query cache • **asynchronous_search**: permission to perform asynchronous search • **script**: permission to execute scripts • **Select/Deselect All**: permission to select or deselect all If users or user groups in the current condition need to manage this policy, select **Delegate Admin**. These users or user groups will become the agent administrators. The agent administrators can update and delete this policy and create sub-policies based on the original policy. To add multiple permission control rules, click  . To delete a permission control rule, click  .
Deny All Other Accesses	Whether to reject all other access requests.

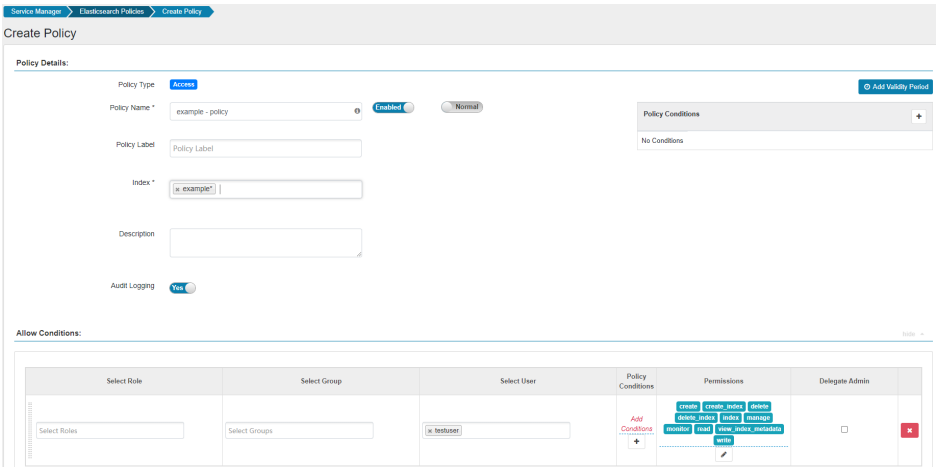
Table 20-28 Setting permissions

Task	Role Authorization
Setting the administrator permission	1. On the home page, click the component plug-in name in the **ELASTICSEARCH** area, for example, **Elasticsearch**. 2. Select the policy whose **Policy Name** is **all - index** and click  to edit the policy. 3. In the **Allow Conditions** area, select a user from the **Select User** drop-down list.
Setting a user's read and write permissions on a specified index	1. Configure an index or index template in the **Index** area. 2. In the **Allow Conditions** area, select a user from the **Select User** drop-down list. 3. Click **Add Permissions** and select **read** and **write**.

Example: Grant user **testuser** the permission to create, delete, read, write, monitor, and manage indexes starting with **index**.



Example: Grant the permission to run the client sample to user **testuser**.



Step 5 (Optional) Add the validity period of the policy. Click **Add Validity period** in the upper right corner of the page, set **Start Time** and **End Time**, and select **Time Zone**. Click **Save**. To add multiple policy validity periods, click  . To delete a policy validity period, click  .

Step 6 Click **Add** to view the basic information about the policy in the policy list. After the policy takes effect, check whether the related permissions are normal.

To disable a policy, click  to edit the policy and set the policy to **Disabled**.

If a policy is no longer used, click  to delete it.

----End

20.18 Adding a Ranger Access Permission Policy for OBS

Scenario

Ranger administrators can use Ranger to configure the read and write permissions on OBS directories or files for OBS users.

Prerequisites

- The Ranger service has been installed and is running properly.
- You have created a user group for which you want to configure permissions.
- The Guardian service has been installed.

Procedure

Step 1 Log in to the Ranger web UI as the Ranger administrator **rangeradmin**. For details, see **Logging In to the Ranger Web UI**.

Step 2 On the home page, click the component plug-in name in the **EXTERNAL AUTHORIZATION** area, for example, **OBS**.

Step 3 Click **Add New Policy** to add an OBS permission control policy.

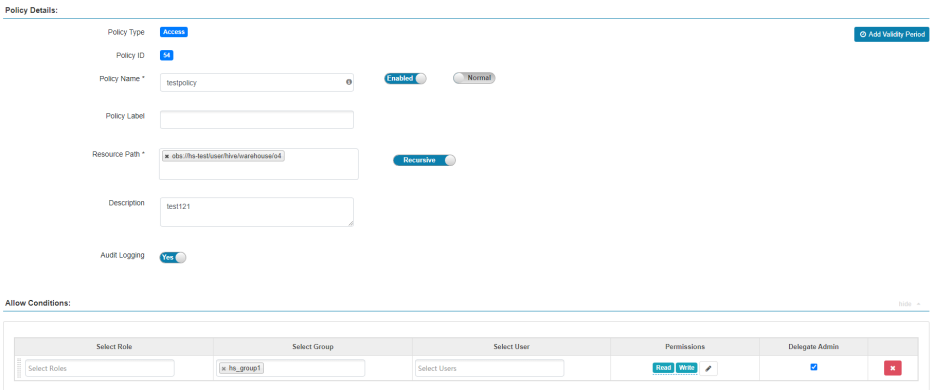
Step 4 Configure the parameters listed in the table below based on service requirements.

Table 20-29 OBS permission parameters

Parameter	Description
Policy Name	Policy name, which can be customized and must be unique in the service
Policy Label	A label specified for the current policy. You can search for reports and filter policies based on labels.
Resource Path	Resource path, which is the OBS path folder or file to which the current policy applies. You can enter multiple values but cannot use the wildcard (*). The configured OBS path folder or file must exist. Otherwise, the authorization fails. By default, permission recursion is enabled on OBS and cannot be modified. Subdirectories without any permission inherit all permissions of their parent directories.
Description	Policy description
Audit Logging	Whether to audit the policy

Parameter	Description
Allow Conditions	Policy allowed condition. You can configure permissions allowed by the policy. In the **Select Group** column, select the created user group to which you want to grant permissions. (The configuration of **Select Role** or **Select User** does not take effect.) Click **Add Permissions** to add permissions. • **Read**: permission to read data • **Write**: permission to write data • **Select/Deselect All**: permission to select or deselect all To add multiple permission control rules, click  . To delete a permission control rule, click  .

For example, to grant the read and write permissions on the **obs://hs-test/user/hive/warehouse/o4** table to user group **hs_group1** (A user group name can contain a maximum of 52 characters, including numbers (0 to 9), letters (A to Z or a to z), underscores (_), and number signs (#). Otherwise, the policy fails to add.), the configuration is as follows:



Step 5 Click **Add** to view basic information about the policy in the policy list. After the policy takes effect, check whether related permissions are normal.

If a policy is no longer used, click  to delete it.

----End

20.19 Hive Tables Supporting Cascading Authorization

Scenario

After cascading authorization is enabled for a cluster, the authentication usability is significantly improved. You only need to authorize for service tables once on the Ranger page, and the system automatically associates the permissions of the data

storage source in a fine-grained manner without detecting the storage path of the tables and without requiring secondary authorization. This also eliminates the disadvantage of storage-compute decoupled authorization. You can authorize for and authenticate storage-compute decoupled tables on Ranger. This function of Hive tables is as follows:

- After Ranger cascading authorization is enabled, when creating a policy in Ranger to authorize for a table, you only need to create a Hive policy for the table and do not need to perform secondary authorization on the table's storage source.
- When the storage source of an authorized database or table changes, the database or table is periodically associated with the new storage source (HDFS/OBS) to generate corresponding permissions.

NOTE

- Cascading authorization is not supported for view tables.
- Cascading authorization can be performed only on databases and tables, and cannot be on partitions. If a partition path is not in the table path, you need to manually authorize the partition path.
- Cascading authorization for Deny Conditions in the Hive Ranger policy is not supported. That is, the Deny Conditions permission only restricts the table permission and cannot generate the permission of the HDFS/OBS storage source.
- A policy whose **database** is ***** and **table** is ***** cannot be created in Hive Ranger.
- The permission of the HDFS Ranger policy is prior to that of the HDFS/OBS storage source generated by cascading authorization. If the HDFS Ranger permission has been set for the HDFS storage source of the table, the cascading permission does not take effect.
- The ALTER operation cannot be performed on tables whose storage source is OBS after cascading authorization. To use this operation, you need to assign the **Read** and **Write** permissions on the parent directory of the OBS table path to the corresponding user group. A user group name can contain a maximum of 52 characters, including numbers (0 to 9), letters (A to Z or a to z), underscores (_), and number signs (#). Otherwise, the policy fails to add.
- If OBS is used as the storage source, the following conditions must be met. Otherwise, the OBS authorization for the table fails.
  - The Guardian service must have been installed in the cluster.
  - Tables stored in OBS can only be authorized to user groups.
  - Only clusters in security mode support OBS cascading authorization.

Enabling Cascading Authorization

Step 1 Log in to FusionInsight Manager, choose **Cluster** > **Services** > **Ranger**, and click **Configurations**.

Step 2 Search for the **ranger.ext.authorization.cascade.enable** parameter and set it to **true**.

Step 3 Click **Save**.

Step 4 Click **Instance** and select all RangerAdmin instances. Click **More** and select **Restart Instance**. Enter the password, and click **OK** to restart all RangerAdmin instances.

----End

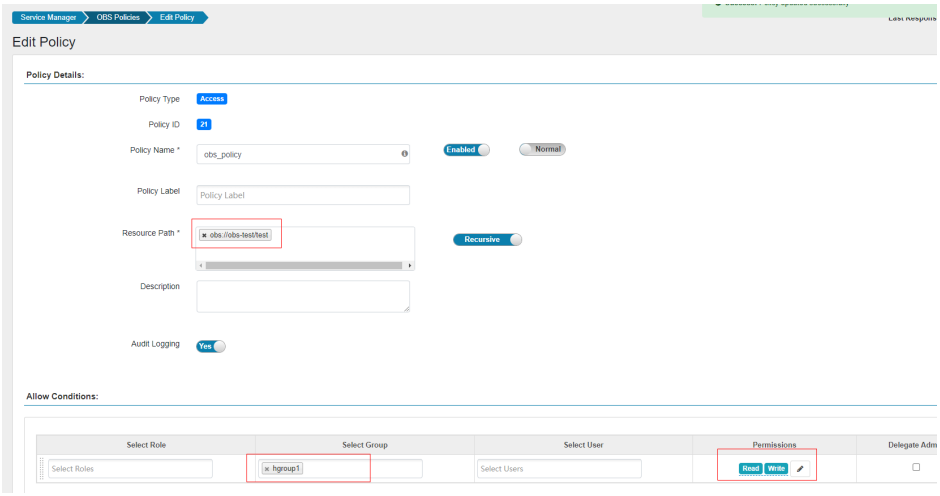
Connecting to the HDFS Storage Source

The HDFS storage source does not need to be configured.

Connecting to the OBS Storage Source

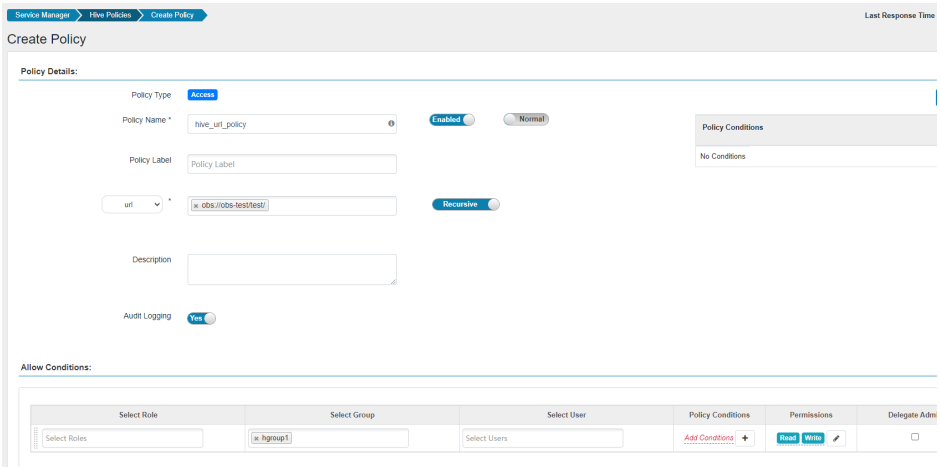
- Setting the location to an OBS path when creating a table
  a. You have configured storage and compute decoupling.
  b. Log in to the Ranger management page as the Ranger administrator **rangeradmin**. On the home page, click **OBS** in the **EXTERNAL AUTHORIZATION** area, click **Add New Policy**, and assign the **Read** and **Write** permissions on the OBS storage path to the user group to which the corresponding user belongs. For details, see **Adding a Ranger Access Permission Policy for OBS**.

     For example, assign the **Read** and **Write** permissions on the **obs://obs-test/test/** directory to the **hgroup1** user group:

  c. On the home page, click the component plug-in name **Hive** in the **HADOOP SQL** area. On the **Access** tab page, click **Add New Policy** to add a URL policy that assigns the **Read** and **Write** permissions on OBS storage paths to the user group to which the corresponding user belongs. For details, see **Adding a Ranger Access Permission Policy for Hive**.

     For example, create the **hive_url_policy URL** policy for the **hgroup1** user group and assign the **Read** and **Write** permissions on the **obs://obs-test/test/** directory to the user group:



d. Log in to the beeline client and set **Location** to the OBS file system path when creating a table.

cd *Client installation directory*

kinit *Component operation user*

beeline

For example, to create a table named **test** whose **Location** is **obs://obs-test/test/***Database name*/*Table name*, run the following command:

create table test(name string) location "obs://*obs-test/test/Database name/Table name***";**

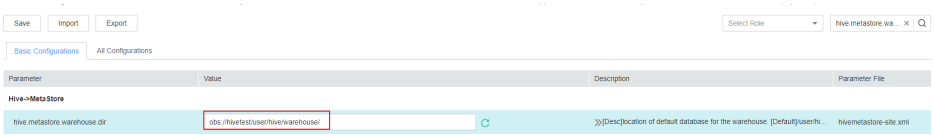
- Interconnecting Hive with OBS through Metastore

a. You have configured storage and compute decoupling.

b. Log in to FusionInsight Manager, choose **Cluster** > **Services** > **Hive**, and click **Configurations**.

c. Search for **hive.metastore.warehouse.dir** in the search box and change the parameter value to an OBS path, for example, **obs://hivetest/user/hive/warehouse/**. **hivetest** indicates the OBS file system name.

Figure 20-3 hive.metastore.warehouse.dir configuration



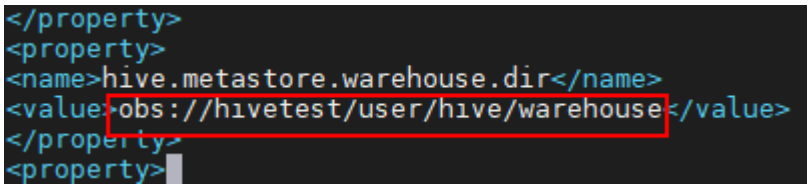
d. Save the configuration. Choose **Cluster** > **Services** and restart the Hive service in the service list.

e. Update the client configuration file.

i. Log in to the node where the Hive client is located and run the following command to modify **hivemetastore-site.xml** in the Hive client configuration file directory:

vi *Client installation directory*/**Hive/config/hivemetastore-site.xml**

ii. Change the value of **hive.metastore.warehouse.dir** to the corresponding OBS path, for example, **obs://hivetest/user/hive/warehouse/**.

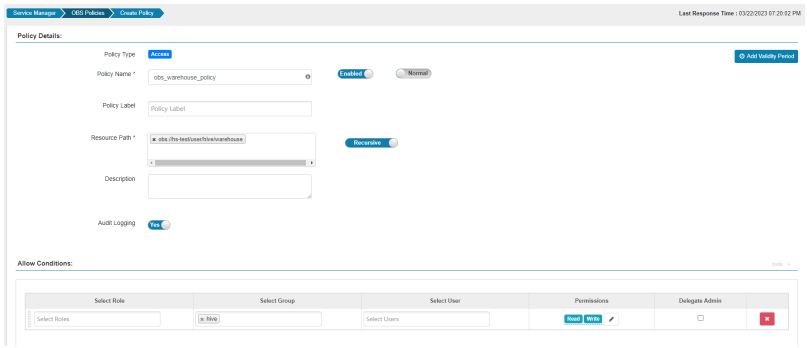


iii. Change the value of **hive.metastore.warehouse.dir** of **hivemetastore-site.xml** in the HCatalog client configuration file directory to the corresponding OBS path, for example, **obs://hivetest/user/hive/warehouse/**.

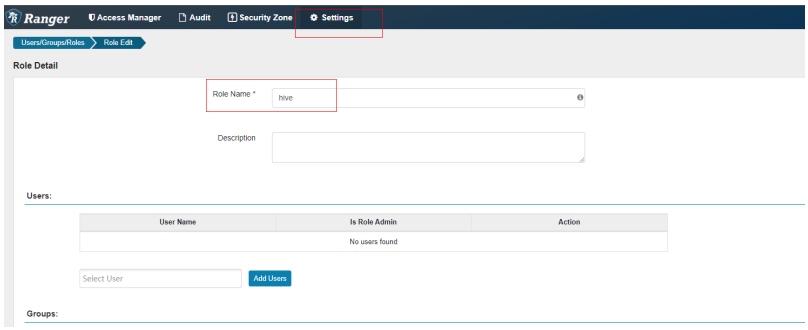
vi *Client installation directory*/**Hive/HCatalog/conf/hivemetastore-site.xml**

iv. Log in to the Ranger management page as the Ranger administrator **rangeradmin**. On the home page, click **OBS** in the **EXTERNAL AUTHORIZATION** area, click **Add New Policy**, and assign the **Read** and **Write** permissions on the OBS storage path to the user group to which the corresponding user belongs.

For example, assign the **Read** and **Write** permissions on the **obs://hivetest/user/hive/warehouse/** directory to the **hgroup1** user group:



v. Choose **Settings** > **Roles**, click **Add New Role**, and create a role whose **Role Name** is **hive**.



f. Go to the Hive Beeline CLI, create a table, and ensure that the location is an OBS path.

cd *Client installation directory*

kinit *Component operation user*

beeline

create table test(name string);

desc formatted test;

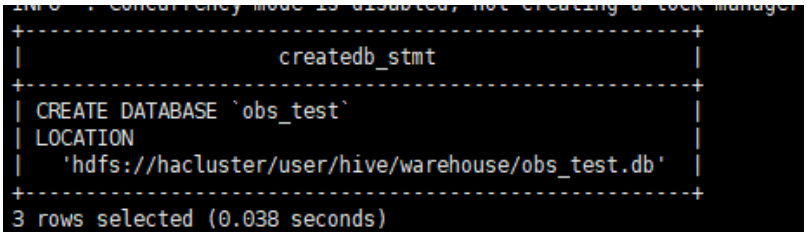
NOTE

If the location of the current database points to HDFS, tables created in the database also point to HDFS by default without specifying the location. To modify the default table creation policy, modify the location of the database to point to OBS.

The procedure is as follows:

1. Run the following command to query the location of the database:

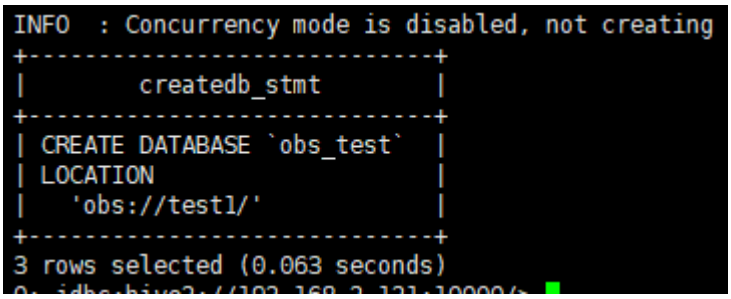
   show create database *obs_test*;

2. Run the following command to modify the database location:

   alter database *obs_test* **set location** *'obs://test1/'*

   Run the **show create database** *obs_test* command to check whether the location of the database points to OBS.

3. Run the following command to modify the table location:

   alter table *user_info* **set location** *'obs://test1/'*

   If the table contains data, migrate the original data file to the new location.

20.20 Configuring Multi-Instance for RangerKMS

Scenario

After two RangerKMS instances are installed in an MRS cluster, you need to modify Ranger KMS configurations before configuring HDFS multi-instance transparent encryption.

NOTE

If only one RangerKMS instance is installed, skip this section.

Prerequisites

Two RangerKMS instances have been installed.

Procedure

Step 1 Choose **Cluster** > **Services** > **Ranger**. Click **Configurations** then **All Configurations**, click **RangerKMS(Role)**, and select **Server**.

Step 2 Change the values of the following parameters:

Parameter	Value	Description
hadoop.kms.authentication.signer.secret.provider	zookeeper	Select the ZooKeeper control token.
hadoop.kms.authentication.signer.secret.provider.zookeeper.path	/ranger-kms/hadoop-auth-signature-secret	Ranger KMS record path in ZooKeeper.

Step 3 Click **All Configurations**, click **RangerKMS(Role)**, and select **Cache**.

Step 4 Change the **hadoop.kms.cache.enable** value to **false**.

Step 5 Click **Save**. In the dialog box that is displayed, click **OK** to save the configuration.

Step 6 Restart RangerKMS and other upper-layer services whose configurations have expired.

----End

20.21 Using the RangerKMS Native UI to Manage Permissions and Keys

Scenario

After KMS is installed, you need to create a user on FusionInsight Manager and associate the user with the KeyAdmin role to grant it the permission to manage keys and encrypt HDFS partitions.

If it is your first time logging in to the RangerKMS UI, you can log in as user **rangerkms** or **keyadmin**. By default, the **keyadmin** user has only the key management permission. User **rangerkms** has both key management permission and key operation permission.

Prerequisites

- The Ranger service has been installed and is running properly.
- You have created a human-machine user and do not need to add permission.

Adding the KeyAdmin Role to a User

Step 1 Log in to FusionInsight Manager as user **admin**. Choose **Cluster** > **Services** > **Ranger**.

Step 2 Click **RangerAdmin** in the **Basic Information** area. The Ranger web UI is displayed.

Step 3 On the Ranger web UI, click the username in the upper right corner, and choose **Log Out** to log out of the current user.

Step 4 Log in to the system again as user **rangerkms** or **keyadmin**. Change the password upon the first login.

For details about the username and default password, contact the MRS cluster administrator.

Step 5 Choose **Settings** > **Users**. In the **User Name** column, click the user to whom you want to assign the KeyAdmin role permission.

Step 6 Select **KeyAdmin** from the **Select Role** drop-down list box. In the dialog box that is displayed, click **OK**.

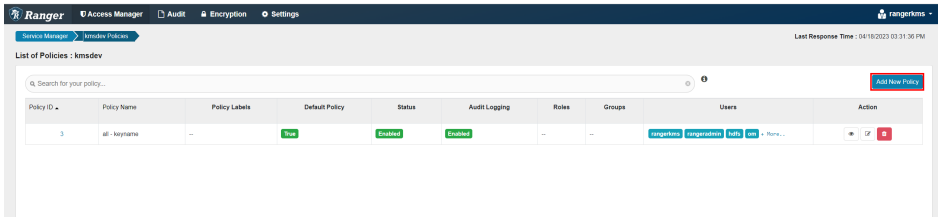
Step 7 Click **Save**. The KeyAdmin role is added.

----End

Key Permission Management

Step 1 Log in to the Ranger UI as **rangerkms**, **keyadmin**, or a user with the KeyAdmin role.

Step 2 On the **Access Manager** page, click **kmsdev**.



Step 3 You can click **Add New Policy** in the upper right corner to add a policy.

Step 4 Configure the parameters listed in the table below based on service requirements.

Table 20-30 Parameters for adding a new policy

Parameter	Description
Policy Type	Access
Policy Name	Policy name, which is mandatory.
Policy Label	Policy label, which is used to classify policies.
Key Name	Key name and EZK name stored in KMS. This policy takes effect for the configured key. If this parameter is set to *, all keys are selected.
Description	Content of a policy.

Parameter	Description
Audit Logging	Audit function.
Allow Conditions	Allow policy to grant permissions to selected users, user groups, or roles. Available key words are as follows: • **Create**: Create a key. • **Delete**: Delete a key. • **Rollover**: Update a key. • **Set Key Material**: Set the key ciphertext. • **Get**: Read a key. • **Get keys**: Read all keys (keys configured in the policy). • **Get Metadata**: Get the metadata of a key. • **Generate EEK**: Generate an EEK. • **Decrypt EEK**: Decrypt an EEK. **Exclude from Allow Conditions**: Configure exception rules.
Deny All Other Accesses	Whether to reject all other access requests. • **True**: All other access requests are rejected. • **False**: **Deny Conditions** can be configured.
Deny Conditions	Policy rejection condition, which is used to configure the permissions and exceptions to be denied in the policy. The configuration method is similar to that of **Allow Conditions**. The priority of **Deny Conditions** is higher than that of allowed conditions configured in **Allow Conditions**. **Exclude from Deny Conditions**: exception rules excluded from the denied conditions

Step 5 Click **Add**. The role, user group, or user corresponding to the policy has the key-related permissions in the policy.

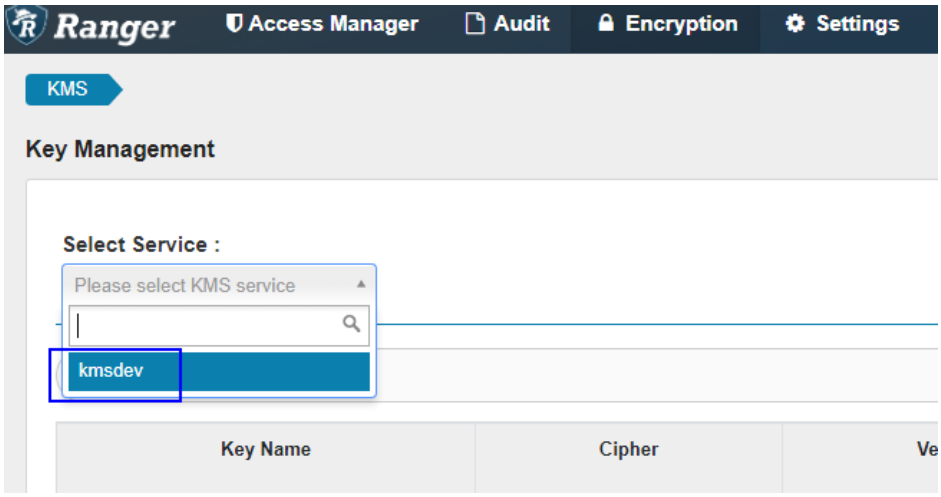
----End

Managing Keys on the Native UI

Step 1 Log in to the Ranger management page as user **rangerkms** or **keyadmin**.

Step 2 Click **Encryption**. The key management page is displayed.

Step 3 Select **kmsdev** from the **Select Service** drop-down list.

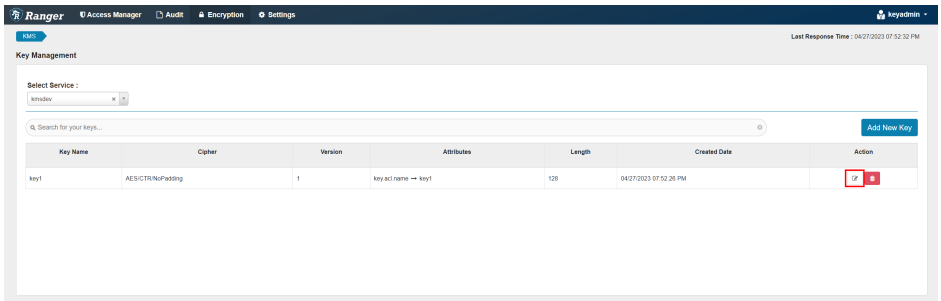


Step 4 Click **Add New Key** on the right to create a key.

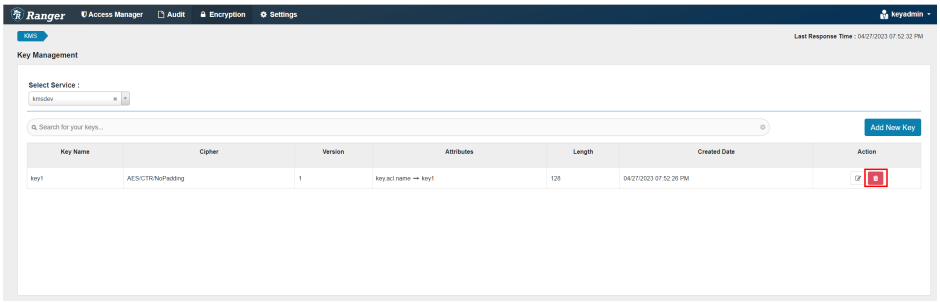
Table 20-31 Parameters on the **Add New Key** page

Parameter	Description
Key Name	Key name.
Cipher	Encryption algorithm. The default value is **AES/CTR/NoPadding** and cannot be changed.
Length	Key length. The value can be 128 or 256.
Description	Content of a key.
Attributes	Custom attribute of the key. You do not need to add any attributes.

Step 5 Click the modification icon to update a key.



Step 6 If you need to delete a key, click the delete icon.



----End

Permission Management for Common Clusters

Step 1 Log in to FusionInsight Manager, choose **Cluster** > **Services** > **Ranger**, click **Configurations** > **RangerKMS**, and click **Customizations**.

Step 2 Add the following parameter to the **dbks-site.xml** line:

hadoop.kms.security.authorization.manager and empty value

Step 3 Save the configuration and restart RangerKMS.

Step 4 If the key management permission is required, add the user to the **rkmsadmin** group.

----End

20.22 Ranger Log Overview

Log Description

Log path: The default storage path of Ranger logs is **/var/log/Bigdata/ranger/***Role name*.

- RangerAdmin: /var/log/Bigdata/ranger/rangeradmin (run logs); /var/log/Bigdata/audit/ranger/rangeradmin (audit logs)
- TagSync: /var/log/Bigdata/ranger/tagsync (run logs)
- UserSync: /var/log/Bigdata/ranger/usersync (run logs)
- RangerKMS: /var/log/Bigdata/ranger/rangerkms (run logs)
- PolicySync: /var/log/Bigdata/ranger/policysync (run logs)

Log archive rule: The automatic compression and archive function is enabled for Ranger logs. By default, when the size of a log file exceeds 20 MB, the log file is automatically compressed. The naming rule of the compressed log file is as follows: *<Original log file name>-<yyyy-mm-dd_hh-mm-ss>.[ID]***.log.zip**. A maximum of 20 compressed files are retained.

Table 20-32 Ranger log list

Type	Name	Description
RangerAdmin run log file	access_log.*<DATE>*.log	Tomcat access log
	catalina.out	Tomcat service run log
	gc-worker-pid*<PID>*-*<Date>*.log.*<ID>*	RangerAdmin garbage collection (GC) log
	postinstallDetail.log	Work log generated after an instance is started before installation
	prestartDetail.log	Log that records preparations before instance startup
	ranger-admin.log	RangerAdmin run log
	ranger_admin_sql.log	RangerAdmin log used to retrieve DBService
	startDetail.log	Instance startup log
TagSync run log	cleanupDetail.log	Instance clearing log
	gc-worker-pid*<PID>*-*<Date>*.log.*<ID>*	GC log file of an instance
	postinstallDetail.log	Work log generated after an instance is started before installation
	prestartDetail.log	Log that records preparations before instance startup
	ranger-tagsync.log	TagSync run log
	startDetail.log	Instance startup log
	tagsync.out	TagSync run log
UserSync run log	auth.log	UnixAuth service run log
	cleanupDetail.log	Instance clearing log
	gc-worker-pid*<PID>*-*<Date>*.log.*<ID>*	GC log file of an instance
	postinstallDetail.log	Work log generated after an instance is started before installation
	prestartDetail.log	Log that records preparations before instance startup

Type	Name	Description
	ranger-usersync.log	UserSync run log
	startDetail.log	Instance startup log
RangerKMS run log	access-<host>-*<DATE>*.log	Tomcat access log
	threadDump-*<DATE>*.log	JVM GC log of the process
	stopDetail.log	Instance stopping log
	startDetail.log	Instance startup log
	ranger-kms.log	Instance run log
	prestartDetail.log	Log that records preparations before instance startup
	catalina.out	Tomcat service run log
	postinstallDetail.log	Work log generated after an instance is started before installation
PolicySync run log	cleanupDetail.log	Instance clearing log
	policysync.out	Instance run log
	postinstallDetail.log	Work log generated after an instance is started before installation
	prestartDetail.log	Log that records preparations before instance startup
	ranger-policysync.log	Instance run log
	startDetail.log	Instance startup log
	gc-worker-pid*<PID>*-*<Date>*.log.*<ID>*	GC log file of an instance
	stopDetail.log	Instance stopping log
Audit log	rangeradmin-audit.log	RangerAdmin audit log

Log Levels

Table 20-33 describes the log levels provided by Ranger. The priorities of log levels are FATAL, ERROR, WARN, INFO, and DEBUG in descending order. Logs whose levels are higher than or equal to the specified level are printed. The number of printed logs decreases as the specified log level increases.

Table 20-33 Log levels

Level	Description
FATAL	Logs of this level record fatal error information about the current event processing that may result in a system crash.
ERROR	Logs of this level record error information about the current event processing, which indicates that system running is abnormal.
WARN	Logs of this level record abnormal information about the current event processing. These abnormalities will not result in system faults.
INFO	Logs of this level record normal running status information about the system and events.
DEBUG	Logs of this level record the system information and system debugging information.

To modify log levels, perform the following operations:

Step 1 Log in to FusionInsight Manager.

Step 2 Choose **Cluster** > **Services** > **Ranger** > **Configurations**.

Step 3 Select **All Configurations**.

Step 4 On the menu bar on the left, select the log menu of the target role.

Step 5 Select a desired log level.

Step 6 Click **Save**. In the displayed dialog box, click **OK** to make the configuration take effect.

NOTE

The configurations take effect immediately without the need to restart the service.

----End

Log Formats

The following table lists the Ranger log formats.

Table 20-34 Log formats

Type	Format	Example Value
Run log	*<yyyy-MM-dd HH:mm:ss,SSS>*|*<Log level>*|*<Name of the thread that generates the log>*|*<Message in the log>*|*<Location where the log event occurs>*	2020-04-29 20:09:28,543 | INFO | http-bio-21401-exec-56 | Request comes from API call, skip cas filter. | CasAuthenticationFilter-Wrapper.java:25

20.23 Common Issues About Ranger

20.23.1 Why Ranger Startup Fails During the Cluster Installation?

Problem

During cluster installation, Ranger fails to be started, and the error message "ERROR: cannot drop sequence X_POLICY_REF_ACCESS_TYPE_SEQ " is displayed in the task list of the Manager process. How do I resolve this problem and properly install Ranger?

Answer

This issue may occur when two RangerAmdin instances are installed. If the instance installation fails, manually restart one RangerAdmin instance and then restart the other instance.

20.23.2 How Do I Determine Whether the Ranger Authentication Is Used for a Service?

Question

How do I determine whether the Ranger authentication is enabled for a service that supports the authentication?

Answer

Log in to FusionInsight Manager and choose **Cluster** > **Services** > *Name of the desired service*. On the service details page, click **More** and check whether the **Enable Ranger** option is available.

- If yes, the Ranger authentication plug-in is not enabled for the service. You can click **Enable Ranger** to enable the function.
- If no, the Ranger authentication plug-in has been enabled for the service. You can configure the permission policy for accessing the service resources on the Ranger management page.

NOTE

If this option does not exist, the current service does not support the Ranger authentication plug-in and Ranger authentication is disabled.

20.23.3 Why Cannot a New User Log In to Ranger After Changing the Password?

Question

When a new user logs in to Ranger, why is the 401 error reported after the password is changed?

Answer

The UserSync synchronizes user data at an interval of 5 minutes by default. Therefore, a new user created on Manager cannot log in to the Ranger before the user data is successfully synchronized because the Ranger database does not have the user information. The user can log in to the Ranger only after the specified interval ends.

In non-security mode, the Ranger does not synchronize user data from Manager. Therefore, only the **admin** user can log in to the Ranger page.

20.23.4 When an HBase Policy Is Added or Modified on Ranger, Wildcard Characters Cannot Be Used to Search for Existing HBase Tables

Question

When a Ranger access permission policy is added for HBase and wildcard characters are used to search for an existing HBase table in the policy, the table cannot be found. The following error is reported in **/var/log/Bigdata/ranger/rangeradmin/ranger-admin-*log**:

```
Caused by: javax.security.sasl.SaslException: No common protection layer between client and server
at com.sun.security.sasl.gsskerb.GssKrb5Client.doFinalHandshake(GssKrb5Client.java:253)
at com.sun.security.sasl.gsskerb.GssKrb5Client.evaluateChallenge(GssKrb5Client.java:186)
at
org.apache.hadoop.hbase.security.AbstractHBaseSaslRpcClient.evaluateChallenge(AbstractHBaseSaslRpcClien
t.java:142)
at org.apache.hadoop.hbase.security.NettyHBaseSaslRpcClientHandler
$2.run(NettyHBaseSaslRpcClientHandler.java:142)
at org.apache.hadoop.hbase.security.NettyHBaseSaslRpcClientHandler
$2.run(NettyHBaseSaslRpcClientHandler.java:138)
at java.security.AccessController.doPrivileged(Native Method)
at javax.security.auth.Subject.doAs(Subject.java:422)
at org.apache.hadoop.security.UserGroupInformation.doAs(UserGroupInformation.java:1761)
at
org.apache.hadoop.hbase.security.NettyHBaseSaslRpcClientHandler.channelRead0(NettyHBaseSaslRpcClientH
andler.java:138)
at
org.apache.hadoop.hbase.security.NettyHBaseSaslRpcClientHandler.channelRead0(NettyHBaseSaslRpcClientH
andler.java:42)
at
org.apache.hbase.thirdparty.io.netty.channel.SimpleChannelInboundHandler.channelRead(SimpleChannelInbo
undHandler.java:105)
```

```
at
org.apache.hbase.thirdparty.io.netty.channel.AbstractChannelHandlerContext.invokeChannelRead(AbstractChannelHandlerContext.java:362)
```

Answer

The value of **hbase.rpc.protection** of the HBase service plug-in on Ranger must be the same as that of **hbase.rpc.protection** on the HBase server.

Step 1 Log in to the Ranger management page. For details, see **Logging In to the Ranger Web UI**.

Step 2 In the **HBASE** area on the home page, click the component plug-in name, for example, the  button of HBase.

Step 3 Search for the configuration item **hbase.rpc.protection** and change its value to the value of **hbase.rpc.protection** on the HBase server.

Step 4 Click **Save**.

----End

20.23.5 How Do I Rectify the Problem that RangerKMS Authentication Fails and the KMS Tab Is Not Displayed on the Ranger Management Page?

Symptom

After the cluster is installed, the authentication tab of the KMS is not displayed.

Answer

There is a Ranger user synchronization period. If the user is missing in the policy, the tab fails to be created.

Step 1 Log in to any RangerKMS node as user **omm**.

Step 2 Run the following command to create the install tag:

touch ${BIGDATA_HOME}/tmp/rangerkmsinstallmarker

Step 3 Log in to Manger, choose **Cluster** > **Ranger** > **Instance**, and restart the RangerKMS instance.

Step 4 Refresh the Ranger management page. The KMS tab is displayed.

----End

21 Using Spark

21.1 Basic Operation

21.1.1 Getting Started

Use Spark from scratch and submit Spark applications, including Spark Core and Spark SQL. Spark Core is the kernel module of Spark. It executes tasks and is used to compile Spark applications. Spark SQL is a module that executes SQL statements.

Scenario Description

Develop a Spark application to perform the following operations on logs about netizens' dwell time for online shopping on a weekend.

- Collect statistics on female netizens who dwell on online shopping for more than 2 hours on the weekend.
- The first column in the log file records names, the second column records genders, and the third column records the dwell durations in the unit of minute. Three columns are separated by comma (,).

log1.txt: logs collected on Saturday

```
LiuYang,female,20
YuanJing,male,10
GuoYijun,male,5
CaiXuyu,female,50
Liyuan,male,20
FangBo,female,50
LiuYang,female,20
YuanJing,male,10
GuoYijun,male,50
CaiXuyu,female,50
FangBo,female,60
```

log2.txt: logs collected on Sunday

```
LiuYang,female,20
YuanJing,male,10
CaiXuyu,female,50
FangBo,female,50
```

```
GuoYijun,male,5
CaiXuyu,female,50
Liyuan,male,20
CaiXuyu,female,50
FangBo,female,50
LiuYang,female,20
YuanJing,male,10
FangBo,female,50
GuoYijun,male,50
CaiXuyu,female,50
FangBo,female,60
```

Prerequisites

- On Manager, you have created a user and granted the HDFS, Yarn, Kafka, and Hive permissions to the user.
- You have installed and configured tools such as IntelliJ IDEA and JDK based on the development language.
- The Spark client has been installed and the network connection of the client has been configured.
- For Spark SQL programs, you have started Spark SQL or Beeline on the client to enter SQL statements.

Procedure

Step 1 Obtain the sample project and import it to IDEA. Import the JAR package on which the sample project depends. Use IDEA to configure and generate JAR files.

Step 2 Prepare the data required by the sample project.

Save the original log files in the scenario description to the HDFS system.

1. Create two text files (**input_data1.txt** and **input_data2.txt**) on the local host and copy the content in the **log1.txt** and **log2.txt** files to the **input_data1.txt** and **input_data2.txt** files, respectively.
2. Create the **/tmp/input** directory in HDFS, and upload **input_data1.txt** and **input_data2.txt** to the **/tmp/input** directory:

Step 3 Upload the generated JAR file to the Spark running environment (Spark client), for example, **/opt/female**.

Step 4 Go the client directory, configure the environment variables, and log in to the system. If multiple Spark instances or services are installed, run the following commands to load environment variables of the instance when using the client to connect to an instance:

source bigdata_env

source Spark/component_env

kinit <*Service user for authentication***>**

Step 5 Run the following script in the **bin** directory to submit the Spark application:

spark-submit --class *com.xxx.bigdata.spark.examples.FemaleInfoCollection* **--master yarn-client** */opt/female/FemaleInfoCollection.jar <inputPath>*

NOTE

- **FemaleInfoCollection.jar** is the JAR package generated in **Step 1**.
- **<inputPath>** is the directory created in **Step 2.2**.

Step 6 (Optional) After calling the **spark-sql** or **spark-beeline** script in the **bin** directory, directly enter SQL statements to perform operations such as query.

For example, create a table, insert a piece of data, and then query the table.

```
spark-sql> CREATE TABLE TEST(NAME STRING, AGE INT);
Time taken: 0.348 seconds
spark-sql>INSERT INTO TEST VALUES('Jack', 20);
Time taken: 1.13 seconds
spark-sql> SELECT * FROM TEST;
Jack    20
Time taken: 0.18 seconds, Fetched 1 row(s)
```

Step 7 View the running result of the Spark application.

- View the running result data in a specified file.

  The storage path and format of the result data are specified by the Spark application.

- Check the running status on the web page.

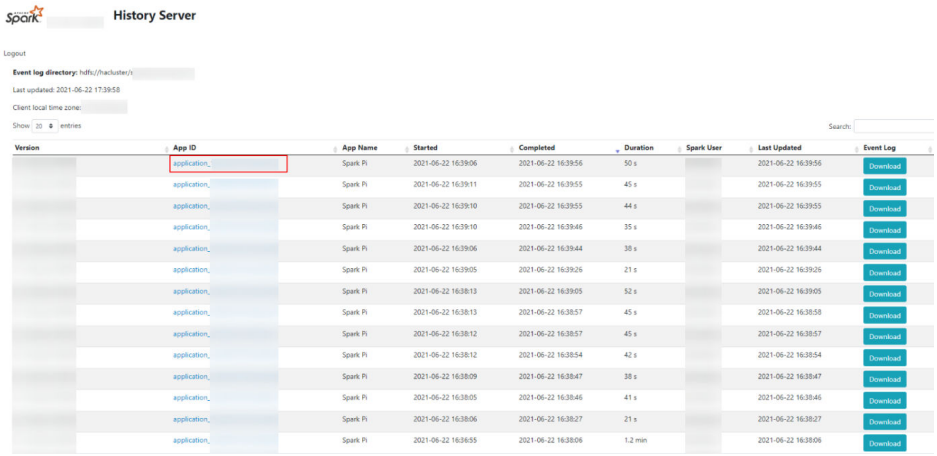
  a. Log in to Manager. Select **Spark** from the **Service** drop-down list.

  b. Go to the Spark overview page and click any SparkWebUI instance, for example, **JobHistory(host2)**.

  c. The History Server UI is displayed.

  The History Server UI is used to display the status of Spark applications that are complete or incomplete.

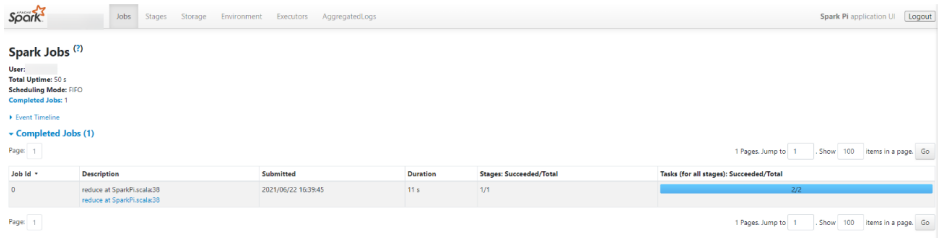
  Figure 21-1 History Server UI

  d. Select an application ID and click this page to go to the Spark UI of the application.

  Spark UI: used to display the status of running applications.

Figure 21-2 Spark UI



- View Spark logs to learn application runtime conditions.

  View **Spark Log Overview** to learn application running status, and adjust applications based on log information.

----End

21.1.2 Configuring Parameters Rapidly

Overview

Quickly configure common parameters and list the parameters that do not need to be modified when you use Spark.

Common parameters to be configured

Some parameters have been adapted during cluster installation. However, the following parameters need to be adjusted based on application scenarios. Unless otherwise specified, the following parameters are configured in the **spark-defaults.conf** file on the Spark client.

Table 21-1 Common parameters to be configured

Configuration Item	Description	Default Value
spark.sql.parquet.compression.codec	Used to set the compression format of a non-partitioned Parquet table. Set the queue in the **spark-defaults.conf** configuration file on the JDBCServer server.	snappy
spark.dynamicAllocation.enabled	Indicates whether to use dynamic resource scheduling, which is used to adjust the number of executors registered with the application according to scale. Currently, this parameter is valid only in Yarn mode. The default value for JDBCServer is **true**, and that for the client is **false**.	false

Configuration Item	Description	Default Value
spark.executor.memory	Indicates the memory size used by each executor process. Its character sting is in the same format as the JVM memory (example: 512 MB or 2 GB).	4G
spark.sql.autoBroadcastJoinThreshold	Indicates the maximum value for the broadcast configuration when two tables are joined. ● When the size of a field in a table involved in an SQL statement is less than the value of this parameter, the system broadcasts the SQL statement. ● If the value is set to **-1**, broadcast is not performed.	10485760
spark.yarn.queue	Specifies the Yarn queue where JDBCServer resides. Set the queue in the **spark-defaults.conf** configuration file on the JDBCServer server.	default
spark.driver.memory	In a large cluster, you are advised to configure the memory used by the 32 GB to 64 GB driver process, that is, the SparkContext initialization process (for example, 512 MB and 2 GB).	4G
spark.yarn.security.credentials.hbase.enabled	Indicates whether to enable the function of obtaining HBase tokens. If the Spark on HBase function is required and a security cluster is configured, set this parameter to **true**. Otherwise, set this parameter to **false**.	false
spark.serializer	Used to serialize the objects that are sent over the network or need to be cached. The default value of Java serialization applies to any Serializable Java object, but the running speed is slow. Therefore, you are advised to use **org.apache.spark.serializer.KryoSerializer** and configure Kryo serialization. It can be any subclass of **org.apache.spark.serializer.Serializer**.	org.apache.spark.serializer.JavaSerializer

Configuration Item	Description	Default Value
spark.executor.cores	Indicates the number of kernels used by each executor. Set this parameter in standalone mode and Mesos coarse-grained mode. When there are sufficient kernels, the application is allowed to execute multiple executable programs on the same worker. Otherwise, each application can run only one executable program on each worker.	1
spark.shuffle.service.enabled	Indicates a long-term auxiliary service in NodeManager for improving shuffle computing performance.	false
spark.sql.adaptive.enabled	Indicates whether to enable the adaptive execution framework.	false
spark.executor.memoryOverhead	Indicates the heap memory to be allocated to each executor, in MB. This is the memory that occupies the overhead of the VM, similar to the internal string and other built-in overhead. The value increases with the executor size (usually 6% to 10%).	1 GB
spark.streaming.kafka.direct.lifo	Indicates whether to enable the LIFO function of Kafka.	false

Parameters Not Recommended to Be Modified

The following parameters have been adapted during cluster installation. You are not advised to modify them.

Table 21-2 Parameters not recommended to be modified

Configuration Item	Description	Default Value or Configuration Example
spark.password.factory	Selects the password parsing mode.	org.apache.spark.om.util.FIPasswordFactory
spark.ssl.ui.protocol	Sets the SSL protocol of the UI.	TLSv1.2

Configuration Item	Description	Default Value or Configuration Example
spark.yarn.archive	Archives Spark JAR files, which are distributed to Yarn cache. If this parameter is set, the value will replace **<code> spark.yarn.jars </code>** and be archived in the containers of all applications. The archive should contain the JAR files in its root directory. Archives can also be hosted on HDFS to speed up file distribution.	hdfs://hacluster/user/spark/jars/8.1.0.1/spark-archive.zip **NOTE** The version number **8.1.0.1** is used as an example. Replace it with the actual version number.
spark.yarn.am.extraJavaOptions	Indicates a string of extra JVM options to pass to the YARN ApplicationMaster in client mode. Use **spark.driver.extraJavaOptions** in cluster mode.	-Dlog4j.configuration=./__spark_conf__/__hadoop_conf__/log4j-executor.properties -Djava.security.auth.login.config=./__spark_conf__/__hadoop_conf__/jaas-zk.conf -Dzookeeper.server.principal=zookeeper/hadoop.<*system domain name*> -Djava.security.krb5.conf=./__spark_conf__/__hadoop_conf__/kdc.conf -Djdk.tls.ephemeralDHKeySize=2048
spark.shuffle.servicev2.port	Indicates the port for the shuffle service to monitor requests for obtaining data.	27338
spark.ssl.historyServer.enabled	Sets whether the history server uses SSL.	true
spark.files.overwrite	When the target file exists and its content does not match that of the source file, whether to overwrite the file added through **SparkContext.addFile()**.	false

Configuration Item	Description	Default Value or Configuration Example
spark.yarn.cluster.driver.extraClassPath	Indicates the extraClassPath of the driver in Yarn-cluster mode. Set the parameter to the path and parameters of the server.	${BIGDATA_HOME}/common/runtime/security
spark.driver.extraClassPath	Indicates the extra class path entries attached to the class path of the driver.	${BIGDATA_HOME}/common/runtime/security
spark.yarn.dist.innerfiles	Sets the files that need to be uploaded to HDFS from Spark in Yarn mode.	/Spark_path/spark/conf/s3p.file,/Spark_path/spark/conf/locals3.jceks *Spark_path* is the installation path of the Spark client.
spark.sql.bigdata.register.dialect	Registers the SQL parser.	org.apache.spark.sql.hbase.HBaseSQLParser
spark.shuffle.manager	Indicates the data processing mode. There are two implementation modes: sort and hash. The sort shuffle has a higher memory utilization. It is the default option in Spark 1.2 and later versions.	SORT
spark.deploy.zookeeper.url	Indicates the address of ZooKeeper. Multiple addresses are separated by commas (,).	For example: host1:2181,host2:2181,host3:2181
spark.broadcast.factory	Indicates the broadcast mode.	org.apache.spark.broadcast.TorrentBroadcastFactory
spark.sql.session.state.builder	Session state constructor.	org.apache.spark.sql.hive.FIHiveACLSessionStateBuilder

Configuration Item	Description	Default Value or Configuration Example
spark.executor.extraLibraryPath	Sets the special library path used when the executor JVM is started.	${BIGDATA_HOME}/FusionInsight_HD_8.1.0.1/install/FusionInsight-Hadoop-*/hadoop/lib/native
spark.ui.customErrorPage	Indicates whether to display the custom error information page when an error occurs on the page.	true
spark.httpdProxy.enable	Indicates whether to use the httpd proxy.	true
spark.ssl.ui.enabledAlgorithms	Sets the SSL algorithm of UI.	TLS_ECDHE_ECDSA_WITH_AES_256_GCM_SHA384,TLS_ECDHE_RSA_WITH_AES_256_GCM_SHA384,TLS_ECDHE_ECDSA_WITH_AES_128_GCM_SHA256,TLS_ECDHE_RSA_WITH_AES_128_GCM_SHA256,TLS_DHE_RSA_WITH_AES_256_GCM_SHA384,TLS_DHE_DSS_WITH_AES_256_GCM_SHA384,TLS_DHE_RSA_WITH_AES_128_GCM_SHA256,TLS_DHE_DSS_WITH_AES_128_GCM_SHA256
spark.ui.logout.enabled	Sets the logout button for the web UI of the Spark component.	true
spark.security.hideInfo.enabled	Indicates whether to hide sensitive information on the UI.	true
spark.yarn.cluster.driver.extraLibraryPath	Indicates the **extraLibraryPath** of the driver in Yarn-cluster mode. Set this parameter to the path and parameters of the server.	${BIGDATA_HOME}/FusionInsight_HD_8.1.0.1/install/FusionInsight-Hadoop-*/hadoop/lib/native
spark.driver.extraLibraryPath	Sets a special library path for starting the driver JVM.	${DATA_NODE_INSTALL_HOME}/hadoop/lib/native

Configuration Item	Description	Default Value or Configuration Example
spark.ui.killEnabled	Allows stages and jobs to be stopped on the web UI.	true
spark.yarn.access.hadoopFileSystems	Spark can access multiple NameService instances. If there are multiple NameService instances, set this parameter to all the NameService instances and separate them with commas (,).	hdfs://hacluster,hdfs://hacluster
spark.yarn.cluster.driver.extraJavaOptions	Indicates extra JVM option passed to the executor, for example, GC setting and logging. Do not set Spark attributes or heap size using this option. Instead, set Spark attributes using the SparkConf object or the **spark-defaults.conf** file specified when the spark-submit script is called. Set heap size using **spark.executor.memory**.	-Xloggc:<LOG_DIR>/gc.log -XX:+PrintGCDetails -XX:-OmitStackTraceInFastThrow -XX:+PrintGCTimeStamps -XX:+PrintGCDateStamps -XX:+UseGCLogFileRotation -XX:NumberOfGCLogFiles=20 -XX:GCLogFileSize=10M -Dlog4j.configuration=./__spark_conf__/__hadoop_conf__/log4j-executor.properties -Djava.security.auth.login.config=./__spark_conf__/__hadoop_conf__/jaas-zk.conf -Dzookeeper.server.principal=zookeeper/hadoop.*<System domain name>* -Djava.security.krb5.conf=./__spark_conf__/__hadoop_conf__/kdc.conf -Djetty.version=x.y.z -Dorg.xerial.snappy.tempdir=${BIGDATA_HOME}/tmp/spark_app -Dcarbon.properties.filepath=./__spark_conf__/__hadoop_conf__/carbon.properties -Djdk.tls.ephemeralDHKeySize=2048

Configuration Item	Description	Default Value or Configuration Example
spark.driver.extraJavaOptions	Indicates a series of extra JVM options passed to the driver,	-Xloggc:${SPARK_LOG_DIR}/indexserver-omm-%p-gc.log -XX:+PrintGCDetails -XX:-OmitStackTraceInFastThrow -XX:+PrintGCTimeStamps -XX:+PrintGCDateStamps -XX:MaxDirectMemorySize=512M -XX:MaxMetaspaceSize=512M -XX:+UseGCLogFileRotation -XX:NumberOfGCLogFiles=20 -XX:GCLogFileSize=10M -XX:OnOutOfMemoryError='kill -9 %p' -Djetty.version=x.y.z -Dorg.xerial.snappy.tempdir=${BIGDATA_HOME}/tmp/spark/JDBCServer/snappy_tmp -Djava.io.tmpdir=${BIGDATA_HOME}/tmp/spark/JDBCServer/io_tmp -Dcarbon.properties.filepath=${SPARK_CONF_DIR}/carbon.properties -Djdk.tls.ephemeralDHKeySize=2048 -Dspark.ssl.keyStore=${SPARK_CONF_DIR}/child.keystore #{java_stack_prefer}
spark.eventLog.overwrite	Indicates whether to overwrite any existing file.	false
spark.eventLog.dir	Indicates the directory for logging Spark events if **spark.eventLog.enabled** is set to **true**. In this directory, Spark creates a subdirectory for each application and logs events of the application in the subdirectory. You can also set a unified address similar to the HDFS directory so that the History Server can read historical files.	hdfs://hacluster/sparkJobHistory
spark.random.port.min	Sets the minimum random port.	22600

Configuration Item	Description	Default Value or Configuration Example
spark.authenticate	Indicates whether Spark authenticates its internal connections. If the application is not running on Yarn, see **spark.authenticate.secret**.	true
spark.random.port.max	Sets the maximum random port.	22899
spark.eventLog.enabled	Indicates whether to log Spark events, which are used to reconstruct the web UI after the application execution is complete.	true

Configuration Item	Description	Default Value or Configuration Example
spark.executor.extraJavaOptions	Indicates extra JVM option passed to the executor, for example, GC setting and logging. Do not set Spark attributes or heap size using this option.	-Xloggc:<LOG_DIR>/gc.log -XX:+PrintGCDetails -XX:-OmitStackTraceInFastThrow -XX:+PrintGCTimeStamps -XX:+PrintGCDateStamps -XX:+UseGCLogFileRotation -XX:NumberOfGCLogFiles=20 -XX:GCLogFileSize=10M -Dlog4j.configuration=./log4j-executor.properties -Djava.security.auth.login.config=./jaas-zk.conf -Dzookeeper.server.principal=zookeeper/hadoop.*<system domain name>* -Djava.security.krb5.conf=./kdc.conf -Dcarbon.properties.filepath=./carbon.properties -Xloggc:<LOG_DIR>/gc.log -XX:+PrintGCDetails -XX:-OmitStackTraceInFastThrow -XX:+PrintGCTimeStamps -XX:+PrintGCDateStamps -XX:+UseGCLogFileRotation -XX:NumberOfGCLogFiles=20 -XX:GCLogFileSize=10M -Dlog4j.configuration=./__spark_conf__/__hadoop_conf__/log4j-executor.properties -Djava.security.auth.login.config=./__spark_conf__/__hadoop_conf__/jaas-zk.conf -Dzookeeper.server.principal=zookeeper/hadoop.*<system domain name>* -Djava.security.krb5.conf=./__spark_conf__/__hadoop_conf__/kdc.conf -Dcarbon.properties.filepath=./__spark_conf__/__hadoop_conf__/carbon.properties -Djdk.tls.ephemeralDHKeySize=2048
spark.sql.authorization.enabled	Indicates whether to enable authentication for the Hive client.	true

21.1.3 Common Parameters

Overview

This section describes common configuration items used in Spark. Subsections are divided by feature so that you can quickly find required configuration items. If you

use MRS clusters, most parameters described in this section have been adapted and you do not need to configure them again. For details about the parameters that need to be configured based on the site requirements, see **Configuring Parameters Rapidly**.

Configuring the Number of Stage Retries

When FetchFailedException occurs in a Spark task, a stage retry is triggered. To prevent infinite stage retries, the number of stage retries is limited. The number of retry times can be adjusted based on the site requirements.

Configure the following parameters in the **spark-defaults.conf** file on the Spark client.

Table 21-3 Parameter description

Parameter	Description	Default Value
spark.stage.maxConsecutiveAttempts	Indicates the maximum number of stage retries.	4

Configuring Whether to Use Cartesian Product

To enable the Cartesian product function, configure the following parameter in the **spark-defaults.conf** configuration file of Spark.

Table 21-4 Cartesian product parameters

Parameter	Description	Default Value
spark.sql.crossJoin.enabled	Indicates whether to allow implicit Cartesian product execution. • **true**: Implicit Cartesian product execution is allowed. • **false**: Implicit Cartesian product execution is not allowed. In this case, only CROSS JOIN can be explicitly included in the query.	true

NOTE

- For JDBC applications, configure this parameter in the **spark-defaults.conf** configuration file of the server.
- For tasks submitted by the Spark client, configure this parameter in the **spark-defaults.conf** configuration file of the client.

Configuring Security Authentication for Long-Time Spark Tasks

In security mode, if the **kinit** command is used for security authentication when the Spark CLI (such as spark-shell, spark-sql, or spark-submit) is used, the task fails due to authentication expiration when the task is running for a long time.

Set the following parameters in the **spark-defaults.conf** configuration file on the client. After the configuration is complete, run the Spark CLI again.

NOTE

If this parameter is set to **true**, ensure that the values of **keytab** and **principal** in **spark-defaults.conf** and **hive-site.xml** are the same.

Table 21-5 Parameter description

Parameter	Description	Default Value
spark.kerberos.principal	Indicates the principal user who has the Spark operation permission. Contact the MRS cluster administrator to obtain the principal user.	-
spark.kerberos.keytab	Indicates the name and path of the keytab file used to configure Spark operation permissions. Contact the MRS cluster administrator to obtain the Keytab file.	-
spark.security.bigdata.loginOnce	Indicates whether the principal user logs in to the system only once. **true**: single login; **false**: multiple logins. The difference between a single login and multiple logins is as follows: The Spark community uses the Kerberos user to log in to the system for multiple times. However, the TGT or token may expire, causing the application to fail to run for a long time. The Kerberos login mode of DataSight is modified to allow users to log in only once, which effectively resolves the expiration problem. The restrictions are as follows: The principal and keytab configuration items of Hive must be the same as those of Spark. **NOTE** If this parameter is set to **true**, ensure that the values of **keytab** and **principal** in **spark-defaults.conf** and **hive-site.xml** are the same.	true

Python Spark

Python Spark is the third programming language of Spark except Scala and Java. Different from Java and Scala that run on the JVM platform, Python Spark has its own Python process as well as the JVM process. The following configuration items

apply only to Python Spark scenarios. However, other configuration items can also take effect in Python Spark scenarios.

Table 21-6 Parameter description

Parameter	Description	Default Value
spark.python.profile	Indicates whether to enable profiling on the Python worker. Use **sc.show_profiles()** to display the analysis results or display the analysis results before the Driver exits. You can use **sc.dump_profiles(path)** to dump the results to a disk. If some analysis results have been manually displayed, they will not be automatically displayed before the driver exits. By default, **pyspark.profiler.BasicProfiler** is used. You can transfer the specified profiler during SparkContext initialization to overwrite the default profiler.	false
spark.python.worker.memory	Indicates the memory size that can be used by each Python worker process during aggregation. The value format is the same as that of the specified JVM memory, for example, 512 MB and 2 GB. If the memory used by a process during aggregation exceeds the value of this parameter, data will be written to disks.	512m
spark.python.worker.reuse	Indicates whether to reuse Python workers. If the reuse function is enabled, a fixed number of Python workers will be reused by the next batch of submitted tasks instead of forking a Python process for each task. This function is useful in large-scale broadcasting because the data does not need to be transferred from the JVM to the Python workers again for the next batch of submitted tasks.	true

Dynamic Allocation

Dynamic resource scheduling is a unique feature of the On Yarn mode. This function can be used only after Yarn External Shuffle is enabled. When Spark is used as a resident service, dynamic resource scheduling greatly improves resource utilization. For example, the JDBCServer process does not accept JDBC requests in most of the time. Therefore, releasing resources in this period greatly reduces the waste of cluster resources.

Table 21-7 Parameter description

Parameter	Description	Default Value
spark.dynamicAllocation.enabled	Indicates whether to use dynamic resource scheduling, which is used to adjust the number of executors registered with the application according to scale. Currently, this parameter is valid only in Yarn mode. To enable dynamic resource scheduling, set **spark.shuffle.service.enabled** to **true**. Related parameters are as follows: **spark.dynamicAllocation.minExecutors**, **spark.dynamicAllocation.maxExecutors**, and **spark.dynamicAllocation.initialExecutors**.	• JDBCServer: true • SparkResource: false
spark.dynamicAllocation.minExecutors	Indicates the minimum number of executors.	0
spark.dynamicAllocation.initialExecutors	Indicates the number of initial executors.	spark.dynamicAllocation.minExecutors
spark.dynamicAllocation.maxExecutors	Indicates the maximum number of executors.	2048
spark.dynamicAllocation.schedulerBacklogTimeout	Indicates the first timeout period for scheduling. The unit is second.	1s
spark.dynamicAllocation.sustainedSchedulerBacklogTimeout	Indicates the second and later timeout interval for scheduling.	1s
spark.dynamicAllocation.executorIdleTimeout	Indicates the idle timeout interval for common executors. The unit is second.	60

Parameter	Description	Default Value
spark.dynamicAllocation.cachedExecutorIdleTimeout	Indicates the idle timeout interval for executors with cached blocks.	• JDBCServer: 2147483647s • IndexServer: 2147483647s • SparkResource: 120

Spark Streaming

Spark Streaming is a streaming data processing function provided by the Spark batch processing platform. It processes data input from external systems in **mini-batch** mode.

Configure the following parameters in the **spark-defaults.conf** file on the Spark client.

Table 21-8 Parameter description

Parameter	Description	Default Value
spark.streaming.receiver.writeAheadLog.enable	Indicates whether to enable the write-ahead log (WAL) function. After this function is enabled, all input data received by the receiver is saved in the WAL. WAL ensures that data can be restored if the driver program becomes faulty.	false
spark.streaming.unpersist	Determines whether to automatically remove RDDs generated and saved by Spark Streaming from the Spark memory. If this function is enabled, original data received by Spark Streaming is also automatically cleared. If this function is disabled, original data and RDDs cannot be automatically cleared. External applications can access the data in Streaming. This, however, occupies more Spark memory resources.	true

Spark Streaming Kafka

The receiver is an important component of Spark Streaming. It receives external data, encapsulates the data into blocks, and provides the blocks for Streaming to

consume. The most common data source is Kafka. Spark Streaming integrates Kafka to ensure reliability and can directly use Kafka as the RDD input.

Table 21-9 Parameter description

Parameter	Description	Default Value
spark.streaming.kafka.maxRatePerPartition	Indicates the maximum rate (number of records per second) for reading data from each Kafka partition if the Kafka direct stream API is used.	-
spark.streaming.blockInterval	Indicates the interval (ms) for accumulating data received by a Spark Streaming receiver into a data block before the data is stored in Spark. A minimum value of 50 ms is recommended.	200ms
spark.streaming.receiver.maxRate	Indicates the maximum rate (number of records per second) for each receiver to receive data. The value **0** or a negative value indicates no limit to the rate.	-
spark.streaming.receiver.writeAheadLog.enable	Indicates whether to use ReliableKafkaReceiver. This receiver ensures the integrity of streaming data.	false

Netty/NIO and Hash/Sort Configuration

Shuffle is critical for big data processing, and the network is critical for the entire shuffle process. Currently, Spark supports two shuffle modes: hash and sort. There are two network modes: Netty and NIO.

Table 21-10 Parameter description

Parameter	Description	Default Value
spark.shuffle.manager	Indicates the data processing mode. There are two implementation modes: sort and hash. The sort shuffle has a higher memory utilization. It is the default option in Spark 1.2 and later versions.	SORT

Parameter	Description	Default Value
spark.shuffle.consolidateFiles	(Only in hash mode) To merge intermediate files created during shuffle, set this parameter to **true**. Decreasing the number of files to be created can improve the processing performance of the file system and reduce risks. If the **ext4** or **xfs** file system is used, you are advised to set this parameter to **true**. Due to file system restrictions, this setting on **ext3** may reduce the processing performance of a server with more than eight cores.	false
spark.shuffle.sort.bypassMergeThreshold	This parameter is valid only when **spark.shuffle.manager** is set to **sort**. When Map aggregation is not performed and the number of partitions for Reduce tasks is less than or equal to the value of this parameter, do not merge and sort data to prevent performance deterioration caused by unnecessary sorting.	200
spark.shuffle.io.maxRetries	(Only in Netty mode) If this parameter is set to a non-zero value, fetch failures caused by I/O-related exceptions will be automatically retried. This retry logic helps the large shuffle keep stable when long GC pauses or intermittent network disconnections occur.	12
spark.shuffle.io.numConnectionsPerPeer	(Only in Netty mode) Connections between hosts are reused to reduce the number of connections between large clusters. For a cluster with many disks but a few hosts, this function may make concurrent requests unable to occupy all disks. Therefore, you can increase the value of this parameter.	1
spark.shuffle.io.preferDirectBufs	(Only in Netty mode) The off-heap buffer is used to reduce GC during shuffle and cache block transfer. In an environment where off-heap memory is strictly limited, you can disable it to force all applications from Netty to use heap memory.	true
spark.shuffle.io.retryWait	(Only in Netty mode) Specifies the duration for waiting for fetch retry, in seconds. The maximum delay caused by retry is **maxRetries** x **retryWait**. The default value is 15 seconds.	5

Common Shuffle Configuration

Table 21-11 Parameter description

Parameter	Description	Default Value
spark.shuffle.spill	If this parameter is set to **true**, data is overflowed to the disk to limit the memory usage during a Reduce task.	true
spark.shuffle.spill.compress	Indicates whether to compress the data overflowed during shuffle. The algorithm specified by **spark.io.compression.codec** is used for data compression.	true
spark.shuffle.file.buffer	Specifies the size of the memory buffer for storing output streams of each shuffle file, in KB. These buffers can reduce the number of disk seek and system calls during the creation of intermediate shuffle file streams. You can also set this parameter by setting **spark.shuffle.file.buffer.kb**.	32KB
spark.shuffle.compress	Indicates whether to compress the output files of a Map task. You are advised to compress the broadcast variables. using **spark.io.compression.codec**.	true
spark.reducer.maxSizeInFlight	Specifies the maximum output size of the Map task that fetches data from each Reduce task, in MB. Each output requires a buffer, which is the fixed memory overhead of each Reduce task. Therefore, keep the value small unless there is a large amount of memory. You can also set this parameter by setting **spark.reducer.maxMbInFlight**.	48MB

Driver Configuration

Spark driver can be considered as the client of Spark applications. All code parsing is completed in this process. Therefore, the parameters of this process are especially important. The following describes how to configure parameters for Spark driver.

- **JavaOptions**: parameter following **-D** in the Java command, which can be obtained by **System.getProperty**
- **ClassPath**: path for loading the Java classes and Native library
- **Java Memory and Cores**: memory and CPU usage of the Java process
- **Spark Configuration**: Spark internal parameter, which is irrelevant to the Java process

Table 21-12 Parameter description

Parameter	Description	Default Value
spark.driver.extraJavaOptions	Indicates a series of extra JVM options passed to the driver, for example, GC setting and logging. Note: In client mode, this configuration cannot be set directly in the application using SparkConf because the driver JVM has been started. You can use **--driver-java-options** or the default property file to set the parameter.	For details, see **Configuring Parameters Rapidly**.
spark.driver.extraClassPath	Indicates the extra class path entries attached to the class path of the driver. Note: In client mode, this configuration cannot be set directly in the application using SparkConf because the driver JVM has been started. You can use **--driver-java-options** or the default property file to set the parameter.	For details, see **Configuring Parameters Rapidly**.
spark.driver.userClassPathFirst	(Trial) Indicates whether to allow JAR files added by users to take precedence over Spark JAR files when classes are loaded in the driver. This feature can be used to mitigate conflicts between Spark dependencies and user dependencies. This feature is in the trial phase and is used only in cluster mode.	false
spark.driver.extraLibraryPath	Sets a special library path for starting the driver JVM. Note: In client mode, this configuration cannot be set directly in the application using SparkConf because the driver JVM has been started. You can use **--driver-java-options** or the default property file to set the parameter.	• JDBCServer: ${SPARK_INSTALL_HOME}/spark/native • SparkResource: ${DATA_NODE_INSTALL_HOME}/hadoop/lib/native

Parameter	Description	Default Value
spark.driver.cores	Specifies the number of cores used by the driver process. This parameter is available only in cluster mode.	1
spark.driver.memory	Indicates the memory used by the driver process, that is, the memory used by the SparkContext initialization process (for example, 512 MB and 2 GB). Note: In client mode, this configuration cannot be set directly in the application using SparkConf because the driver JVM has been started. You can use **--driver-java-options** or the default property file to set the parameter.	4G
spark.driver.maxResultSize	Indicates the total size of serialization results of all partitions for each Spark action operation (for example, collect). The value must be at least 1 MB. If this parameter is set to **0**, the size is not limited. If the total amount exceeds this limit, the task will be aborted. If the value is too large, the memory of the driver may be insufficient (depending on the object memory overhead of **spark.driver.memory** and JVM). Set a proper limit to ensure sufficient memory for the driver.	1G
spark.driver.host	Specifies the host name or IP address for the driver to listen on, which is used for the driver to communicate with the executor.	(local hostname)
spark.driver.port	Specifies the port for the driver to listen on, which is used for the driver to communicate with the executor.	(random)

ExecutorLauncher Configuration

ExecutorLauncher exists only in Yarn-client mode. In Yarn-client mode, ExecutorLauncher and the driver are not in the same process. Therefore, you need to configure parameters for ExecutorLauncher.

Table 21-13 Parameter description

Parameter	Description	Default Value
spark.yarn.am.extraJavaOptions	Indicates a string of extra JVM options to pass to the YARN ApplicationMaster in client mode. Use **spark.driver.extraJavaOptions** in cluster mode.	For details, see **Configuring Parameters Rapidly**.
spark.yarn.am.memory	Indicates the amount of memory to use for the YARN ApplicationMaster in client mode, in the same format as JVM memory strings (for example, 512 MB or 2 GB). In cluster mode, use **spark.driver.memory** instead.	1G
spark.yarn.am.memoryOverhead	This parameter is the same as **spark.yarn.driver.memoryOverhead**. However, this parameter applies only to ApplicationMaster in client mode.	-
spark.yarn.am.cores	Indicates the number of cores to use for the YARN ApplicationMaster in client mode. Use **spark.driver.cores** in cluster mode.	1

Executor Configuration

An executor is a Java process. However, unlike the driver and ApplicationMaster, an executor can have multiple processes. Spark supports only same configurations. That is, the process parameters of all executors must be the same.

Table 21-14 Parameter description

Parameter	Description	Default Value
spark.executor.extraJavaOptions	Indicates extra JVM option passed to the executor, for example, GC setting and logging. Do not set Spark attributes or heap size using this option. Instead, set Spark attributes using the SparkConf object or the **spark-defaults.conf** file specified when the spark-submit script is called. Set heap size using **spark.executor.memory**.	For details, see **Configuring Parameters Rapidly**.

Parameter	Description	Default Value
spark.executor.extraClassPath	Indicates the extra classpath attached to the executor classpath. This parameter ensures compatibility with historical versions of Spark. Generally, you do not need to set this parameter.	-
spark.executor.extraLibraryPath	Sets the special library path used when the executor JVM is started.	For details, see **Configuring Parameters Rapidly**.
spark.executor.userClassPathFirst	(Trial) Same function as **spark.driver.userClassPathFirst**. However, this parameter applies to executor instances.	false
spark.executor.memory	Indicates the memory size used by each executor process. Its character sting is in the same format as the JVM memory (example: 512 MB or 2 GB).	4G
spark.executorEnv.[EnvironmentVariableName]	Adds the environment variable specified by **EnvironmentVariableName** to the executor process. You can specify multiple environment variables.	-
spark.executor.logs.rolling.maxRetainedFiles	Sets the number of latest log files to be retained by the system during rolling. The old log files are deleted. This function is disabled by default.	-
spark.executor.logs.rolling.size.maxBytes	Sets the maximum size of the executor log file for rolling. This function is disabled by default. The value is in bytes. To automatically clear old logs, see **spark.executor.logs.rolling.maxRetainedFiles**.	-
spark.executor.logs.rolling.strategy	Sets the executor log rolling policy. Rolling is disabled by default. The value can be **time** (time-based rolling) or **size** (size-based rolling). If this parameter is set to **time**, the value of the **spark.executor.logs.rolling.time.interval** attribute is used as the log rolling interval. If this parameter is set to **size**, **spark.executor.logs.rolling.size.maxBytes** is used to set the maximum size of the file for rolling.	-

Parameter	Description	Default Value
spark.executor.logs.rolling.time.interval	Sets the time interval for executor log rolling. This function is disabled by default. The value can be **daily**, **hourly**, **minutely**, or any number of seconds. To automatically clear old logs, see **spark.executor.logs.rolling.maxRetainedFiles**.	daily

WebUI

The Web UI displays the running process and status of the Spark application.

Table 21-15 Parameter description

Parameter	Description	Default Value
spark.ui.killEnabled	Allows stages and jobs to be stopped on the web UI. **NOTE** For security purposes, the default value of this parameter is set to **false** to prevent misoperations. To enable this function, set this parameter to **true** in the **spark-defaults.conf** configuration file. Exercise caution when performing this operation.	true
spark.ui.port	Specifies the port for your application's dashboard, which displays memory and workload data.	• JDBCServer: 4040 • SparkResource: 0 • IndexServer: 22901
spark.ui.retainedJobs	Specifies the number of jobs recorded by the Spark UI and status API before GC.	1000
spark.ui.retainedStages	Specifies the number of stages recorded by the Spark UI and status API before GC.	1000

HistoryServer

A History Server reads the **EventLog** file in the file system and displays the running status of the Spark application.

Table 21-16 Parameter description

Parameter	Description	Default Value
spark.history.fs.logDirectory	Specifies the log directory of a History Server.	-
spark.history.ui.port	Specifies the port for JobHistory listening to connection.	18080
spark.history.fs.updateInterval	Specifies the update interval of the information displayed on a History Server, in seconds. Each update checks for changes made to the event logs in the persistent store.	10s
spark.history.fs.update.interval.seconds	Specifies the interval for checking the update of each event log. This parameter has the same function as **spark.history.fs.updateInterval**. **spark.history.fs.updateInterval** is recommended.	10s
spark.history.updateInterval	This parameter has the same function as **spark.history.fs.update.interval.seconds** and **spark.history.fs.updateInterval**. **spark.history.fs.updateInterval** is recommended.	10s

History Server UI Timeout and Maximum Number of Access Times

Table 21-17 Parameter description

Parameter	Description	Default Value
spark.session.maxAge	Specifies the session timeout interval, in seconds. This parameter applies only to the security mode. This parameter cannot be set in normal mode.	600
spark.connection.maxRequest	Specifies the maximum number of concurrent client access requests to JobHistory.	5000

EventLog

During the running of Spark applications, the running status is written into the file system in JSON format in real time for the History Server service to read and reproduce the application running status.

Table 21-18 Parameter description

Parameter	Description	Default Value
spark.eventLog.enabled	Indicates whether to log Spark events, which are used to reconstruct the web UI after the application execution is complete.	true
spark.eventLog.dir	Indicates the directory for logging Spark events if **spark.eventLog.enabled** is set to **true**. In this directory, Spark creates a subdirectory for each application and logs events of the application in the subdirectory. You can also set a unified address similar to the HDFS directory so that the History Server can read historical files.	hdfs://hacluster/sparkJobHistory
spark.eventLog.compress	Indicates whether to compress logged events when **spark.eventLog.enabled** is set to **true**.	false

Periodic Clearing of Event Logs

Event logs on JobHistory increases with submitted tasks. Too many event log files exist as the number of submitted tasks increases. Spark provides the function for periodically clearing event logs. You can enable this function and set the clearing interval using related parameters.

Table 21-19 Parameter description

Parameter	Description	Default Value
spark.history.fs.cleaner.enabled	Indicates whether to enable the clearing function.	true
spark.history.fs.cleaner.interval	Indicates the check interval of the clearing function.	1d
spark.history.fs.cleaner.maxAge	Indicates the maximum duration for storing logs.	4d

Kryo

Kryo is a highly efficient Java serialization framework, which is integrated into Spark by default. Almost all Spark performance tuning requires the process of converting the default serializer of Spark into a Kryo serializer. Kryo serialization

supports only serialization at the Spark data layer. To configure Kryo serialization, set **spark.serializer** to **org.apache.spark.serializer.KryoSerializer** and configure the following parameters to optimize Kryo serialization performance:

Table 21-20 Parameter description

Parameter	Description	Default Value
spark.kryo.classesToRegister	Specifies the name of the class that needs to be registered with Kryo when Kryo serialization is used. Multiple classes are separated by commas (,).	-
spark.kryo.referenceTracking	Indicates whether to trace the references to the same object when Kryo is used to serialize data. This function is applicable to the scenario where the object graph has circular references or the same object has multiple copies. Otherwise, you can disable this function to improve performance.	true
spark.kryo.registrationRequired	Indicates whether Kryo is used to register an object. When this parameter is set to **true**, an exception is thrown if an object that is not registered with Kryo is serialized. When it is set to **false** (default value), Kryo writes unregistered class names to the serialized object. This operation causes a large amount of performance overhead. Therefore, you need to enable this option before deleting a class from the registration queue.	false
spark.kryo.registrator	If Kryo serialization is used, use Kryo to register the class with the custom class. Use this property if you need to register a class in a custom way, such as specifying a custom field serializer. Otherwise, use **spark.kryo.classesToRegister**, which is simpler. Set this parameter to a class that extends KryoRegistrator.	-
spark.kryoserializer.buffer.max	Specifies the maximum size of the Kryo serialization buffer, in MB. The value must be greater than the object that attempts to be serialized. If the error "buffer limit exceeded" occurs in Kryo, increase the value of this parameter. You can also set this parameter by setting **spark.kryoserializer.buffer.max**.	64MB

Parameter	Description	Default Value
spark.kryoserializer.buffer	Specifies the initial size of the Kryo serialization buffer, in MB. Each core of each worker has a buffer. If necessary, the buffer size will be increased to the value of **spark.kryoserializer.buffer.max**. You can also set this parameter by setting **spark.kryoserializer.buffer**.	64KB

Broadcast

Broadcast is used to transmit data blocks between Spark processes. In Spark, broadcast can be used for JAR packages, files, closures, and returned results. Broadcast supports two modes: Torrent and HTTP. The Torrent mode divides data into small fragments and distributes them to clusters. Data can be obtained remotely if necessary. The HTTP mode saves files to the local disk and transfers the entire files to the remote end through HTTP if necessary. The former is more stable than the latter. Therefore, Torrent is the default broadcast mode.

Table 21-21 Parameter description

Parameter	Description	Default Value
spark.broadcast.factory	Indicates the broadcast mode.	org.apache.spark.broadcast.TorrentBroadcastFactory
spark.broadcast.blockSize	Indicates the block size of **TorrentBroadcastFactory**. If the value is too large, the concurrency during broadcast is reduced (the speed is slow). If the value is too small, BlockManager performance may be affected.	4096
spark.broadcast.compress	Indicates whether to compress broadcast variables before sending them. You are advised to compress the broadcast variables.	true

Storage

Spark features in-memory computing. Spark Storage is used to manage memory resources. Storage stores data blocks generated during RDD caching. The heap memory in the JVM acts as a whole. Therefore, **Storage Memory Size** is an important concept during Spark Storage management.

Table 21-22 Parameter description

Parameter	Description	Default Value
spark.storage.memoryMapThreshold	Specifies the block size. If the size of a block exceeds the value of this parameter, Spark performs memory mapping for the disk file. This prevents Spark from mapping too small blocks during memory mapping. Generally, memory mapping for blocks whose page size is close to or less than that of the operating system has high overhead.	2m

PORT

Table 21-23 Parameter description

Parameter	Description	Default Value
spark.ui.port	Specifies the port for your application's dashboard, which displays memory and workload data.	• JDBCServer: 4040 • SparkResource: 0
spark.blockManager.port	Specifies all ports listened by BlockManager. These ports are on both the driver and executor.	**Range of Random Ports**
spark.driver.port	Specifies the port for the driver to listen on, which is used for the driver to communicate with the executor.	**Range of Random Ports**

Range of Random Ports

All random ports must be within a certain range.

Table 21-24 Parameter description

Parameter	Description	Default Value
spark.random.port.min	Sets the minimum random port.	22600
spark.random.port.max	Sets the maximum random port.	22899

TIMEOUT

By default, computation tasks that can well process medium-scale data are configured in Spark. However, if the data volume is too large, the tasks may fail due to timeout. In the scenario with a large amount of data, the timeout parameter in Spark needs to be assigned a larger value.

Table 21-25 Parameter description

Parameter	Description	Default Value
spark.files.fetchTimeout	Specifies the communication timeout (in seconds) when fetching files added using **SparkContext.addFile()** of the driver.	60s
spark.network.timeout	Specifies the default timeout for all network interactions, in seconds. You can use this parameter to replace **spark.core.connection.ack.wait.timeout**, **spark.akka.timeout**, **spark.storage.blockManagerSlaveTimeoutMs**, or **spark.shuffle.io.connectionTimeout**.	360s
spark.core.connection.ack.wait.timeout	Specifies the timeout for a connection to wait for a response, in seconds. To avoid long-time waiting caused by GC, you can set this parameter to a larger value.	60

Encryption

Spark supports SSL for Akka and HTTP (for the broadcast and file server) protocols, but does not support SSL for the web UI and block transfer service.

SSL must be configured on each node and configured for each component involved in communication using a particular protocol.

Table 21-26 Parameter description

Parameter	Description	Default Value
spark.ssl.enabled	Indicates whether to enable SSL connections for all supported protocols. All SSL settings similar to **spark.ssl.*xxx*** indicate the global configuration of all supported protocols. To override the global configuration of a particular protocol, you must override the property in the namespace specified by the protocol. Use **spark.ssl.YYY.XXX** to overwrite the global configuration of the particular protocol specified by **YYY**. **YYY** can be either **akka** for Akka-based connections or **fs** for the broadcast and file server.	false
spark.ssl.enabledAlgorithms	Indicates the comma-separated list of passwords. The specified passwords must be supported by the JVM.	-
spark.ssl.keyPassword	Specifies the password of a private key in the keystore.	-
spark.ssl.keyStore	Specifies the path of the keystore file. The path can be absolute or relative to the directory where the component is started.	-
spark.ssl.keyStorePassword	Specifies the password of the keystore.	-
spark.ssl.protocol	Specifies the protocol name. This protocol must be supported by the JVM. The reference list of protocols is available on this page.	-
spark.ssl.trustStore	Specifies the path of the truststore file. The path can be absolute or relative to the directory where the component is started.	-
spark.ssl.trustStorePassword	Specifies the password of the truststore.	-

Security

Spark supports shared key-based authentication. You can use **spark.authenticate** to configure authentication. This parameter controls whether the Spark communication protocol uses the shared key for authentication. This authentication is a basic handshake that ensures that both sides have the same shared key and are allowed to communicate. If the shared keys are different, the communication is not allowed. You can create shared keys as follows:

- For Spark on Yarn deployments, set **spark.authenticate** to **true**. Then, shared keys are automatically generated and distributed. Each application exclusively occupies a shared key.

- For other types of Spark deployments, configure Spark parameter **spark.authenticate.secret** on each node. All masters, workers, and applications use this key.

Table 21-27 Parameter description

Parameter	Description	Default Value
spark.acls.enable	Indicates whether to enable Spark ACLs. If Spark ACLs are enabled, the system checks whether the user has the permission to access and modify jobs. Note that this requires the user to be identifiable. If the user is identified as invalid, the check will not be performed. Filters can be used to verify and set users on the UI.	true
spark.admin.acls	Specifies the comma-separated list of users/administrators that have the permissions to view and modify all Spark jobs. This list can be used if you are running on a shared cluster and working with the help of an MRS cluster administrator or developer.	admin
spark.authenticate	Indicates whether Spark authenticates its internal connections. If the application is not running on Yarn, see **spark.authenticate.secret**.	true
spark.authenticate.secret	Sets the key for authentication between Spark components. This parameter must be set if Spark does not run on Yarn and authentication is disabled.	-
spark.modify.acls	Specifies the comma-separated list of users who have the permission to modify Spark jobs. By default, only users who have enabled Spark jobs have the permission to modify the list (for example, delete the list).	-
spark.ui.view.acls	Specifies the comma-separated list of users who have the permission to access the Spark web UI. By default, only users who have enabled Spark jobs have the access permission.	-

Enabling the Authentication Mechanism Between Spark Processes

Spark currently supports authentication via a shared secret. You can determine whether to enable Spark authentication during communication by configuring **spark.authenticate**. In this authentication mode, the two communication parties share the same secret through a simple handshake.

Configure the following parameters in the **spark-defaults.conf** file on the Spark client.

Table 21-28 Parameter description

Parameter	Description	Default Value
spark.authenticate	For Spark on Yarn deployments, set this parameter to **true**. Then, keys are automatically generated and distributed, and each application uses a unique key.	true

Compression

Data compression is policy that optimizes memory usage at the expense of CPU. Therefore, when the Spark memory is severely insufficient (this issue is common due to the characteristics of in-memory computing), data compression can greatly improve performance. Spark supports three types of compression algorithm: Snappy, LZ4, and LZF. Snappy is the default compression algorithm and invokes the native method to compress and decompress data. In Yarn mode, pay attention to the impact of non-heap memory on the container process.

Table 21-29 Parameter description

Parameter	Description	Default Value
spark.io.compression.codec	Indicates the codec for compressing internal data, such as RDD partitions, broadcast variables, and shuffle output. By default, Spark supports three types of compression algorithm: LZ4, LZF, and Snappy. You can specify algorithms using fully qualified class names, such as **org.apache.spark.io.LZ4CompressionCodec**, **org.apache.spark.io.LZFCompressionCodec**, and **org.apache.spark.io.SnappyCompression-Codec**.	lz4
spark.io.compression.lz4.block.size	Indicates the block size (bytes) used in LZ4 compression when the LZ4 compression algorithm is used. When LZ4 is used, reducing the block size also reduces the shuffle memory usage.	32768
spark.io.compression.snappy.block.size	Indicates the block size (bytes) used in Snappy compression when the Snappy compression algorithm is used. When Snappy is used, reducing the block size also reduces the shuffle memory usage.	32768
spark.shuffle.compress	Indicates whether to compress the output files of a Map task. You are advised to compress the broadcast variables. using **spark.io.compression.codec**.	true

Parameter	Description	Default Value
spark.shuffle.spill.compress	Indicates whether to compress the data overflowed during shuffle using **spark.io.compression.codec**.	true
spark.eventLog.compress	Indicates whether to compress logged events when **spark.eventLog.enabled** is set to **true**.	false
spark.broadcast.compress	Indicates whether to compress broadcast variables before sending them. You are advised to compress the broadcast variables.	true
spark.rdd.compress	Indicates whether to compress serialized RDD partitions (for example, the **StorageLevel.MEMORY_ONLY_SER** partition). Substantial space can be saved at the cost of some extra CPU time.	false

Reducing the Probability of Abnormal Client Application Operations When Resources Are Insufficient

When resources are insufficient, ApplicationMaster tasks must wait and will not be processed until enough resources are available for use. If the actual waiting time exceeds the configured waiting time, the ApplicationMaster tasks will be deleted. Adjust the following parameters to reduce the probability of abnormal client application operation.

Configure the following parameters in the **spark-defaults.conf** file on the client.

Table 21-30 Parameter description

Parameter	Description	Default Value
spark.yarn.applicationMaster.waitTries	Specifies the number of the times that ApplicationMaster waits for Spark master, which is also the times that ApplicationMaster waits for SparkContext initialization. Enlarge this parameter value to prevent ApplicationMaster tasks from being deleted and reduce the probability of abnormal client application operations.	10
spark.yarn.am.memory	Specifies the ApplicationMaster memory. Enlarge this parameter value to prevent ApplicationMaster tasks from being deleted by ResourceManager due to insufficient memory and reduce the probability of abnormal client application operations.	1G

21.1.4 Spark on HBase Overview and Basic Applications

Scenario

Spark on HBase allows users to query HBase tables in Spark SQL and to store data for HBase tables using the Beeline tool. You can use HBase APIs to create, read data from, and insert data into tables.

Procedure

Step 1 Log in to FusionInsight Manager and choose **Cluster** > **Cluster Properties** to check whether the cluster is in security mode.

- If yes, go to **Step 2**.
- If no, go to **Step 5**.

Step 2 Choose **Cluster** > **Services** > **Spark** and click **Configurations** then **All Configurations**. Click **JDBCServer**, select **Default**, and modify the following parameter:

Table 21-31 Parameter list 1

Parameter	Default Value	Changed To
spark.yarn.security.credentials.hbase.enabled	false	true

NOTE

To ensure that Spark can access HBase for a long time, do not modify the following parameters of HBase and HDFS:

- dfs.namenode.delegation.token.renew-interval
- dfs.namenode.delegation.token.max-lifetime
- hbase.auth.key.update.interval
- hbase.auth.token.max.lifetime (The value is fixed to **604800000** ms, that is, 7 days.)

If the preceding parameter configuration must be modified based on service requirements, ensure that the value of the HDFS parameter **dfs.namenode.delegation.token.renew-interval** is not greater than the values of the HBase parameters **hbase.auth.key.update.interval**, **hbase.auth.token.max.lifetime**, and **dfs.namenode.delegation.token.max-lifetime**.

Step 3 Choose **SparkResource** > **Default** and modify the following parameters:

Table 21-32 Parameter list 2

Parameter	Default Value	Changed To
spark.yarn.security.credentials.hbase.enabled	false	true

Step 4 Restart the Spark service for the configuration to take effect.

NOTE

To use the Spark on HBase function on the Spark client, download and install the Spark client again.

Step 5 On the Spark client, use spark-sql or spark-beeline to query tables created by Hive on HBase. You can create HBase tables by running SQL commands or create foreign tables to associate with HBase tables. Before creating tables, ensure that HBase tables exist in HBase. The HBase table **table1** is used as an example.

1. Run the following commands to create the HBase table using the Beeline tool:

   create table *hbaseTable*

   (

   id string,

   name string,

   age int

)

   using org.apache.spark.sql.hbase.HBaseSource

   options(

   hbaseTableName *"table1"***,**

   keyCols *"id"***,**

   colsMapping "

   name=cf1.cq1,

   age=cf1.cq2

   ");

   NOTE

   - **hbaseTable**: name of the created Spark table
   - **id string,name string**, **age int**: field name and field type of the Spark table
   - **table1**: name of the HBase table
   - *id*: row key column name of the HBase table
   - *name=cf1.cq1*, *age=cf1.cq2*: mapping between columns in the Spark table and columns in the HBase table. The **name** column of the Spark table maps the **cq1** column in the **cf1** column family of the HBase table, and the **age** column of the Spark table maps the **cq2** column in the **cf1** column family of the HBase table.

2. Run the following command to import data to the HBase table using a CSV file:

   hbase org.apache.hadoop.hbase.mapreduce.ImportTsv -Dimporttsv.separator="," -Dimporttsv.columns=HBASE_ROW_KEY,*cf1:cq1,cf1:cq2,cf1:cq3,cf1:cq4,cf1:cq5 table1 /hperson*

   Where **table1** indicates the name of the HBase table, and **/hperson** indicates the path where the CSV file is stored.

3. Run the following command to query data in spark-sql or spark-beeline, where *hbaseTable* is the corresponding Spark table name: The command is as follows:

select * from *hbaseTable;*

----End

21.1.5 Spark on HBase V2 Overview and Basic Applications

Scenario

Spark on HBase V2 allows users to query HBase tables in Spark SQL and to store data for HBase tables using the Beeline tool. You can use HBase APIs to create, read data from, and insert data into tables.

Procedure

Step 1 Log in to FusionInsight Manager and choose **Cluster** > **Cluster Properties** to check whether the cluster is in security mode.

- If yes, go to **Step 2**.
- If no, go to **Step 5**.

Step 2 Choose **Cluster** > **Services** > **Spark** and click **Configurations** then **All Configurations**. Click **JDBCServer**, select **Default**, and modify the following parameter:

Table 21-33 Parameter list 1

Parameter	Default Value	Changed To
spark.yarn.security.credentials.hbase.enabled	false	true

NOTE

To ensure that Spark can access HBase for a long time, do not modify the following parameters of HBase and HDFS:

- dfs.namenode.delegation.token.renew-interval
- dfs.namenode.delegation.token.max-lifetime
- hbase.auth.key.update.interval
- hbase.auth.token.max.lifetime (The value is fixed to **604800000** ms, that is, 7 days.)

If the preceding parameter configuration must be modified based on service requirements, ensure that the value of the HDFS parameter **dfs.namenode.delegation.token.renew-interval** is not greater than the values of the HBase parameters **hbase.auth.key.update.interval**, **hbase.auth.token.max.lifetime**, and **dfs.namenode.delegation.token.max-lifetime**.

Step 3 Choose **SparkResource** > **Default** and modify the following parameters:

Table 21-34 Parameter list 2

Parameter	Default Value	Changed To
spark.yarn.security.credentials.hbase.enabled	false	true

Step 4 Restart the Spark service for the configuration to take effect.

NOTE

If you need to use the Spark on HBase function on the Spark client, download and install the Spark client again.

Step 5 On the Spark client, use spark-sql or spark-beeline to query tables created by Hive on HBase. You can create HBase tables by running SQL commands or create foreign tables to associate with HBase tables. For details, see the following description. The following uses the HBase table **table1** as an example.

1. Run the following commands to create a table using the spark-beeline tool:

   create table *hbaseTable*1

   (*id string, name string, age int***)**

   using org.apache.spark.sql.hbase.HBaseSourceV2

   options(

   hbaseTableName *"table2"***,**

   keyCols *"id"***,**

   colsMapping "*name=cf1.cq1,age=cf1.cq2***");**

   NOTE

   - **hbaseTable1**: name of the created Spark table
   - **id string,name string**, **age int**: field name and field type of the Spark table
   - **table2**: name of the HBase table
   - *id*: row key column name of the HBase table
   - *name=cf1.cq1*, *age=cf1.cq2*: mapping between columns in the Spark table and columns in the HBase table. The **name** column of the Spark table maps the **cq1** column in the **cf1** column family of the HBase table, and the **age** column of the Spark table maps the **cq2** column in the **cf1** column family of the HBase table.

2. Run the following command to import data to the HBase table using a CSV file:

   hbase org.apache.hadoop.hbase.mapreduce.ImportTsv -Dimporttsv.separator="," -Dimporttsv.columns=HBASE_ROW_KEY,*cf1:cq1,cf1:cq2,cf1:cq3,cf1:cq4,cf1:cq5 table2 /hperson*

   Where **table2** indicates the name of the HBase table, and **/hperson** indicates the path where the CSV file is stored.

3. Run the following command to query data in spark-sql or spark-beeline. *hbaseTable1* indicates the corresponding Spark table name.

   select * from *hbaseTable1;*

----End

21.1.6 SparkSQL Permission Management(Security Mode)

21.1.6.1 Spark SQL Permissions

SparkSQL Permissions

Similar to Hive, Spark SQL is a data warehouse framework built on Hadoop, providing storage of structured data like structured query language (SQL).

MRS supports users, user groups, and roles. Permissions in a cluster must be assigned to roles, and then roles are bound to users or user groups. Users can obtain permissions only by binding a role or joining a group that is bound with a role.

NOTE

- If the current component uses Ranger for permission control, you need to configure permission management policies based on Ranger. For details, see **Adding a Ranger Access Permission Policy for Spark**.
- After Ranger authentication is enabled or disabled on Spark, restart the Spark service and download the client again or update the client configuration file **spark/conf/spark-defaults.conf**.

  Enable Ranger authentication: **spark.ranger.plugin.authorization.enable=true**

  Disable Ranger authentication: **spark.ranger.plugin.authorization.enable=false**

Permission Management

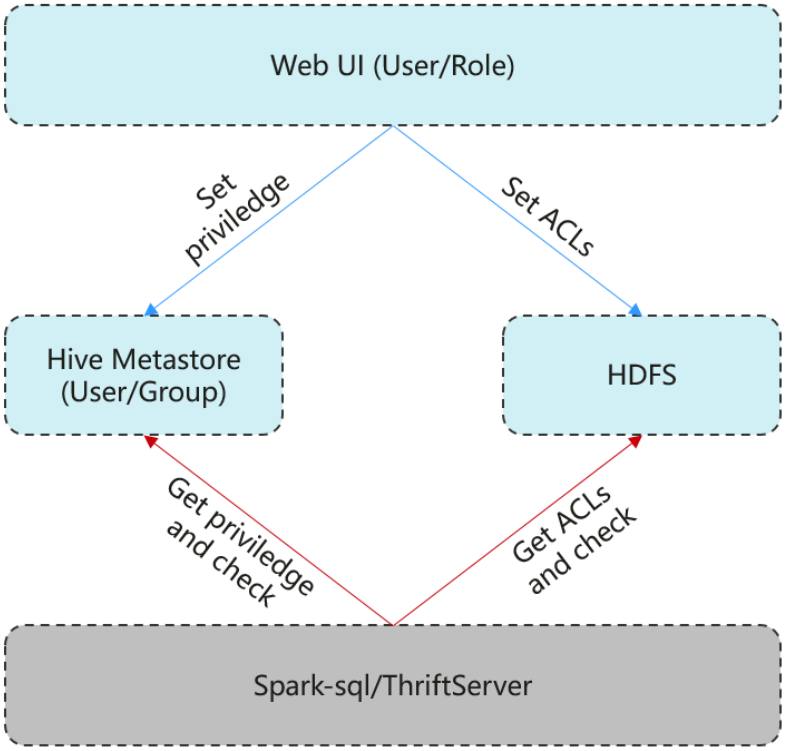
Spark SQL permission management indicates the permission system for managing and controlling users' operations on databases, to ensure that different users can operate databases separately and securely. A user can operate another user's tables and databases only with the corresponding permissions. Otherwise, operations will be rejected.

Spark SQL permission management integrates the functions of Hive management. The Metastore service of Hive and the permission assignment function are required to enable Spark SQL permission management.

Figure 21-3 shows the basic architecture of Spark SQL permission management. This architecture includes two parts: granting permissions on the page, and obtaining and judging a service.

- Granting permissions on the page: Spark SQL only supports granting permissions on the page. On FusionInsight Manager, choose **System** > **Permission** to add or delete a user, user group, or a role, and to grant permissions or cancel permissions.
- Obtaining and judging a service: When the DDL and DML commands are received from a client, Spark SQL will obtain the client's permissions on database information from MetaStore, and check whether the required permissions are included. If the required permissions are included, continue the execution. If the required permissions are not included, reject the user's operations. After the MetaStore permissions are checked, ACL permission also needs to be checked on HDFS.

Figure 21-3 Spark SQL permission management architecture



Additionally, Spark SQL provides column and view permissions to meet requirements of different scenarios.

- Column permission

  Spark SQL permission control consists of metadata permission control and HDFS ACL permission control. When Hive MetaStore automatically synchronizes table permissions to the HDFS ACL, column-level permissions are not synchronized. In other words, a user with partial or all column-level permissions cannot access the entire HDFS file using the HDFS client.

  - In **spark-sql** mode, users with only column-level permissions cannot access HDFS files. Therefore, they cannot access the columns of the corresponding tables.
  - In Beeline/JDBCServer mode, permissions are assigned among users, for example, the permissions on the table created by user A are assigned to user B.

    - **hive.server2.enable.doAs**=**true** (configured in the **hive-site.xml** file on the Spark server)

      In this case, user B cannot query the information. You need to manually assign the read permission on the file in HDFS.

    - **hive.server2.enable.doAs**=false
      - Users A and B are connected by Beeline. User B can query the information.
      - User A creates a table using SQL statements, and user B can query the table in Beeline.

      However, information query is not supported in other scenarios, for example, user A uses Beeline to create a table and user B uses SQL

to query the table, or user A uses SQL to create a table and user B uses SQL to query the table. You need to manually assign the read permission on the file in HDFS.

NOTE

The **spark** user is the Spark administrator in HDFS ACL permission control. The permission control of the Beeline client user depends only on the metadata permission on Spark.

- View permission

  View permission indicates the operation permission such as query and modification on the view of a table, regardless of the corresponding permission of a table. Namely, if you have the permission to query the view of a table, the permission to query the table is not mandatory. The view permission is applicable to the whole table but not to the columns.

  Restrictions of view and column permissions on SparkSQL are similar. The following uses the view permission as an example:

  - In spark-sql mode, if you have only the view permission but not the table permission and do not have the permission to read HDFS, you cannot access the table data stored in HDFS. That is, you cannot query the view of the table.
  - In Beeline/JDBCServer mode, permissions are assigned among users, for example, the permissions on the view created by user A are assigned to user B.

    - **hive.server2.enable.doAs**=**true** (configured in the **hive-site.xml** file on the Spark server)

      In this case, user B cannot query the information. You need to manually assign the read permission on the file in HDFS.

    - **hive.server2.enable.doAs**=false
      - Users A and B are connected by Beeline. User B can query the information.
      - User A creates a view using SQL statements, and user B can query the view in Beeline.

      However, information query is not supported in other scenarios. For example, user A uses Beeline to create a view but user B cannot use SQL to query the view, or user A uses SQL to create a view but user B cannot use SQL to query the view. You need to manually assign the read permission on the file in HDFS.

  Permission of operations on the view of a table is as follows:

  - To create a view, you must have the CREATE permission on the database and the SELECT and SELECT_of_GRANT permissions on the tables.
  - Creating and describing a view only entail the SELECT permission on the view. Querying views and tables at the same time entails the SELECT permission on other tables. For example, to perform **select * from v1 join t1**, you must have the SELECT permission on the **v1** view and **t1** table, even through the **v1** view depends on the **t1** table.

NOTE

In Beeline/JDBCServer mode, to query a view, you must have the SELECT permission on the tables. In spark-sql mode, to query a view, you must have the SELECT permission on the view and tables.

- Deleting and modifying a view entail the permission of owner on the view.

SparkSQL Permission Model

If you want to perform SQL operations using SparkSQL, you must be granted with permissions of SparkSQL databases and tables (include external tables and views). The complete permission model of SparkSQL consists of the meta data permission and HDFS file permission. Permissions required to use a database or a table is just one type of SparkSQL permission.

- Metadata permissions

  Metadata permissions are controlled at the metadata layer. Similar to traditional relational databases, SparkSQL databases involve the CREATE and SELECT permissions, and tables and columns involve the SELECT, INSERT, UPDATE, and DELETE permissions. SparkSQL also supports the permissions of **OWNERSHIP** and **ADMIN**.

- Data file permissions (that is, HDFS file permissions)

  SparkSQL database and table files are stored in HDFS. The created databases or tables are saved in the **/user/hive/warehouse** directory of HDFS by default. The system automatically creates subdirectories named after database names and database table names. To access a database or table, you must have the **Read**, **Write** and **Execute** permissions on the corresponding file in HDFS.

To perform various operations on SparkSQL databases or tables, you need to associate the metadata permission and HDFS file permission. For example, to query SparkSQL data tables, you need to associate the metadata permission **SELECT** and HDFS file permissions **Read** and **Execute**.

Using the management function of Manager GUI to manage the permissions of SparkSQL databases and tables, only requires the configuration of metadata permission, and the system will automatically associate and configure the HDFS file permission. In this way, operations on the interface are simplified, and the efficiency is improved.

Usage Scenarios and Related Permissions

Creating a database with SparkSQL service requires users to join in the hive group, without granting a role. Users have all permissions on the databases or tables created by themselves in Hive or HDFS. They can create tables, select, delete, insert, or update data, and grant permissions to other users to allow them to access the tables and corresponding HDFS directories and files.

A user can access the tables or database only with permissions. Users' permissions vary depending on different SparkSQL scenarios.

Table 21-35 SparkSQL scenarios

Typical Scenario	Required Permission
Using SparkSQL tables, columns, or databases	Permissions required in different scenarios are as follows: ● To create a table, the CREATE permission is required. ● To query data, the SELECT permission is required. ● To insert data, the INSERT permission is required.
Associating and using other components	In some scenarios, except the SparkSQL permission, other permissions may be also required. For example: Using Spark on HBase to query HBase data in SparkSQL requires HBase permissions.

In some special SparkSQL scenarios, other permissions must be configured separately.

Table 21-36 SparkSQL scenarios and required permissions

Scenario	Required Permission
Creating SparkSQL databases, tables, and external tables, or adding partitions to created Hive tables or external tables when data files specified by Hive users are saved to other HDFS directories except **/user/hive/warehouse**	● The directory must exist, the client user must be the owner of the directory, and the user must have the **Read**, **Write**, and **Execute** permissions on the directory. The user must have the **Read** and **Execute** permissions of all the upper-layer directories of the directory. ● In Spark3x, to create an HBase foreign table, you must have the **Create** permission on the Hive database. However, in Spark 1.5, the **Create** permissions of both the Hive database and HBase namespace are required if you want to create a HBase table.

Scenario	Required Permission
Importing all the files or specified files in a specified directory to the table using load	• The data source is a Linux local disk, the specified directory exists, and the system user **omm** has read and execute permission of the directory and all its upper-layer directories. The specified file exists, and user **omm** has the **Read** permission on the file and has the **Read** and **Execute** permissions on all the upper-layer directories of the file. • The data source is HDFS, the specified directory exists, and the SparkSQL user is the owner of the directory and has the **Read**, **Write**, and **Execute** permissions on the directory and its subdirectories, and has the **Read** and **Execute** permissions on all its upper-layer directories. The specified file exists, and the SparkSQL user is the owner of the file and has the **Read**, **Write**, and **Execute** permissions on the file and has the **Read** and **Execute** permissions on all its upper-layer directories.
Creating or deleting functions or modifying any database	The **ADMIN** permission is required.
Performing operations on all databases and tables in Hive	The user must be added to the **supergroup** user group, and be assigned the **ADMIN** permission.
After assigning the **Insert** permission on some DataSource tables, assigning the **Write** permission on table directories in HDFS before performing the insert or analyze operation	When the **Insert** permission is assigned to the **spark datasource** table, if the table format is text, CSV, JSON, Parquet, or ORC, the permission on the table directory is not changed. After the **Insert** permission is assigned to the DataSource table of the preceding formats, you need to assign the **Write** permission to the table directories in HDFS separately so that users can perform the insert or analyze operation on the tables.

21.1.6.2 Creating a Spark SQL Role

Scenario

This section describes how to create and configure a SparkSQL role on Manager. The Spark SQL role can be configured with the Spark administrator permission or the permission of performing operations on the table data.

Creating a database with Hive requires users to join in the **hive** group, without granting a role. Users have all permissions on the databases or tables created by themselves in Hive or HDFS. They can create tables, select, delete, insert, or update data, and grant permissions to other users to allow them to access the tables and corresponding HDFS directories and files. The created databases or tables are saved in the **/user/hive/warehouse** directory of HDFS by default.

NOTE

- If the current component uses Ranger for permission control, you need to configure permission management policies based on Ranger. For details, see **Adding a Ranger Access Permission Policy for Spark**.
- After Ranger authentication is enabled or disabled on Spark, restart the Spark service and download the client again or update the client configuration file **spark/conf/spark-defaults.conf**.

  Enable Ranger authentication: **spark.ranger.plugin.authorization.enable=true**

  Disable Ranger authentication: **spark.ranger.plugin.authorization.enable=false**

Procedure

1. Log in to Manager, and choose **System > Permission > Role**.
2. Click **Create Role** and set a role name and enter description.
3. Set **Configure Resource Permission**. For details, see **Table 21-37**.
   - **Hive Admin Privilege**: Hive administrator permissions.
   - **Hive Read Write Privileges**: Hive data table management permission, which is the operation permission to set and manage the data of created tables.

     NOTE

     - Hive role management supports Hive administrator permissions and the permissions to access tables and views, but does not support granting permissions on databases.
     - The permissions of the Hive administrator do not include the permission to manage HDFS.
     - If there are too many tables in the database or too many files in tables, the permission granting may last a while. For example, if a table contains 10,000 files, the permission granting lasts about 2 minutes.

Table 21-37 Setting a role

Task	Operation
Hive administrator permission	In the **Configure Resource Permission** table, choose *Name of the desired cluster* > **Hive** and select **Hive Admin Privilege**. After being bound to the Hive administrator role, perform the following operations during each maintenance operation: 1. Log in to the node where the Spark client is installed as the client installation user. 2. Run the following command to configure environment variables: For example, if the Spark client installation directory is **/opt/client**, run the **source /opt/client/bigdata_env** command. **source /opt/client/Spark/component_env** 3. Run the following command to perform user authentication: ***kinit*** *Hive service user* 4. Run the following command to log in to the client tool: **/opt/client/Spark/spark/bin/beeline -u "jdbc:hive2://<zkNode1_IP>:<zkNode1_Port>,<zkNode2_IP>:<zkNode2_Port>,<zkNode3_IP>:<zkNode3_Port>/;serviceDiscoveryMode=zooKeeper;zooKeeperNamespace=sparkthriftserver;user.principal=spark2x/hadoop.**<*System domain name*>**@**<*System domain name*>**;saslQop=auth-conf;auth=KERBEROS;principal=spark2x/hadoop.**<*System domain name*>**@**<*System domain name*>**;"**

Task	Operation
	NOTE • **<zkNode1_IP>:<zkNode1_Port>,<zkNode2_IP>:<zkNode2_Port>,<zkNode3_IP>:<zkNode3_Port>** indicates the ZooKeeper URL, for example, 192.168.81.37:2181,192.168.195.232:2181,192.168.169.84:2181. • **sparkthriftserver** indicates a ZooKeeper directory, from which a random TriftServer or ProxyThriftServer is connected by the client. • You can log in to Manager, choose **System** > **Permission** > **Domain and Mutual Trust**, and view the value of **Local Domain**, which is the current system domain name. **spark2x/hadoop.**<*System domain name*> is the username. All letters in the system domain name contained in the username are lowercase letters. For example, **Local Domain** is set to **9427068F-6EFA-4833-B43E-60CB641E5B6C.COM**, and the username is **spark2x/hadoo.9427068f-6efa-4833-b43e-60cb641e5b6c.com**. 5. Run the following command to update the administrator permissions: **set role admin;**
Setting the permission to query a table of another user in the default database	1. In the **Configure Resource Permission** table, choose *Name of the desired cluster* > **Hive** > **Hive Read Write Privileges**. 2. Click the name of the specified database in the database list. Tables in the database are displayed. 3. In the **Permission** column of the specified table, select **SELECT**.
Setting the permission to import data to a table of another user in the default database	1. In the **Configure Resource Permission** table, choose *Name of the desired cluster* > **Hive** > **Hive Read Write Privileges**. 2. Click the name of the specified database in the database list. Tables in the database are displayed. 3. In the **Permission** column of the specified table, select **DELETE** and **INSERT**.

4. Click **OK**.

21.1.6.3 Configuring Permissions for SparkSQL Tables, Columns, and Databases

Scenario

You can configure related permissions if you need to access tables or databases created by other users. SparkSQL supports column-based permission control. If a user needs to access some columns in tables created by other users, the user must be granted the permission for columns. The following describes how to grant table, column, and database permissions to users by using the role management function of Manager.

Procedure

The operations for granting permissions on SparkSQL tables, columns, and databases are the same as those for Hive. For details, see **Permission Management**.

NOTE

- Any permission for a table in the database is automatically associated with the HDFS permission for the database directory to facilitate permission management. When any permission for a table is canceled, the system does not automatically cancel the HDFS permission for the database directory to ensure performance. In this case, users can only log in to the database and view table names.
- When the query permission on a database is added to or deleted from a role, the query permission on tables in the database is automatically added to or deleted from the role. This mechanism is inherited from Hive.
- In Spark, the column name of the struct data type cannot contain special characters, that is, characters other than letters, digits, and underscores (_). If the column name of the struct data type contains special characters, the column cannot be displayed on the FusionInsight Manager console when you grant permissions to roles on the role page.

Concepts

SparkSQL statements are processed in SparkSQL. **Table 21-38** describes the permission requirements.

Table 21-38 Scenarios of using SparkSQL tables, columns, or databases

Scenario	Required Permission
CREATE TABLE	**CREATE**, RWX+ownership (for creating external tables - the location) **NOTE** When creating datasource tables in a specified file path, the RWX and ownership permission on the file next to the path is required.
DROP TABLE	**Ownership** (of table)
DROP TABLE PROPERTIES	**Ownership**
DESCRIBE TABLE	**Select**

Scenario	Required Permission
SHOW PARTITIONS	**Select**
ALTER TABLE LOCATION	**Ownership**, RWX+ownership (for new location)
ALTER PARTITION LOCATION	**Ownership**, RWX+ownership (for new partition location)
ALTER TABLE ADD PARTITION	**Insert**, RWX and ownership (for partition location)
ALTER TABLE DROP PARTITION	**Delete**
ALTER TABLE(all of them except the ones above)	**Update**, **Ownership**
TRUNCATE TABLE	**Ownership**
CREATE VIEW	**Select**, **Grant Of Select**, **CREATE**
ALTER VIEW PROPERTIES	**Ownership**
ALTER VIEW RENAME	**Ownership**
ALTER VIEW ADD PARTS	**Ownership**
ALTER VIEW AS	**Ownership**
ALTER VIEW DROPPARTS	**Ownership**
ANALYZE TABLE	**Search**, **Insert**
SHOW COLUMNS	**Select**
SHOW TABLE PROPERTIES	**Select**
CREATE TABLE AS SELECT	**Select**, **CREATE**
SELECT	**Select** **NOTE** The same as tables, you need to have the **Select** permission on a view when performing a SELECT operation on the view.
INSERT	**Insert**, **Delete (for overwrite)**
LOAD	**Insert**, **Delete**, RWX+ownership(input location)
SHOW CREATE TABLE	**Select**, **Grant Of Select**
CREATE FUNCTION	**ADMIN**
DROP FUNCTION	**ADMIN**
DESC FUNCTION	-
SHOW FUNCTIONS	-

Scenario	Required Permission
MSCK (metastore check)	**Ownership**
ALTER DATABASE	**ADMIN**
CREATE DATABASE	-
SHOW DATABASES	-
EXPLAIN	**Select**
DROP DATABASE	**Ownership**
DESC DATABASE	-
CACHE TABLE	**Select**
UNCACHE TABLE	**Select**
CLEAR CACHE TABLE	**ADMIN**
REFRESH TABLE	**Select**
ADD FILE	**ADMIN**
ADD JAR	**ADMIN**
HEALTHCHECK	-

21.1.6.4 Configuring Permissions for SparkSQL to Use Other Components

Scenario

SparkSQL may need to be associated with other components. For example, Spark on HBase requires HBase permissions. The following describes how to associate SparkSQL with HBase.

Prerequisites

- The Spark client has been installed in a directory, for example, **/opt/client**.
- You have obtained a user account with the MRS cluster administrator permissions, for example, **admin**.

Procedure

- **Spark on HBase authorization**

  After the permissions are assigned, you can use statements that are similar to SQL statements to access HBase tables from SparkSQL. The following uses the procedure for assigning a user the permissions to query HBase tables as an example.

  NOTE

  Set **spark.yarn.security.credentials.hbase.enabled** to **true**.

a. On Manager, create a role, for example, **hive_hbase_create**, and grant the permission to create HBase tables to the role.

   In the **Configure Resource Permission** table, choose *Name of the desired cluster* > **HBase** > **HBase Scope** > **global**. Select **create** of the namespace **default**, and click **OK**.

   NOTE

   In this example, the created table is saved in the default database of Hive and has the CREATE permission of the default database. If you save the table to a Hive database other than **default**, perform the following operations:

   In the **Configure Resource Permission** table, choose *Name of the desired cluster* > **Hive** > **Hive Read Write Privileges**, select **CREATE** for the desired database, and click **OK**.

b. On Manager, create a role, for example, **hive_hbase_submit**, and grant the permission to submit tasks to the Yarn queue.

   In the **Configure Resource Permission** table, choose *Name of the desired cluster* > **Yarn** > **Scheduling Queue** > **root**. Select **Submit** of **default**, and click **OK**.

c. On Manager, create a human-machine user, for example, **hbase_creates_user**, add the user to the **hive** group, and bind the **hive_hbase_create** and **hive_hbase_submit** roles to create SparkSQL and HBase tables.

d. Log in to the node where the client is installed as the client installation user.

e. Run the following command to configure environment variables:

   source /opt/client/bigdata_env

   source /opt/client/Spark/component_env

f. Run the following command to authenticate the user:

   kinit hbase_creates_user

g. Run the following commands to enter the shell environment on the Spark JDBCServer client:

   /opt/client/Spark/spark/bin/beeline -u "jdbc:hive2://<zkNode1_IP>:<zkNode1_Port>,<zkNode2_IP>:<zkNode2_Port>,<zkNode3_IP>:<zkNode3_Port>/;serviceDiscoveryMode=zooKeeper;zooKeeperNamespace=sparkthriftserver;user.principal=spark2x/hadoop.*<System domain name>***@***<System domain name>***;saslQop=auth-conf;auth=KERBEROS;principal=spark2x/hadoop.***<System domain name>***@***<System domain name>***;"**

h. Run the following command to create a table in SparkSQL and HBase, for example, create the **hbaseTable** table:

   create table hbaseTable (id string, name string, age int) using org.apache.spark.sql.hbase.HBaseSource options (hbaseTableName "table1", keyCols "id", colsMapping = ", name=cf1.cq1, age=cf1.cq2");

   The created SparkSQL table and the HBase table are stored in the Hive database **default** and the HBase namespace **default**, respectively.

i. On Manager, create a role, for example, **hive_hbase_select**, and grant the role the permission to query SparkSQL on HBase table **hbaseTable** and HBase table **hbaseTable**.

- In the **Configure Resource Permission** table, choose *Name of the desired cluster* > **HBase** > **HBase Scope** > **global** > **default**. Select **read** for the **hbaseTable** table, and click **OK** to grant the table query permission to the HBase role.
- Edit the role. In the **Configure Resource Permission** table, choose *Name of the desired cluster* > **HBase** > **HBase Scope** > **global** > **hbase**. Select **Execute** for **hbase:meta**, and click **OK**.
- Edit the role. In the **Configure Resource Permission** table, choose *Name of the desired cluster* > **Hive** > **Hive Read Write Privileges** > **default**. Select **SELECT** for the **hbaseTable** table, and click **OK**.

j. On Manager, create a human-machine user, for example, **hbase_select_user**, add the user to the **hive** group, and bind the **hive_hbase_select** role to the user for querying SparkSQL and HBase tables.

k. Run the following command to configure environment variables:

source /opt/client/bigdata_env

source /opt/client/Spark/component_env

l. Run the following command to authenticate users:

kinit hbase_select_user

m. Run the following commands to enter the shell environment on the Spark JDBCServer client:

/opt/client/Spark/spark/bin/beeline -u "jdbc:hive2://<zkNode1_IP>:<zkNode1_Port>,<zkNode2_IP>:<zkNode2_Port>,<zkNode3_IP>:<zkNode3_Port>/;serviceDiscoveryMode=zooKeeper;zooKeeperNamespace=sparkthriftserver;user.principal=spark2x/hadoop.*<System domain name>***@***<System domain name>***;saslQop=auth-conf;auth=KERBEROS;principal=spark2x/hadoop.***<System domain name>***@***<System domain name>***;"**

n. Run the following command to use a SparkSQL statement to query HBase table data:

select * from hbaseTable;

21.1.6.5 Configuring the Client and Server

This section describes how to configure SparkSQL permission management functions (client configuration is similar to server configuration). To enable table permission, add following configurations on the client and server:

- **spark-defaults.conf** configuration file

Table 21-39 Parameter description (1)

Parameter	Description	Default Value
spark.sql.authorization.enabled	Specifies whether to enable permission authentication of the datasource statement. It is recommended that the parameter value be set to **true** to enable permission authentication.	true

- **hive-site.xml** configuration file

Table 21-40 Parameter description (2)

Parameter	Description	Default Value
hive.metastore.uris	Specifies the MetaStore service address of the Hive component, for example, **thrift://10.10.169.84:21088,thrift://10.10.81.37:21088**.	-
hive.metastore.sasl.enabled	Specifies whether the MetaStore service uses SASL to improve security. The table permission function must be enabled.	true
hive.metastore.kerberos.principal	Specifies the principal of the MetaStore service in the Hive component, for example, **hive/hadoop.**<*system domain name*>@<*system domain name*>.	hive-metastore/_HOST@EXAMPLE.COM
hive.metastore.thrift.sasl.qop	After the SparkSQL permission management function is enabled, set the parameter to **auth-conf**.	auth-conf
hive.metastore.token.signature	Specifies the token identifier of the MetaStore service, which is set to **HiveServer2ImpersonationToken**.	HiveServer2ImpersonationToken
hive.security.authenticator.manager	Specifies the manager authenticated by the Hive client, which is set to **org.apache.hadoop.hive.ql.security.SessionStateUserGroupAuthenticator**.	org.apache.hadoop.hive.ql.security.SessionStateUserMSGroupAuthenticator
hive.security.authorization.enabled	Specifies whether to enable client authentication, which is set to **true**.	true

Parameter	Description	Default Value
hive.security.authorization.createtable.owner.grants	Specifies which permissions are granted to the owner who creates the table, which is set to **ALL**.	ALL

- **core-site.xml** configuration file of the MetaStore service

Table 21-41 Parameter description (3)

Parameter	Description	Default Value
hadoop.proxyuser.spark.hosts	Specifies the hosts from which Spark users can be masqueraded, which is set to *, indicating all hosts.	-
hadoop.proxyuser.spark.groups	Specifies the user groups from which Spark users can be masqueraded, which is set to *, indicating all user groups.	-

21.1.7 Scenario-Specific Configuration

21.1.7.1 Configuring Multi-active Instance Mode

Scenario

In this mode, multiple ThriftServers coexist in the cluster and the client can randomly connect any ThriftServer to perform service operations. When one or multiple ThriftServers stop working, a client can connect to another functional ThriftServer.

Configuration Description

Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Spark**. Click **Configurations** then **All Configurations**, and search for and modify the following parameters:

Table 21-42 Parameter description

Parameter	Description	Default Value
spark.thriftserver.zookeeper.connection.timeout	Specifies the timeout interval of connection between ZooKeeper client and ThriftServer. The unit is millisecond.	60000

Parameter	Description	Default Value
spark.thriftserver.zookeeper.session.timeout	Specifies the timeout interval of a ZooKeeper client session. The unit is millisecond.	90000
spark.thriftserver.zookeeper.retry.times	Specifies the retry times after ZooKeeper disconnection.	3
spark.yarn.queue	Specifies the Yarn queue where the JDBCServer service resides.	default

21.1.7.2 Configuring the Multi-Tenant Mode

Scenario

In multi-tenant mode, JDBCServers are bound with tenants. Each tenant corresponds to one or more JDBCServers, and a JDBCServer provides services for only one tenant. Different tenants can be configured with different Yarn queues to implement resource isolation.

NOTE

If cluster resources are insufficient for a long time, use the Spark multi-active instance mode.

Configuration Description

Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Spark**. Click **Configurations** then **All Configurations**, and search for and modify the following parameters:

Table 21-43 Parameter description

Parameter	Description	Default Value
spark.proxyserver.hash.enabled	Specifies whether to connect to ProxyServer using the Hash algorithm. • **true** indicates using the Hash algorithm. In multi-tenant mode, this parameter must be configured to **true**. • **false** indicates using random connection. In multi-active instance mode, this parameter must be configured to **false**.	true **NOTE** After this parameter is modified, you need to download the client again.

Parameter	Description	Default Value
spark.thriftserver.proxy.enabled	Specifies whether to use the multi-tenant mode. • **false**: The multi-instance mode is used. • **true**: The multi-tenant mode is used.	true
spark.thriftserver.proxy.maxThriftServerPerTenancy	Specifies the maximum number of JDBCServer instances that can be started by a tenant in multi-tenant mode.	1
spark.thriftserver.proxy.maxSessionPerThriftServer	Specifies the maximum number of sessions in a single JDBCServer instance in multi-tenant mode. If the number of sessions exceeds this value and the number of JDBCServer instances does not exceed the upper limit, a new JDBCServer instance is started. Otherwise, an alarm log is output.	50
spark.thriftserver.proxy.sessionWaitTime	Specifies the wait time before a JDBCServer instance is stopped when it has no session connections in multi-tenant mode.	180000
spark.thriftserver.proxy.sessionThreshold	In multi-tenant mode, when the session usage (formula: number of current sessions/ spark.thriftserver.proxy.maxSessionPerThriftServer x number of current JDBCServer instances) of the JDBCServer instance reaches the threshold, a new JDBCServer instance is automatically added.	100
spark.thriftserver.proxy.healthcheck.period	Specifies the period of JDBCServer health checks conducted by the JDBCServer proxy in multi-tenant mode.	60000
spark.thriftserver.proxy.healthcheck.recheckTimes	Specifies the number of JDBCServer health check retries conducted by the JDBCServer proxy in multi-tenant mode.	3
spark.thriftserver.proxy.healthcheck.waitTime	Specifies the wait time for JDBCServer to respond to a health check request sent by the JDBCServer proxy.	10000
spark.thriftserver.proxy.session.check.interval	Specifies the period of JDBCServer proxy sessions in multi-tenant mode.	6h

Parameter	Description	Default Value
spark.thriftserver.proxy.idle.session.timeout	Specifies the idle time interval of a JDBCServer proxy session in multi-tenant mode. If no operation is performed within this period, the session is closed.	7d
spark.thriftserver.proxy.idle.session.check.operation	Specifies whether to check that operations still exist on a JDBCServer proxy session when the session is checked for expiration in multi-tenant mode.	true
spark.thriftserver.proxy.idle.operation.timeout	Specifies the timeout interval of an operation in multi-tenant mode. An operation that times out is closed.	5d
hive.spark.client.server.connect.timeout	Client connection timeout interval in multi-tenant mode	5min

21.1.7.3 Configuring the Switchover Between the Multi-active Instance Mode and the Multi-tenant Mode

Scenario

When using a cluster, if you want to switch between multi-active instance mode and multi-tenant mode, the following configurations are required.

- Switch from multi-tenant mode to multi-active instance mode.

  Modify the following parameters of the Spark service:

  - spark.thriftserver.proxy.enabled=false
  - spark.proxyserver.hash.enabled=false
- Switch from multi-active instance mode to multi-tenant mode.

  Modify the following parameters of the Spark service:

  - spark.thriftserver.proxy.enabled=true
  - spark.proxyserver.hash.enabled=true

Configuration Description

Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Spark**. Click **Configurations** then **All Configurations**, and search for and modify the following parameters:

Table 21-44 Parameter description

Parameter	Description	Default Value
spark.thriftserver.proxy.enabled	Specifies whether to use the multi-tenant mode. • **false**: The multi-instance mode is used. • **true**: The multi-tenant mode is used.	true
spark.scheduler.allocation.file	Specifies the fair scheduling file path.	hdfs://hacluster/user/spark/jars/*<Version number>*/fairscheduler.xml
spark.proxyserver.hash.enabled	Specifies whether to connect to ProxyServer using the Hash algorithm. • **true** indicates using the Hash algorithm. In multi-tenant mode, this parameter must be configured to **true**. • **false** indicates using random connection. In multi-active instance mode, this parameter must be configured to **false**.	true **NOTE** After this parameter is modified, you need to download the client again.

21.1.7.4 Configuring the Size of the Event Queue

Scenario

Functions such as UI, EventLog, and dynamic resource scheduling in Spark are implemented through event transfer. Events include SparkListenerJobStart and SparkListenerJobEnd, which record each important process.

Each event is saved to a queue after it occurs. When creating a SparkContext object, Driver starts a thread to obtain an event from the queue in sequence and sends the event to each Listener. Each Listener processes the event after detecting the event.

Therefore, when the queuing speed is faster than the read speed, the queue overflows. As a result, the overflow event is lost, affecting the UI, EventLog, and dynamic resource scheduling functions. Therefore, a configuration item is added for more flexible use. You can set a proper value based on the memory size of the driver.

Configuration Description

Navigation path for setting parameters:

Before executing an application, modify the Spark service configuration. On Manager, choose **Cluster** > **Services** > **Spark**, click **Configurations** then **All Configurations**, and enter a parameter name in the search box.

Table 21-45 Parameter description

Parameter	Description	Default Value
spark.scheduler.listenerbus.eventqueue.capacity	Specifies the size of the event queue. Configure this parameter based on the memory of the driver.	1000000

NOTE

If the following information is displayed in the Driver log, the queue overflows.

1. Common application:
   ```
   Dropping SparkListenerEvent because no remaining room in event queue.
   This likely means one of the SparkListeners is too slow and cannot keep
   up with the rate at which tasks are being started by the scheduler.
   ```
2. Spark Streaming application:
   ```
   Dropping StreamingListenerEvent because no remaining room in event queue.
   This likely means one of the StreamingListeners is too slow and cannot keep
   up with the rate at which events are being started by the scheduler.
   ```

21.1.7.5 Configuring Executor Off-Heap Memory

Scenario

When the executor off-heap memory is too small, or processes with higher priority preempt resources, the physical memory usage will exceed the maximal value. To prevent the physical memory usage from exceeding, set the following parameter.

Configuration

Navigation path for setting parameters:

When submitting an application, set the following parameter using **--conf** or adjust the parameter in the **spark-defaults.conf** configuration file on the client.

Table 21-46 Parameter description

Parameter	Description	Default Value
spark.executor.memoryOverhead	Indicates the off-heap memory of each executor, in MB. Increasing the value of this parameter prevents the physical memory usage from exceeding the maximal value. The value is calculated based on max(384, Executor – Memory x 0.1). The minimal value is 384.	1024

21.1.7.6 Enhancing Stability in a Limited Memory Condition

Scenario

A large amount of memory is required when Spark SQL executes a query, especially during Aggregate and Join operations. If the memory is limited, OutOfMemoryError may occur. Stability in a limited memory condition ensures queries to be run in limited memory without OutOfMemoryError.

NOTE

Limited memory does not mean infinitely small memory, but ensures stable queries by using disks in a scenario where memory fails to store the data amount that is several times larger than the available memory size. For example, for queries involving Join, the data of the same key used for Join needs to be stored in memory. If the data amount is too large to be stored in the available memory, OutOfMemoryError occurs.

Stability in a limited memory condition involves the following sub-functions:

1. ExternalSort

   If the memory is inadequate during sorting, partial data overflows to disks.

2. TungstenAggregate

   By default, ExternalSort is used to sort data before data aggregation. Therefore, if the memory is inadequate, the data overflows to disks during sorting. The data has been properly sorted before aggregation and only aggregation results of the current key are remained, which use a small amount of memory.

3. SortMergeJoin and SortMergeOuterJoin

   SortMergeJoin and SortMergeOuterJoinan are based on the equivalence join of sorted data. By default, ExternalSort is used to sort the data before the equivalence join. Therefore, if the memory is inadequate, the data overflows to disks during sorting. The data has been properly sorted before the equivalence join and only the data of the same key are remained, which uses a small amount of memory.

Configuration

Navigation path for setting parameters:

When submitting an application, set the following parameters using **--conf** or adjust the parameters in the **spark-defaults.conf** configuration file on the client.

Table 21-47 Parameter description

Parameter	Scenario	Description	Default Value
spark.sql.tungsten.enabled	/	Type: Boolean • If the value is **true**, tungsten is enabled. That is, the logic plan is equivalent to the codegeneration function, and the physical plan uses the corresponding tungsten execution plan. • If the value is **false**, tungsten is disabled.	true
spark.sql.codegen.wholeStage		Type: Boolean • If the value is **true**, codegeneration is enabled. That is, for some specified queries, the logic plan code will be generated dynamically when running. • If the value is **false**, codegeneration is disabled and the existing static code is used.	true

NOTE

1. To enable ExternalSort, you need to set **spark.sql.planner.externalSort** to **true** and **spark.sql.unsafe.enabled** to **false** or **spark.sql.codegen.wholeStage** to **false**.
2. To enable TungstenAggregate, use either of the following methods:

   Set **spark.sql.codegen.wholeStage** and **spark.sql.unsafe.enabled** to **true** in the configuration file or CLI.

   If neither **spark.sql.codegen.wholeStage** nor **spark.sql.unsafe.enabled** is **true** or either of them is **true**, TungstenAggregate is enabled as long as **spark.sql.tungsten.enabled** is set to **true**.

21.1.7.7 Viewing Aggregated Container Logs on the Web UI

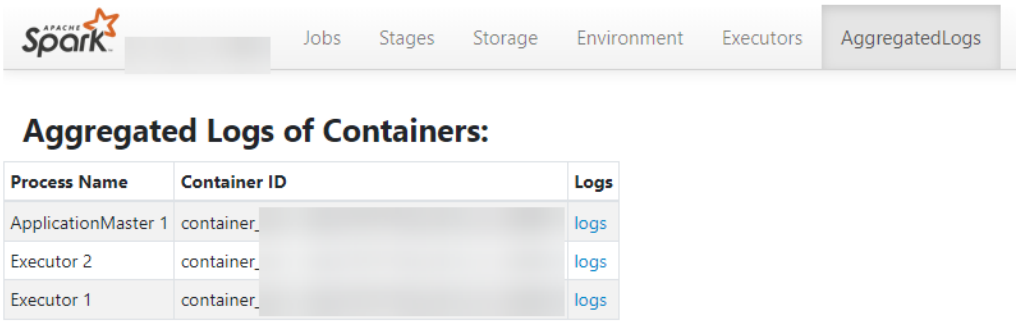
Scenarios

When **yarn.log-aggregation-enable** of Yarn is set to **true**, the container log aggregation function is enabled. Log aggregation indicates that after applications are run on Yarn, NodeManager aggregates all container logs of the node to HDFS and deletes local logs. For details, see **Configuring Container Log Aggregation**.

However, all logs will be aggregated to an HDFS directory and can only be viewed by accessing an HDFS file. Open-source Spark and Yarn do not support the function of viewing aggregated logs on the web UI.

Spark supports this function. As shown in **Figure 21-4**, the **AggregatedLogs** tab is added to the HistoryServer page. You can click **logs** to view aggregated logs.

Figure 21-4 Aggregated log page



Configuration Description

To display logs on the web UI, aggregated logs need to be parsed and presented. Spark parses aggregation logs using JobHistoryServer of Hadoop. Therefore, you can use the **spark.jobhistory.address** parameter to specify the URL of the JobHistoryServer page to parse and present the logs.

Navigation path for setting parameters:

When submitting an application, set these parameters using **--conf** or adjust the following parameter in the **spark-defaults.conf** configuration file on the client.

NOTE

- This function depends on JobHistoryServer of Hadoop. Therefore, ensure that JobHistoryServer is running properly before using the log aggregation function.
- If the parameter value is empty, the **AggregatedLogs** tab page still exists, but you cannot view logs by clicking **logs**.
- The aggregated container logs can be viewed only when the application is running and event log files of the application exist on HDFS.
- You can click the log link on the **Executors** page to view the logs of a running task. After the task completes, the logs are aggregated to HDFS, and the log link on the **Executors** page becomes invalid. In this case, you can click **logs** on the **AggregatedLogs** page to view the aggregated logs.

Table 21-48 Parameter description

Parameter	Description	Default Value
spark.jobhistory.address	URL of the JobHistoryServer page. The format is *http(s)://ip:port/jobhistory*. For example, **https://10.92.115.1:26014/jobhistory**. The default value is empty, indicating that container aggregation logs cannot be viewed on the web UI. Restart the service for the configuration to take effect.	-

21.1.7.8 Configuring Environment Variables in Yarn-Client and Yarn-Cluster Modes

Scenario

Values of some configuration parameters of Spark client vary depending on its work mode (YARN-Client or YARN-Cluster). If you switch Spark client between different modes without first changing values of such configuration parameters, Spark client fails to submit jobs in the new mode.

To avoid this, configure parameters as described in **Table 21-49**.

- In Yarn-Cluster mode, use the new parameters (path and parameters of Spark server).
- In Yarn-Client mode, uses the original parameters.

  They are **spark.driver.extraClassPath**, **spark.driver.extraJavaOptions**, and **spark.driver.extraLibraryPath**.

NOTE

If you choose not to add the parameters in **Table 21-49**, Spark client can continue to operate well in either mode but the mode switch requires changes to some of its configuration parameters.

Configuration Parameters

Navigation path for setting parameters:

On Manager, choose **Cluster** > **Services** > **Spark**, click **Configurations** then **All Configurations**, and enter a parameter name in the search box.

Table 21-49 Parameter description

Parameter	Description	Default Value
spark.yarn.cluster.driver.extraClassPath	Indicates the extraClassPath of the driver in Yarn-cluster mode. Set the parameter to the path and parameters of the server. The original parameter **spark.driver.extraClassPath** indicates the extraClassPath of Spark client. By using different parameters to separate the settings of Spark server from the settings of Spark client, you can switch Spark client to different modes without changing parameter values.	${BIGDATA_HOME}/common/runtime/security

Parameter	Description	Default Value
spark.yarn.cluster.driver.extraJavaOptions	Indicates the extraJavaOptions of Driver in Yarn-Cluster mode and is set to path and parameters of extraJavaOptions of Spark server. The original parameter **spark.driver.extraJavaOptions** indicates the path of extraJavaOptions of Spark client. By using different parameters to separate the settings of Spark server from the settings of Spark client, you can switch Spark client to different modes without changing parameter values.	-Xloggc:<LOG_DIR>/indexserver-%p-gc.log -XX:+PrintGCDetails -XX:-OmitStackTraceInFastThrow -XX:+PrintGCTimeStamps -XX:+PrintGCDateStamps -XX:+UseGCLogFileRotation -XX:NumberOfGCLogFiles=20 -XX:GCLogFileSize=10M -Dlog4j.configuration=./__spark_conf__/__hadoop_conf__/log4j-executor.properties -Dlog4j.configuration.watch=true -Djava.security.auth.login.config=./__spark_conf__/__hadoop_conf__/jaas-zk.conf -Dzookeeper.server.principal=${ZOOKEEPER_SERVER_PRINCIPAL} -Djava.security.krb5.conf=./__spark_conf__/__hadoop_conf__/kdc.conf -Djetty.version=x.y.z -Dorg.xerial.snappy.tempdir=${BIGDATA_HOME}/tmp -Dcarbon.properties.filepath=./__spark_conf__/__hadoop_conf__/carbon.properties -Djdk.tls.ephemeralDHKeySize=2048 -Dspark.ssl.keyStore=./child.keystore #{java_stack_prefer}

21.1.7.9 Configuring the Default Number of Data Blocks Divided by SparkSQL

Scenario

By default, SparkSQL divides data into 200 data blocks during shuffle. In data-intensive scenarios, each data block may have excessive size. If a single data block of a task is larger than 2 GB, an error similar to the following will be reported while Spark attempts to fetch the data block:

```
Adjusted frame length exceeds 2147483647: 2717729270 - discarded
```

For example, setting the number of default data blocks to 200 causes SparkSQL to encounter an error in running a TPCDS 500-GB test. To avoid this, increase the number of default blocks in data-intensive scenarios.

Configuration parameters

Navigation path for setting parameters:

On Manager, choose **Cluster** > **Services** > **Spark**, click **Configurations** then **All Configurations**, and enter a parameter name in the search box.

Table 21-50 Parameter description

Parameter	Description	Default Value
spark.sql.shuffle.partitions	Indicates the default number of blocks divided during shuffle.	200

21.1.7.10 Configuring the Compression Format of a Parquet Table

Scenario

The compression format of a Parquet table can be configured as follows:

1. If the Parquet table is a partitioned one, set the **parquet.compression** parameter of the Parquet table to specify the compression format. For example, set **tblproperties** in the table creation statement: **"parquet.compression"="snappy"**.
2. If the Parquet table is a non-partitioned one, set the **spark.sql.parquet.compression.codec** parameter to specify the compression format. The configuration of the **parquet.compression** parameter is invalid, because the value of the **spark.sql.parquet.compression.codec** parameter is read by the **parquet.compression** parameter. If the **spark.sql.parquet.compression.codec** parameter is not configured, the default value is **snappy** and will be read by the **parquet.compression** parameter.

Therefore, the **spark.sql.parquet.compression.codec** parameter can only be used to set the compression format of a non-partitioned Parquet table.

Configuration parameters

Navigation path for setting parameters:

On Manager, choose **Cluster** > **Services** > **Spark**, click **Configurations** then **All Configurations**, and enter a parameter name in the search box.

Table 21-51 Parameter description

Parameter	Description	Default Value
spark.sql.parquet.compression.codec	Used to set the compression format of a non-partitioned Parquet table.	snappy

21.1.7.11 Configuring the Number of Lost Executors Displayed in WebUI

Scenario

In Spark WebUI, the **Executor** page can display information about Lost Executor. Executors are dynamically recycled. If the JDBCServer tasks are large, there may be too many lost executors displayed in WebUI. Therefore, the number of displayed lost executors can be configured.

Procedure

Configure the following parameter in the **spark-defaults.conf** file on Spark client.

Table 21-52 Parameter description

Parameter	Description	Default Value
spark.ui.retainedDeadExecutors	The maximum number of Lost Executors displayed in Spark WebUI.	100

21.1.7.12 Setting the Log Level Dynamically

Scenario

In some scenarios, to locate problems or check information by changing the log level,

you can add the **-Dlog4j.configuration.watch=true** parameter to the JVM parameter of a process before the process is started. After the process is started, you can modify the log4j configuration file corresponding to the process to change the log level.

The following processes support the dynamic setting of log levels: driver, executor, ApplicationMaster, JobHistory and JDBCServer.

Allowed log levels are as follows: FATAL, ERROR, WARN, INFO, DEBUG, TRACE, and ALL.

Configuration Description

Add the following parameters to the JVM parameter corresponding to a process.

Table 21-53 Parameter description

Parameter	Description	Default Value
-Dlog4j.configuration.watch	Indicates a JVM parameter of a process. If this parameter is set to **true**, the dynamic configuration of log levels is enabled.	Left blank, indicating that the dynamic configuration of log levels is disabled

Table 21-54 lists the JVM parameters of the driver, executor, and ApplicationMaster processes. Configure the following parameters in the **spark-defaults.conf** file on the Spark client. Set the log levels of the driver, executor, and ApplicationMaster processes in the log4j configuration file specified by the **-Dlog4j.configuration** parameter.

Table 21-54 JVM parameters of processes (1)

Parameter	Description	Default Log Level
spark.driver.extraJavaOptions	Indicates the JVM parameter of the driver process.	INFO
spark.executor.extraJavaOptions	Indicates the JVM parameter of the executor process.	INFO
spark.yarn.am.extraJavaOptions	Indicates the JVM parameter of the ApplicationMaster process.	INFO

Table 21-55 describes the JVM parameters of JobHistory Server and JDBCServer. Set the parameters in the **ENV_VARS** configuration file. Set the log levels of JobHistory Server and JDBCServer in the **log4j.properties** configuration file.

Table 21-55 JVM parameters of processes (2)

Parameter	Description	Default Log Level
GC_OPTS	Indicates the JVM parameter of the JobHistory Server process.	INFO
SPARK_SUBMIT_OPTS	Indicates the JVM parameter of JDBCServer.	INFO

Example:

To change the log level of the executor process to DEBUG dynamically, modify the **spark.executor.extraJavaOptions** JVM parameter of the executor process in the

spark-defaults.conf file and run the following command to add the following configuration before the process is started:

```
-Dlog4j.configuration.watch=true
```

After the user application is submitted, change the log level in the Log4j configuration file (for example, **-Dlog4j.configuration=file:${BIGDATA_HOME}/FusionInsight_Spark_8.1.0.1/install/FusionInsight-Spark-*/spark/conf/log4j-executor.properties**) specified by the **-Dlog4j.configuration** parameter in **spark.executor.extraJavaOptions** to **DEBUG**:

```
log4j.rootCategory=DEBUG, sparklog
```

It takes several seconds for the DEBUG level to take effect.

21.1.7.13 Configuring Whether Spark Obtains HBase Tokens

Scenario

When Spark is used to submit tasks, the driver obtains tokens from HBase by default. To access HBase, you need to configure the **jaas.conf** file for security authentication. If the **jaas.conf** file is not configured, the application will fail to run.

Therefore, perform the following operations based on whether the application involves HBase:

- If the application does not involve HBase, you do not need to obtain the HBase tokens. In this case, set **spark.yarn.security.credentials.hbase.enabled** to **false**.
- If the application involves HBase, set **spark.yarn.security.credentials.hbase.enabled** to **true** and configure the **jaas.conf** file on the driver as follows:

  ```
  {client}/spark/bin/spark-sql  --master yarn-client --principal {principal} --keytab {keytab} --driver-java-options "-Djava.security.auth.login.config={LocalPath}/jaas.conf"
  ```

  Specify Keytab and Principal in the **jaas.conf** file. The following is an example:

  ```
  Client {
  com.sun.security.auth.module.Krb5LoginModule required
  useKeyTab=true
  keyTab = "{LocalPath}/user.keytab"
  principal="super@<System domain name>"
  useTicketCache=false
  debug=false;
  };
  ```

Configuration

Configure the following parameter in the **spark-defaults.conf** file of the Spark client.

Table 21-56 Parameter description

Parameter	Description	Default Value
spark.yarn.security.credentials.hbase.enabled	Indicates whether HBase obtains a token. • **true**: HBase obtains a token. • **false**: HBase does not obtain a token.	false

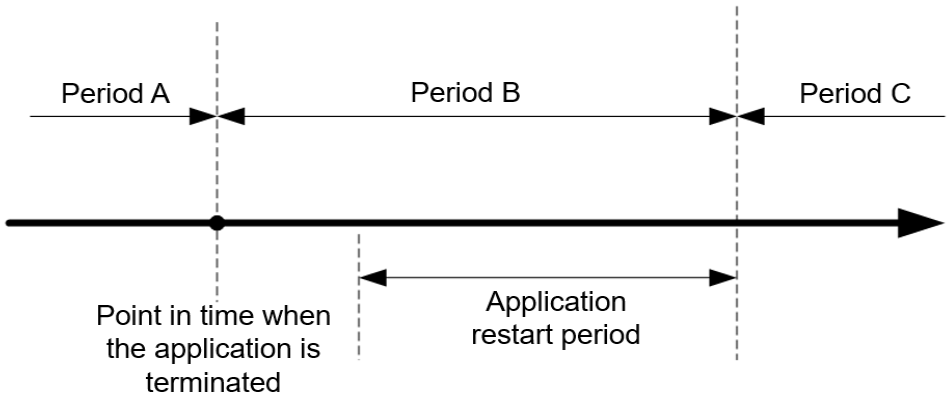
21.1.7.14 Configuring LIFO for Kafka

Scenario

If the Spark Streaming application is connected to Kafka, after the Spark Streaming application is terminated abnormally and restarted from the checkpoint, the system preferentially processes the tasks that are not completed before the application is terminated (Period A) and the tasks generated based on data that enters Kafka during the period (Period B) from the application termination to the restart. Then the application processes the tasks generated based on data that enters Kafka after the application is restarted (Period C). For data that enters Kafka in period B, Spark generates a corresponding number of tasks based on the end time (**batch** time). The first task reads all data, but other tasks may not read data. As a result, the task processing pressure is uneven.

If the tasks in Period A and Period B are processed slowly, the processing of tasks in period C is affected. To cope with the preceding scenario, Spark provides the last-in first-out (LIFO) function for Kafka.

Figure 21-5 Time axis for restarting the Spark Streaming application



After this function is enabled, Spark preferentially schedules tasks in Period C. If there are multiple tasks in Period C, Spark schedules and executes the tasks in the sequence of task generation. Then Spark executes the tasks in Periods A and B. For data that enters Kafka in Period B, Spark generates tasks based on the end time

and evenly distributes all data that enters Kafka in this period to each task to avoid uneven task processing pressure.

Constraints:

- This function applies only to the direct mode of Spark Streaming, and the execution result does not depend on the processing result of the previous batch (that is, stateless operation, for example, **updatestatebykey**). Multiple data input streams must be comparatively independent from each other. Otherwise, the result may change after the data is divided.
- The Kafka LIFO function can be enabled only when the application is connected to the Kafka input source.
- If both Kafka LIFO and flow control functions are enabled when the application is submitted, the flow control function is not enabled for the data that enters Kafka in Period B to ensure that the task scheduling priority for reading the data is the lowest. Flow control is enabled for the tasks in Period C after the application is restarted.

Configuration

Configure the following parameters in the **spark-defaults.conf** file on the Spark driver.

Table 21-57 Parameter description

Parameter	Description	Default Value
spark.streaming.kafka.direct.lifo	Specifies whether to enable the LIFO function of Kafka.	false
spark.streaming.kafka010.inputstream.class	Obtains the decoupled class on FusionInsight.	org.apache.spark.streaming.kafka010.HWDirectKafkaInputDStream

21.1.7.15 Configuring Reliability for Connected Kafka

Scenario

When the Spark Streaming application is connected to Kafka and the application is restarted, the application reads data from Kafka based on the last read topic offset and the latest offset of the current topic.

If the leader of a Kafka topic fails and the offset of the Kafka leader is greatly different from that of the Kafka follower, the Kafka follower and leader are switched over after the Kafka service is restarted. As a result, the offset of the topic decreases after the Kafka service is restarted.

- If the Spark Streaming application keeps running, the start position for reading Kafka data is greater than the end position because the offset of the topic in Kafka decreases. As a result, the application cannot read data from Kafka and reports an error.

- Before restarting the Kafka service, stop the Spark Streaming application. After the Kafka service is restarted, restart the Spark Streaming application to restore the application from the checkpoint. In this case, the Spark Streaming application records the offset position read before the termination and uses the position as the reference to read subsequent data. The Kafka offset decreases (for example, from 100,000 to 10,000). Spark Streaming consumes data only after the offset of the Kafka leader increases to 100,000. As a result, the newly sent data whose offset is between 10,000 and 100,000 is lost.

To resolve the preceding problem, you can configure reliability for Kafka connected to Spark Streaming. After the reliability function of connected Kafka is enabled:

- If the offset of a topic in Kafka decreases when the Spark Streaming application is running, the latest offset of the topic in Kafka is used as the start position for reading Kafka data and subsequent data is read.

  For a task that has been generated but has not been scheduled, if the read Kafka offset is greater than the latest offset of the topic in Kafka, the task fails to be executed.

  NOTE

  If a large number of tasks fail, the Executor is added to the blacklist. As a result, subsequent tasks cannot be deployed and run. If this happens, you can set **spark.blacklist.enabled** to disable the blacklist function. The blacklist function is enabled by default.

- If the offset of a topic in Kafka decreases, the Spark Streaming application restarts to restore the unfinished tasks. If the read Kafka offset range is greater than the latest offset of the topic in Kafka, the task is directly discarded.

NOTE

If the state function is used in the Spark Streaming application, do not enable the reliability function of connected Kafka.

Configuration

Configure the following parameter in the **spark-defaults.conf** file of the Spark client.

Table 21-58 Parameter description

Parameter	Description	Default Value
spark.streaming.Kafka.reliability	Indicates whether to enable the reliability function for Kafka connected to Spark Streaming. • **true**: The reliability function is enabled. • **false**: The reliability function is disabled.	false

21.1.7.16 Configuring Streaming Reading of Driver Execution Results

Scenario

When a query statement is executed, the returned result may be large (containing more than 100,000 records). In this case, JDBCServer out of memory (OOM) may occur. Therefore, the data aggregation function is provided to avoid OOM without sacrificing the performance.

Configuration

Two data aggregation function configuration parameters are provided. The two parameters are set in the **tunning** option on the Spark JDBCServer server. After the setting is complete, restart JDBCServer.

Table 21-59 Parameter description

Parameter	Description	Default Value
spark.sql.bigdata.thriftServer.useHdfsCollect	Indicates whether to save result data to HDFS instead of the memory. Advantages: The query result is stored in HDFS. Therefore, JDBCServer OOM does not occur. Disadvantages: The query is slow. ● **true**: Result data is saved to HDFS. ● **false**: This function is disabled. **NOTICE** When **spark.sql.bigdata.thriftServer.useHdfsCollect** is set to **true**, result data is saved to HDFS. However, the job description on the native JobHistory page cannot be associated with the corresponding SQL statement. In addition, the execution ID in the spark-beeline command output is null. To solve the JDBCServer OOM problem and ensure correct information display, you are advised to set **spark.sql.userlocalFileCollect**.	false

Parameter	Description	Default Value
spark.sql.uselocalFileCollect	Indicates whether to save result data to the local disk instead of memory. Advantages: In the case of small data volume, the performance loss can be ignored compared with the data storage mode using the native memory. In the case of large data volume (hundreds of millions of data records), the performance is much better than that when data is stored in the HDFS and native memory. Disadvantages: Optimization is required. In the case of large data volume, it is recommended that the JDBCServer driver memory be 10 GB and each core of the executor be allocated with 3 GB memory. ● **true**: This function is enabled. ● **false**: This function is disabled.	false
spark.sql.collect.Hive	This parameter is valid only when **spark.sql.uselocalFileCollect** is set to **true**. It indicates whether to save the result data to a disk in direct serialization mode or in indirect serialization mode. Advantage: For queries of tables with a large number of partitions, the aggregation performance of the query results is better than that of the storage mode that query results are directly stored on the disk. Disadvantages: The disadvantages are the same as those when **spark.sql.uselocalFileCollect** is enabled. ● **true**: This function is enabled. ● **false**: This function is disabled.	false
spark.sql.collect.serialize	This parameter takes effect only when both **spark.sql.uselocalFileCollect** and **spark.sql.collect.Hive** are set to **true**. The function is to further improve performance. ● **java**: Data is collected in Java serialization mode. ● **kryo**: Data is collected in kryo serialization mode. The performance is better than that when the Java serialization mode is used.	java

NOTE

spark.sql.bigdata.thriftServer.useHdfsCollect and **spark.sql.uselocalFileCollect** cannot be set to **true** at the same time.

21.1.7.17 Filtering Partitions without Paths in Partitioned Tables

Scenario

When you perform the ***select*** query in Hive partitioned tables, the **FileNotFoundException** exception is displayed if a specified partition path does not exist in HDFS. To avoid the preceding exception, configure **spark.sql.hive.verifyPartitionPath** parameter to filter partitions without paths.

Procedure

Perform either of the following methods to filter partitions without paths:

- Configure the following parameter in the **spark-defaults.conf** file on Spark client.

  Table 21-60 Parameter description

Parameter	Description	Default Value
spark.sql.hive.verifyPartitionPath	Whether to filter partitions without paths when reading Hive partitioned tables. **true**: enables the filtering **false**: disables the filtering	false

- When running the spark-submit command to submit an application, configure the **--conf** parameter to filter partitions without paths.

  For example:

  ```
  spark-submit --class org.apache.spark.examples.SparkPi  --conf spark.sql.hive.verifyPartitionPath=true $SPARK_HOME/lib/spark-examples_*.jar
  ```

21.1.7.18 Configuring Spark Web UI ACLs

Scenario

Configure ACLs on the Spark web UI to protect your private data from being viewed by other users. Once a user attempts to log in to the UI, Spark can check the view ACL of the user to determine whether to allow the access.

Spark has two types of web UIs. One is for running tasks, which can be accessed through the application link on the native YARN page or the REST API. The other is for ended tasks, which can be accessed through the Spark JobHistory service or the REST API.

NOTE

This section applies only to clusters in security mode (with Kerberos authentication enabled).

- Configuring the ACL of the web UI for running tasks

  For a running task, you can set the following parameters on the server:

  - **spark.admin.acls**: specifies the web UI administrator list.
  - **spark.admin.acls.groups**: specifies the administrator group list.
  - **spark.ui.view.acls**: specifies the Yarn page visitor list.
  - **spark.modify.acls.groups**: specifies the Yarn page visitor group list.
  - **spark.modify.acls**: specifies the web UI modifier list.
  - **spark.ui.view.acls.groups**: specifies the web UI modifier group list.

- Configuring the ACL of the web UI for ended tasks

  For ended tasks, use client parameter **spark.history.ui.acls.enable** to enable or disable the ACL access permission.

  If ACL control is enabled, configure client parameters **spark.admin.acls** and **spark.admin.acls.groups** to specify the web UI administrator list and administrator group list. Use client parameters **spark.ui.view.acls** and **spark.modify.acls.groups** to specify the visitor list and visitor group list that view web UI task details. Use client parameters **spark.modify.acls** and **spark.ui.view.acls.groups** to specify the visitor list and group list that modify web UI task details.

Configuration

Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Spark**. Click **Configurations** then **All Configurations**, search for **acl**, and modify the following parameters on the JobHistory, JDBCServer, SparkResource, and Spark pages:

Table 21-61 Parameter description

Parameter	Description	Default Value
spark.history.ui.acls.enable	Indicates whether JobHistory supports the permission verification of a single task.	true
spark.acls.enable	Indicates whether to enable Spark permission management. If this function is enabled, the system checks whether the user has the permission to access and modify task information.	true
spark.admin.acls	Indicates the list of Spark administrators. All members in the list have the rights to manage all Spark tasks. You can configure multiple administrators and separate them from each other using commas (,).	admin

Parameter	Description	Default Value
spark.admin.acls.groups	Indicates the list of Spark administrator groups. All groups in the list have the permission to manage all Spark tasks. You can configure multiple administrator groups and separate them from each other using commas (,).	-
spark.modify.acls	Indicates the list of members that have the permission to modify Spark tasks. By default, the user who starts a task has the permission to modify the task. You can configure multiple users and separate them from each other using commas (,).	-
spark.modify.acls.groups	Indicates the list of groups that have the permission to modify Spark tasks. You can configure multiple groups and separate them from each other using commas (,).	-
spark.ui.view.acls	Indicates the list of members that have the permission to access Spark tasks. By default, the user who starts a task has the permission to modify the task. You can configure multiple users and separate them from each other using commas (,).	-
spark.ui.view.acls.groups	Indicates the list of groups that have the permission to access Spark tasks. You can configure multiple groups and separate them from each other using commas (,).	-

NOTE

If you use a client to submit tasks, you must download the client again after modifying the **spark.admin.acls**, **spark.admin.acls.groups**, **spark.modify.acls**, **spark.modify.acls.groups**, **spark.ui.view.acls**, and **spark.ui.view.acls.groups** parameters.

21.1.7.19 Configuring Vector-based ORC Data Reading

Scenario

ORC is a column-based storage format in the Hadoop ecosystem. It originates from Apache Hive and is used to reduce the Hadoop data storage space and accelerate the Hive query speed. Similar to Parquet, ORC is not a pure column-based storage format. In the ORC format, the entire table is split based on the row

group, data in each row group is stored by column, and data is compressed as much as possible to reduce storage space consumption. Vector-based ORC data reading significantly improves the ORC data reading performance. In Spark2.3, SparkSQL supports vector-based ORC data reading (this function is supported in earlier Hive versions). Vector-based ORC data reading improves the data reading performance by multiple times.

This feature can be enabled using the following parameters:

- **spark.sql.orc.enableVectorizedReader**: specifies whether vector-based ORC data reading is supported. The default value is **true**.
- **spark.sql.codegen.wholeStage**: specifies whether to compile all stages of multiple operations into a Java method. The default value is **true**.
- **spark.sql.codegen.maxFields**: specifies the maximum number of fields (including nested fields) supported by all stages of codegen. The default value is **100**.
- **spark.sql.orc.impl**: specifies whether Hive or Spark SQL native is used as the SQL execution engine to read ORC data. The default value is **hive**.

Parameters

Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Spark**. Click **Configurations** then **All Configurations**, and search for the following parameters:

Parameter	Description	Default Value	Value Range
spark.sql.orc.enableVectorizedReader	Specifies whether vector-based ORC data reading is supported. The default value is **true**.	true	[true,false]
spark.sql.codegen.wholeStage	Specifies whether to compile all stages of multiple operations into a Java method. The default value is **true**.	true	[true,false]
spark.sql.codegen.maxFields	Specifies the maximum number of fields (including nested fields) supported by all stages of codegen. The default value is **100**.	100	Greater than 0
spark.sql.orc.impl	Specifies whether Hive or Spark SQL native is used as the SQL execution engine to read ORC data. The default value is **hive**.	hive	[hive,native]

NOTE

1. To use vector-based ORC data reading of SparkSQL, the following conditions must be met:
   - **spark.sql.orc.enableVectorizedReader** must be set to **true** (default value). Generally, the value is not changed.
   - **spark.sql.codegen.wholeStage** must be set to **true** (default value). Generally, the value is not changed.
   - The value of **spark.sql.codegen.maxFields** must be greater than or equal to the number of columns in scheme.
   - All data is of the AtomicType. Specifically, data is not null or of the UDT, array, or map type. If there is data of the preceding types, expected performance cannot be obtained.
   - **spark.sql.orc.impl** must be set to **native**. The default value is **hive**.
2. If a task is submitted using the client, modification of the following parameters takes effect only after you download the client again: **spark.sql.orc.enableVectorizedReader**, **spark.sql.codegen.wholeStage**, **spark.sql.codegen.maxFields**, and **spark.sql.orc.impl**.

21.1.7.20 Broaden Support for Hive Partition Pruning Predicate Pushdown

Scenario

In earlier versions, the predicate for pruning Hive table partitions is pushed down. Only comparison expressions between column names and integers or character strings can be pushed down. In version 2.3, pushdown of the null, in, and, or expressions are supported. In version 3.1.1 or later, comparison expressions between the column name and the char or varchar type, including !=, like, not like, and not in, can be pushed down. Currently, only % can be used as the wildcard for like and not like.

- Formats supported by like pushdown expressions of the char type: **{value}%** and **%{value}%**
- Formats supported by not like pushdown expressions: **{value}%** and **% {value}%**
- Formats supported by like pushdown expressions of the varchar type: **{value} %**, **%{value}%**, **%{value}**, and **{value1}%{value2}**.
- Formats supported by not like pushdown expressions: **{value}%**, **%{value}%**, **%{value}**, and **{value1}%{value2}**.

Parameters

Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Spark**. Click **Configurations** then **All Configurations**, and search for the following parameters:

Parameter	Description	Default Value	Value Range
spark.sql.hive.advancedPartitionPredicatePushdown.enabled	Specifies whether to broaden the support for Hive partition pruning predicate pushdown.	true	[true,false]

Parameter	Description	Default Value	Value Range
spark.sql.hive.varcharPartitionPredicatePushdown.enabled	Whether to support the pushdown of predicates of the char and varchar types.	false	[true,false]

21.1.7.21 Hive Dynamic Partition Overwriting Syntax

Scenario

In earlier versions, when the **insert overwrite** syntax is used to overwrite partition tables, only partitions with specified expressions are matched, and partitions without specified expressions are deleted. In Spark2.3, partitions without specified expressions are automatically matched. The syntax is the same as that of the dynamic partition matching syntax of Hive.

Parameters

Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Spark**. Click **Configurations** then **All Configurations**, and search for the following parameters:

Parameter	Description	Default Value	Value Range
spark.sql.sources.partitionOverwriteMode	Specifies the mode for inserting data in partition tables by running the **insert overwrite** command, which can be **STATIC** or **DYNAMIC**. When it is set to **STATIC**, Spark deletes all partitions based on the matching conditions. When it is set to **DYNAMIC**, Spark matches partitions based on matching conditions and dynamically matches partitions without specified conditions.	STATIC	[STATIC,DYNAMIC]

21.1.7.22 Configuring the Column Statistics Histogram for Higher CBO Accuracy

Scenario

Typically, Spark SQL statements are optimized using heuristic optimization rules. Such rules are provided only based on the characteristics of the logical plan and

the characteristics of the data (the execution cost of the operator) are not considered. Spark 2.2 introduces cost-based optimizer (CBO). CBO collects table and column statistics and estimates the number of output records and byte size of each operator based on the input data set of the operator. These are the cost of executing an operator.

CBO adjusts the execution plan to minimize the end-to-end query time. The idea is as follows:

- Filter out irrelevant data as early as possible.
- Minimize the cost of each operator.

The CBO optimization process is divided into two steps:

1. Collect statistics.
2. Estimate the output data set of a specific operator based on the input data set.

Table-level statistics include the number of records and the total size of table data files.

Column-level statistics include the number of unique values, maximum value, minimum value, number of null values, average length, maximum length, and histogram.

After the statistics are obtained, the execution cost of the operator can be estimated. Common operators include the Filter and Join operators.

Histogram is a type of column statistics. It can clearly describe the distribution of column data. The column data is distributed to a specified number of bins that are displayed in ascending order by size. The upper and lower limits of each bin are calculated. The amount of data in all bins is the same (a contour histogram). With the detailed distribution of data, the cost estimation of each operator is more accurate and the optimization effect is better.

This feature can be enabled using the following parameter:

spark.sql.statistics.histogram.enabled: specifies whether to enable the histogram function. The default value is **false**.

Parameters

Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Spark**. Click **Configurations** then **All Configurations**, and search for the following parameters:

Parameter	Description	Default Value	Value Range
spark.sql.cbo.enabled	Whether to enable CBO to estimate the statistics of the execution plan	false	[true,false]
spark.sql.cbo.joinReorder.enabled	Whether to enable CBO connection reordering	false	[true,false]

Parameter	Description	Default Value	Value Range
spark.sql.cbo.joinReorder.dp.threshold	Maximum number of join nodes allowed in the dynamic planning algorithm	12	>=1
spark.sql.cbo.joinReorder.card.weight	Proportion of the dimension (number of rows) in the cost comparison of the reconnection execution plan: Number of rows x Proportion + File size x (1 – Proportion)	0.7	0-1
spark.sql.statistics.size.autoUpdate.enabled	Whether to enable the function of automatically updating the table size when the table data changes. If there are a large number of data files in a table, this operation consumes a lot of resources and slows down data operations.	false	[true,false]
spark.sql.statistics.histogram.enabled	After this function is enabled, a histogram is generated when column information is collected. Histograms can improve estimation accuracy, but collecting histogram information requires additional workload.	false	[true,false]
spark.sql.statistics.histogram.numBins	Number of slots in the generated histogram	254	>=2
spark.sql.statistics.ndv.maxError	Maximum estimation error allowed by the HyperLogLog++ algorithm when column-level statistics are generated	0.05	0-1

Parameter	Description	Default Value	Value Range
spark.sql.statistics.percentile.accuracy	Accuracy of percentile estimation when generating equal height histograms. A larger value indicates more accuracy. The estimated error value can be obtained using 1.0/Percentile estimation accuracy.	10000	>=1

NOTE

- A histogram takes effect in CBO only when the following conditions are met:
  - **spark.sql.statistics.histogram.enabled**: The default value is **false**. Change the value to **true** to enable the histogram function.
  - **spark.sql.cbo.enabled**: The default value is **false**. Change the value to **true** to enable CBO.
  - **spark.sql.cbo.joinReorder.enabled**: The default value is **false**. Change the value to **true** to enable connection reordering.
- If a client is used to submit tasks, the modification of **spark.sql.cbo.enabled**, **spark.sql.cbo.joinReorder.enabled**, **spark.sql.cbo.joinReorder.dp.threshold**, **spark.sql.cbo.joinReorder.card.weight**, **spark.sql.statistics.size.autoUpdate.enabled**, **spark.sql.statistics.histogram.enabled**, **spark.sql.statistics.histogram.numBins**, **spark.sql.statistics.ndv.maxError**, and **spark.sql.statistics.percentile.accuracy** takes effect only after the client is downloaded again.

21.1.7.23 Configuring Local Disk Cache for JobHistory

Scenario

JobHistory can use local disks to cache historical data of Spark applications to prevent large volumes of application data from being loaded to the JobHistory memory and reduce memory usage. In addition, the cached data can be reused to accelerate access to the same application.

Parameters

Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Spark**. Click **Configurations** then **All Configurations**, and search for the following parameters:

Parameter	Description	Default Value
spark.history.store.path	Local directory for JobHistory to cache historical data. If this parameter is configured, JobHistory caches historical application data in local disks instead of the memory.	${BIGDATA_HOME}/tmp/spark_JobHistory
spark.history.store.maxDiskUsage	Maximum available space for JobHistory to caching data in local disks	10g

21.1.7.24 Configuring Spark SQL to Enable the Adaptive Execution Feature

Scenario

The Spark SQL adaptive execution feature enables Spark SQL to optimize subsequent execution processes based on intermediate results to improve overall execution efficiency. The following features have been implemented:

1. Automatic configuration of the number of shuffle partitions

   Before the adaptive execution feature is enabled, Spark SQL specifies the number of partitions for a shuffle process by specifying the **spark.sql.shuffle.partitions** parameter. This method lacks flexibility when multiple SQL queries are performed on an application and cannot ensure optimal performance in all scenarios. After adaptive execution is enabled, Spark SQL automatically configures the number of partitions for each shuffle process, instead of using the general configuration. In this way, the proper number of partitions is automatically used during each shuffle process.

2. Dynamic adjusting of the join execution plan

   Before the adaptive execution feature is enabled, Spark SQL creates an execution plan based on the optimization results of rule-based optimization (RBO) and Cost-Based Optimization (CBO). This method ignores changes of result sets during data execution. For example, when a view created based on a large table is joined with other large tables, the execution plan cannot be adjusted to BroadcastJoin even if the result set of the view is small. After the adaptive execution feature is enabled, Spark SQL can dynamically adjust the execution plan based on the execution result of the previous stage to obtain better performance.

3. Automatic processing of data skew

   If data skew occurs during SQL statement execution, the memory overflow of an executor or slow task execution may occur. After the adaptive execution feature is enabled, Spark SQL can automatically process data skew scenarios. Multiple tasks are started for partitions where data skew occurs. Each task reads several output files obtained from the shuffle process and performs union operations on the join results of these tasks to eliminate data skew.

Parameters

Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Spark**. Click **Configurations** then **All Configurations**, and search for the following parameters:

Parameter	Description	Default Value
spark.sql.adaptive.enabled	Specifies whether to enable the adaptive execution function. Note: If AQE and Static Partition Pruning (DPP) are enabled at the same time, DPP takes precedence over AQE during SparkSQL task execution. As a result, AQE does not take effect.	false
spark.sql.optimizer.dynamicPartitionPruning.enabled	The switch to enable DPP.	true
spark.sql.adaptive.coalescePartitions.enabled	If this parameter is set to **true** and **spark.sql.adaptive.enabled** is set to **true**, Spark combines partitions that are consecutively random played based on the target size (specified by **spark.sql.adaptive.advisoryPartitionSizeInBytes**) to prevent too many small tasks from being executed.	true
spark.sql.adaptive.coalescePartitions.initialPartitionNum	Initial number of shuffle partitions before merge. The default value is the same as the value of **spark.sql.shuffle.partitions**. This parameter is valid only when **spark.sql.adaptive.enabled** and **spark.sql.adaptive.coalescePartitions.enabled** are set to **true**. This parameter is optional. The initial number of partitions must be a positive number.	200
spark.sql.adaptive.coalescePartitions.minPartitionNum	Minimum number of shuffle partitions after merge. If this parameter is not set, the default degree of parallelism (DOP) of the Spark cluster is used. This parameter is valid only when **spark.sql.adaptive.enabled** and **spark.sql.adaptive.coalescePartitions.enable** are set to **true**. This parameter is optional. The initial number of partitions must be a positive number.	1

Parameter	Description	Default Value
spark.sql.adaptive.shuffle.targetPostShuffleInputSize	Target size of a partition after shuffling. Spark 3.0 and later versions do not support this parameter.	64MB
spark.sql.adaptive.advisoryPartitionSizeInBytes	Size of a shuffle partition (unit: byte) during adaptive optimization (**spark.sql.adaptive.enabled** is set to **true**). This parameter takes effect when Spark aggregates small shuffle partitions or splits shuffle partitions where skew occurs.	64MB
spark.sql.adaptive.fetchShuffleBlocksInBatch	Whether to obtain consecutive shuffle blocks in batches. For the same map job, reading consecutive shuffle blocks in batches can reduce I/Os and improve performance, instead of reading blocks one by one. Note that multiple consecutive blocks exist in a single read request only when **spark.sql.adaptive.enabled** and **spark.sql.adaptive.coalescePartitions.enabled** are set to **true**. This feature also relies on a relocatable serializer that uses cascading to support the codec and the latest version of the shuffle extraction protocol.	true
spark.sql.adaptive.localShuffleReader.enabled	If the value of this parameter is **true** and the value of **spark.sql.adaptive.enabled** is **true**, Spark attempts to use the local shuffle reader to read shuffle data when shuffling of partitions is not required, for example, after sort-merge join is converted to broadcast-hash join.	true
spark.sql.adaptive.skewJoin.enabled	Specifies whether to enable the function of automatic processing of the data skew in join operations. The function is enabled when this parameter is set to **true** and **spark.sql.adaptive.enabled** is set to **true**.	true

Parameter	Description	Default Value
spark.sql.adaptive.skewJoin.skewedPartitionFactor	This parameter is a multiplier used to determine whether a partition is a data skew partition. If the data size of a partition exceeds the value of this parameter multiplied by the median of the all partition sizes except this partition and exceeds the value of **spark.sql.adaptive.skewJoin.skewedPartitionThresholdInBytes**, this partition is considered as a data skew partition.	5
spark.sql.adaptive.skewJoin.skewedPartitionThresholdInBytes	If the partition size (unit: byte) is greater than the threshold as well as the product of the **spark.sql.adaptive.skewJoin.skewedPartitionFactor** value and the median partition size, skew occurs in the partition. Ideally, the value of this parameter should be greater than that of **spark.sql.adaptive.advisoryPartitionSizeInBytes.**.	256MB
spark.sql.adaptive.nonEmptyPartitionRatioForBroadcastJoin	If the ratio of non-null partitions is less than the value of this parameter when two tables are joined, broadcast hash join cannot be properly performed regardless of the partition size. This parameter is valid only when **spark.sql.adaptive.enabled** is set to **true**.	0.2

21.1.7.25 Configuring Event Log Rollover

Scenario

When the event log mode is enabled for Spark, that is, **spark.eventLog.enabled** is set to **true**, events are written to a configured log file to record the program running process. If a program, for example JDBCServer or Spark Streaming, runs for a long period of time and has run many jobs and tasks during this period, many events are recorded in the log file, significantly increasing the file size.

When log rollover is enabled, metadata events are written into the log file and job events are written into a new log file (whether a job event is written to the new log file depends on the file size). Metadata events include EnviromentUpdate, BlockManagerAdded, BlockManagerRemoved, UnpersistRDD, ExecutorAdded, ExecutorRemoved, MetricsUpdate, ApplicationStart, ApplicationEnd, and LogStart. Job events include StageSubmitted, StageCompleted, TaskResubmit, TaskStart,

TaskEnd, TaskGettingResult, JobStart, and JobEnd. For Spark SQL applications, job events also include ExecutionStart and ExecutionEnd.

The UI for the HistoryServer service of Spark is obtained by reading and parsing these log files. The memory size is preset before the HistoryServer process starts. Therefore, when the size of log files is large, loading and parsing these files may cause problems such as insufficient memory and driver GC.

To load large log files in small memory mode, you need to enable log rollover for large applications. Generally, it is recommended that this function be enabled for long-running applications.

Parameters

Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Spark**. Click **Configurations** then **All Configurations**, and search for the following parameters:

Parameter	Description	Default Value
spark.eventLog.rolling.enabled	Whether to enable rollover for event log files. If this parameter is set to **true**, the size of each event log file is reduced to the configured size.	true
spark.eventLog.rolling.maxFileSize	Maximum size of the event log file to be rolled over when **spark.eventlog.rolling.enabled** is set to **true**.	128M
spark.eventLog.compression.codec	Codec used to compress event logs. By default, Spark provides four types of codecs: LZ4, LZF, Snappy, and ZSTD. If this parameter is not specified, **spark.io.compression.codec** is used.	None
spark.eventLog.logStageExecutorMetrics	Whether to write each stage peak value (for each executor) of executor metrics to the event log.	false

21.1.7.26 Configuring the Spark Native Engine

Scenario

The Spark Native engine uses the vectorized C++ acceleration library to accelerate Spark operators. Traditional SparkSQL is based on row data and uses JVM codegen to accelerate query. The JVM has a range of restrictions on the generated Java code, such as the method length and number of parameters, and the memory bandwidth utilization of row data is low. The performance needs to be improved. When the mature vectorized C++ acceleration library is used, data is stored in the memory in vectorized format, which improves bandwidth utilization and speeds up queries by processing columns in batches.

You can enable the Spark Native engine to accelerate SparkSQL queries.

Constraints

- The Scan operator supports the following data types: Boolean, Integer, Long, Float, Double, String, Date, and Decimal.
- Parquet and ORC data formats are supported.
- OBS and HDFS file systems are supported.
- ADM64 and Arm architectures are supported.
- Spark SQL mode is supported.

Parameters

1. Modify the following parameters in the *Client installation directory*/**Spark/spark/conf/spark-defaults.conf** file on the Spark client.

Parameter	Description	Default Value
spark.plugins	Plug-in used by Spark. Set this parameter to **io.glutenproject.GlutenPlugin**. **NOTE** If **spark.plugins** has been configured, you can add **io.glutenproject.GlutenPlugin** to the file and separate them with commas (,).	N/A
spark.memory.offHeap.enabled	If this parameter is set to **true**, Native acceleration requires the off-heap memory of the JVM.	false
spark.memory.offHeap.size	Size of the off-heap memory. Set the value based on the site requirements. The initial value is 1 GB.	-1

Parameter	Description	Default Value
spark.yarn.dist.files	This parameter is used to distribute **libch.so** and **libjsig.so** to all nodes so that all executors can use the **spark.executorEnv.LD_PRELOAD** parameter to preload the above libraries. ● For the x86 architecture, set this parameter to **{***Client installation directory***}/Spark/spark/native/libch.so,{***Client installation directory***}/JDK/jdk1.8.0_372/jre/lib/amd64/libjsig.so**. ● For the Arm architecture, set this parameter to **{***Client installation directory***}/Spark/spark/native/libch.so,{***Client installation directory***}/JDK/jdk1.8.0_372/jre/lib/aarch64/libjsig.so**. **NOTE** If **spark.yarn.dist.files** has been configured, you can add this parameter to it and separate them with commas (,). **libch.so** and **libjsig.so** in the same path as **export LD_PRELOAD** in **spark-env.sh** in **2** must be used.	None
spark.executorEnv.LD_PRELOAD	Environment variable LD_PRELOAD for the executor. Set this parameter to **$PWD/libch.so $PWD/libjsig.so**. **NOTE** This parameter is used by the executor to preload **libch.so** and **libjsig.so**. If **spark.executorEnv.LD_PRELOAD** has been configured, add the preceding parameters and separate them with spaces.	None

Parameter	Description	Default Value
spark.gluten.sql.columnar.libpath	Path of the Native acceleration library on the server. This file does not exist if database mirroring is not used. Leave it blank.	Spark installation directory in the cluster, for example, **${BIGDATA_HOME}/FusionInsight_Spark_xxx/install/FusionInsight-Spark-*/spark/native/libch.so**
spark.sql.orc.impl	**native**: The native ORC of Spark is used to read data. **hive**: Hive is used to process ORC data. Set this parameter to **native**.	hive
spark.gluten.sql.columnar.scanOnly	Whether to enable scanOnly for acceleration. Set this parameter to **true** to enable the scanOnly mode.	false

2. Modify the following parameters in the *Client installation directory*/**Spark/spark/conf/spark-env.sh** file on the Spark client.
   - For the x86 architecture:

     Set **export LD_PRELOAD** to *{Client installation directory}*/**Spark/spark/native/libch.so** *{Client installation directory}*/**JDK/jdk1.8.0_372/jre/lib/amd64/libjsig.so**.
   - For the Arm architecture:

     Set **export LD_PRELOAD** to *{Client installation directory}*/**Spark/spark/native/libch.so** *{Client installation directory}*/**JDK/jdk1.8.0_372/jre/lib/aarch64/libjsig.so**.

     Note: Use the **libch.so** and **libjsig.so** that are in the same path of the **spark.yarn.dist.files** parameter. If there are multiple SO files, separate them with commas (,) and add double quotation marks (") before and after each SO file.

21.1.7.27 Configuring Automatic Merging of Small Files

Scenario

After the automatic small file merging feature is enabled, Spark writes data to the temporary directory and then checks whether the average file size of each partition is less than 16 MB (default value). If the average file size is less than 16 MB, the partition contains small files. Spark starts a job to merge these small files and writes the large files to the final table directory.

Constraints

- Only Hive and DataSource tables can be written.
- Parquet and ORC data formats are supported.

Parameter Configuration

Modify the following parameters in the *Client installation directory*/**Spark/spark/conf/spark-defaults.conf** file on the Spark client.

Parameter	Description	Default Value
spark.sql.mergeSmallFiles.enabled	If this parameter is set to **true**, Spark checks whether small files are written when writing data to the target table. If small files are found, Spark starts the file merging job.	false
spark.sql.mergeSmallFiles.threshold.avgSize	If the average file size of a partition is smaller than the value of this parameter, small file merging is started.	16 MB
spark.sql.mergeSmallFiles.maxSizePerTask	Target size of each file after the merging.	256 MB
spark.sql.mergeSmallFiles.moveParallelism	Maximum degree of parallelism of moving temporary files to the final directory. If the number of temporary files exceed the specified value, a file merging job is triggered.	10,000

21.1.8 Adapting to the Third-party JDK When Ranger Is Used

Scenarios

When Ranger is used as the permission management service of Spark SQL, the certificate in the cluster is required for accessing RangerAdmin. If you use a third-party JDK instead of the JDK or JRE in the cluster, RangerAdmin fails to be accessed. As a result, the Spark application fails to be started.

In this scenario, you need to perform the following operations to import the certificate in the cluster to the third-party JDK or JRE.

Configuration Method

Step 1 Run the following command to export the certificate from the cluster:

1. Install the cluster client in a client, for example, **/opt/client**.

2. Run the following command to switch to the client installation directory:

   cd /opt/client

3. Run the following command to configure environment variables:

   source bigdata_env

4. Generate a certificate file. For details about how to obtain *the password of the JRE truststore*, contact the system administrator.

   keytool -export -alias fusioninsightsubroot -storepass Password of the JRE truststore **-keystore /opt/client/JRE/jre/lib/security/cacerts -file fusioninsightsubroot.crt**

Step 2 Import the certificate in the cluster to the third-party JDK or JRE.

Copy the **fusioninsightsubroot.crt** file generated in **Step 1** to the third-party JRE node, set the **JAVA_HOME** environment variable of the node, and run the following command to import the certificate:

keytool -import -trustcacerts -alias fusioninsightsubroot -storepass changeit -file fusioninsightsubroot.crt -keystore MY_JRE/lib/security/cacerts

NOTE

MY_JRE indicates the installation path of the third-party JRE. Change it based on the site requirements.

----End

21.2 Spark Log Overview

Log Description

Log paths:

- Executor run log: **${BIGDATA_DATA_HOME}/hadoop/data${i}/nm/containerlogs/application_${appid}/container_{$contid}**

  NOTE

  The logs of running tasks are stored in the preceding path. After the running is complete, the system determines whether to aggregate the logs to an HDFS directory based on the Yarn configuration. For details, see **Common YARN Parameters**.

- Other logs: **/var/log/Bigdata/spark**

Log archiving rule:

- When tasks are submitted in **yarn-client** or **yarn-cluster** mode, executor log files are stored each time when the size of the log files reaches 50 MB. A maximum of 10 log files can be reserved without being compressed.
- By default, JobHistory log files are compressed and stored once when the file size reaches 100 MB. A maximum of 100 log files are retained.
- By default, JDBCServer log files are compressed and stored once when the file size reaches 100 MB. A maximum of 100 log files are retained.
- By default, IndexServer log files are compressed and stored once when the file size reaches 100 MB. A maximum of 100 log files are retained.

- By default, JDBCServer audit log files are compressed and stored once when the file size reaches 20 MB. A maximum of 20 log files are retained.
- The log file size and the number of compressed files to be reserved can be configured on FusionInsight Manager.

Table 21-62 Spark log file list

Log Type	Name	Description
SparkResource log	spark.log	Spark initialization log
	prestart.log	Prestart script log
	cleanup.log	Cleanup log file for instance installation and uninstallation
	spark-availability-check.log	Spark health check log
	spark-service-check.log	Spark service check log
JDBCServer log	JDBCServer-start.log	JDBCServer startup log
	JDBCServer-stop.log	JDBCServer stop log
	JDBCServer.log	JDBCServer run log on the server
	jdbc-state-check.log	JDBCServer health check log
	jdbcserver-omm-pid***-gc.log.*.current	JDBCServer process GC log
	spark-omm-org.apache.spark.sql.hive.thriftserver.HiveThriftProxyServer2-***.out*	JDBCServer process startup log. If the process stops, the **jstack** information is printed.
JobHistory log	jobHistory-start.log	JobHistory startup log
	jobHistory-stop.log	JobHistory stop log
	JobHistory.log	JobHistory running process log
	jobhistory-omm-pid***-gc.log.*.current	JobHistory process GC log
	spark-omm-org.apache.spark.deploy.history.HistoryServer-***.out*	JobHistory process startup log If the process stops, the **jstack** information is printed.
IndexServer log	IndexServer-start.log	IndexServer startup log
	IndexServer-stop.log	IndexServer stop log
	IndexServer.log	IndexServer run log on the server

Log Type	Name	Description
	indexserver-state-check.log	IndexServer health check log
	indexserver-omm-pid***-gc.log.*.current	IndexServer process GC log
	spark-omm-org.apache.spark.sql.hive.thriftserver.IndexServerProxy-***.out*	IndexServer process startup log. If the process stops, the **jstack** information is printed.
Audit Log	jdbcserver-audit.log ranger-audit.log	JDBCServer audit log

Log levels

Table 21-63 describes the log levels provided by Spark. The priorities of log levels are ERROR, WARN, INFO, and DEBUG in descending order. Logs whose levels are higher than or equal to the specified level are printed. The number of printed logs decreases as the specified log level increases.

Table 21-63 Log levels

Level	Description
ERROR	Error information about the current event processing
WARN	Exception information about the current event processing
INFO	Logs of this level record normal running status information about the system and events.
DEBUG	Logs of this level record the system information and system debugging information.

To modify log levels, perform the following operations:

NOTE

By default, the service does not need to be restarted after the Spark log levels are configured.

Step 1 Log in to FusionInsight Manager.

Step 2 Choose **Cluster** > **Services** > **Spark** and click **Configurations**.

Step 3 Select **All Configurations**.

Step 4 On the menu bar on the left, select the log menu of the target role.

Step 5 Select a desired log level.

Step 6 Click **Save**. Then, click **OK**.

----End

Log Format

Table 21-64 Log Format

Type	Format	Example
Run log	<*yyyy-MM-dd HH:mm:ss,SSS*>|<*Log level*>|<*Name of the thread that generates the log*>|<*Message in the log*>|<*Location where the log event occurs*>	2014-09-22 11:16:23,980 INFO DAGScheduler: Final stage: Stage 0(reduce at SparkPi.scala:35)

21.3 Obtaining Container Logs of a Running Spark Application

Container logs of running Spark applications are distributed on multiple nodes. This section describes how to quickly obtain container logs.

Scenario Description

You can run the **yarn logs** command to obtain the logs of applications running on Yarn. In different scenarios, you can run the following commands to obtain required logs:

1. Obtain complete logs of the application: **yarn logs --applicationId** *<appId>* **-out** *<outputDir>*.

   Example: **yarn logs --applicationId application_1574856994802_0016 -out /opt/test**

   The following figure shows the command output.

   a. If the application is running, container logs in the **dead** state cannot be obtained.

   b. If the application is stopped, all archived container logs can be obtained.

2. Obtain logs of a specified container: **yarn logs -applicationId** *<appId>* **-containerId** *<containerId>*.

   Example: **yarn logs -applicationId application_1574856994802_0018 -containerId container_e01_1574856994802_0018_01_000003**

   The following figure shows the command output.

   a. If the application is running, container logs in the **dead** state cannot be obtained.

   b. If the application is stopped, you can obtain logs of any container.

3. Obtain container logs in any state: **yarn logs -applicationId** *<appId>* **-containerId** *<containerId>* **-nodeAddress** *<nodeAddress>*

Example: **yarn logs -applicationId application_1574856994802_0019 -containerId container_e01_1574856994802_0019_01_000003 -nodeAddress 192-168-1-1:**8041

Execution result: Logs of any container can be obtained.

NOTE

You need to set *nodeAddress* in the command. You can run the following command to obtain the value:

yarn node -list -all

21.4 Small File Combination Tools

Tool Overview

In a large-scale Hadoop production cluster, HDFS metadata is stored in the NameNode memory, and the cluster scale is restricted by the memory limitation of each NameNode. If there are a large number of small files in the HDFS, a large amount of NameNode memory is consumed, which greatly reduces the read and write performance and prolongs the job running time. Based on the preceding information, the small file problem is a key factor that restricts the expansion of the Hadoop cluster.

This tool provides the following functions:

1. Checks the number of small files whose size is less than the threshold configured by the user in tables and returns the average size of all data files in the table directory.
2. Provides the function of combination table files. Users can set the average file size after combination.

Supported Table Types

Spark: Parquet, ORC, CSV, Text, and Json.

Hive: Parquet, ORC, CSV, Text, RCFile, Sequence and Bucket.

NOTE

1. After tables with compressed data are merged, Spark uses the default compression format Snappy for data compression. You can configure **spark.sql.parquet.compression.codec** (available values: **uncompressed**, **gzip**, and **snappy**) and **spark.sql.orc.compression.codec** (available values: **uncompressed**, **zlib**, **lzo**, and **snappy**) on the client to select the compression format for the Parquet and ORC tables. Compression formats available for Hive and Spark tables are different. Except the preceding compression formats, other compression formats are not supported.
2. To merge bucket table data, you need to add the following configurations to the **hive-site.xml** file on the Spark client:

```
<property>
<name>hive.enforce.bucketing</name>
<value>false</value>
</property>
<property>
<name>hive.enforce.sorting</name>
<value>false</value>
</property>
```

3. Spark does not support the feature of encrypting data columns in Hive.

Tool Usage

Download and install the client. For example, the installation directory is **/opt/client**. Go to **/opt/client/Spark/spark/bin** and execute **mergetool.sh**.

Environment variables loading

source /opt/client/bigdata_env

source /opt/client/Spark/component_env

Scanning function

Command: **sh mergetool.sh scan <db.table> <filesize>**

The format of *db.table* is *Database name*,*Table name*. *filesize* is the user-defined threshold of the small file size (unit: MB). The returned result is the number of files that is smaller than the threshold and the average size of data files in the table directory.

Example: **sh mergetool.sh scan default.table1 128**

Combination function

Command: **sh mergetool.sh merge <db.table> <filesize> <shuffle>**

The format of *db.table* is *Database name,Table name*. **filesize** is the user-defined average file size after file combination (unit: MB). **shuffle** is a Boolean value, and the value is **true** or **false**, which is used to configure whether to allow data to be shuffled during the merge.

Example: **sh mergetool.sh merge default.table1 128 false**

If the following information is displayed, the operation is successful:

```
SUCCESS: Merge succeeded
```

NOTE

1. Ensure that the current user is the owner of the merged table.
2. Before combination, ensure that HDFS has sufficient storage space, greater than the size of the combined table.
3. Table data must be combined separately. If a table is read during table data combination, the file may not be found temporarily. After the combination is complete, this problem is resolved. During the combination, do not write data to the corresponding tables. Otherwise, data inconsistency may occur.
4. If an error occurs indicating that the file does not exist when the query of data in a partitioned table is performed on the session spark-beeline/spark-sql that is always in the connected status. You can run the **refresh table***Table name* command as prompted to query the data again.
5. Configure **filesize** based on the site requirements. For example, you can set **filesize** to a value greater than the average during file merging after obtaining the average file size by file scan. Otherwise, the number of files may increase after the file merging.
6. During the file merging, data in the original tables is removed to the recycle bin. In the case of any exception occurs on the data after file merging, the data in the original tables is used to replace the damaged data. If an exception occurs during the process, restore the data in the trash directory by running the **mv** command in HDFS.
7. In the HDFS router federation scenario, if the target NameService of the table root path is different from that of the root path **/user**, you need to manually clear the original table files stored in the recycle bin during the second combination. Otherwise, the combination fails.
8. This tool uses the configuration of the client. Performance optimization can be performed modifying required configuration in the client configuration file.

shuffle configuration

For the combination function, you can roughly estimate the change on the number of partitions before and after the combination.

Generally, if the number of old partitions is greater than the number of new partitions, set **shuffle** to **false**. However, if the number of old partitions is much greater than that of new partitions (for example, more than 100 times), you can set **shuffle** to **true** to increase the degree of parallelism and improve the combination speed.

NOTICE

- If **shuffle** is set to **true** (repartition), the performance is improved. However, due to the particularity of the Parquet and ORC storage modes, repartition will reduce the compression ratio and the total size of the table in HDFS increases by 1.3 times.
- If **shuffle** is set to **false** (coalesce), the merged files may have some difference in size, which is close to the value of the configured **filesize**.

Log storage location

The default log storage path is **/tmp/SmallFilesLog.log4j**. To customize the log storage path, you can configure **log4j.appender.logfile.File** in **/opt/client/Spark/spark/tool/log4j.properties**.

21.5 Using CarbonData for First Query

Tool Overview

The first query of CarbonData is slow, which may cause a delay for nodes that have high requirements on real-time performance.

The tool provides the following functions:

- Preheat the tables that have high requirements on query delay for the first time.

Tool Usage

Download and install the client. For example, the installation directory is **/opt/client**. Go to the **/opt/client/Spark/spark/bin** directory and execute **start-prequery.sh**.

Configure **prequeryParams.properties** by referring to **Table 21-65**.

Table 21-65 Parameters

Parameter	Description	Example
spark.prequery.period.max.minute	Maximum preheating duration, in minutes.	60
spark.prequery.tables	Table name configuration, *database.table:int*. The table name supports the wildcard (*). **int** indicates the duration (unit: day) within which the table is updated before it is preheated.	default.test*:10
spark.prequery.maxThreads	Maximum number of concurrent threads during preheating	50
spark.prequery.sslEnable	The value is **true** in security mode and **false** in non-security mode.	true

Parameter	Description	Example
spark.prequery.driver	IP address and port number of JDBCServer. The format is *IP address:Port number*. If multiple servers need to be preheated, enter multiple *IP address:Port number* of the servers and separate them with commas (,).	192.168.0.2:22550
spark.prequery.sql	SQL statement for preheating. Different statements are separated by colons (:).	SELECT COUNT(*) FROM %s;SELECT * FROM %s LIMIT 1
spark.security.url	URL required by JDBC in security mode	;saslQop=auth-conf;auth=KERBEROS;principal=spark2x/hadoop.hadoop.com@HADOOP.COM;

NOTE

The statement configured in **spark.prequery.sql** is executed in each preheated table. The table name is replaced with **%s**.

Script Usage

Command format: **sh start-prequery.sh**

To run this command, place **user.keytab** or **jaas.conf** (either of them) and **krb5.conf** (mandatory) in the **conf** directory.

NOTE

- Currently, this tool supports only Carbon tables.
- This tool initializes the Carbon environment and pre-reads table metadata to JDBCServer. Therefore, this tool is more suitable for multi-active instances and static allocation mode.

21.6 Spark Performance Tuning

21.6.1 Spark Core Tuning

21.6.1.1 Data Serialization

Scenario

Spark supports the following types of serialization:

- JavaSerializer
- KryoSerializer

Data serialization affects the Spark application performance. In specific data format, KryoSerializer offers 10X higher performance than JavaSerializer. For Int data, performance optimization can be ignored.

KryoSerializer depends on Chill of Twitter. Not all Java Serializable objects support KryoSerializer. Therefore, class must be manually registered.

Serialization involves task serialization and data serialization. Only JavaSerializer can be used for Spark task serialization. JavaSerializer and KryoSerializer can be used for data serialization.

Procedure

When the Spark program is running, a large volume of data needs to be serialized during the shuffle and RDD cache procedures. By default, JavaSerializer is used. You can also configure KryoSerializer as the data serializer to improve serialization performance.

Add the following code to enable KryoSerializer to be used:

- Implement the class registrar and manually register the class.

```
package com.etl.common;

import com.esotericsoftware.kryo.Kryo;
import org.apache.spark.serializer.KryoRegistrator;

public class DemoRegistrator implements KryoRegistrator
{
   @Override
   public void registerClasses(Kryo kryo)
   {
      //Class examples are given below. Register the custom classes.
      kryo.register(AggrateKey.class);
      kryo.register(AggrateValue.class);
   }
}
```

  You can configure **spark.kryo.registrationRequired** on Spark client. Whether to require registration with Kryo. If set to 'true', Kryo will throw an exception if an unregistered class is serialized. If set to false (the default), Kryo will write unregistered class names along with each object. Writing class names can cause significant performance overhead. This operation will affect the system performance. If the value of **spark.kryo.registrationRequired** is configured to **true**, you need to manually register the class. For a class that is not serialized, the system will not automatically write the class name, but display an exception. Compare the configuration of **true** with that of **false**, the configuration of **true** has the better performance.

- Configure KryoSerializer as the data serializer and class registrar.

```
val conf = new SparkConf()
conf.set("spark.serializer", "org.apache.spark.serializer.KryoSerializer")
.set("spark.kryo.registrator", "com.etl.common.DemoRegistrator")
```

21.6.1.2 Optimizing Memory Configuration

Scenario

Spark is a memory-based computing frame. If the memory is insufficient during computing, the Spark execution efficiency will be adversely affected. You can determine whether memory becomes the performance bottleneck by monitoring garbage collection (GC) and evaluating the resilient distributed dataset (RDD) size in the memory, and take performance optimization measures.

To monitor GC of node processes, add the -verbose:gc -XX:+PrintGCDetails -XX:+PrintGCTimeStamps parameter to the **spark.driver.extraJavaOptions** and **spark.executor.extraJavaOptions** in the client configuration file **conf/spark-default.conf**. If "Full GC" is frequently reported, GC needs to be optimized. Cache the RDD and query the RDD size in the log. If a large value is found, change the RDD storage level.

Procedure

- To optimize GC, adjust the ratio of the young generation and tenured generation. Add **-XX:NewRatio** parameter to the **spark.driver.extraJavaOptions** and **spark.executor.extraJavaOptions** in the client configuration file **conf/spark-default.conf**. For example, export SPARK_JAVA_OPTS=" -XX:NewRatio=2". The new generation accounts for 1/3 of the heap, and the tenured generation accounts for 2/3.
- Optimize the RDD data structure when compiling Spark programs.
  - Use primitive arrays to replace fastutil arrays, for example, use fastutil library.
  - Avoid nested structure.
  - Avoid using String in keys.
- Suggest serializing the RDDs when developing Spark programs.

  By default, data is not serialized when RDDs are cached. You can set the storage level to serialize the RDDs and minimize memory usage. For example:

  ```
  testRDD.persist(StorageLevel.MEMORY_ONLY_SER)
  ```

21.6.1.3 Setting the DOP

Scenario

The degree of parallelism (DOP) specifies the number of tasks to be executed concurrently. It determines the number of data blocks after the shuffle operation. Configure the DOP to improve the processing capability of the system.

Query the CPU and memory usage. If the tasks and data are not evenly distributed among nodes, increase the DOP. Generally, set the DOP to two or three times that of the total CPUs in the cluster.

Procedure

Configure the DOP parameter using one of the following methods based on the actual memory, CPU, data, and application logic conditions:

- Configure the DOP parameter in the operation function that generates the shuffle. This method has the highest priority.
  ```
  testRDD.groupByKey(24)
  ```
- Configure the DOP using **spark.default.parallelism**. This method has the lower priority than the preceding one.
  ```
  val conf = new SparkConf();
  conf.set("spark.default.parallelism", 24);
  ```
- Configure the value of **spark.default.parallelism** in the **$SPARK_HOME/conf/spark-defaults.conf** file. This method has the lowest priority.
  ```
  spark.default.parallelism    24
  ```

21.6.1.4 Using Broadcast Variables

Scenario

Broadcast distributes data sets to each node. It allows data to be obtained locally when a data set is needed during a Spark task. If broadcast is not used, data serialization will be scheduled to tasks each time when a task requires data sets. It is time-consuming and makes the task get bigger.

1. If a data set will be used by each slice of a task, broadcast the data set to each node.
2. When small and big tables need to be joined, broadcast small tables to each node. This eliminates the shuffle operation, changing the join operation into a common operation.

Procedure

Add the following code to broadcast the testArr data to each node:

```
def main(args: Array[String) {
  ...
  val testArr: Array[Long] = new Array[Long](200)
  val testBroadcast: Broadcast[Array[Long]] = sc.broadcast(testArr)
  val resultRdd: RDD[Long] = inpputRdd.map(input => handleData(testBroadcast, input))
  ...
}

def handleData(broadcast: Broadcast[Array[Long]], input: String) {
  val value = broadcast.value
  ...
}
```

21.6.1.5 Using the external shuffle service to improve performance

Scenario

When the Spark system runs applications that contain a shuffle process, an executor process also writes shuffle data and provides shuffle data for other executors in addition to running tasks. If the executor is heavily loaded and GC is triggered, the executor cannot provide shuffle data for other executors, affecting task running.

The external shuffle service is an auxiliary service in NodeManager. It captures shuffle data to reduce the load on executors. If GC occurs on an executor, tasks on other executors are not affected.

Procedure

Step 1 Log in to FusionInsight Manager.

Step 2 Choose **Cluster** > **Services** > **Spark** and click **Configurations** then **All Configurations**.

Step 3 Click **SparkResource**, select **Default**, and modify the following parameter:

Table 21-66 Parameter

Parameter	Default Value	Changed To
spark.shuffle.service.enabled	false	true

Step 4 Restart the Spark service for the configuration to take effect.

NOTE

To use External Shuffle Service on the Spark client, you need to download and install the Spark client again.

----End

21.6.1.6 Configuring Dynamic Resource Scheduling in Yarn Mode

Scenario

Resources are a key factor that affects Spark execution efficiency. When a long-running service (such as the JDBCServer) is allocated with multiple executors without tasks but resources of other applications are insufficient, resources are wasted and scheduled improperly.

Dynamic resource scheduling can add or remove executors of applications in real time based on the task load. In this way, resources are dynamically scheduled to applications.

Procedure

Step 1 Configure the external shuffle service.

Step 2 Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Spark**. Click **Configurations** then **All Configurations**. Enter **spark.dynamicAllocation.enabled** in the search box and set its value to **true** to enable the dynamic resource scheduling function. This function is disabled by default.

----End

Table 21-67 lists some optional configuration items.

Table 21-67 Parameters for dynamic resource scheduling

Configuration Item	Description	Default Value
spark.dynamicAllocation.minExecutors	Indicates the minimum number of executors.	0
spark.dynamicAllocation.initialExecutors	Indicates the number of initial executors.	0
spark.dynamicAllocation.maxExecutors	Indicates the maximum number of executors.	2048
spark.dynamicAllocation.schedulerBacklogTimeout	Indicates the first timeout period for scheduling.	1s
spark.dynamicAllocation.sustainedSchedulerBacklogTimeout	Indicates the second and later timeout interval for scheduling.	1s
spark.dynamicAllocation.executorIdleTimeout	Indicates the idle timeout interval for common executors.	60s
spark.dynamicAllocation.cachedExecutorIdleTimeout	Indicates the idle timeout interval for executors with cached blocks.	• JDBCServer: 2147483647s • IndexServer: 2147483647s • SparkResource: 120

NOTE

The external shuffle service must be configured before using the dynamic resource scheduling function.

21.6.1.7 Configuring Process Parameters

Scenario

There are three processes in Spark on Yarn mode: driver, ApplicationMaster, and executor. The Driver and Executor handle the scheduling and running of the task. The ApplicationMaster handles the start and stop of the container.

Therefore, the configuration of the driver and executor is very important to run the Spark application. You can optimize the performance of the Spark cluster according to the following procedure.

Procedure

Step 1 Configure the driver memory.

The driver schedules tasks and communicates with the executor and the ApplicationMaster. Add driver memory when the number and parallelism level of the tasks increases.

You can configure the driver memory based on the number of the tasks.

- Set **spark.driver.memory** in **spark-defaults.conf** to a proper value.
- Add the **--driver-memory MEM** parameter to configure the memory when using the **spark-submit** command.

Step 2 Configure the number of the executors.

One core in an executor can run one task at the same time. Therefore, more tasks can be processed at the same time if you increase the number of the executors. You can add the number of the executors to increase the efficiency if resources are sufficient.

- Set **spark.executor.instance** in **spark-defaults.conf** or **SPARK_EXECUTOR_INSTANCES** in **spark-env.sh** to a proper value.
- Add the **--num-executors NUM** parameter to configure the number of the executors when using the **spark-submit** command.

Step 3 Configure the number of the executor cores.

Multiple cores in an executor can run multiple tasks at the same time, which increases the task concurrency. However, because all cores share the memory of an executor, you need to balance the memory and the number of cores.

- Set **spark.executor.cores** in **spark-defaults.conf** or **SPARK_EXECUTOR_CORES** in **spark-env.sh** to a proper value.
- When you run the **spark-submit** command, add the **--executor-cores NUM** parameter to set the number of executor cores.

Step 4 Configure the executor memory.

The executor memory is used for task execution and communication. You can increase the memory for a big task that needs more resources, and reduce the memory to increase the concurrency level for a small task that runs fast.

- Set **spark.executor.memory** in **spark-defaults.conf** or **SPARK_EXECUTOR_MEMORY** in **spark-env.sh** to a proper value.
- When you run the **spark-submit** command, add the **--executor-memory MEM** parameter to set the memory.

----End

Example

- During the **spark wordcount** calculation, the amount of data is 1.6 TB and the number of the executors is 250.

  The execution fails under the default configuration, and the **Futures timed out** and **OOM** errors occur.

  However each task of wordcount is small and runs fast, the amount of the data is big and the tasks are too many. Therefore the objects on the driver end become huge when there are many tasks. Besides the fact that the executor communicates with the driver once each task is finished, the

problem of disconnection between processes caused by insufficient memory occurs.

The application runs successfully when the memory of the Driver is set to 4 GB.

- Many errors still occurred in the default configuration when running TPC-DS test on JDBCServer, such as "Executor Lost". When there is 30 GB of driver memory, 2 executor cores, 125 executors, and 6 GB of executor memory, all tasks can be successfully executed.

21.6.1.8 Designing the Direction Acyclic Graph (DAG)

Scenario

Optimal program structure helps increase execution efficiency. During application programming, avoid shuffle operations and combine narrow-dependency operations.

Procedure

This topic describes how to design the DAG using the following example:

- **Data format**: Time when a vehicle passes a toll station, license plate number, toll station number, and more
- **Logic**: Two vehicles are determined to be traveling together if the following conditions are met:
  - Both vehicles pass the same toll stations in the same sequence.
  - The difference between the time that the vehicles pass the same toll station is smaller than a specified value.

There are two implementation ways for this example. **Figure 21-6** shows the logic of implementation 1 and **Figure 21-7** shows logic of implementation 2.

Figure 21-6 Implementation logic 1

Logic description:

1. Collect information about the toll stations passed by each vehicle based on the vehicle license plate number and sort the toll stations.

The following data is obtained: vehicle license plate number 1, [(time, toll station 3), (time, toll station 2), (time, toll station 4), (time, toll station 5)]

2. Determine the sequence in which the vehicle passed through.

   (toll station 3, (vehicle license plate number 1, time, 1st toll station))

   (toll station 2, (vehicle license plate number 1, time, 2nd toll station))

   (toll station 4, (vehicle license plate number 1, time, 3rd toll station))

   (toll station 5, (vehicle license plate number 1, time, 4th toll station))

3. Aggregate data by toll station.

   toll station 1, [(vehicle license plate number 1, time, 1st toll station), (vehicle license plate number 2, time, 5th toll station), (vehicle license plate number 3, time, 2nd toll station)]

4. Determine whether the time difference that two vehicles passed through the same toll station is below the specified value. If yes, fetch information about the two vehicles.

   (vehicle license plate number 1, vehicle license plate number 2),(1st toll station, 5th toll station)

   (vehicle license plate number 1, vehicle license plate number 3),(1st toll station, 2nd toll station)

5. Aggregate data based on the vehicle license plate numbers that passed through the same toll stations.

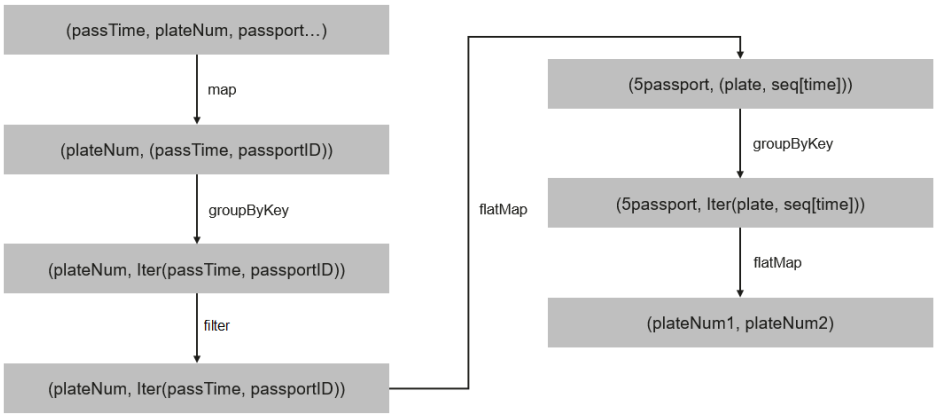
   (vehicle license plate number 1, vehicle license plate number 2), [(1st toll station, 5th toll station), (2nd toll station, 6th toll station), (1st toll station, 7th toll station), (3rd toll station, 8th toll station)]

6. If the two vehicles pass through the same toll stations in sequence, for example, toll stations 3, 4, 5 are the first, second, and third toll station passed by vehicle 1 and the 6th, 7th, and 8th toll station passed by vehicle 2, and the number of toll stations meets the specified requirements, the two vehicles are determined to be traveling together.

The logic of implementation 1 has the following disadvantages:

- The logic is complex.
- Too many shuffle operations affect performance.

Figure 21-7 Implementation logic 2



Logic description:

1. Collect information about the toll stations passed by each vehicle based on the vehicle license plate number and sort the toll stations.

   The following data is obtained: vehicle license plate number 1, [(time, toll station 3), (time, toll station 2), (time, toll station 4), (time, toll station 5)]

2. Based on the number of toll stations (the number is 3 in this example) that must be passed by these vehicles, divide the toll station sequence as follows:

   toll station 3 > toll station 2 > toll station 4, (vehicle license plate number 1, [time passing through toll station 3, time passing through toll station 2, time passing through toll station 4])

   toll station 2 > toll station 4 > toll station 5, (vehicle license plate number 1, [time passing through toll station 2, time passing through toll station 4, time passing through toll station 5])

3. Aggregate information about vehicles that pass the same toll stations in the same sequence.

   toll station 3 > toll station 2 > toll station 4, [(vehicle license plate number 1, [time passing through toll station 3, time passing through toll station 2, time passing through toll station 4]), (vehicle license plate number 2, [time passing through toll station 3, time passing through toll station 2, time passing through toll station 4]), (vehicle license plate number 3, [time passing through toll station 3, time passing through toll station 2, time passing through toll station 4])]

4. Determine whether the time difference that these vehicles passed through the same toll station is below the specified value. If yes, the vehicles are determined to be traveling together.

The logic of implementation 2 has the following advantages:

- The logic is simplified.
- One **groupByKey** is reduced, that is, one less shuffle operation is performed. It helps improve performance.

21.6.1.9 Experience

Use mapPartitions to calculate data by partition.

If the overhead of each record is high, for example:

```
rdd.map{x=>conn=getDBConn;conn.write(x.toString);conn.close}
```

Use mapPartitions to calculate data by partition.

```
rdd.mapPartitions(records => conn.getDBConn;for(item <- records)
write(item.toString); conn.close)
```

Use mapPartitions to flexibly operate data. For example, to calculate the TopN of a large data, mapPartitions can be used to calculate the TopN of each partition and then sort the TopN of all partitions when N is small. Compared with sorting full data for the TopN, this method has the higher efficiency.

Use coalesce to adjust the number of slices.

Use coalesce to adjust the number of slices. There are two coalesce functions:

```
coalesce(numPartitions: Int, shuffle: Boolean = false)
```

When **shuffle** is set to **true**, the function is the same as repartition(numPartitions:Int). Partitions are recreated using the shuffle. When **shuffle** is set to **false**, partitions of the parent resilient distributed datasets (RDD) are calculated in the same task. In this case, if the value of **numPartitions** is larger than the number of sections of the parent RDD, partitions will not be recreated.

The following scenario is encountered, you can choose the coalesce operator:

- If the previous operation involves a large number of filters, use coalesce to minimize the number of zero-loaded tasks. In coalesce(numPartitions, false), the value of **numPartitions** is smaller than the number of sections of the parent RDD.
- Use coalesce when the number of slices entered is too big to execute.
- Use coalesce when the programs are suspended in the shuffle operation because of a large number of tasks or the Linux resources are limited. In this case, use coalesce(numPartitions, true) to recreate partitions.

Configure a localDir for each disk.

During the shuffle procedure of Spark, data needs to be written into local disks. The performance bottleneck of Spark is shuffle, and the bottleneck of shuffle is the I/O. To improve the I/O performance, you can configure multiple disks to implement concurrent data writing. If a node is mounted with multiple disks, configure a Spark local Dir for each disk. This can effectively distribute shuffle files in multiple locations, improving disk I/O efficiency. The performance cannot be improved effectively if a disk is configured with multiple directories.

Collect small data sets.

The collect operation does not apply to a large data volume.

When the collect operation is performed, the Executor data will be sent to the Driver. Before performing this operation, ensure that the memory of Driver is sufficient. Otherwise, the Driver process may encounter an OutOfMemory error. If the data volume is unknown, perform the saveAsTextFile operation to write data into the HDFS. If the data volume is known and the Driver has sufficient memory, perform the collect operation.

Use reduceByKey

reduceByKey causes local aggregation on the Map side, which offers a smooth shuffle procedure. The shuffle operations, like groupByKey, will not perform aggregation on the Map side. Therefore, use reduceByKey as possible as you can, and avoid groupByKey().map(x=>(x._1,x._2.size)).

Broadcast map instead of array.

If table query is required for each record of the data transmitted from the Driver side, broadcast the data in the set/map instead of Iterator. The query speed of Set/Map is approximately O(1), while the query speed of Iterator is O(n).

Avoid data skew.

If data skew occurs (certain data volume is extremely large), the execution time of tasks is inconsistent even if there is no Garbage Collection (GC).

- Redefine the keys. Use keys of smaller granularity to optimize the task size.
- Modify the degree of parallelism (DOP).

Optimize the data structure.

- Store data by column. As a result, only the required columns are scanned when data is read.
- When using the Hash Shuffle, set **spark.shuffle.consolidateFiles** to **true** to combine the intermediate files of shuffle, minimize the number of shuffle files and file I/O operations, and improve performance. The number of final files is the number of reduce tasks.

21.6.2 Spark SQL and DataFrame Tuning

21.6.2.1 Optimizing the Spark SQL Join Operation

Scenario

When two tables are joined in Spark SQL, the broadcast function (see section "Using Broadcast Variables") can be used to broadcast tables to each node. This minimizes shuffle operations and improves task execution efficiency.

NOTE

The join operation refers to the inner join operation only.

Procedure

The following describes how to optimize the join operation in Spark SQL. Assume that both tables A and B have the **name** column. Join tables A and B as follows:

1. Estimate the table sizes.

   Estimate the table size based on the size of data loaded each time.

   You can also check the table size in the directory of the Hive database. In the **hive-site.xml** configuration file of Spark, view the Hive database directory, which is **/user/hive/warehouse** by default. The default Hive database directory for multi-instance Spark is **/user/***hive***/warehouse**, for example, **/user/hive1/warehouse**.

   ```
   <property>
     <name>hive.metastore.warehouse.dir</name>
    <value>${test.warehouse.dir}</value>
    <description></description>
   </property>
   ```

   Run the **hadoop** command to check the size of the table. For example, run the following command to view the size of table **A**:

   ```
   hadoop fs -du -s -h ${test.warehouse.dir}/a
   ```

NOTE

To perform the broadcast operation, ensure that at least one table is not empty.

2. Configure a threshold for automatic broadcast.

   The threshold for triggering broadcast for a table is 10485760 (that is, 10 MB) in Spark. If either of the table sizes is smaller than 10 MB, skip this step.

   Table 21-68 lists configuration parameters of the threshold for automatic broadcasting.

   Table 21-68 Parameter description

Parameter	Default Value	Description
spark.sql.autoBroadcastJoinThreshold	10485760	Indicates the maximum value for the broadcast configuration when two tables are joined. • When the size of a field in a table involved in an SQL statement is less than the value of this parameter, the system broadcasts the SQL statement. • If the value is set to **-1**, broadcast is not performed.

   Methods for configuring the threshold for automatic broadcasting:

   – Set **spark.sql.autoBroadcastJoinThreshold** in the **spark-defaults.conf** configuration file of Spark.

   ```
   spark.sql.autoBroadcastJoinThreshold = <size>
   ```

   – Run the Hive command to set the threshold. Before joining the tables, run the following command:

   ```
   SET spark.sql.autoBroadcastJoinThreshold=<size>;
   ```

3. Join the tables.

   – The size of each table is smaller than the threshold.

   ▪ If the size of table A is smaller than that of table B, run the following command:

   ```
   SELECT A.name FROM B JOIN A ON A.name = B.name;
   ```

   ▪ If the size of table B is smaller than that of table A, run the following command:

   ```
   SELECT A.name FROM A JOIN B ON A.name = B.name;
   ```

   – One table size is smaller than the threshold, while the other table size is greater than the threshold.

   Broadcast the smaller table.

   – The size of each table is greater than the threshold.

   Compare the size of the field involved in the query with the threshold.

   ▪ If the values of the fields in a table are smaller than the threshold, the corresponding data in the table is broadcast.

    - If the values of the fields in the two tables are greater than the threshold, do not broadcast either of the table.

4. (Optional) In the following scenarios, you need to run the Analyze command (***ANALYZE TABLE tableName COMPUTE STATISTICS noscan;***) to update metadata before performing the broadcast operation:
   - The table to be broadcasted is a newly created partitioned table and the file type is non-Parquet.
   - The table to be broadcasted is a newly updated partitioned table.

Reference

A task is ended if a timeout occurs during the execution of the to-be-broadcasted table.

By default, BroadCastJoin allows only 5 minutes for the to-be-broadcasted table calculation. If the time is exceeded, a timeout will occur. However, the broadcast task of the to-be-broadcasted table calculation is still being executed, resulting in resource waste.

The following methods can be used to address this issue:

- Modify the value of **spark.sql.broadcastTimeout** to increase the timeout duration.
- Reduce the value of **spark.sql.autoBroadcastJoinThreshold** to disable the optimization of BroadCastJoin.

21.6.2.2 Improving Spark SQL Calculation Performance Under Data Skew

Scenario

When multiple tables are joined in Spark SQL, skew occurs in join keys and the data volume in some Hash buckets is much higher than that in other buckets. As a result, some tasks with a large amount of data run slowly, resulting low computing performance. Other tasks with a small amount of data are quickly completed, which frees many CPUs and results in a waste of CPU resources.

If the automatic data skew function is enabled, data that exceeds the bucketing threshold is bucketed. Multiple tasks proceed data in one bucket. Therefore, CPU usage is enhanced and the system performance is improved.

NOTE

Data that has no skew is bucketed and run in the original way.

Restrictions:

- Only the join between two tables is supported.
- FULL OUTER JOIN data does not support data skew.

  For example, the following SQL statement indicates that the skew of table **a** or table **b** cannot trigger the optimization.

  select aid FROM a FULL OUTER JOIN b ON aid=bid;
- LEFT OUTER JOIN data does not support the data skew of the right table.

For example, the following SQL statement indicates that the skew of table **b** cannot trigger the optimization.

select aid FROM a LEFT OUTER JOIN b ON aid=bid;

- RIGHT OUTER JOIN does not support the data skew of the left table.

  For example, the following SQL statement indicates that the skew of table **a** cannot trigger the optimization.

  select aid FROM a RIGHT OUTER JOIN b ON aid=bid;

Configuration Description

Add the following parameters in the following table to the **spark-defaults.conf** configuration file on the Spark driver.

Table 21-69 Parameter description

Parameter	Description	Default Value
spark.sql.adaptive.enabled	The switch to enable the adaptive execution feature. Note: If AQE and Static Partition Pruning (DPP) are enabled at the same time, DPP takes precedence over AQE during SparkSQL task execution. As a result, AQE does not take effect. The DPP in the cluster is enabled by default. Therefore, you need to disable it when enabling the AQE.	false
spark.sql.optimizer.dynamicPartitionPruning.enabled	The switch to enable DPP.	true
spark.sql.adaptive.skewJoin.enabled	Specifies whether to enable the function of automatic processing of the data skew in join operations. The function is enabled when this parameter is set to **true** and **spark.sql.adaptive.enabled** is set to **true**.	true
spark.sql.adaptive.skewJoin.skewedPartitionFactor	This parameter is a multiplier used to determine whether a partition is a data skew partition. If the data size of a partition exceeds the value of this parameter multiplied by the median of the all partition sizes except this partition and exceeds the value of **spark.sql.adaptive.skewJoin.skewedPartitionThresholdInBytes**, this partition is considered as a data skew partition.	5

Parameter	Description	Default Value
spark.sql.adaptive.skewjoin.skewedPartitionThresholdInBytes	If the partition size (unit: byte) is greater than the threshold as well as the product of the **spark.sql.adaptive.skewJoin.skewedPartitionFactor** value and the median partition size, skew occurs in the partition. Ideally, the value of this parameter should be greater than that of **spark.sql.adaptive.advisoryPartitionSizeInBytes.**.	256MB
spark.sql.adaptive.shuffle.targetPostShuffleInputSize	Minimum amount of shuffle data processed by each task. The unit is byte.	67108864

21.6.2.3 Optimizing Spark SQL Performance in the Small File Scenario

Scenario

A Spark SQL table may have many small files (far smaller than an HDFS block), each of which maps to a partition on the Spark by default. In other words, each small file is a task. If the small files are great in number, Spark must initiate a large number of tasks. If shuffle operations exist in Spark SQL, the number of hash buckets increases, affecting performance.

In this scenario, you can manually specify the split size of each task to avoid an excessive number of tasks and improve performance.

NOTE

If the SQL logic does not involve shuffle operations, this optimization does not improve performance.

Configuration

If you want to enable small file optimization, configure the **spark-defaults.conf** file on the Spark client.

Table 21-70 Parameter description

Parameter	Description	Default Value
spark.sql.files.maxPartitionBytes	The maximum number of bytes that can be packed into a single partition when a file is read. Unit: byte	134217728 (128 MB)

Parameter	Description	Default Value
spark.files.openCostInBytes	The estimated cost to open a file, measured by the number of bytes that can be scanned in the same time. This is used when putting multiple files into a partition. It is better to over estimate, then the partitions with small files will be faster than partitions with larger files.	4 MB

21.6.2.4 Optimizing the INSERT...SELECT Operation

Scenario

The INSERT...SELECT operation needs to be optimized if any of the following conditions is true:

- Many small files need to be queried.
- A few large files need to be queried.
- The INSERT...SELECT operation is performed by a non-spark user in Beeline/JDBCServer mode.

Procedure

Optimize the INSERT...SELECT operation as follows:

- If the table to be created is the Hive table, set the storage type to Parquet. This enables INSERT...SELECT statements to be run faster.
- Perform the INSERT...SELECT operation as a spark-sql user or spark user (if in Beeline/JDBCServer mode). In this way, it is no longer necessary to change the file owner repeatedly, accelerating the execution of INSERT...SELECT statements.

  NOTE

  In Beeline/JDBCServer mode, the executor user is the same as the driver user. The driver user is a spark user because the driver is a part of JDBCServer service and started by a spark user. If the Beeline user is not a spark user, the file owner must be changed to the Beeline user (actual user) because the executor is unaware of the Beeline user.

- If many small files need to be queried, set spark.sql.files.maxPartitionBytes and spark.files.openCostInBytes to set the maximum size in bytes of partition and combine multiple small files in a partition to reduce file amount. This accelerates file renaming, ultimately enabling INSERT...SELECT statements to be run faster.

NOTE

The preceding optimizations are not a one-size-fits-all solution. In the following scenario, it still takes long to perform the INSERT...SELECT operation:

The dynamic partitioned table contains many partitions.

21.6.2.5 Multiple JDBC Clients Concurrently Connecting to JDBCServer

Scenario

Multiple clients can be connected to JDBCServer at the same time. However, if the number of concurrent tasks is too large, the default configuration of JDBCServer must be optimized to adapt to the scenario.

Procedure

1. Set the fair scheduling policy of JDBCServer.

   The default scheduling policy of Spark is **FIFO**, which may cause a failure of short tasks in multi-task scenarios. Therefore, the fair scheduling policy must be used in multi-task scenarios to prevent task failure.

   a. Configure fair scheduling in Spark. For details, visit the following website:

   b. Configure Fair Scheduler on the JDBC client.

      i. In the Beeline command line client or the code defined by JDBC, run the following statement:

         PoolName is a scheduling pool for Fair Scheduler.

         ```
         SET spark.sql.thriftserver.scheduler.pool=PoolName;
         ```

      ii. Run the SQL command. The Spark task will be executed in the preceding scheduling pool.

2. Set the **BroadCastHashJoin** timeout interval.

   There is a timeout parameter of **BroadCastHashJoin**. The task query fails if the query period exceeds the preset timeout interval. In multi-task scenarios, the Spark task of BroadCastHashJoin may fail due to resource preemption. Therefore, it is necessary to modify the timeout interval in the **spark-defaults.conf** file of JDBCServer.

   Table 21-71 Parameter description

Parameter	Description	Default Value
spark.sql.broadcastTimeout	The timeout interval in the broadcast table of **BroadcastHashJoin**. If there are many concurrent tasks, set the parameter to a larger value or a negative number.	-1 (Numeral type. The actual value is 5 minutes.)

21.6.2.6 Optimizing Memory when Data Is Inserted into Dynamic Partitioned Tables

Scenario

When SparkSQL inserts data to dynamic partitioned tables, the more partitions there are, the more HDFS files a single task generates and the more memory metadata occupies. In this case, Garbage Collection (GC) is severe and Out of Memory (OOM) may occur.

Assume there are 10240 tasks and 2000 partitioned. Before the rename operation of HDFS files from a temporary directory to the target directory, there is about 29 GB FileStatus metadata.

Procedure

Insert **distribute by** followed by partition fields into dynamic partition statements.

For example:

insert into table store_returns partition (sr_returned_date_sk) select sr_return_time_sk,sr_item_sk,sr_customer_sk,sr_cdemo_sk,sr_hdemo_sk,sr_addr_sk,sr_store_sk,sr_reason_sk,sr_ticket_number,sr_return_quantity,sr_return_amt,sr_return_tax,sr_return_amt_inc_tax,sr_fee,sr_return_ship_cost,sr_refunded_cash,sr_reversed_charge,sr_store_credit,sr_net_loss,sr_returned_date_sk from ${SOURCE}.store_returns **distribute by sr_returned_date_sk**;

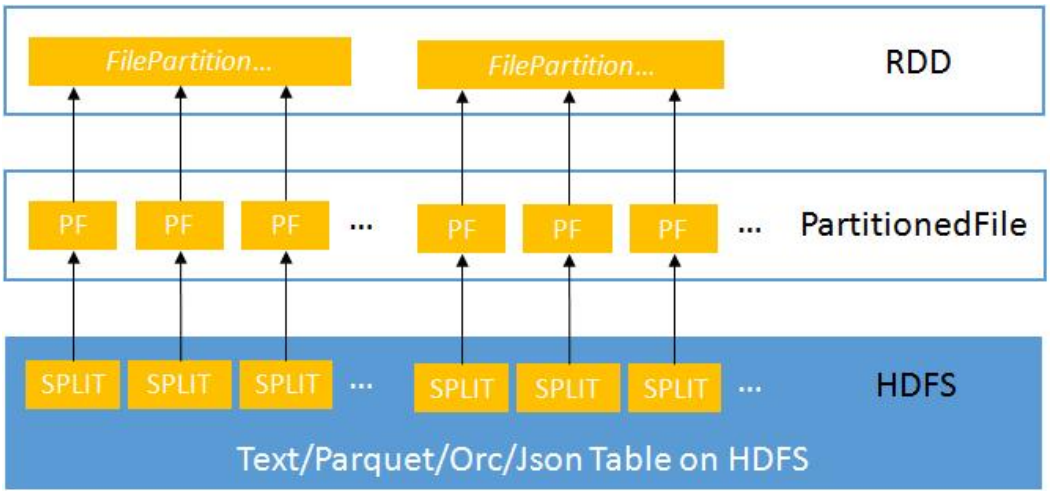
21.6.2.7 Optimizing Small Files

Scenario

A Spark SQL table may have many small files (far smaller than an HDFS block), each of which maps to a partition on the Spark by default. In other words, each small file is a task. In this way, Spark has to start many such tasks. If a shuffle operation is involved in the SQL logic, the number of hash buckets soars, severely hindering system performance.

In case of massive number of small files, when DataSource creates an RDD, it splits small files in the Spark SQL table to PartitionedFiles and then merges the PartitionedFiles to a partition to avoid generating too many hash buckets during the shuffle operation. See **Figure 21-8**.

Figure 21-8 Merging small files



Procedure

If you want to enable small file optimization, configure the **spark-defaults.conf** file on the Spark client.

Table 21-72 Parameter description

Parameter	Description	Default Value
spark.sql.files.maxPartitionBytes	The maximum number of bytes that can be packed into a single partition when a file is read. Unit: byte	134217728 (128 MB)
spark.files.openCostInBytes	The estimated cost to open a file, measured by the number of bytes that can be scanned in the same time. This is used when putting multiple files into a partition. It is better to over estimate, then the partitions with small files will be faster than partitions with larger files.	4 MB

21.6.2.8 Optimizing the Aggregate Algorithms

Scenario

Spark SQL supports hash aggregate algorithm. Namely, use fast aggregate hashmap as cache to improve aggregate performance. The hashmap replaces the previous ColumnarBatch to avoid performance problems caused by the wide mode (multiple key or value fields) of an aggregate table.

Procedure

If you want to enable optimization of aggregate algorithm, configure following parameters in the **spark-defaults.conf** file on the Spark client.

Table 21-73 Parameter description

Parameter	Description	Default Value
spark.sql.codegen.aggregate.map.twolevel.enabled	Specifies whether to enable aggregation algorithm optimization. • **true**: Enable • **false**: Disable	true

21.6.2.9 Optimizing Datasource Tables

Scenario

Save the partition information about the datasource table to the Metastore and process partition information in the Metastore.

- Optimize the datasource tables, support syntax such as adding, deletion, and modification in the table based on partitions, improving compatibility with Hive.
- Support statements of partition tailoring and push down to the Metastore to filter unmatched partitions.

  Example:

  ```
  select count(*) from table where partCol=1;    //partCol (partition column)
  ```

  You need only to process data corresponding to partCol=1 when performing the TableScan operation in the physical plan.

Procedure

If you want to enable Datasource table optimization, configure the **spark-defaults.conf** file on the Spark client.

Table 21-74 Parameter description

Parameter	Description	Default Value
spark.sql.hive.manageFilesourcePartitions	Specifies whether to enable Metastore partition management (including datasource tables and converted Hive). • **true** indicates enabling Metastore partition management. In this case, datasource tables are stored in Hive and Metastore is used to tailor partitions in query statements. • **false** indicates disabling Metastore partition management.	true
spark.sql.hive.metastorePartitionPruning	Specifies whether to support pushing down predicate to Hive Metastore. • **true** indicates supporting pushing down predicate to Hive Metastore. Only the predicate of Hive tables is supported. • **false** indicates not supporting pushing down predicate to Hive Metastore.	true
spark.sql.hive.filesourcePartitionFileCacheSize	The cache size of the partition file metadata in the memory. All tables share a cache that can use up to specified num bytes for file metadata. This parameter is valid only when **spark.sql.hive.manageFilesourcePartitions** is set to **true**.	250 * 1024 * 1024

Parameter	Description	Default Value
spark.sql.hive.convertMetastoreOrc	The processing approach of ORC tables. • **false**: Spark SQL uses Hive SerDe to process ORC tables. • **true**: Spark SQL uses the Spark built-in mechanism to process ORC tables.	true

21.6.2.10 Merging CBO

Scenario

Spark SQL supports rule-based optimization by default. However, the rule-based optimization cannot ensure that Spark selects the optimal query plan. Cost-Based Optimizer (CBO) is a technology that intelligently selects query plans for SQL statements. After CBO is enabled, the CBO optimizer performs a series of estimations based on the table and column statistics to select the optimal query plan.

Procedure

Perform the following steps to enable CBO:

1. You need to run corresponding SQL commands to collect required table and column statistics.

   SQL commands are as follows (to be chosen as required):

   – Generate table-level statistics (table scanning):

   ANALYZE TABLE src COMPUTE STATISTICS

   This command generates **sizeInBytes** and **rowCount**.

   When you use the ANALYZE statement to collect statistics, sizes of tables not from HDFS cannot be calculated.

   – Generate table-level statistics (no table scanning):

   ANALYZE TABLE src COMPUTE STATISTICS NOSCAN

   This command generates only **sizeInBytes**. Compared with the originally generated **sizeInBytes** and **rowCount** if the **sizeInBytes** remains unchanged, **rowCount** (if any) reserves. Otherwise, **rowCount** is cleared.

   – Generate column-level statistics:

   ANALYZE TABLE src COMPUTE STATISTICS FOR COLUMNS a, b, c

   This command generates column statistics and updates table statistics for consistency. Statistics of complicated data types (such as Seq and Map) and HiveStringType cannot be generated.

   – Display statistics:

   DESC FORMATTED src

This command displays *xxx* bytes and *xxx* rows in **Statistics** to indicate table-level statistics. You can also run the following command to display column statistics:

DESC FORMATTED src a

Limitation: The current statistics collection does not support statistics for partition levels for partitioned tables.

2. Configure parameters in **Table 21-75** in the **spark-defaults.conf** file on the Spark client.

Table 21-75 Parameter description

Parameter	Description	Default Value
spark.sql.cbo.enabled	The switch to enable or disable CBO. • **true**: Enable • **false**: Disable To enable this function, ensure that statistics of related tables and columns are generated.	false
spark.sql.cbo.joinReorder.enabled	Specifies whether to automatically adjust the sequence of consecutive inner joins by using CBO. • **true**: Enable • **false**: Disable To enable this function, ensure that statistics of related tables and columns are generated and CBO is enabled.	false
spark.sql.cbo.joinReorder.dp.threshold	Specifies the threshold of the number of tables that the sequence of consecutive inner joins is automatically adjusted by CBO. If the threshold is exceeded, the sequence of joins is not adjusted.	12

21.6.2.11 Optimizing SQL Query of Data of Multiple Sources

Scenario

This section describes how to enable or disable the query optimization for inter-source complex SQL.

Procedure

- (Optional) Prepare for connecting to the MPPDB data source.

If the data source to be connected is MPPDB, a class name conflict occurs because the MPPDB Driver file **gsjdbc4.jar** and the Spark JAR package **gsjdbc4-VXXXRXXXCXXSPCXXX.jar** contain the same class name. Therefore, before connecting to the MPPDB data source, perform the following steps:

a. Move **gsjdbc4-VXXXRXXXCXXSPCXXX.jar** from Spark. Spark running does not depend on this JAR file. Therefore, moving this JAR file to another directory (for example, the **/tmp** directory) will not affect Spark running.

   i. Log in to the Spark server and remove **gsjdbc4-VXXXRXXXCXXSPCXXX.jar** from the **${BIGDATA_HOME}/FusionInsight_Spark_8.1.0.1/install/FusionInsight-Spark-*/spark/jars** directory.

   ii. Log in to the Spark client host and remove **gsjdbc4-VXXXRXXXCXXSPCXXX.jar** from the **/opt/client/Spark/spark/jars** directory.

b. Obtain the MPPDB Driver file **gsjdbc4.jar** from the MPPDB installation package and upload the file to the following directories:

   NOTE

   Obtain **gsjdbc4.jar** from **FusionInsight_MPPDB\software\components\package\FusionInsight-MPPDB-*xxx*\package\Gauss-MPPDB-ALL-PACKAGES\GaussDB-*xxx*-REDHAT-*xxx*-Jdbc\jdbc**, the directory where the MPPDB installation package is stored.

   - **/${BIGDATA_HOME}/FusionInsight_Spark_8.1.0.1/install/FusionInsight-Spark-*/spark/jars** on the Spark server
   - **/opt/client/Spark/spark/jars** on the Spark client

c. Update the **/user/spark/jars/8.1.0.1/spark-archive.zip** package stored in HDFS.

   NOTE

   The version number **8.1.0.1** is used as an example. Replace it with the actual version number.

   i. Log in to the node where the client is installed as a client installation user. Run the following command to switch to the client installation directory, for example, **/opt/client**:

      cd /opt/client

   ii. Run the following command to configure environment variables:

      source bigdata_env

   iii. If the cluster is in security mode, run the following command to get authenticated:

      kinit *Component service user*

   iv. Run the following commands to create the temporary file **./tmp**, obtain **spark-archiv.zip** from HDFS, and decompress it to the **tmp** directory:

      mkdir tmp

      hdfs dfs -get /user/spark/jars/8.1.0.1/spark-archive.zip **./**

      unzip spark-archive.zip -d ./tmp

v. Switch to the **tmp** directory, delete the **gsjdbc4-VXXXRXXXCXXSPCXXX.jar** file, upload the MPPDB Driver file **gsjdbc4.jar** to the **tmp** directory, and run the following command to compress the file again:

zip -r spark-archive.zip *.jar

vi. Delete **spark-archive.zip** from HDFS and copy the **spark-archive.zip** package generated in **c.v** to the **/user/spark/jars/8.1.0.1/** directory in HDFS.

hdfs dfs -rm /user/spark/jars/8.1.0.1/spark-archive.zip

hdfs dfs -put ./spark-archive.zip /user/spark/jars/8.1.0.1

d. Restart the Spark service. After the Spark service is restarted, restart the Spark client.

- Enable the optimization function.

  For all modules that support query pushdown, you can run the **SET** command on the **spark-beeline** client to enable the cross-source query optimization function. By default, the function is disabled.

  Pushdown configurations can be performed in dimensions of global, data sources, and tables. Commands are as follows:

  – Global (valid for all data sources):

    SET spark.sql.datasource.jdbc = project,aggregate,orderby-limit

  – Data sources:

    SET spark.sql.datasource.${url} = project,aggregate,orderby-limit

  – Tables:

    SET spark.sql.datasource.${url}.${table} = project,aggregate,orderby-limit

  When you run the **SET** command to configure preceding parameters, you are allowed to specify multiple pushdown modules and separate them by commas. The following table lists parameters of corresponding pushdown modules.

Table 21-76 Parameters of modules

Module	Parameter Value in the SET Command
project	project
aggregate	aggregate
order by, limit over project or aggregate	orderby-limit

The following is a statement for creating an external table of MySQL:

create table if not exists pdmysql using org.apache.spark.sql.jdbc options(driver "com.mysql.jdbc.Driver", url "jdbc:mysql://ip2:3306/test", user "hive", password "*xxx*", dbtable "mysqldata");

In the preceding statement:

  - ${url} = jdbc:mysql://ip2:3306/test
  - ${table} = mysqldata

  NOTE

  - On the right of the equal sign (=) is the operators (separated by commas) to be enabled by pushdown.
  - Priority: table > data source > global. If the table switch is set, the global switch of the data source is invalid for the table. If a data source switch is set, the global switch is invalid for the data source.
  - The equal sign (=) is not allowed in URL. Equal signs (=) are automatically deleted in the SET clause.
  - After multiple SET operations, results with different keys will not overwrite each other.
  - Commands carrying authentication passwords pose security risks. Disable historical command recording before running such commands to prevent information leakage.

- Add functions that support query pushdown.

  In addition to query pushdown of mathematical, time, and string functions such as abs(), month(), and length(), you can run the **SET** command to add a data source that supports query pushdown. Run the following command on the Spark-beeline client:

  SET spark.sql.datasource.${datasource}.functions = fun1,fun2

- Reset the configuration set by the **SET** command.

  Currently, you can only run the **RESET** command on the **spark-beeline** client to cancel all **SET** content. After running the **RESET** command, all values in the **SET** command will be cleared. Exercise caution when performing this operation.

  The **SET** command is valid in the current session on the client. After the client is shut down, the content in the **SET** command turns invalid.

  Alternatively, change the value of **spark.sql.locale.support** in the **spark-defaults.conf** file to **true**.

Precautions

Only MySQL, MPPDB, Hive, oracle, and PostgreSQL data sources are supported.

21.6.2.12 SQL Optimization for Multi-level Nesting and Hybrid Join

Scenario

This section describes the optimization suggestions for SQL statements in multi-level nesting and hybrid join scenarios.

Prerequisites

The following provides an example of complex query statements:

```
select
s_name,
count(1) as numwait
from (
select s_name from (
```

```
select
s_name,
t2.l_orderkey,
l_suppkey,
count_suppkey,
max_suppkey
from
test2 t2 right outer join (
select
s_name,
l_orderkey,
l_suppkey from (
select
s_name,
t1.l_orderkey,
l_suppkey,
count_suppkey,
max_suppkey
from
test1 t1 join (
select
s_name,
l_orderkey,
l_suppkey
from
orders o join (
select
s_name,
l_orderkey,
l_suppkey
from
nation n join supplier s
on
s.s_nationkey = n.n_nationkey
and n.n_name = 'SAUDI ARABIA'
join lineitem l
on
s.s_suppkey = l.l_suppkey
where
l.l_receiptdate > l.l_commitdate
and l.l_orderkey is not null
) l1 on o.o_orderkey = l1.l_orderkey and o.o_orderstatus = 'F'
) l2 on l2.l_orderkey = t1.l_orderkey
) a
where
(count_suppkey > 1)
or ((count_suppkey=1)
and (l_suppkey <> max_suppkey))
) l3 on l3.l_orderkey = t2.l_orderkey
) b
where
(count_suppkey is null)
or ((count_suppkey=1)
and (l_suppkey = max_suppkey))
) c
group by
s_name
order by
numwait desc,
s_name
limit 100;
```

Procedure

Step 1 Analyze services.

Analyze business to determine whether SQL statements can be simplified through measures, for example, by combining tables to reduce the number of nesting levels layers and join times.

Step 2 If the SQL statements cannot be simplified, configure the driver memory.

- Use **spark-submit** or **spark-sql** to run SQL statements and go to **Step 3**.
- Use **spark-beeline** to run SQL statements and go to **Step 4**.

Step 3 During execution of SQL statements, specify the **driver-memory** parameter. An example of SQL statements is as follows:

/spark-sql --master=local[4] --driver-memory=512M -f /tpch.sql

Step 4 Before you run SQL statements, change the memory size as the MRS cluster administrator.

1. Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Spark**, and click **Configurations**.
2. Click the **All Configurations** sub-tab and search for **SPARK_DRIVER_MEMORY**.
3. Set the parameter to a larger value to increase the memory size. The value must be an integer, and the unit must be MB or GB. For example, enter **512 MB**.

----End

Related Information

In the event of insufficient DRIVER memory, the following error may be displayed during the query:

```
2018-02-11 09:13:14,683 | WARN  | Executor task launch worker for task 5 | Calling spill() on
RowBasedKeyValueBatch. Will not spill but return 0. |
org.apache.spark.sql.catalyst.expressions.RowBasedKeyValueBatch.spill(RowBasedKeyValueBatch.java:173)
2018-02-11 09:13:14,682 | WARN  | Executor task launch worker for task 3 | Calling spill() on
RowBasedKeyValueBatch. Will not spill but return 0. |
org.apache.spark.sql.catalyst.expressions.RowBasedKeyValueBatch.spill(RowBasedKeyValueBatch.java:173)
2018-02-11 09:13:14,704 | ERROR | Executor task launch worker for task 2 | Exception in task 2.0 in stage
1.0 (TID 2) | org.apache.spark.internal.Logging$class.logError(Logging.scala:91)
java.lang.OutOfMemoryError: Unable to acquire 262144 bytes of memory, got 0
        at org.apache.spark.memory.MemoryConsumer.allocateArray(MemoryConsumer.java:100)
        at org.apache.spark.unsafe.map.BytesToBytesMap.allocate(BytesToBytesMap.java:791)
        at org.apache.spark.unsafe.map.BytesToBytesMap.<init>(BytesToBytesMap.java:208)
        at org.apache.spark.unsafe.map.BytesToBytesMap.<init>(BytesToBytesMap.java:223)
        at
org.apache.spark.sql.execution.UnsafeFixedWidthAggregationMap.<init>(UnsafeFixedWidthAggregationMap.j
ava:104)
        at
org.apache.spark.sql.execution.aggregate.HashAggregateExec.createHashMap(HashAggregateExec.scala:307)
        at org.apache.spark.sql.catalyst.expressions.GeneratedClass
$GeneratedIterator.agg_doAggregateWithKeys$(Unknown Source)
        at org.apache.spark.sql.catalyst.expressions.GeneratedClass$GeneratedIterator.processNext(Unknown
Source)
        at org.apache.spark.sql.execution.BufferedRowIterator.hasNext(BufferedRowIterator.java:43)
        at org.apache.spark.sql.execution.WholeStageCodegenExec$$anonfun$8$$anon
$1.hasNext(WholeStageCodegenExec.scala:381)
        at scala.collection.Iterator$$anon$11.hasNext(Iterator.scala:408)
        at
org.apache.spark.shuffle.sort.BypassMergeSortShuffleWriter.write(BypassMergeSortShuffleWriter.java:126)
        at org.apache.spark.scheduler.ShuffleMapTask.runTask(ShuffleMapTask.scala:96)
        at org.apache.spark.scheduler.ShuffleMapTask.runTask(ShuffleMapTask.scala:53)
        at org.apache.spark.scheduler.Task.run(Task.scala:99)
```

```
at org.apache.spark.executor.Executor$TaskRunner.run(Executor.scala:325)
at java.util.concurrent.ThreadPoolExecutor.runWorker(ThreadPoolExecutor.java:1149)
at java.util.concurrent.ThreadPoolExecutor$Worker.run(ThreadPoolExecutor.java:624)
at java.lang.Thread.run(Thread.java:748)
```

21.6.3 Spark Streaming Tuning

Scenario

Streaming is a mini-batch streaming processing framework that features second-level delay and high throughput. To optimize Streaming is to improve its throughput while maintaining second-level delay so that more data can be processed per unit time.

NOTE

This section applies to the scenario where the input data source is Kafka.

Procedure

A simple streaming processing system consists of a data source, a receiver, and a processor. The data source is Kafka, the receiver is the Kafka data source receiver of Streaming, and the processor is Streaming.

Streaming optimization is to optimize the performance of the three components.

- **Data source optimization**

  In actual application scenarios, the data source stores the data in the local disks to ensure the error tolerance of the data. However, the calculation results of the Streaming are stored in the memory, and the data source may become the largest bottleneck of the streaming system.

  Kafka can be optimized from the following aspects:

  - Use Kafka-0.8.2 or later version that allows you to use new Producer APIs in asynchronous mode.
  - Configure multiple Broker directories, multiple I/O threads, and a proper number of partitions for a topic.

- **Receiver optimization**

  Streaming has multiple data source receivers, such as Kafka, Flume, MQTT, and ZeroMQ. Kafka has the most receiver types and is the most mature receiver.

  Kafka provides three types of receiver APIs:

  - KafkaReceiver directly receives Kafka data. If the process is abnormal, data may be lost.
  - ReliableKafkaReceiver receives data displacement through ZooKeeper records.
  - DirectKafka reads data from each partition of Kafka through the RDD, ensuring high reliability.

  According to the implementation mechanism and test results, DirectKafka provides better performance than the other two APIs. Therefore, the DirectKafka API is recommended to implement the receiver.

  Kafka receivers function as Kafka consumers.

- **Processor optimization**

  The bottom layer of Spark Streaming is executed by Spark. Therefore, most optimization measures for Spark can also be applied to Spark Streaming. The following is an example:

  – Data serialization
  – Memory configuration
  – Configuring DOP
  – Using the external shuffle service to improve performance

  NOTE

  Higher performance of Spark Streaming indicates lower overall reliability. Examples:

  If **spark.streaming.receiver.writeAheadLog.enable** is set to **false**, disk I/Os are reduced and performance is improved. However, because WAL is disabled, data is lost during fault recovery.

  Therefore, do not disable configuration items that ensure data reliability in production environments during Spark Streaming tuning.

- **Log archive optimization**

  The **spark.eventLog.group.size** parameter is used to group **JobHistory** logs of an application based on the specified number of jobs. Each group creates a file recording log to prevent **JobHistory** reading failures caused by an oversized log generated during the long-term running of the application. If this parameter is set to **0**, logs are not grouped.

  Most Spark Streaming jobs are small jobs and are generated at a high speed. As a result, frequent grouping is performed and a large number of small log files are generated, consuming disk I/O resources. You are advised to increase the parameter value to, for example, **1000** or greater.

21.6.4 Spark on OBS Tuning

Scenario

In the scenario where a small number of requests are frequently sent from Spark on OBS to OBS, you can disable OBS monitoring to improve performance.

Configuration

Modify the configuration in the **core-site.xml** file on the Spark client.

Table 21-77 Parameter description

Parameter	Description	Default Value
fs.obs.metrics.switch	Specifies whether to report OBS monitoring metrics. • **true**: enable • **false**: disable	true

Parameter	Description	Default Value
fs.obs.metrics.consumer	Specifies the processing mode of OBS monitoring metrics. • **org.apache.hadoop.fs.obs.metrics.OBSAMetricsProvider**: indicates that OBS monitoring metrics are collected. • **org.apache.hadoop.fs.obs.DefaultMetricsConsumer**: indicates that OBS monitoring metrics are not collected. To use the OBS monitoring function, ensure that the function of reporting OBS monitoring metrics is enabled.	org.apache.hadoop.fs.obs.metrics.OBSAMetricsProvider

21.7 Spark FAQ

21.7.1 Spark Core

21.7.1.1 How Do I View Aggregated Spark Application Logs?

Question

How do I view the aggregated container logs on the page when the log aggregation function is enabled on YARN?

Answer

For details, see **Viewing Aggregated Container Logs on the Web UI**.

21.7.1.2 Why Cannot Exit the Driver Process?

Question

Why cannot exit the Driver process after running the **yarn application -kill applicationID** command to stop the Spark Streaming application?

Answer

Running the **yarn application -kill applicationID** command can only stop the SparkContext corresponding to Spark Streaming application, but cannot exit the current Driver process. If there are other permanent threads in the Driver process (for example, the spark shell is continually checking command input or Spark Streaming is continually reading data form data source), the Driver process will not be killed when the SparkContext is stopped. To exit the Driver process, you are advised to run the **kill -9 pid** command to kill the current Driver process by hand.

21.7.1.3 Why Does FetchFailedException Occur When the Network Connection Is Timed out

Question

On a large cluster of 380 nodes, run the ScalaSort test case in the HiBench test that runs the 29T data, and configure Executor as **--executor-cores 4**. The following abnormality is displayed:

```
org.apache.spark.shuffle.FetchFailedException: Failed to connect to /192.168.114.12:23242
    at
org.apache.spark.storage.ShuffleBlockFetcherIterator.throwFetchFailedException(ShuffleBlockFetcherIterator.s
cala:321)
    at org.apache.spark.storage.ShuffleBlockFetcherIterator.next(ShuffleBlockFetcherIterator.scala:306)
    at org.apache.spark.storage.ShuffleBlockFetcherIterator.next(ShuffleBlockFetcherIterator.scala:51)
    at scala.collection.Iterator$$anon$11.next(Iterator.scala:328)
    at scala.collection.Iterator$$anon$13.hasNext(Iterator.scala:371)
    at scala.collection.Iterator$$anon$11.hasNext(Iterator.scala:327)
    at org.apache.spark.util.CompletionIterator.hasNext(CompletionIterator.scala:32)
    at org.apache.spark.InterruptibleIterator.hasNext(InterruptibleIterator.scala:39)
    at org.apache.spark.util.collection.ExternalSorter.insertAll(ExternalSorter.scala:217)
    at org.apache.spark.shuffle.hash.HashShuffleReader.read(HashShuffleReader.scala:102)
    at org.apache.spark.rdd.ShuffledRDD.compute(ShuffledRDD.scala:90)
    at org.apache.spark.rdd.RDD.computeOrReadCheckpoint(RDD.scala:301)
    at org.apache.spark.rdd.RDD.iterator(RDD.scala:265)
    at org.apache.spark.rdd.MapPartitionsRDD.compute(MapPartitionsRDD.scala:38)
    at org.apache.spark.rdd.RDD.computeOrReadCheckpoint(RDD.scala:301)
    at org.apache.spark.rdd.RDD.iterator(RDD.scala:265)
    at org.apache.spark.rdd.MapPartitionsRDD.compute(MapPartitionsRDD.scala:38)
    at org.apache.spark.rdd.RDD.computeOrReadCheckpoint(RDD.scala:301)
    at org.apache.spark.rdd.RDD.iterator(RDD.scala:265)
    at org.apache.spark.rdd.UnionRDD.compute(UnionRDD.scala:87)
    at org.apache.spark.rdd.RDD.computeOrReadCheckpoint(RDD.scala:301)
    at org.apache.spark.rdd.RDD.iterator(RDD.scala:265)
    at org.apache.spark.scheduler.ShuffleMapTask.runTask(ShuffleMapTask.scala:73)
    at org.apache.spark.scheduler.ShuffleMapTask.runTask(ShuffleMapTask.scala:41)
    at org.apache.spark.scheduler.Task.run(Task.scala:87)
    at org.apache.spark.executor.Executor$TaskRunner.run(Executor.scala:213)
    at java.util.concurrent.ThreadPoolExecutor.runWorker(ThreadPoolExecutor.java:1142)
    at java.util.concurrent.ThreadPoolExecutor$Worker.run(ThreadPoolExecutor.java:617)
    at java.lang.Thread.run(Thread.java:745)
Caused by: java.io.IOException: Failed to connect to /192.168.114.12:23242
    at org.apache.spark.network.client.TransportClientFactory.createClient(TransportClientFactory.java:214)
    at org.apache.spark.network.client.TransportClientFactory.createClient(TransportClientFactory.java:167)
    at org.apache.spark.network.netty.NettyBlockTransferService$$anon
$1.createAndStart(NettyBlockTransferService.scala:91)
    at
org.apache.spark.network.shuffle.RetryingBlockFetcher.fetchAllOutstanding(RetryingBlockFetcher.java:140)
    at org.apache.spark.network.shuffle.RetryingBlockFetcher.access$200(RetryingBlockFetcher.java:43)
    at org.apache.spark.network.shuffle.RetryingBlockFetcher$1.run(RetryingBlockFetcher.java:170)
    at java.util.concurrent.Executors$RunnableAdapter.call(Executors.java:511)
    at java.util.concurrent.FutureTask.run(FutureTask.java:266)
    ... 3 more
Caused by: java.net.ConnectException: Connection timed out: /192.168.114.12:23242
    at sun.nio.ch.SocketChannelImpl.checkConnect(Native Method)
    at sun.nio.ch.SocketChannelImpl.finishConnect(SocketChannelImpl.java:717)
    at io.netty.channel.socket.nio.NioSocketChannel.doFinishConnect(NioSocketChannel.java:224)
    at io.netty.channel.nio.AbstractNioChannel
$AbstractNioUnsafe.finishConnect(AbstractNioChannel.java:289)
    at io.netty.channel.nio.NioEventLoop.processSelectedKey(NioEventLoop.java:528)
    at io.netty.channel.nio.NioEventLoop.processSelectedKeysOptimized(NioEventLoop.java:468)
    at io.netty.channel.nio.NioEventLoop.processSelectedKeys(NioEventLoop.java:382)
    at io.netty.channel.nio.NioEventLoop.run(NioEventLoop.java:354)
    at io.netty.util.concurrent.SingleThreadEventExecutor$2.run(SingleThreadEventExecutor.java:111)
    ... 1 more
```

Answer

When an application is run, configure the Executor parameter as **--executor-cores 4**. The degree of parallelism (DOP) is high in a single process, resulting in that the IO is highly occupied and the task works slowly.

```
16/02/26 10:04:53 INFO TaskSetManager: Finished task 2139.0 in stage 1.0 (TID 151149) in 376455 ms on 10-196-115-2 (694/153378)
```

Because running a single task takes more than 6 minutes. The network connection is timed out and the running task fails.

Set the number of cores as 1, which is **--executor-cores 1**. A task is executed smoothly in proper time (within 15s).

```
16/02/29 02:24:46 INFO TaskSetManager: Finished task 59564.0 in stage 1.0 (TID 208574) in 15088 ms on 10-196-115-6 (59515/153378)
```

Therefore, to process the task of network connection timed out and avoid such error, you can reduce the core number of a single Executor.

21.7.1.4 How to Configure Event Queue Size If Event Queue Overflows?

Question

How to configure the event queue size if the following Driver log information is displayed indicating that the event queue overflows?

- Common applications

  ```
  Dropping SparkListenerEvent because no remaining room in event queue.
  This likely means one of the SparkListeners is too slow and cannot keep
  up with the rate at which tasks are being started by the scheduler.
  ```

- Spark Streaming applications

  ```
  Dropping StreamingListenerEvent because no remaining room in event queue.
  This likely means one of the StreamingListeners is too slow and cannot keep
  up with the rate at which events are being started by the scheduler.
  ```

Answer

1. Stop the application. Set the configuration option **spark.event.listener.logEnable** in the Spark configuration file **spark-defaults.conf** to **true**. And set the configuration option **spark.eventQueue.size** to **1000W**. If you need to control the logging rate (in milliseconds), also change the value of the configuration option **spark.event.listener.logRate**.

   By default, the logging rate is 1000 ms, which means that one log is printed out every 1000 ms.

2. Start the application.

   The following log information is displayed, including the event consumption rate, event production rate, and **MaxSize** (maximum size of messages in the queue).

   ```
   INFO LiveListenerBus: [SparkListenerBus]:16044 events are consumed in 5000 ms.
   INFO LiveListenerBus: [SparkListenerBus]:51381 events are produced in 5000 ms, eventQueue still has 86417 events, MaxSize: 171764.
   ```

3. Change the value of the configuration option **spark.eventQueue.size** in the Spark configuration file **spark-defaults.conf** based on the **MaxSize** in the log information.

For example, if **MaxSize** is 250000, the appropriate message queue size is 300000.

21.7.1.5 What Can I Do If the getApplicationReport Exception Is Recorded in Logs During Spark Application Execution and the Application Does Not Exit for a Long Time?

Question

During Spark application execution, if the driver fails to connect to ResourceManager, the following error is reported and it does not exit for a long time. What can I do?

```
16/04/23 15:31:44 INFO RetryInvocationHandler: Exception while invoking getApplicationReport of class ApplicationClientProtocolPBClientImpl over 37 after 1 fail over attempts. Trying to fail over after sleeping for 44160ms.
java.net.ConnectException: Call From vm1/192.168.39.30 to vm1:8032 failed on connection exception: java.net.ConnectException: Connection refused; For more details see:  http://wiki.apache.org/hadoop/ConnectionRefused
```

Answer

In Spark, there is a scheduled thread that listens to the status of ApplicationMaster by connecting to ResourceManager. The connection to the ResourceManager times out. As a result, the preceding error is reported and the system keeps trying to connect to the ResourceManager. In the ResourceManager, the number of retry times is limited. By default, the number of retry times is 30 and the retry interval is about 30 seconds. The preceding error is reported during each retry. The driver exits only after the number of times is exceeded.

Table 21-78 describes the retry-related configuration items in the ResourceManager.

Table 21-78 Parameter description

Parameter	Description	Default Value
yarn.resourcemanager.connect.max-wait.ms	Maximum waiting time for connecting to the ResourceManager.	900000
yarn.resourcemanager.connect.retry-interval.ms	Interval for reconnecting to the ResourceManager.	30000

Number of retries (**yarn.resourcemanager.connect.max-wait.ms/yarn.resourcemanager.connect.retry-interval.ms**) = Maximum waiting time for connecting to the ResourceManager/Interval for reconnecting to the ResourceManager

On the Spark client, modify the **conf/yarn-site.xml** file to add and configure **yarn.resourcemanager.connect.max-wait.ms** and **yarn.resourcemanager.connect.retry-interval.ms**. In this way, the number of retry times can be changed, and the Spark application can exit in advance.

21.7.1.6 What Can I Do If "Connection to ip:port has been quiet for xxx ms while there are outstanding requests" Is Reported When Spark Executes an Application and the Application Ends?

Question

When Spark executes an application, an error similar to the following is reported and the application ends. What can I do?

```
2016-04-20 10:42:00,557 | ERROR | [shuffle-server-2] | Connection to 10-91-8-208/10.18.0.115:57959 has
been quiet for 180000 ms while there are outstanding requests. Assuming connection is dead; please adju
st spark.network.timeout if this is wrong. |
org.apache.spark.network.server.TransportChannelHandler.userEventTriggered(TransportChannelHandler.java:
128)
2016-04-20 10:42:00,558 | ERROR | [shuffle-server-2] | Still have 1 requests outstanding when connection
from 10-91-8-208/10.18.0.115:57959 is closed | org.apache.spark.network.client.TransportResponseHandl
er.channelUnregistered(TransportResponseHandler.java:102)
2016-04-20 10:42:00,562 | WARN  | [yarn-scheduler-ask-am-thread-pool-160] | Error sending message
[message = DoShuffleClean(application_1459995017785_0108,319)] in 1 attempts |
org.apache.spark.Logging$clas
s.logWarning(Logging.scala:92)
java.io.IOException: Connection from 10-91-8-208/10.18.0.115:57959 closed
        at
org.apache.spark.network.client.TransportResponseHandler.channelUnregistered(TransportResponseHandler.j
ava:104)
        at
org.apache.spark.network.server.TransportChannelHandler.channelUnregistered(TransportChannelHandler.jav
a:94)
        at
io.netty.channel.AbstractChannelHandlerContext.invokeChannelUnregistered(AbstractChannelHandlerContex
t.java:158)
        at
io.netty.channel.AbstractChannelHandlerContext.fireChannelUnregistered(AbstractChannelHandlerContext.ja
va:144)
        at
io.netty.channel.ChannelInboundHandlerAdapter.channelUnregistered(ChannelInboundHandlerAdapter.java:5
3)
        at
io.netty.channel.AbstractChannelHandlerContext.invokeChannelUnregistered(AbstractChannelHandlerContex
t.java:158)
        at
io.netty.channel.AbstractChannelHandlerContext.fireChannelUnregistered(AbstractChannelHandlerContext.ja
va:144)
        at
io.netty.channel.ChannelInboundHandlerAdapter.channelUnregistered(ChannelInboundHandlerAdapter.java:5
3)
        at
io.netty.channel.AbstractChannelHandlerContext.invokeChannelUnregistered(AbstractChannelHandlerContex
t.java:158)
        at
io.netty.channel.AbstractChannelHandlerContext.fireChannelUnregistered(AbstractChannelHandlerContext.ja
va:144)
        at
io.netty.channel.ChannelInboundHandlerAdapter.channelUnregistered(ChannelInboundHandlerAdapter.java:5
3)
        at
io.netty.channel.AbstractChannelHandlerContext.invokeChannelUnregistered(AbstractChannelHandlerContex
t.java:158)
        at
io.netty.channel.AbstractChannelHandlerContext.fireChannelUnregistered(AbstractChannelHandlerContext.ja
va:144)
        at io.netty.channel.DefaultChannelPipeline.fireChannelUnregistered(DefaultChannelPipeline.java:739)
        at io.netty.channel.AbstractChannel$AbstractUnsafe$8.run(AbstractChannel.java:659)
        at io.netty.util.concurrent.SingleThreadEventExecutor.runAllTasks(SingleThreadEventExecutor.java:357)
        at io.netty.channel.nio.NioEventLoop.run(NioEventLoop.java:357)
        at io.netty.util.concurrent.SingleThreadEventExecutor$2.run(SingleThreadEventExecutor.java:111)
        at java.lang.Thread.run(Thread.java:745)
```

```
2016-04-20 10:42:00,573 | INFO  | [dispatcher-event-loop-14] | Starting task 177.0 in stage 1492.0 (TID 1996351, linux-254, PROCESS_LOCAL, 2106 bytes) | org.apache.spark.Logging$class.logInfo(Logging.scala:59)
2016-04-20 10:42:00,574 | INFO  | [task-result-getter-0] | Finished task 85.0 in stage 1492.0 (TID 1996259) in 191336 ms on linux-254 (106/3000) | org.apache.spark.Logging$class.logInfo(Logging.scala:59)
2016-04-20 10:42:00,811 | ERROR | [Yarn application state monitor] | Yarn application has already exited with state FINISHED! | org.apache.spark.Logging$class.logError(Logging.scala:75)
```

Answer

Symptom: The value of **spark.rpc.io.connectionTimeout** is less than the value of **spark.rpc.askTimeout**. In full GC or network delay scenarios, when the channel reaches the expiration time and still receives no response, the channel is terminated. When detecting that the channel is terminated, the AM considers the driver as disconnected, and the entire application is stopped.

Solution: Set the parameter in the **spark-defaults.conf** file on the Spark client by running the **set** command. During parameter configuration, ensure that the channel expiration time (**spark.rpc.io.connectionTimeout**) is greater than or equal to the RPC response timeout (**spark.rpc.askTimeout**).

Table 21-79 Parameter description

Parameter	Description	Default Value
spark.rpc.askTimeout	RPC response timeout. If this parameter is not set, the value of **spark.network.timeout** is used by default.	120s

21.7.1.7 Why Do Executors Fail to be Removed After the NodeManeger Is Shut Down?

Question

If the NodeManager is shut down with the Executor dynamic allocation enabled, the Executors on the node where the NodeManeger is shut down fail to be removed from the driver page after the idle time expires.

Answer

When the ResourceManager detects that the NodeManager is shut down, the driver has requested to kill Executors due to idle time expiry. However, the Executors cannot actually be killed because the NodeManager is shut down. The driver cannot detect the LOST events of these Executors and does not remove Executors from its Executor list. Therefore, the Executors are not removed from the driver page. This phenomenon is normal after the YARN NodeManager is shut down. The Executors will be removed after the NodeManager restarts.

21.7.1.8 What Can I Do If the Message "Password cannot be null if SASL is enabled" Is Displayed?

Question

ExternalShuffle is enabled for the application that runs Spark. Task loss occurs in the application because the message "java.lang.NullPointerException: Password cannot be null if SASL is enabled" is displayed. The following shows some key logs:

```
2016-05-13 12:05:27,093 | WARN  | [task-result-getter-2] | Lost task 98.0 in stage 22.1 (TID 193603, linux-173, 2): FetchFailed(BlockManagerId(13, 172.168.100.13, 27337),
org.apache.spark.shuffle.FetchFailedException: java.lang.NullPointerException: Password cannot be null if SASL is enabled
        at org.spark-project.guava.base.Preconditions.checkNotNull(Preconditions.java:208)
        at org.apache.spark.network.sasl.SparkSaslServer.encodePassword(SparkSaslServer.java:196)
        at org.apache.spark.network.sasl.SparkSaslServer$DigestCallbackHandler.handle(SparkSaslServer.java:166)
        at com.sun.security.sasl.digest.DigestMD5Server.validateClientResponse(DigestMD5Server.java:589)
        at com.sun.security.sasl.digest.DigestMD5Server.evaluateResponse(DigestMD5Server.java:244)
        at org.apache.spark.network.sasl.SparkSaslServer.response(SparkSaslServer.java:119)
        at org.apache.spark.network.sasl.SaslRpcHandler.receive(SaslRpcHandler.java:100)
        at org.apache.spark.network.server.TransportRequestHandler.processRpcRequest(TransportRequestHandler.java:128)
        at org.apache.spark.network.server.TransportRequestHandler.handle(TransportRequestHandler.java:99)
        at org.apache.spark.network.server.TransportChannelHandler.channelRead0(TransportChannelHandler.java:104)
```

Answer

The cause is that NodeManager restarts. When ExternalShuffle is used, Spark uses NodeManager to transmit shuffle data. Therefore, the memory of NodeManager may be seriously insufficient.

In the FusionInsight of the current version, the default memory of NodeManager is only 1 GB. When the data volume of Spark tasks is large (greater than 1 TB), the memory is severely insufficient and the message response is slow. As a result, the FusionInsight health check determines that the NodeManager process exits and forcibly restarts the NodeManager, causing the preceding problem.

Solution

Adjust the memory of the NodeManager. If the data volume is large (greater than 1 TB), the memory of NodeManager must be greater than 4 GB.

21.7.1.9 What Should I Do If the Message "Failed to CREATE_FILE" Is Displayed in the Restarted Tasks When Data Is Inserted Into the Dynamic Partition Table?

Question

When inserting data into the dynamic partition table, a large number of shuffle files are damaged due to the disk disconnection, node error, and the like. In this case, why the message **Failed to CREATE_FILE** is displayed in the restarted tasks?

```
2016-06-25 15:11:31,323 | ERROR | [Executor task launch worker-0] | Exception in task 15.0 in stage 10.1 (TID 1258) | org.apache.spark.Logging$class.logError(Logging.scala:96)
org.apache.hadoop.hive.ql.metadata.HiveException:
org.apache.hadoop.ipc.RemoteException(org.apache.hadoop.hdfs.protocol.AlreadyBeingCreatedException):
Failed to CREATE_FILE /user/hive/warehouse/testdb.db/we
b_sales/.hive-staging_hive_2016-06-25_15-09-16_999_8137121701603617850-1/-ext-10000/_temporary/0/
_temporary/attempt_201606251509_0010_m_000015_0/ws_sold_date=1999-12-17/part-00015 for
DFSClient_attempt_2016
06251509_0010_m_000015_0_353134803_151 on 10.1.1.5 because this file lease is currently owned by
DFSClient_attempt_201606251509_0010_m_000015_0_-848353830_156 on 10.1.1.6
```

Answer

The last step of inserting data into the dynamic partition table is to read shuffle files and then write the data to the mapped partition files.

After a large number of shuffle files are damaged, a large number of tasks fail, causing the restart of jobs. Before the restart of jobs, Spark closes the handles that write table partition files. However, the HDFS cannot process the scenario of batch tasks closing handles. After tasks restart next time, the handles are not released in a timely manner on the NameNode. As a result, the message **Failed to CREATE_FILE** is displayed.

This error only occurs when a large number of shuffle files are damaged. The tasks will restart after the error occurs and the restart can be completed within milliseconds.

21.7.1.10 Why Tasks Fail When Hash Shuffle Is Used?

Question

When Hash shuffle is used to run a job that consists of 1000000 map tasks x 100000 reduce tasks, run logs report many message failures and Executor heartbeat timeout, leading to task failures. Why does this happen?

Answer

During the shuffle process, Hash shuffle just writes the data of different reduce partitions to their respective disk files according to hash results without sorting the data.

If there are many reduce partitions, a large number of disk files will be generated. In your case, 10^11 shuffle files, that is, 1000000 * 100000 shuffle files, will be generated. The sheer number of disk files will have a great impact on the file read and write performance. In addition, the operations such as sorting and compressing will consume a large amount of temporary memory space because a large number of file handles are open, presenting great challenges to memory management and garbage collection and incurring the possibility that the Executor fails to respond to Driver.

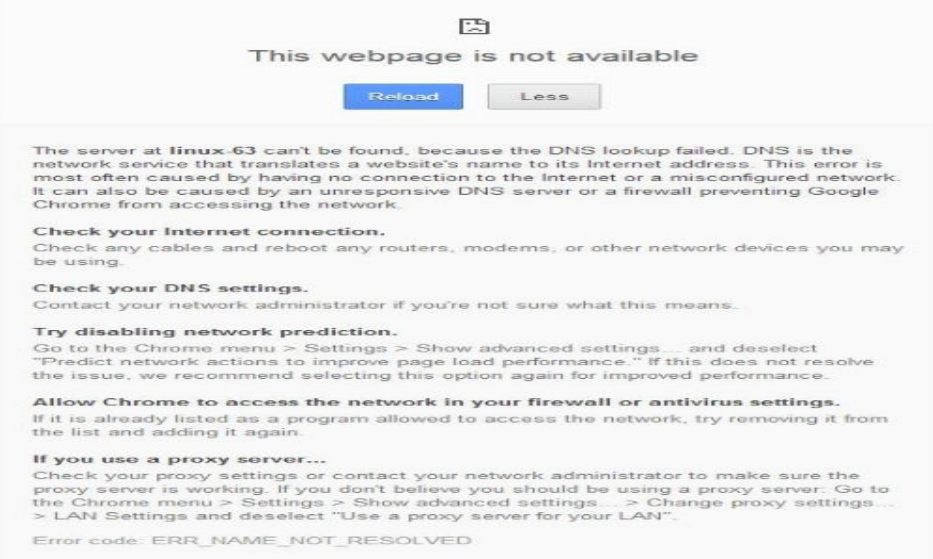
Sort shuffle, instead of Hash shuffle, is recommended to run a job.

21.7.1.11 What Can I Do If the Error Message "DNS query failed" Is Displayed When I Access the Aggregated Logs Page of Spark Applications?

Question

When the **http(s)://<spark ip>:<spark port>** mode is used to access the Spark JobHistory page, if the displayed Spark JobHistory page is not the page of FusionInsight Manager (the URL of FusionInsight Manager is similar to **https://<oms ip>:20026/Spark/JobHistory/xx/**), click an application and click **AggregatedLogs**, click the logs of an executor to be viewed. An error message in **Figure 21-9** is displayed.

Figure 21-9 DNS query failure



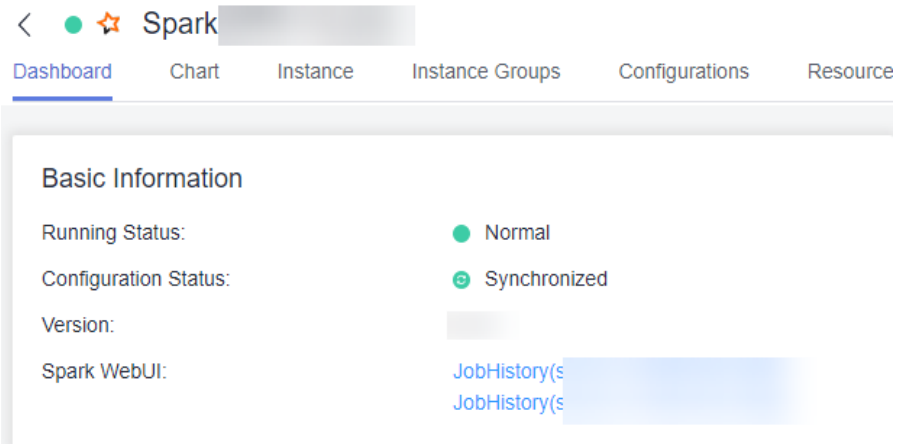
Answer

Cause: The domain name is not added to the **hosts** file of the Windows OS in the pop-up URL (for example, **https://<hostname>:20026/Spark/JobHistory/xx/history/application_xxx/jobs/**). As a result, the DNS query fails and the web page cannot be displayed.

Solution:

- You are advised to visit the **Spark JobHistory** page using FusionInsight Manager. Click the links in the blue box in **Figure 21-10**.

  Figure 21-10 Spark page of FusionInsight Manager

- If you do not want to access the **Spark JobHistory** page using the FusionInsight Manager, change **<hostname>** in the URL to the IP address or add the domain name to the **hosts** file of the Windows OS.

21.7.1.12 What Can I Do If Shuffle Fetch Fails Due to the "Timeout Waiting for Task" Exception?

Question

When I execute a 100 TB TPC-DS test suite in the JDBCServer mode, the "Timeout waiting for task" is displayed. As a result, shuffle fetch fails, the stage keeps retrying, and the task cannot be completed properly. What can I do?

Answer

The ShuffleService function is used in JDBCServer mode. In the reduce phase, all executors obtain data from NodeManager. When the data volume reaches a level (more than 10 TB), the NodeManager may reach the bottleneck (ShuffleService is in the NodeManager process). As a result, some tasks for obtaining data time out. Therefore, the problem occurs.

You are advised to disable ShuffleService for Spark tasks whose data volume is greater than 10 TB. That is, set **spark.shuffle.service.enabled** in the **Spark-defaults.conf** configuration file to **false**.

21.7.1.13 Why Does the Stage Retry due to the Crash of the Executor?

Question

When I run Spark tasks with a large data volume, for example, 100 TB TPCDS test suite, why does the Stage retry due to Executor loss sometimes? The message "Executor 532 is lost rpc with driver, but is still alive, going to kill it" is displayed, indicating that the loss of the Executor is caused by a JVM crash.

The log of the key JVM crash is as follows:

```
#
# A fatal error has been detected by the Java Runtime Environment:
#
#  Internal Error (sharedRuntime.cpp:834), pid=241075, tid=140476258551552
#  fatal error: exception happened outside interpreter, nmethods and vtable stubs at pc
0x00007fcda9eb8eb1
```

Answer

This error does not affect services. This error is caused by defects of the Oracle JVM, but not the platform code. There is the fault tolerance mechanism for Executors in Spark: the Stage retries in case of an Executor crash to ensure the success execution of tasks.

21.7.1.14 Why Do the Executors Fail to Register Shuffle Services During the Shuffle of a Large Amount of Data?

Question

When more than 50 terabytes of data is shuffled, some executors fail to register shuffle services due to timeout. The shuffle tasks then fail. Why? The error log is as follows:

```
2016-10-19 01:33:34,030 | WARN | ContainersLauncher #14 | Exception from container-launch with
container ID: container_e1452_1476801295027_2003_01_004512 and exit code: 1 |
LinuxContainerExecutor.java:397
ExitCodeException exitCode=1:
at org.apache.hadoop.util.Shell.runCommand(Shell.java:561)
at org.apache.hadoop.util.Shell.run(Shell.java:472)
at org.apache.hadoop.util.Shell$ShellCommandExecutor.execute(Shell.java:738)
at
org.apache.hadoop.yarn.server.nodemanager.LinuxContainerExecutor.launchContainer(LinuxContainerExecuto
r.java:381)
at
org.apache.hadoop.yarn.server.nodemanager.containermanager.launcher.ContainerLaunch.call(ContainerLaun
ch.java:312)
at
org.apache.hadoop.yarn.server.nodemanager.containermanager.launcher.ContainerLaunch.call(ContainerLaun
ch.java:88)
at java.util.concurrent.FutureTask.run(FutureTask.java:266)
at java.util.concurrent.ThreadPoolExecutor.runWorker(ThreadPoolExecutor.java:1142)
at java.util.concurrent.ThreadPoolExecutor$Worker.run(ThreadPoolExecutor.java:617)
at java.lang.Thread.run(Thread.java:745)
2016-10-19 01:33:34,031 | INFO | ContainersLauncher #14 | Exception from container-launch. |
ContainerExecutor.java:300
2016-10-19 01:33:34,031 | INFO | ContainersLauncher #14 | Container id:
container_e1452_1476801295027_2003_01_004512 | ContainerExecutor.java:300
2016-10-19 01:33:34,031 | INFO | ContainersLauncher #14 | Exit code: 1 | ContainerExecutor.java:300
2016-10-19 01:33:34,031 | INFO | ContainersLauncher #14 | Stack trace: ExitCodeException exitCode=1: |
ContainerExecutor.java:300
```

Answer

The imported data exceeds 50 TB, which exceeds the shuffle processing capability. The shuffle may fail to respond to the registration request of an executor in a timely manner due to the heavy load.

The timeout interval for an executor to register the shuffle service is 5 seconds. The maximum number of retries is 3. This parameter is not configurable.

You are advised to increase the number of task retry times and the number of allowed executor failure times.

Configure the following parameters in the **spark-defaults.conf** file on the client: If **spark.yarn.max.executor.failures** does not exist, manually add it.

Table 21-80 Parameter Description

Parameter	Description	Default Value
spark.task.maxFailures	Specifies task retry times.	4
spark.yarn.max.executor.failures	Specifies executor failure attempt times. Set **spark.dynamicAllocation.enabled** to **false**, to disable the dynamic allocation of executors.	numExecutors * 2, with minimum of 3

Parameter	Description	Default Value
	Specifies executor failure attempt times. Set **spark.dynamicAllocation.enabled** to **true**, to enable the dynamic allocation of executors.	3

21.7.1.15 NodeManager OOM Occurs During Spark Application Execution

Question

When YARN' External Shuffle Service is enabled, if there are too many shuffle connections during Spark application execution, the "java.lang.OutofMemoryError: Direct buffer Memory" message is displayed. This indicates that the memory is insufficient. The error log is as follows:

```
2016-12-06 02:01:00,768 | WARN  | shuffle-server-38 | Exception in connection from /192.168.101.95:53680 | TransportChannelHandler.java:79
io.netty.handler.codec.DecoderException: java.lang.OutOfMemoryError: Direct buffer memory
        at io.netty.handler.codec.ByteToMessageDecoder.channelRead(ByteToMessageDecoder.java:153)
        at io.netty.channel.AbstractChannelHandlerContext.invokeChannelRead(AbstractChannelHandlerContext.java:333)
        at io.netty.channel.AbstractChannelHandlerContext.fireChannelRead(AbstractChannelHandlerContext.java:319)
        at io.netty.channel.DefaultChannelPipeline.fireChannelRead(DefaultChannelPipeline.java:787)
        at io.netty.channel.nio.AbstractNioByteChannel$NioByteUnsafe.read(AbstractNioByteChannel.java:130)
        at io.netty.channel.nio.NioEventLoop.processSelectedKey(NioEventLoop.java:511)
        at io.netty.channel.nio.NioEventLoop.processSelectedKeysOptimized(NioEventLoop.java:468)
        at io.netty.channel.nio.NioEventLoop.processSelectedKeys(NioEventLoop.java:382)
        at io.netty.channel.nio.NioEventLoop.run(NioEventLoop.java:354)
        at io.netty.util.concurrent.SingleThreadEventExecutor$2.run(SingleThreadEventExecutor.java:116)
        at java.lang.Thread.run(Thread.java:745)
Caused by: java.lang.OutOfMemoryError: Direct buffer memory
        at java.nio.Bits.reserveMemory(Bits.java:693)
        at java.nio.DirectByteBuffer.<init>(DirectByteBuffer.java:123)
        at java.nio.ByteBuffer.allocateDirect(ByteBuffer.java:311)
        at io.netty.buffer.PoolArena$DirectArena.newChunk(PoolArena.java:434)
        at io.netty.buffer.PoolArena.allocateNormal(PoolArena.java:179)
        at io.netty.buffer.PoolArena.allocate(PoolArena.java:168)
        at io.netty.buffer.PoolArena.reallocate(PoolArena.java:277)
        at io.netty.buffer.PooledByteBuf.capacity(PooledByteBuf.java:108)
        at io.netty.buffer.AbstractByteBuf.ensureWritable(AbstractByteBuf.java:251)
        at io.netty.buffer.AbstractByteBuf.writeBytes(AbstractByteBuf.java:849)
        at io.netty.buffer.AbstractByteBuf.writeBytes(AbstractByteBuf.java:841)
        at io.netty.buffer.AbstractByteBuf.writeBytes(AbstractByteBuf.java:831)
        at io.netty.handler.codec.ByteToMessageDecoder.channelRead(ByteToMessageDecoder.java:146)
        ... 10 more
```

Answer

For YARN's External Shuffle Service, the number of started threads is twice the number of available vCPUs. However, the default direct buffer memory is 128 MB. Therefore, when a large number of shuffle connections are established at the same time, the direct buffer memory evenly allocated to each thread is low. For

example, if a node has 40 vCPUs, the number of threads started by YARN's External Shuffle Service is 80, and the 80 threads share the direct buffer memory in the process. In this case, the memory allocated to each thread is less than 2 MB.

So, you are advised to adjust the value of direct buffer memory based on the number of vCPUs of the NodeManager node in the cluster. For example, if the number of vCPUs is 40, set direct buffer memory to 512 MB. That is, set the **GC_OPTS** parameter of the NodeManager node. For example:

-XX:MaxDirectMemorySize=512M

NOTE

-XX:MaxDirectMemorySize is not used by default. You can add it to the **GC_OPTS** parameter as needed.

Perform the following operations to configure the parameter:

Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Yarn**. Click **Configurations** then **All Configurations**, click **NodeManager**, and select **System**. Then, modify the configuration in the **GC_OPTS** parameter in the right pane.

Table 21-81 Parameters

Parameter	Description	Default Value
GC_OPTS	GC parameter of YARN NodeManager	128M

21.7.1.16 Why Does the Realm Information Fail to Be Obtained When SparkBench is Run on HiBench for the Cluster in Security Mode?

Question

Execution of the sparkbench task (for example, Wordcount) of HiBench6 fails. The bench.log indicates that the Yarn task fails to be executed. The failure information displayed on the Yarn UI is as follows:

```
Exception in thread "main" org.apache.spark.SparkException: Unable to load YARN support
  at org.apache.spark.deploy.SparkHadoopUtil$.liftedTree1$1(SparkHadoopUtil.scala:390)
  at org.apache.spark.deploy.SparkHadoopUtil$.yarn$lzycompute(SparkHadoopUtil.scala:385)
  at org.apache.spark.deploy.SparkHadoopUtil$.yarn(SparkHadoopUtil.scala:385)
  at org.apache.spark.deploy.SparkHadoopUtil$.get(SparkHadoopUtil.scala:410)
  at org.apache.spark.deploy.yarn.ApplicationMaster$.main(ApplicationMaster.scala:796)
  at org.apache.spark.deploy.yarn.ExecutorLauncher$.main(ApplicationMaster.scala:821)
  at org.apache.spark.deploy.yarn.ExecutorLauncher.main(ApplicationMaster.scala)
 Caused by: java.lang.IllegalArgumentException: Can't get Kerberos realm
  at org.apache.hadoop.security.HadoopKerberosName.setConfiguration(HadoopKerberosName.java:65)
  at org.apache.hadoop.security.UserGroupInformation.initialize(UserGroupInformation.java:288)
  at org.apache.hadoop.security.UserGroupInformation.setConfiguration(UserGroupInformation.java:336)
  at org.apache.spark.deploy.SparkHadoopUtil.<init>(SparkHadoopUtil.scala:51)
  at org.apache.spark.deploy.yarn.YarnSparkHadoopUtil.<init>(YarnSparkHadoopUtil.scala:49)
  at sun.reflect.NativeConstructorAccessorImpl.newInstance0(Native Method)
  at sun.reflect.NativeConstructorAccessorImpl.newInstance(NativeConstructorAccessorImpl.java:62)
  at sun.reflect.DelegatingConstructorAccessorImpl.newInstance(DelegatingConstructorAccessorImpl.java:45)
  at java.lang.reflect.Constructor.newInstance(Constructor.java:423)
  at java.lang.Class.newInstance(Class.java:442)
  at org.apache.spark.deploy.SparkHadoopUtil$.liftedTree1$1(SparkHadoopUtil.scala:387)
  ... 6 more
 Caused by: java.lang.reflect.InvocationTargetException
```

```
 at sun.reflect.NativeMethodAccessorImpl.invoke0(Native Method)
 at sun.reflect.NativeMethodAccessorImpl.invoke(NativeMethodAccessorImpl.java:62)
 at sun.reflect.DelegatingMethodAccessorImpl.invoke(DelegatingMethodAccessorImpl.java:43)
 at java.lang.reflect.Method.invoke(Method.java:498)
 at org.apache.hadoop.security.authentication.util.KerberosUtil.getDefaultRealm(KerberosUtil.java:88)
 at org.apache.hadoop.security.HadoopKerberosName.setConfiguration(HadoopKerberosName.java:63)
 ... 16 more
Caused by: KrbException: Cannot locate default realm
 at sun.security.krb5.Config.getDefaultRealm(Config.java:1029)
 ... 22 more
```

Answer

In C80SPC200 and later, the file stored in the **/etc/krb5.conf** directory is no longer replaced during cluster installation. Instead, the file is stored in the corresponding path on the client through parameter configurations, and HiBench does not reference the client configuration file. Solution: Use the file stored in the **/opt/client/KrbClient/kerberos/var/krb5kdc/krb5.conf** directory on the client to overwrite that in the **/etc/krb5.conf** directories of all nodes. Make a backup before the overwriting.

21.7.2 Spark SQL and DataFrame

21.7.2.1 What Do I have to Note When Using Spark SQL ROLLUP and CUBE?

Question

Suppose that there is a table src(d1, d2, m) with the following data:

```
1 a 1
1 b 1
2 b 2
```

The results for statement "select d1, sum(d1) from src group by d1, d2 with rollup" are shown as below:

```
NULL 0
1    2
2    2
1    1
1    1
2    2
```

Why the first line of the above results is (NULL,0), rather than (NULL,4)?

Answer

When conducting the rollup and cube operation, we usually perform the dimension-based analysis and what we need is the measurement result, so we would not conduct aggregation operation on the dimension.

Suppose that there is a table src(d1, d2, m), so the statement 1 "select d1, sum(m) from src group by d1, d2 with rollup" conducts the rollup operation on the dimension d1 and d2 to compute the result of m. It has actual business meaning, and its results are in line with the expectation. However, the statement 2 "select d1, sum(d1) from src group by d1, d2 with rollup" cannot be explained from the business perspective. For the statement 2, the result for all aggregations (sum/avg/max/min) is 0.

NOTE

Only when there is an aggregation operation for fields in "group by" in the rollup and cube operation, the result is 0. For non-rollup and non-cube operations, the result will be in line with the expectation.

21.7.2.2 Why Spark SQL Is Displayed as a Temporary Table in Different Databases?

Question

Why temporary tables of the previous database are displayed after the database is switched?

1. Create a temporary DataSource table, for example:
```
create temporary table ds_parquet
using org.apache.spark.sql.parquet
options(path '/tmp/users.parquet');
```
2. Switch to another database, and run ***show tables***. The temporary table created in the previous table is displayed.
```
0: jdbc:hive2://192.168.169.84:22550/default> show tables;
+-----------------+--------------+--+
|    tableName    | isTemporary  |
+-----------------+--------------+--+
| ds_parquet      | true         |
| cmb_tbl_carbon  | false        |
+-----------------+--------------+--+
2 rows selected (0.109 seconds)
0: jdbc:hive2://192.168.169.84:22550/default>
```

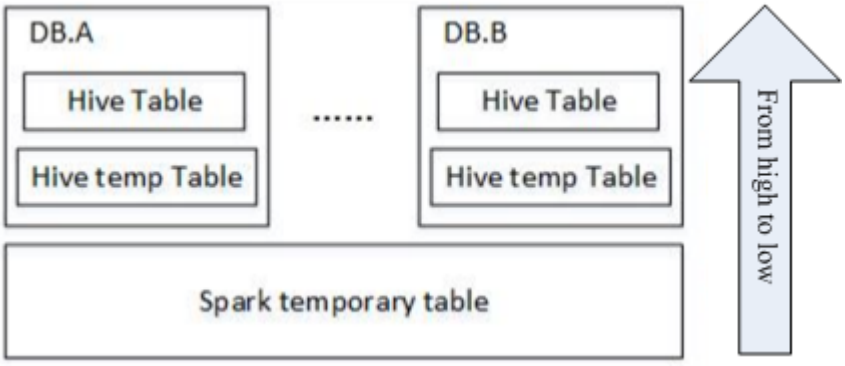
Answer

The table management hierarchy of Spark is shown in **Figure 21-11**. The lowest layer stores all temporary DataSource tables. There is no such concept as database at this layer. DataSource tables are visible in various databases.

The MetaStore of Hive is located at the upper layer. This layer distinguishes among databases. In each database, there are two types of Hive table, permanent and temporary. Therefore, Spark supports data tables of the same name at three layers.

During query, SparkSQL first checks for temporary Spark tables, then temporary Hive tables in the current database, and at last the permanent tables in the current database.

Figure 21-11 Spark table management hierarchy



When a session quits, temporary tables related to the user operation are automatically deleted. Manual deletion of temporary files is not recommended.

When deleting temporary files, use the same priority as that for query. The priorities are temporary Spark table, temporary Hive table, and permanent Hive table ranging from high to low. If you want to directly delete Hive tables but not temporary Spark tables, you can directly use the ***drop table DbName.TableName*** command.

21.7.2.3 How to Assign a Parameter Value in a Spark Command?

Question

Is it possible to assign parameter values through Spark commands, in addition to through a user interface or a configuration file?

Answer

Spark configuration options can be defined either in a configuration file or in Spark commands.

To assign a parameter value, run the --conf command on a Spark client. The parameter value takes effect immediately after the command is run.

The command format is --conf + parameter name + parameter value. Example command:

--conf spark.eventQueue.size=50000

21.7.2.4 What Directory Permissions Do I Need to Create a Table Using SparkSQL?

Question

The following error information is displayed when a new user creates a table using SparkSQL:

```
0: jdbc:hive2://192.168.169.84:22550/default> create table testACL(c string);
Error: org.apache.spark.sql.execution.QueryExecutionException: FAILED: Execution Error, return code 1 from
org.apache.hadoop.hive.ql.exec.DDLTask. MetaException(message:Got exception:
org.apache.hadoop.security.AccessControlException
Permission denied: user=testACL, access=EXECUTE, inode="/user/hive/warehouse/
testacl":spark:hadoop:drwxrwx---
    at
org.apache.hadoop.hdfs.server.namenode.FSPermissionChecker.checkAccessAcl(FSPermissionChecker.java:403
)
    at org.apache.hadoop.hdfs.server.namenode.FSPermissionChecker.check(FSPermissionChecker.java:306)
    at
org.apache.hadoop.hdfs.server.namenode.FSPermissionChecker.checkTraverse(FSPermissionChecker.java:259)
    at
org.apache.hadoop.hdfs.server.namenode.FSPermissionChecker.checkPermission(FSPermissionChecker.java:20
5)
    at
org.apache.hadoop.hdfs.server.namenode.FSPermissionChecker.checkPermission(FSPermissionChecker.java:19
0)
    at org.apache.hadoop.hdfs.server.namenode.FSDirectory.checkPermission(FSDirectory.java:1710)
    at
org.apache.hadoop.hdfs.server.namenode.FSDirStatAndListingOp.getFileInfo(FSDirStatAndListingOp.java:109)
    at org.apache.hadoop.hdfs.server.namenode.FSNamesystem.getFileInfo(FSNamesystem.java:3762)
```

```
    at
org.apache.hadoop.hdfs.server.namenode.NameNodeRpcServer.getFileInfo(NameNodeRpcServer.java:1014)
    at
org.apache.hadoop.hdfs.protocolPB.ClientNamenodeProtocolServerSideTranslatorPB.getFileInfo(ClientNamen
odeProtocolServerSideTranslatorPB.java:853)
    at org.apache.hadoop.hdfs.protocol.proto.ClientNamenodeProtocolProtos$ClientNamenodeProtocol
$2.callBlockingMethod(ClientNamenodeProtocolProtos.java)
    at org.apache.hadoop.ipc.ProtobufRpcEngine$Server$ProtoBufRpcInvoker.call(ProtobufRpcEngine.java:616)
    at org.apache.hadoop.ipc.RPC$Server.call(RPC.java:973)
    at org.apache.hadoop.ipc.Server$Handler$1.run(Server.java:2089)
    at org.apache.hadoop.ipc.Server$Handler$1.run(Server.java:2085)
    at java.security.AccessController.doPrivileged(Native Method)
    at javax.security.auth.Subject.doAs(Subject.java:422)
    at org.apache.hadoop.security.UserGroupInformation.doAs(UserGroupInformation.java:1675)
    at org.apache.hadoop.ipc.Server$Handler.run(Server.java:2083)
) (state=,code=0)
```

Answer

When you create a table using Spark SQL, the interface of Hive is called by the underlying system and a directory named after the table will be created in the **/user/hive/warehouse** directory. Therefore, you must have the permissions to read, write, and execute the **/user/hive/warehouse** directory or the group permission of Hive.

The**/user/hive/warehouse** is specified by the hive.metastore.warehouse.dir parameter.

21.7.2.5 Why Do I Fail to Delete the UDF Using Another Service?

Question

Why do I fail to delete the UDF using another service, for example, delete the UDF created by Hive using Spark SQL.

Answer

The UDF can be created using any of the following services:

1. Hive client.
2. JDBCServer API. You can connect JDBCServer to Spark Beeline or JDBC client code, and run SQL statements to create the UDF.
3. spark-sql.

The scenarios in which the UDF failed to be deleted may be as follows:

- If you use Spark Beeline to delete the UDF created by other services, you must restart the JDBCServer before the deletion. Otherwise, the deletion fails. If you use spark-sql to delete the UDF created by other services, you must restart the spark-sql before the deletion. Otherwise, the deletion fails.

  Cause: After the UDF is created, if the JDBCServer or the spark-sql has not been restarted, the newly created UDF will not be saved by the FunctionRegistry object in the thread where Spark locates. As a result, the UDF failed to be deleted.

  Solution: Restart the JDBCServer and spark-sql of the Spark client and delete the UDF.

- When creating UDF on the Hive client, the **add jar** command (e.g. **add jar /opt/test/two_udfs.jar**) is used to add the **.jar** package instead of specifying the path of **.jar** package in creating UDF statement. As a result, the **ClassNotfound** error occurs when you use other services to delete the UDF.

  Cause: When you use a service to delete the UDF, the service will load the class that corresponds to the UDF to obtain the UDF. However, the **.jar** package is added by the ***add jar*** command and jar package does not exist in the classpath of other services. As a result, the **ClassNotfound** error occurs and the UDF failed to be deleted.

  Solution: The UDF created using the preceding approach must be deleted using the same approach. No other approaches are allowed.

21.7.2.6 Why Cannot I Query Newly Inserted Data in a Parquet Hive Table Using SparkSQL?

Question

Why cannot I query newly inserted data in a parquet Hive table using SparkSQL? This problem occurs in the following scenarios:

1. For partitioned tables and non-partitioned tables, after data is inserted on the Hive client, the latest inserted data cannot be queried using SparkSQL.
2. After data is inserted into a partitioned table using SparkSQL, if the partition information remains unchanged, the newly inserted data cannot be queried using SparkSQL.

Answer

To improve Spark performance, parquet metadata is cached. When the parquet table is updated by Hive or another means, the cached metadata remains unchanged, resulting in SparkSQL failing to query the newly inserted data.

For a parquet Hive partition table, if the partition information remains unchanged after data is inserted, the cached metadata is not updated. As a result, the newly inserted data cannot be queried by SparkSQL.

To solve the query problem, update metadata before starting a Spark SQL query.

REFRESH TABLE table_name;

table_name indicates the name of the table to be updated. The table must exist. Otherwise, an error is reported.

When the query statement is executed, the latest inserted data can be obtained.

21.7.2.7 How to Use Cache Table?

Question

What is cache table used for? Which point should I pay attention to while using cache table?

Answer

Spark SQL caches tables into memory so that data can be directly read from memory instead of disks, reducing memory overhead due to disk reads.

Note that cached tables consume Executor's memory. This means that caching large or many tables compromises Executor's stability even if compressed storage has been used to reduce memory overhead as much as possible.

If it is no longer necessary to accelerate data query by means of cache table, run the following command to uncache tables to free up memory:

uncache table *table_name*

NOTE

The Storage tab page of the Spark Driver user interface displays the cached tables.

21.7.2.8 Why Are Some Partitions Empty During Repartition?

Question

During the repartition operation, the number of blocks (**spark.sql.shuffle.partitions**) is set to 4,500, and the number of keys used by repartition exceeds 4,000. It is expected that data corresponding to different keys can be allocated to different partitions. However, only 2,000 partitions have data, and data corresponding to different keys is allocated to the same partition.

Answer

This is normal.

The partition to which data is distributed is obtained by performing a modulo operation on hashcode of a key. Different hashcodes may have the same modulo result. In this case, data is distributed to the same partition, as a result, some partitions do not have data, and some partitions have data corresponding to multiple keys.

You can adjust the value of **spark.sql.shuffle.partitions** to adjust the cardinality during modulo operation and improve the unevenness of data blocks. After multiple verifications, it is found that the effect is good when the parameter is set to a prime number or an odd number.

Configure the following parameters in the **spark-defaults.conf** file on the Driver client.

Table 21-82 Parameter Description

Parameter	Description	Default Value
spark.sql.shuffle.partitions	Number of shuffle data blocks during the shuffle operation.	200

21.7.2.9 Why Does 16 Terabytes of Text Data Fails to Be Converted into 4 Terabytes of Parquet Data?

Question

When the default configuration is used, 16 terabytes of text data fails to be converted into 4 terabytes of parquet data, and the error information below is displayed. Why?

```
Job aborted due to stage failure: Task 2866 in stage 11.0 failed 4 times, most recent failure: Lost task
2866.6 in stage 11.0 (TID 54863, linux-161, 2): java.io.IOException: Failed to connect to /10.16.1.11:23124
at org.apache.spark.network.client.TransportClientFactory.createClient(TransportClientFactory.java:214)
at org.apache.spark.network.client.TransportClientFactory.createClient(TransportClientFactory.java:167)
at org.apache.spark.network.netty.NettyBlockTransferService$$anon
$1.createAndStart(NettyBlockTransferService.scala:92)
```

Table 21-83 lists the default configuration.

Table 21-83 Parameter Description

Parameter	Description	Default Value
spark.sql.shuffle.partitions	Number of shuffle data blocks during the shuffle operation.	200
spark.shuffle.sasl.timeout	Timeout interval of SASL authentication for the shuffle operation. Unit: second	120s
spark.shuffle.io.connectionTimeout	Timeout interval for connecting to a remote node during the shuffle operation. Unit: second	120s
spark.network.timeout	Timeout interval for all network connection operations. Unit: second	360s

Answer

The current data volume is 16 TB, but the number of partitions is only 200. As a result, each task is overloaded and the preceding problem occurs.

To solve the preceding problem, you need to adjust the parameters.

- Increase the number of partitions to divide the task into smaller ones.
- Increase the timeout interval during task execution.

Configure the following parameters in the **spark-defaults.conf** file on the client:

Table 21-84 Parameter Description

Parameter	Description	Recommended Value
spark.sql.shuffle.partitions	Number of shuffle data blocks during the shuffle operation.	4501
spark.shuffle.sasl.timeout	Timeout interval of SASL authentication for the shuffle operation. Unit: second	2000s
spark.shuffle.io.connectionTimeout	Timeout interval for connecting to a remote node during the shuffle operation. Unit: second	3000s
spark.network.timeout	Timeout interval for all network connection operations. Unit: second	360s

21.7.2.10 How Do I Rectify the Exception Occurred When I Perform an Operation on the Table Named table?

Symptom

After a table named **table** is created, the following error message is displayed when you run **drop table table** or perform other operations.

```
16/07/12 18:56:29 ERROR SparkSQLDriver: Failed in [drop table table]
java.lang.RuntimeException: [1.1] failure: identifier expected
table
^
at scala.sys.package$.error(package.scala:27)
at org.apache.spark.sql.catalyst.SqlParserTrait$class.parseTableIdentifier(SqlParser.scala:56)
at org.apache.spark.sql.catalyst.SqlParser$.parseTableIdentifier(SqlParser.scala:485)
```

Answer

table is a keyword of Spark SQL and cannot be used as a table name. Do not name a table **table**.

21.7.2.11 Why Is a Task Suspended When the ANALYZE TABLE Statement Is Executed and Resources Are Insufficient?

Question

When the ***analyze table*** statement is executed using spark-sql, the task is suspended and the information below is displayed. Why?

```
spark-sql> analyze table hivetable2 compute statistics;
Query ID = root_20160716174218_90f55869-000a-40b4-a908-533f63866fed
Total jobs = 1
```

```
Launching Job 1 out of 1
Number of reduce tasks is set to 0 since there's no reduce operator
16/07/20 17:40:56 WARN JobResourceUploader: Hadoop command-line option parsing not performed.
Implement the Tool interface and execute your application with ToolRunner to remedy this.
Starting Job = job_1468982600676_0002, Tracking URL = http://10-120-175-107:8088/proxy/
application_1468982600676_0002/
Kill Command = /opt/client/HDFS/hadoop/bin/hadoop job  -kill job_1468982600676_0002
```

Answer

When the statement is executed, the SQL statement starts the ***analyze table hivetable2 compute statistics*** MapReduce tasks. On the ResourceManager Web UI of Yarn, the task is not executed due to insufficient resources. As a result, the task is suspended.

Figure 21-12 ResourceManager web UI

You are advised to add **noscan** when running the ***analyze table*** statement. The function of this statement is the same as that of the ***analyze table hivetable2 compute statistics*** statement. The command is as follows:

```
spark-sql> analyze table hivetable2 compute statistics noscan
```

This command does not start MapReduce tasks and does not occupy Yarn resources. Therefore, the tasks can be executed.

21.7.2.12 If I Access a parquet Table on Which I Do not Have Permission, Why a Job Is Run Before "Missing Privileges" Is Displayed?

Question

If I access a parquet table on which I do not have permission, why a job is run before "Missing Privileges" is displayed?

Answer

The execution sequence of Spark SQL statement parse the table in the statement first, then obtain the metadata in the table, and finally check the permission.

The metadata of a parquet table contains the Split information (which is read by HDFS API) about files. If the table contains many files, the HDFS API reads data in serial mode, in which degrades the performance. If the number of files in the table exceeds the threshold *spark.sql.sources.parallelSplitDiscovery.threshold*, a job will be generated to use Executor to read the data in parallel mode.

The permission authentication is executed after the metadata is obtained. Therefore, when the number of files in the table exceeds the threshold, a job is run before the permission authentication error message **Missing Privileges**.

21.7.2.13 Why Do I Fail to Modify MetaData by Running the Hive Command?

Question

When do I fail to modify the metadata in the datasource and Spark on HBase table by running the Hive command?

Answer

The current Spark version does not support modifying the metadata in the datasource and Spark on HBase tables by running the Hive command.

21.7.2.14 Why Is "RejectedExecutionException" Displayed When I Exit Spark SQL?

Question

After successfully running Spark tasks with large data volume, for example, 2-TB TPCDS test suite, why is the abnormal stack information **"RejectedExecutionException"** displayed sometimes? The log is as follows:

```
16/07/16 10:19:56 ERROR TransportResponseHandler: Still have 2 requests outstanding when connection from linux-192/10.1.1.5:59250 is closed
java.util.concurrent.RejectedExecutionException: Task scala.concurrent.impl.CallbackRunnable@5fc1ab rejected from java.util.concurrent.ThreadPoolExecutor@52fa7e19[Terminated, pool size = 0, active threads = 0, queued tasks = 0, completed tasks = 3025]
```

Answer

When Spark SQL is closed, the application and the message channel are closed. If there are unprocessed messages, the connection should be closed to rectify the exception. If the thread pool inside Scala is closed, the abnormal stack information "RejectedExecutionException" is displayed. This abnormal stack information will not be displayed if the thread pool inside Scala is not closed.

The error occurs when the application is successfully run and closed. Therefore, the error will not affect the services.

21.7.2.15 How Do I Do If I Incidentally Kill the JDBCServer Process During Health Check?

Question

In the health check solution, when the number of concurrently executed statements reaches the upper limit of the thread pool, the health check command fails to run. As a result, the health check program times out and the Spark JDBCServer process is killed.

Answer

Currently, JDBCServer has two thread pools **HiveServer2-Handler-Pool** and **HiveServer2-Background-Pool**. HiveServer2-Handler-Pool is used to process session connections, and HiveServer2-Background-Pool is used to execute SQL statements.

In the current health check mechanism, a session connection is created and the health check command **HEALTHCHECK** is executed in the thread where the session is located to determine the health status of Spark JDBCServer. Therefore, HiveServer2-Handler-Pool must reserve a thread to process the health check session connection and execute the health check command, otherwise, the health check session cannot be established or the health check command cannot be executed. As a result, Spark JDBCServer is regarded as unhealthy and then killed. That is, if the number of thread pools of HiveServer2-Handler-Pool is 100, a maximum of 99 sessions can be connected.

21.7.2.16 Why No Result Is found When 2016-6-30 Is Set in the Date Field as the Filter Condition?

Question

Why no result is found when 2016-6-30 is set in the date field as the filter condition?

As shown in the following figure, trx_dte_par in the select count (*) from trxfintrx2012 a where trx_dte_par='2016-6-30' statement is a date field. However, no search result is found when the filter condition is where trx_dte_par='2016-6-30'. Search results are found only when the filter condition is where trx_dte_par='2016-06-30'.

Figure 21-13 Example

```
0: jdbc:hive2://ha-cluster/default> select count(*)
0: jdbc:hive2://ha-cluster/default>   from TRXFINTRX2012 a
0: jdbc:hive2://ha-cluster/default>   where trx_dte_par = '2016-6-30';
+------+--+
| _c0  |
+------+--+
| 0    |
+------+--+
1 row selected (0.498 seconds)
0: jdbc:hive2://ha-cluster/default> select count(*)
0: jdbc:hive2://ha-cluster/default>   from TRXFINTRX2012 a
0: jdbc:hive2://ha-cluster/default>   where trx_dte_par = '2016-06-30';
+----------+--+
|   _c0    |
+----------+--+
| 8520808  |
+----------+--+
1 row selected (15.788 seconds)
```

Answer

If a data string of the date type is present in Spark SQL statements, the Spark SQL will search the matching character string without checking the date format. In this case, if the date format in the SQL statement is incorrect, the query will fail. For example, if the data format is yyyy-mm-dd, then no search results matching '2016-6-30' will be found.

21.7.2.17 Why Does the "--hivevar" Option I Specified in the Command for Starting spark-beeline Fail to Take Effect?

Question

Why does the ***--hivevar*** option I specified in the command for starting spark-beeline fail to take effect?

In the V100R002C60 version, if I use the ***--hivevar <VAR_NAME>=<var_value>*** option to define a variable in the command for starting spark-beeline, no error is reported in spark-beeline. However, if the variable *<VAR_NAME>* is used in SQL, the variable cannot be parsed and the <VAR_NAME> exception is reported.

For example:

1. Run the following command to start the spark-beeline:

   spark-beeline --hivevar <VAR_NAME>=<var_value>

2. After spark-beeline is started successfully, I run the SQL statements ***DROP TABLE ${VAR_NAME}*** in spark-beeline. The VAR_NAME exception occurs.

Answer

In the V100R002C60 version, the ***--hivevar <VAR_NAME>=<var_value>*** feature of Hive is not supported in Spark because multi-session management function is added. Therefore, the ***--hivevar*** option in the command for starting spark-beeline is invalid.

21.7.2.18 Why Is Memory Insufficient if 10 Terabytes of TPCDS Test Suites Are Consecutively Run in Beeline/JDBCServer Mode?

Question

When the driver memory is set to 10 GB and the 10 TB TPCDS test suites are continuously run in Beeline/JDBCServer mode, SQL statements fail to be executed due to insufficient driver memory. Why?

Answer

By default, 1000 UI data records of jobs and stages are reserved in the memory.

The function of overflowing UI data to disks has been added to optimize large clusters. The overflow condition is that the size of UI data in each stage reaches the minimum threshold 5 MB. If the number of tasks in each stage is small, the size of UI data in the stage may not reach the threshold. As a result, the UI data in the stage is cached in the memory until the number of UI data records reaches the upper limit (1000 by default). Only then the old UI data is cleared from the memory.

Therefore, before the old UI data is cleared, the UI data occupies a large amount of memory. As a result, the driver memory is insufficient when 10 terabytes of TPCDS test suites are executed.

Workaround:

- Set **spark.ui.retainedJobs** and **spark.ui.retainedStages** based on service requirements to specify the number of UI data records of jobs and stages to be reserved. For details, see **Table 21-15** in **Common Parameters**.
- If a large amount of UI data of jobs and stages needs to be reserved, increase the memory of the driver by setting the **spark.driver.memory** parameter. For details, see **Table 21-12** in **Common Parameters**.

21.7.2.19 Why Are Some Functions Not Available when ThriftJDBCServers Are Connected?

Question

Scenario 1:

I set up permanent functions through the add jar. When another ThriftJDBCServer is connected or restarted, the add jar needs to be restarted.

Figure 21-14 Error information in Scenario 1

```
0: jdbc:hive2://192.168.91.247:23040/default> create function a1 as '                                                    ';
+---------+--+
| result  |
+---------+--+
+---------+--+
No rows selected (0.222 seconds)
0: jdbc:hive2://192.168.91.247:23040/default> SELECT test.a1(array(1, 2, 3), array(2));
+-------+--+
|  _c0  |
+-------+--+
| true  |
+-------+--+
1 row selected (8.282 seconds)
0: jdbc:hive2://192.168.91.247:23040/default> Closing: 0: jdbc:hive2://192.168.91.247:24002,192.168.154.81:24002,192.168.8.27:24002;serviceDiscoveryMode=zooKeep
p=auth-conf;auth=KERBEROS;principal=spark/hadoop.hadoop.com@HADOOP.COM;
100-106-121-140:/opt/hadoopclient # ./spark-beeline
It's running the fi spark-beeline, it calls /opt/hadoopclient/Spark/spark/bin/beeline
and helps to connect to the JDBCServer automatically
Connecting to jdbc:hive2://192.168.91.247:24002,192.168.154.81:24002,192.168.8.27:24002;serviceDiscoveryMode=zooKeeper;zooKeeperNamespace=sparkthriftserver;sas
doop.hadoop.com@HADOOP.COM;
2017-06-15 08:17:55,495 | WARN  | Thread-2 | TGT refresh thread time adjusted from : Thu Jun 15 05:59:42 GMT+08:00 2017 to : Thu Jun 15 08:18:55 GMT+08:00 2017
fresh interval (60 seconds) from now. | org.apache.zookeeper.Login$1.run(Login.java:177)
2017-06-15 08:17:56,743 | WARN  | main | Unable to load native-hadoop library for your platform... using builtin-java classes where applicable | org.apache.had
ader.java:62)
2017-06-15 08:17:56,773 | WARN  | TGT Renewer for sparkuser@HADOOP.COM | Exception encountered while running the renewal command. Aborting renew thread. ExitCo
1 requested option while renewing credentials
 | org.apache.hadoop.security.UserGroupInformation$1.run(UserGroupInformation.java:946)
Connected to: Spark SQL (version)
Driver: Hive JDBC (version 1.2.1.spark)
Transaction isolation: TRANSACTION_REPEATABLE_READ
Beeline version 1.2.1.spark by Apache Hive
[INFO] Unable to bind key for unsupported operation: backward-delete-word
[INFO] Unable to bind key for unsupported operation: backward-delete-word
[INFO] Unable to bind key for unsupported operation: down-history
[INFO] Unable to bind key for unsupported operation: up-history
[INFO] Unable to bind key for unsupported operation: up-history
[INFO] Unable to bind key for unsupported operation: down-history
[INFO] Unable to bind key for unsupported operation: up-history
[INFO] Unable to bind key for unsupported operation: down-history
[INFO] Unable to bind key for unsupported operation: up-history
[INFO] Unable to bind key for unsupported operation: down-history
[INFO] Unable to bind key for unsupported operation: up-history
[INFO] Unable to bind key for unsupported operation: down-history
0: jdbc:hive2://192.168.8.27:23040/default> SELECT test.a1(array(1, 2, 3), array(2));
Error: org.apache.spark.SparkException: Unable to load UDF class (state=,code=0)
0: jdbc:hive2://192.168.8.27:23040/default> set role admin;
+-------------+--------+--+
|     key     | value  |
+-------------+--------+--+
| role admin  |        |
+-------------+--------+--+
1 row selected (0.465 seconds)
0: jdbc:hive2://192.168.8.27:23040/default> add jar /home/smartcare-udf-0.0.1-SNAPSHOT.jar;
+---------+--+
| result  |
+---------+--+
| 0       |
+---------+--+
```

Scenario 2:

show functions can be used to query functions, but cannot be used. The reason is that connected JDBC node does not contain jar packages of the corresponding path. After adding corresponding jar packages, the show functions can be properly used.

Figure 21-15 Error information in scenario 2

Answer

Scenario 1:

The **addjar** statement loads the jar only to the jarClassLoader of the currently connected JDBCServer. Different JDBCServers do not share the jarClassLoader. After JDBCServer restarts, new jarClassLoader is created. So the **addjar** statement needs to be run again.

You can add a JAR file in either of the following ways: Add a JAR file when starting spark-sql, for example, **spark-sql --jars /opt/test/two_udfs.jar**. Add a JAR file after spark-sql is started, for example, **add jar /opt/test/two_udfs.jar**. The path specified by add jar can be a local path or an HDFS path.

Scenario 2:

The **show functions** command obtains all functions in the current database from the external catalog. When a function is used in SQL statements, JDBCServer loads the JAR package corresponding to the function.

If the JAR file does not exist, the function cannot be used. In this case, run the ***add jar*** command again.

21.7.2.20 Why Does Spark-beeline Fail to Run and Error Message "Failed to create ThriftService instance" Is Displayed?

Question

Why does "Failed to create ThriftService instance" occur when spark beeline fails to run?

Beeline logs are as follows:

Error: Failed to create ThriftService instance (state=,code=0)
Beeline version 1.2.1.spark by Apache Hive
[INFO] Unable to bind key for unsupported operation: backward-delete-word

```
[INFO] Unable to bind key for unsupported operation: backward-delete-word
[INFO] Unable to bind key for unsupported operation: down-history
[INFO] Unable to bind key for unsupported operation: up-history
[INFO] Unable to bind key for unsupported operation: up-history
[INFO] Unable to bind key for unsupported operation: down-history
[INFO] Unable to bind key for unsupported operation: up-history
[INFO] Unable to bind key for unsupported operation: down-history
[INFO] Unable to bind key for unsupported operation: up-history
[INFO] Unable to bind key for unsupported operation: down-history
[INFO] Unable to bind key for unsupported operation: up-history
[INFO] Unable to bind key for unsupported operation: down-history
beeline>
```

In addition, the "Timed out waiting for client to connect" error log is generated on the JDBCServer. The details are as follows:

```
2017-07-12 17:35:11,284 | INFO  | [main] | Will try to open client transport with JDBC Uri:
jdbc:hive2://192.168.101.97:23040/default;principal=spark/hadoop.<System domain name>@<System
domain name>;healthcheck=true;saslQop=auth-conf;auth=KERBEROS;user.principal=spark/hadoop.<System
domain name>@<System domain name>;user.keytab=${BIGDATA_HOME}/FusionInsight_HD_8.1.0.1/install/
FusionInsight-Spark-*/keytab/spark/JDBCServer/spark.keytab |
org.apache.hive.jdbc.HiveConnection.openTransport(HiveConnection.java:317)
2017-07-12 17:35:11,326 | INFO  | [HiveServer2-Handler-Pool: Thread-92] | Client protocol version:
HIVE_CLI_SERVICE_PROTOCOL_V8 |
org.apache.proxy.service.ThriftCLIProxyService.OpenSession(ThriftCLIProxyService.java:554)
2017-07-12 17:35:49,790 | ERROR | [HiveServer2-Handler-Pool: Thread-113] | Timed out waiting for client
to connect.
Possible reasons include network issues, errors in remote driver or the cluster has no available resources, etc.
Please check YARN or Spark driver's logs for further information. |
org.apache.proxy.service.client.SparkClientImpl.<init>(SparkClientImpl.java:90)
java.util.concurrent.ExecutionException: java.util.concurrent.TimeoutException: Timed out waiting for
client connection.
 at io.netty.util.concurrent.AbstractFuture.get(AbstractFuture.java:37)
 at org.apache.proxy.service.client.SparkClientImpl.<init>(SparkClientImpl.java:87)
 at org.apache.proxy.service.client.SparkClientFactory.createClient(SparkClientFactory.java:79)
 at org.apache.proxy.service.SparkClientManager.createSparkClient(SparkClientManager.java:145)
 at org.apache.proxy.service.SparkClientManager.createThriftServerInstance(SparkClientManager.java:160)
 at org.apache.proxy.service.ThriftServiceManager.getOrCreateThriftServer(ThriftServiceManager.java:182)
 at org.apache.proxy.service.ThriftCLIProxyService.OpenSession(ThriftCLIProxyService.java:596)
 at org.apache.hive.service.cli.thrift.TCLIService$Processor$OpenSession.getResult(TCLIService.java:1257)
 at org.apache.hive.service.cli.thrift.TCLIService$Processor$OpenSession.getResult(TCLIService.java:1242)
 at org.apache.thrift.ProcessFunction.process(ProcessFunction.java:39)
 at org.apache.thrift.TBaseProcessor.process(TBaseProcessor.java:39)
 at org.apache.hadoop.hive.thrift.HadoopThriftAuthBridge$Server
$TUGIAssumingProcessor.process(HadoopThriftAuthBridge.java:696)
 at org.apache.thrift.server.TThreadPoolServer$WorkerProcess.run(TThreadPoolServer.java:286)
 at java.util.concurrent.ThreadPoolExecutor.runWorker(ThreadPoolExecutor.java:1142)
 at java.util.concurrent.ThreadPoolExecutor$Worker.run(ThreadPoolExecutor.java:617)
 at java.lang.Thread.run(Thread.java:748)
Caused by: java.util.concurrent.TimeoutException: Timed out waiting for client connection.
```

Answer

This problem occurs when the network is unstable. When a timed-out exception occurs in beeline, Spark does not attempt to reconnect to beeline.

Solution

Restart spark-beeline for reconnection.

21.7.2.21 Why Cannot I Query Newly Inserted Data in an ORC Hive Table Using Spark SQL?

Question

Why cannot I query newly inserted data in an ORC Hive table using Spark SQL? This problem occurs in the following scenarios:

- For partitioned tables and non-partitioned tables, after data is inserted on the Hive client, the latest inserted data cannot be queried using Spark SQL.
- After data is inserted into a partitioned table using Spark SQL, if the partition information remains unchanged, the newly inserted data cannot be queried using Spark SQL.

Answer

To improve Spark performance, ORC metadata is cached. When the ORC table is updated by Hive or another means, the cached metadata remains unchanged, resulting in Spark SQL failing to query the newly inserted data.

For an ORC Hive partition table, if the partition information remains unchanged after data is inserted, the cached metadata is not updated. As a result, the newly inserted data cannot be queried by Spark SQL.

Solution

1. To solve the query problem, update metadata before starting a Spark SQL query.

   REFRESH TABLE *table_name*;

   table_name indicates the name of the table to be updated. The table must exist. Otherwise, an error is reported.

   When the query statement is executed, the latest inserted data can be obtained.
2. Run the following command to disable Spark optimization when using Spark:

   set spark.sql.hive.convertMetastoreOrc=false;

21.7.3 Spark Streaming

21.7.3.1 What Can I Do If Spark Streaming Tasks Are Blocked?

Question

After a Spark Streaming task is run and data is input, no processing result is displayed. Open the web page to view the Spark job execution status. The following figure shows that two jobs are waiting to be executed but cannot be executed successfully.

Figure 21-16 Active Jobs

Active Jobs (2)

Job Id	Description	Submitted	Duration	Stages: Succeeded/Total
3	print at test2StreamFromKafka.scala:31	2015/05/25 18:28:55	63.7 h	0/3
2	start at test2StreamFromKafka.scala:34	2015/05/25 18:28:55	63.7 h	0/1

Check the completed jobs. Only two jobs are found, indicating that Spark Streaming does not trigger data computing tasks. (By default, Spark Streaming has two jobs that attempt to run. See the figure below.)

Figure 21-17 Completed Jobs

Completed Jobs (2)

Job Id	Description	Submitted	Duration	Stages: Succeeded/Total
1	print at test2StreamFromKafka.scala:31	2015/05/25 18:28:55	0.7 s	2/2 (1 skipped)
0	start at test2StreamFromKafka.scala:34	2015/05/25 18:28:54	1 s	2/2

Answer

After fault locating, it is found that the number of computing cores of Spark Streaming is less than the number of receivers. As a result, after some receivers are started, no resources are available to run computing tasks. Therefore, the first task keeps waiting and subsequent tasks keep queuing. **Figure 21-16** is an example of two queuing tasks.

To address this problem, it is advised to check whether the number of Spark cores is greater than the number of receivers when two tasks are queuing.

NOTE

Receiver is a permanent Spark job in Spark Streaming. It is common for Spark, but its life cycle is the same as that of a Spark Streaming task and occupies one computing core.

Pay attention to the relationship between the number of cores and the number of receivers in scenarios where default configurations are often used, such as debugging and testing.

21.7.3.2 What Should I Pay Attention to When Optimizing Spark Streaming Task Parameters?

Question

When Spark Streaming tasks are running, the data processing performance does not improve significantly as the number of executors increases. What should I pay attention to if I perform parameter optimization?

Answer

When the number of executor cores is 1, comply with the following rules to optimize Spark Streaming running parameters:

- The Spark task processing speed is related to the number of partitions in Kafka. When the number of partitions is less than the specified number of executors, the number of actually used executors is the same as the number of partitions, and other executors will be idle. Therefore, the number of executors must be less than or equal to the number of partitions.
- When data skew occurs on different partitions of Kafka, the executor corresponding to the partition with a large amount of data touches the glass ceiling of data processing. Therefore, when the Producer program is executed, data is sent to each partition on average to improve the processing speed.

- When partition data is evenly distributed, increasing the number of partitions and executors will improve the Spark processing speed. (When the number of partitions is the same as that of executors, the processing speed is the fastest.)
- When partition data is evenly distributed, ensure that the number of partitions is an integer multiple of the number of executors for proper allocation of resources.

21.7.3.3 Why Does the Spark Streaming Application Fail to Be Submitted After the Token Validity Period Expires?

Question

Change the validity period of the Kerberos ticket and HDFS token to 5 minutes, set **dfs.namenode.delegation.token.renew-interval** to a value less than 60 seconds, and submit the Spark Streaming application. If the token expires, the error message below is displayed, and the application exits. Why?

```
token (HDFS_DELEGATION_TOKEN token 17410 for spark) is expired
```

Answer

- Possible causes:

  The credential refresh thread of the ApplicationMaster process uploads the updated credential file to the HDFS based on the *token renew period multiplied by 0.75*.

  In the executor process, the credential refresh thread obtains the updated credential file from the HDFS based on the time ratio of the *token renewal period multiplied by 0.8* to update the token in UserGroupInformation, preventing the token from being invalid.

  When the credential refresh thread of the executor process detects that the current time is later than the credential file update time (*token renew period x 0.8*), it waits for 1 minute and then obtains the latest credential file from the HDFS to ensure that the AM has stored the updated credential file in the HDFS.

  When the value of **dfs.namenode.delegation.token.renew-interval** is less than 60 seconds, the started executor detects that the current time is later than the time when the credential file is updated. One minute later, the executor obtains the latest credential file from the HDFS. However, the token is already invalid, and the task fails to be executed. Then, other executor processes retry within 1 minute. The task also fails to run on other executors. As a result, the executors that fail to run are added to the blacklist. If no executors are available, the application exits.

- Solution:

  In the Spark application scenario, set **dfs.namenode.delegation.token.renew-interval** to a value greater than 80 seconds. For details about the **dfs.namenode.delegation.token.renew-interval** parameter, see **Table 21-85**.

Table 21-85 Parameter description

Parameter	Description	Default Value
dfs.namenode.delegation.token.renew-interval	This parameter is a server parameter. It specifies the maximum lifetime to renew a token. Unit: milliseconds.	86400000

21.7.3.4 Why Does the Spark Streaming Application Fail to Be Started from the Checkpoint When the Input Stream Has No Output Logic?

Symptom

One input stream was created for the Spark Streaming application, but the input stream had no output logic. The application failed to be started from the checkpoint. The error information is as follows:

```
17/04/24 10:13:57 ERROR Utils: Exception encountered
java.lang.NullPointerException
at org.apache.spark.streaming.dstream.DStreamCheckpointData$$anonfun$writeObject$1.apply$mcV
$sp(DStreamCheckpointData.scala:125)
at org.apache.spark.streaming.dstream.DStreamCheckpointData$$anonfun$writeObject
$1.apply(DStreamCheckpointData.scala:123)
at org.apache.spark.streaming.dstream.DStreamCheckpointData$$anonfun$writeObject
$1.apply(DStreamCheckpointData.scala:123)
at org.apache.spark.util.Utils$.tryOrIOException(Utils.scala:1195)
at
org.apache.spark.streaming.dstream.DStreamCheckpointData.writeObject(DStreamCheckpointData.scala:123
)
at sun.reflect.NativeMethodAccessorImpl.invoke0(Native Method)
at sun.reflect.NativeMethodAccessorImpl.invoke(NativeMethodAccessorImpl.java:62)
at sun.reflect.DelegatingMethodAccessorImpl.invoke(DelegatingMethodAccessorImpl.java:43)
at java.lang.reflect.Method.invoke(Method.java:498)
at java.io.ObjectStreamClass.invokeWriteObject(ObjectStreamClass.java:1028)
at java.io.ObjectOutputStream.writeSerialData(ObjectOutputStream.java:1496)
at java.io.ObjectOutputStream.writeOrdinaryObject(ObjectOutputStream.java:1432
at java.io.ObjectOutputStream.writeObject0(ObjectOutputStream.java:1178)
at java.io.ObjectOutputStream.defaultWriteFields(ObjectOutputStream.java:1548)
at java.io.ObjectOutputStream.defaultWriteObject(ObjectOutputStream.java:441)
at org.apache.spark.streaming.dstream.DStream$$anonfun$writeObject$1.apply$mcV$sp(DStream.scala:515)
at org.apache.spark.streaming.dstream.DStream$$anonfun$writeObject$1.apply(DStream.scala:510)
at org.apache.spark.streaming.dstream.DStream$$anonfun$writeObject$1.apply(DStream.scala:510)
at org.apache.spark.util.Utils$.tryOrIOException(Utils.scala:1195)
at org.apache.spark.streaming.dstream.DStream.writeObject(DStream.scala:510)
at sun.reflect.NativeMethodAccessorImpl.invoke0(Native Method)
at sun.reflect.NativeMethodAccessorImpl.invoke(NativeMethodAccessorImpl.java:62)
at sun.reflect.DelegatingMethodAccessorImpl.invoke(DelegatingMethodAccessorImpl.java:43)
at java.lang.reflect.Method.invoke(Method.java:498)
at java.io.ObjectStreamClass.invokeWriteObject(ObjectStreamClass.java:1028)
at java.io.ObjectOutputStream.writeSerialData(ObjectOutputStream.java:1496)
at java.io.ObjectOutputStream.writeOrdinaryObject(ObjectOutputStream.java:1432
at java.io.ObjectOutputStream.writeObject0(ObjectOutputStream.java:1178)
at java.io.ObjectOutputStream.writeArray(ObjectOutputStream.java:1378)
at java.io.ObjectOutputStream.writeObject0(ObjectOutputStream.java:1174)
at java.io.ObjectOutputStream.defaultWriteFields(ObjectOutputStream.java:1548)
at java.io.ObjectOutputStream.writeSerialData(ObjectOutputStream.java:1509)
at java.io.ObjectOutputStream.writeOrdinaryObject(ObjectOutputStream.java:1432
at java.io.ObjectOutputStream.writeObject0(ObjectOutputStream.java:1178)
at java.io.ObjectOutputStream.defaultWriteFields(ObjectOutputStream.java:1548)
```

```
at java.io.ObjectOutputStream.defaultWriteObject(ObjectOutputStream.java:441)
at org.apache.spark.streaming.DStreamGraph$$anonfun$writeObject$1.apply$mcV
$sp(DStreamGraph.scala:191)
at org.apache.spark.streaming.DStreamGraph$$anonfun$writeObject$1.apply(DStreamGraph.scala:186)
at org.apache.spark.streaming.DStreamGraph$$anonfun$writeObject$1.apply(DStreamGraph.scala:186)
at org.apache.spark.util.Utils$.tryOrIOException(Utils.scala:1195)
at org.apache.spark.streaming.DStreamGraph.writeObject(DStreamGraph.scala:186
at sun.reflect.NativeMethodAccessorImpl.invoke0(Native Method)
at sun.reflect.NativeMethodAccessorImpl.invoke(NativeMethodAccessorImpl.java:62)
at sun.reflect.DelegatingMethodAccessorImpl.invoke(DelegatingMethodAccessorImpl.java:43)
at java.lang.reflect.Method.invoke(Method.java:498)
at java.io.ObjectStreamClass.invokeWriteObject(ObjectStreamClass.java:1028)
at java.io.ObjectOutputStream.writeSerialData(ObjectOutputStream.java:1496)
at java.io.ObjectOutputStream.writeOrdinaryObject(ObjectOutputStream.java:1432
at java.io.ObjectOutputStream.writeObject0(ObjectOutputStream.java:1178)
at java.io.ObjectOutputStream.defaultWriteFields(ObjectOutputStream.java:1548)
at java.io.ObjectOutputStream.writeSerialData(ObjectOutputStream.java:1509)
at java.io.ObjectOutputStream.writeOrdinaryObject(ObjectOutputStream.java:1432
at java.io.ObjectOutputStream.writeObject0(ObjectOutputStream.java:1178)
at java.io.ObjectOutputStream.writeObject(ObjectOutputStream.java:348)
at org.apache.spark.streaming.Checkpoint$$anonfun$serialize$1.apply$mcV$sp(Checkpoint.scala:142)
at org.apache.spark.streaming.Checkpoint$$anonfun$serialize$1.apply(Checkpoint.scala:142)
at org.apache.spark.streaming.Checkpoint$$anonfun$serialize$1.apply(Checkpoint.scala:142)
at org.apache.spark.util.Utils$.tryWithSafeFinally(Utils.scala:1230)
at org.apache.spark.streaming.Checkpoint$.serialize(Checkpoint.scala:143)
at org.apache.spark.streaming.StreamingContext.validate(StreamingContext.scala:566)
at org.apache.spark.streaming.StreamingContext.liftedTree1$1(StreamingContext.scala:612)
at org.apache.spark.streaming.StreamingContext.start(StreamingContext.scala:611)
at com.spark.test.kafka08LifoTwoInkfk$.main(kafka08LifoTwoInkfk.scala:21)
at com.spark.test.kafka08LifoTwoInkfk.main(kafka08LifoTwoInkfk.scala)
at sun.reflect.NativeMethodAccessorImpl.invoke0(Native Method)
at sun.reflect.NativeMethodAccessorImpl.invoke(NativeMethodAccessorImpl.java:62)
at sun.reflect.DelegatingMethodAccessorImpl.invoke(DelegatingMethodAccessorImpl.java:43)
at java.lang.reflect.Method.invoke(Method.java:498)
at org.apache.spark.deploy.SparkSubmit$.org$apache$spark$deploy$SparkSubmit$
$runMain(SparkSubmit.scala:772)
at org.apache.spark.deploy.SparkSubmit$.doRunMain$1(SparkSubmit.scala:183)
at org.apache.spark.deploy.SparkSubmit$.submit(SparkSubmit.scala:208)
at org.apache.spark.deploy.SparkSubmit$.main(SparkSubmit.scala:123)
at org.apache.spark.deploy.SparkSubmit.main(SparkSubmit.scala)
```

Answer

When Streaming Context is started, if a checkpoint is set for an application, the DStream checkpoint object in the application needs to be serialized. **dstream.context** is used during serialization.

dstream.context is used to reversely search for dependent DStreams from output Streams when Streaming Context is started, and to set **context** one by one. If an input stream is created for a Spark Streaming application but the input stream has no output logic, no **context** is set for the input stream. As a result, **NullPointerException** is reported during serialization.

Solution: If the input stream of the output logic does not exist in the application, delete the input stream from the code or add the output logic of the input stream.

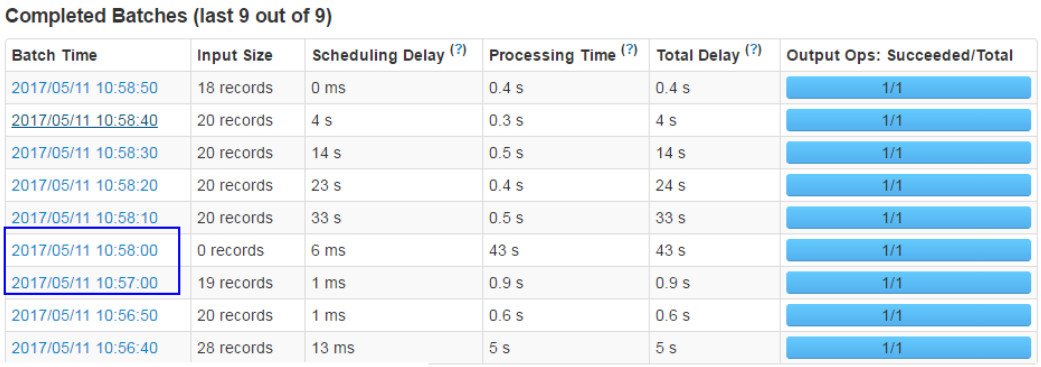
21.7.3.5 Why Is the Input Size Corresponding to Batch Time on the Web UI Set to 0 Records When Kafka Is Restarted During Spark Streaming Running?

Question

When the Kafka is restarted during the execution of the Spark Streaming application, the application cannot obtain the topic offset from the Kafka. As a

result, the job fails to be generated. As shown in **Figure 21-18**, **2017/05/11 10:57:00-2017/05/11 10:58:00** indicates the Kafka restart time. After the restart is successful at 10:58:00 on May,11,2017, the value of **Input Size** is **0 records**.

Figure 21-18 On the Web UI, the **input size** corresponding to the **batch time** is **0 records**.


Completed Batches (last 9 out of 9)

Batch Time	Input Size	Scheduling Delay (?)	Processing Time (?)	Total Delay (?)	Output Ops: Succeeded/Total
2017/05/11 10:58:50	18 records	0 ms	0.4 s	0.4 s	1/1
2017/05/11 10:58:40	20 records	4 s	0.3 s	4 s	1/1
2017/05/11 10:58:30	20 records	14 s	0.5 s	14 s	1/1
2017/05/11 10:58:20	20 records	23 s	0.4 s	24 s	1/1
2017/05/11 10:58:10	20 records	33 s	0.5 s	33 s	1/1
2017/05/11 10:58:00	0 records	6 ms	43 s	43 s	1/1
2017/05/11 10:57:00	19 records	1 ms	0.9 s	0.9 s	1/1
2017/05/11 10:56:50	20 records	1 ms	0.6 s	0.6 s	1/1
2017/05/11 10:56:40	28 records	13 ms	5 s	5 s	1/1

Answer

After Kafka is restarted, the application supplements the missing RDD between 10:57:00 on May 11, 2017 and 10:58:00 on May 11, 2017 based on the batch time. Although the number of read data records displayed on the UI is **0**, the missing data is processed in the supplemented RDD. So, no data is lost.

The data processing mechanism during the Kafka restart period is as follows:

The Spark Streaming application uses the **state** function (for example, **updateStateByKey**). After Kafka is restarted, the Spark Streaming application generates a batch task at 10:58:00 on May 11, 2017. The missing RDD between10:57:00 on May 11, 2017 and 10:58:00 on May 11, 2017 is supplemented based on the batch time (data that is not read in Kafka before Kafka restart, which belongs to the batch before 10:57:00 on May 11, 2017).

21.7.4 Spark Ranger FAQ

21.7.4.1 Why Do Ranger Authentication and ACL Authentication Fail?

Question

The following errors are reported during query or table creation:

1. Failed to use Ranger authentication.
   ```
   org.apache.ranger.authorization.spark.authorizer.SparkAccessControlException: Permission denied: user [username] does not have [SELECT] privilege on [databasename/tablename]
   ```
2. Failed to use ACL authentication.
   ```
   org.apache.hadoop.security.AccessControlException: Permission denied
   ```

Causes

1. User permissions to use authentication modes are not configured.

2. The corresponding authentication mode is not used after the user permission is configured: ACL authentication is used after the Ranger access permission policy for Spark is added, or Ranger authentication is used after the ACL access permission policy is added.

Solution

1. Check the current authentication mode.

   View the parameters.

   Method 1: Check the **spark.ranger.plugin.authorization.enable** value in the **spark-defaults.conf** configuration file. **true** indicates that Ranger authentication is used, and **false** indicates that ACL authentication is used.

   Method 2: Run the **set spark.ranger.plugin.authorization.enable** command in the Spark application. If the command output is **true**, Ranger authentication is used. If the command output is **false**, ACL authentication is used.

2. Configure the access permission policy.

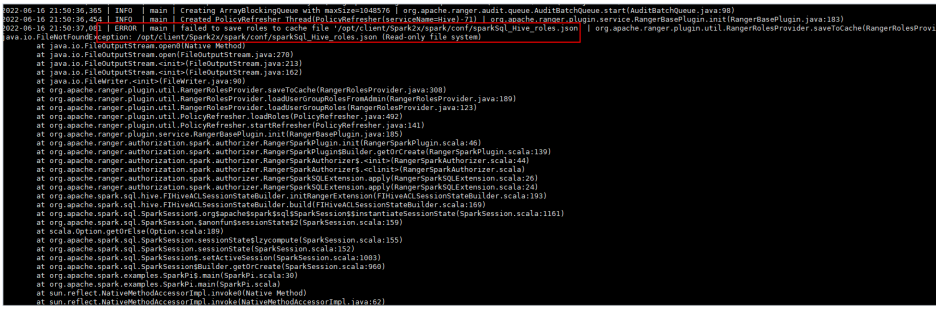
   For details about the Ranger access permission policy, see **Adding a Ranger Access Permission Policy for Spark**.

   For details about the ACL access permission policy, see **SparkSQL Permission Management(Security Mode)**.

21.7.4.2 Why Do spark-sql and spark-submit Fail to Execute When Ranger Authentication Is Used and the Client Is Mounted in Read-Only Mode?

Question

When Ranger authentication is used and the client is mounted in read-only mode, **spark-sql** and **spark-submit** fail to execute, and an error message is displayed, indicating that saving roles to the **sparkSql_Hive_roles.json** file fails.



Possible Causes

When submitting an application, the Spark client reads the latest Ranger authentication policy file, caches it locally, and updates the **$SPARK_HOME/conf/sparkSql_Hive.json** and **$SPARK_HOME/conf/sparkSql_Hive_roles.json** files. In read-only mode, the client configuration files cannot be updated. As a result, an error is reported.

Solution

Method 1: Change the Ranger authentication mode to ACL authentication. For details, see **SparkSQL Permission Management(Security Mode)**.

Method 2: Change the path for storing the policy file and add the modification permission.

On the client, change the **ranger.plugin.spark.policy.cache.dir** value in the **/opt/client/Spark/spark/conf/ranger-spark-security.xml** file to a directory that is not on the client, and the directory has the execution permission on Spark.

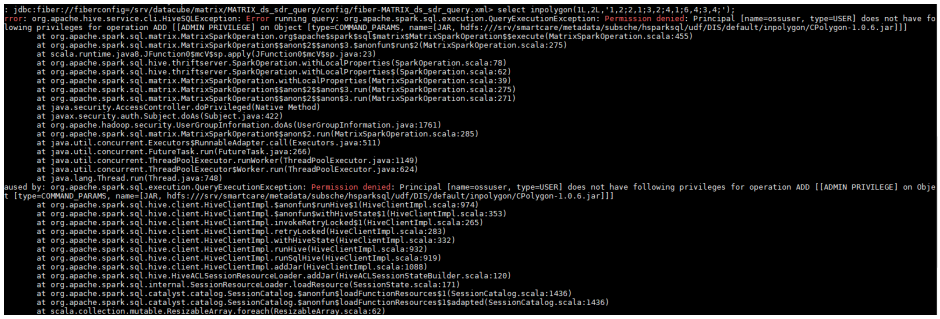
```
<?xml version="1.0" encoding="UTF-8"?>
<configuration>
<property>
<name>ranger.plugin.spark.policy.cache.dir</name>
<value>/opt/liuyongan/conf</value>
</property>
<property>
<name>ranger.plugin.spark.policy.pollIntervalMs</name>
<value>30000</value>
</property>
<property>
<name>ranger.plugin.spark.urlauth.filesystem.schemes</name>
<value>hdfs:,file:,obs:,viewfs:</value>
</property>
```

Method 3: Cancel the read-only configuration of the client configuration files as the user.

21.7.4.3 Why Is a Permission Exception Reported When Ranger Authentication and UDFs Are Used?

Question

When Ranger authentication is used and user-defined functions (UDFs) are used, a permission exception is reported.



Causes

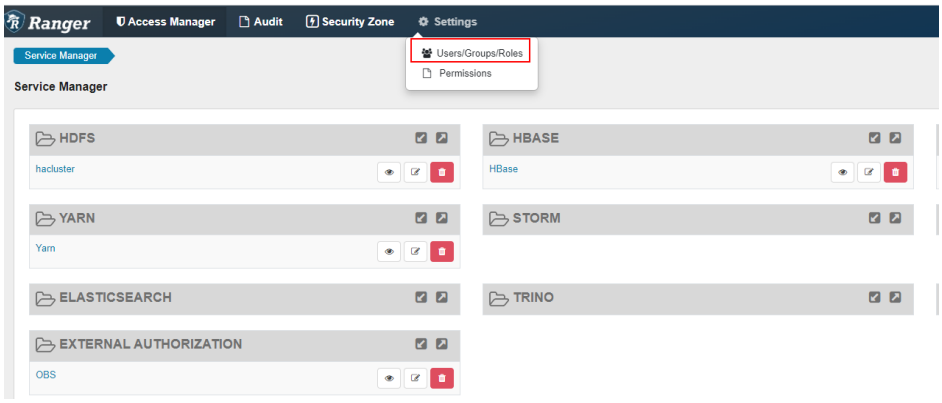
If Ranger authentication is used, you must have the administrator permission to create, use, and delete functions. You can perform the management operations only after the administrator permissions are updated.

Solution

Add the admin permission of the user to Ranger.

1. Log in to the Ranger management page as user **rangeradmin** by referring to **Logging In to the Ranger Web UI**.

2. On the home page, click **Settings** and choose **Roles**.



3. Click the role with **Role Name** set to **admin**. In the **Users** area, click **Select User** and select a username.
4. Click **Add Users**, select **Is Role Admin** in the row where the username is located, and click **Save**.

Update the administrator permissions of a user.

5. Use PuTTY to log in to the node where the Spark client is installed as the client installation user and run the following commands:

   source *{Spark client installation directory}*/**bigdata_env**

   kinit *Spark service user*

   spark-beeline
6. Run the following command to update the administrator permissions of the user:

   set role admin;

21.7.5 Why Is the RESTful Interface Information Obtained by Accessing Spark Incorrect?

Question

After Spark stops, I access the RESTful interface of the application to obtain the job information. It is found that the value of **numActiveTasks** is a negative number.

Figure 21-19 Job information


```
[ {
  "jobId" : 0,
  "name" : "reduce at SparkPi.scala:36",
  "submissionTime" : "2016-05-28T09:35:34.415GMT",
  "completionTime" : "2016-05-28T09:35:35.686GMT",
  "stageIds" : [ 0 ],
  "status" : "SUCCEEDED",
  "numTasks" : 2,
  "numActiveTasks" : -1,
  "numCompletedTasks" : 2,
  "numSkippedTasks" : 2,
  "numFailedTasks" : 0,
  "numActiveStages" : 0,
  "numCompletedStages" : 1,
  "numSkippedStages" : 0,
  "numFailedStages" : 0
} ]
```


NOTE

numActiveTasks indicates the number of running tasks.

Answer

Obtain job information in either of the following ways:

- Set **spark.history.briefInfo.gather** to **true** and view **brief** information about JobHistory.
- Visit the Spark JobHistory page **https://IP:port/api/v1/<appid>/jobs/**.

The value of **numActiveTasks** in the job information is calculated based on the difference between the number of SparkListenerTaskStart events and the number of SparkListenerTaskEnd events in the **eventlog** file. If any event in **eventlog** is lost, the problem may occur.

21.7.6 Why Cannot I Switch from the Yarn Web UI to the Spark Web UI?

Question

In FusionInsight, the Spark application is run in yarn-client mode on the client. The following error occurs during the switch from the Yarn web UI to the application web UI:

The YARN ResourceManager log shows the following information:

2016-07-21 16:35:27,099 | INFO | Socket Reader #1 for port 8032 | Auth successful for mapred/hadoop.*<System domain name>*@*<System domain name>* (auth:KERBEROS) | Server.java:1388

```
2016-07-21 16:35:27,105 | INFO  | 1526016381@qtp-1178290888-1015 | admin is accessing unchecked
http://10.120.169.53:23011 which is the app master GUI of
application_1468986660719_0045 owned by spark | WebAppProxyServlet.java:393
2016-07-21 16:36:02,843 | INFO  | Socket Reader #1 for port 8032 | Auth successful for hive/
hadoop.<System domain name>@<System domain name> (auth:KERBEROS) | Server.java:1388
2016-07-21 16:36:02,851 | INFO  | Socket Reader #1 for port 8032 | Auth successful for hive/
hadoop.<System domain name>@<System domain name> (auth:KERBEROS) | Server.java:1388
2016-07-21 16:36:12,163 | WARN  | 1526016381@qtp-1178290888-1015 | /proxy/
application_1468986660719_0045/: java.net.ConnectException: Connection timed out |
Slf4jLog.java:76
2016-07-21 16:37:03,918 | INFO  | Socket Reader #1 for port 8032 | Auth successful for hive/
hadoop.<System domain name>@<System domain name> (auth:KERBEROS) | Server.java:1388
2016-07-21 16:37:03,926 | INFO  | Socket Reader #1 for port 8032 | Auth successful for hive/
hadoop.<System domain name>@<System domain name> (auth:KERBEROS) | Server.java:1388
2016-07-21 16:37:11,956 | INFO  | AsyncDispatcher event handler | Updating application attempt
appattempt_1468986660719_0045_000001 with final state: FINISHING,
and exit status: -1000 | RMAppAttemptImpl.java:1253
```

Answer

On FusionInsight Manager, the IP address of the Yarn service is in the 192 network segment.

In Yarn logs, the IP address of Spark web UI read by Yarn is http://10.120.169.53:23011, which is in the 10 network segment. The IP addresses in the 192 network segment cannot communicate with those in the 10 network segment. As a result, the Spark web UI fails to be accessed.

Solution:

Log in to the client whose IP address is **10.120.169.53** and change the IP address in the **/etc/hosts** file to the IP address in the 192 network segment. Run the Spark application again. The Spark web UI is displayed.

21.7.7 What Can I Do If an Error Occurs when I Access the Application Page Because the Application Cached by HistoryServer Is Recycled?

Question

An error occurs when I access a Spark application page on the HistoryServer page.

Check the HistoryServer logs. The "FileNotFound" exception is found. The related logs are as follows:

```
2016-11-22 23:58:03,694 | WARN  | [qtp55429210-232] | /history/application_1479662594976_0001/stages/
stage/ | org.sparkproject.jetty.servlet.ServletHandler.doHandle(ServletHandler.java:628)
java.io.FileNotFoundException: ${BIGDATA_HOME}/tmp/spark/jobHistoryTemp/
blockmgr-5f1f6aca-2303-4290-9845-88fa94d78480/09/temp_shuffle_11f82aaf-e226-46dc-
b1f0-002751557694 (No such file or directory)
```

Answer

If a Spark application with a large number of tasks is run on the HistoryServer page, the memory overflows to disk and files with the **temp_shuffle** prefix are generated.

By default, HistoryServer caches 50 Spark applications (determined by the **spark.history.retainedApplications** configuration item). When the number of

Spark applications in the memory exceeds 50, HistoryServer reclaims the first cached Spark application and clears the corresponding **temp_shuffle** file.

When a user is viewing Spark applications to be recycled, the **temp_shuffle** file may not be found. As a result, the current page cannot be accessed.

If the preceding problem occurs, use either of the following methods to solve the problem:

- Access the HistoryServer page of the Spark application again. The correct page information is displayed.
- If more than 50 Spark applications need to be accessed at the same time, increase the value of **spark.history.retainedApplications**.

  Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Spark**. Click **Configurations** then **All Configurations**. In the navigation tree on the left, click JobHistory and select **Page**. Then, configure the parameter as follows:

  Table 21-86 Parameter description

Parameter	Description	Default Value
spark.history.retainedApplications	Number of Spark applications cached by HistoryServer. When the number of applications to be cached exceeds the value of this parameter, HistoryServer reclaims the first cached Spark application.	50

21.7.8 Why Is not an Application Displayed When I Run the Application with the Empty Part File?

Question

When I run an application with an empty part file in HDFS with the log grouping function enabled, why is not the application displayed on the homepage of JobHistory?

Answer

On the JobHistory page, information about applications is updated only with changed sizes of part files in HDFS. If a file is read for the first time, its size is compared with 0. The file is read only when the file size is greater than 0.

When the log grouping function is enabled, if the application you run does not have jobs in running status, the part file is empty. As a result, JobHistory does not read the part file and the application information is not displayed on the JobHistory page. However, if the size of part file is changed later, the application will be displayed on JobHistory.

21.7.9 Why Does Spark Fail to Export a Table with Duplicate Field Names?

Question

The following code fails to execute on spark-shell of Spark:

```
val acctId = List(("49562", "Amal", "Derry"), ("00000", "Fred", "Xanadu"))
val rddLeft = sc.makeRDD(acctId)
val dfLeft = rddLeft.toDF("Id", "Name", "City")
//dfLeft.show
val acctCustId = List(("Amal", "49562", "CO"), ("Dave", "99999", "ZZ"))
val rddRight = sc.makeRDD(acctCustId)
val dfRight = rddRight.toDF("Name", "CustId", "State")
//dfRight.show
val dfJoin = dfLeft.join(dfRight, dfLeft("Id") === dfRight("CustId"), "outer")
dfJoin.show
dfJoin.repartition(1).write.format("com.databricks.spark.csv").option("delimiter", "\t").option("header",
"true").option("treatEmptyValuesAsNulls", "true").option("nullValue", "").save("/tmp/outputDir")
```

Answer

In Spark, check whether there are duplicate field names in join statements. If so, modify the code to ensure there is no duplicate field name in the table.

21.7.10 Why JRE fatal error after running Spark application multiple times?

Question

Why JRE fatal error after running Spark application multiple times?

Answer

When you run Spark application multiple times, JRE fatal error occurs and this is due to the problem with the Linux Kernel.

To resolve this issue, upgrade the **kernel version to 4.13.9-2.ge7d7106-default**.

21.7.11 Why Is "This page can't be displayed" Displayed or an Error Reported When I Use Internet Explorer to Access the Native Web UI of Spark?

Question

When I use Internet Explorer 9, 10, or 11 to access the native web UI of Spark, the "This page can't be displayed" message is displayed or an error is reported.

Symptom

Internet Explorer fails to access the native Spark UI.

Cause

Some versions of Internet Explorer 9, 10, and 11 fail to process SSL handshakes.

Solution

Use Google Chrome 71 or later for access.

21.7.12 How Does Spark Access External Cluster Components?

Question

There are two clusters: cluster 1 and cluster 2. How do I use Spark in cluster 1 to access HDFS, Hive, HBase, and Kafka in cluster 2?

Answer

1. Components in two clusters can access each other. However, there are the following restrictions:
   - Only one Hive MetaStore can be accessed. Specifically, Hive MetaStore in cluster 1 and Hive MetaStore in cluster 2 cannot be accessed at the same time.
   - User systems in different clusters are not synchronized. When users access components in another cluster, user permission is determined by the user configuration of the peer cluster. For example, if user A of cluster 1 does not have the permissions to access the HBase meta table in cluster 1 but user A of cluster 2 can access the HBase meta table in cluster 2, user A of cluster 1 can access the HBase meta table in cluster 2.
   - To enable components in a security cluster to communicate with each other across Manager, you need to configure mutual trust.
2. The following describes how to access Hive, HBase, and Kafka components in cluster 2 as user A.

   NOTE

   The following operations are based on the assumption that you use the FusionInsight client to submit the Spark application. If you use your own configuration file directory, you need to modify the corresponding file in the configuration directory of the application and upload the configuration file to the executor.

   When the HDFS and HBase clients access the server, **hostname** is used to configure the server address. Therefore, the hosts configuration of all nodes to be accessed must be saved in the **/etc/hosts** file on the client. You can add the host of the peer cluster node to the **/etc/hosts** file of the client node in advance.

   - Access Hive Metastore: Replace the **hive-site.xml** file in the **conf** directory of the Spark client in cluster 1 with the **hive-site.xml** file in the **conf** directory of the Spark client in cluster 2.

After the preceding operations are performed, you can use Spark SQL to access Hive MetaStore. To access Hive table data, you need to perform the operations in **• Access HDFS of two clusters at the same time:** and set **nameservice** of the peer cluster to **LOCATION**.

- Access HBase of the peer cluster.
  i. Configure the IP addresses and host names of all ZooKeeper nodes and HBase nodes in cluster 2 in the **/etc/hosts** file on the client node of cluster 1.
  ii. Replace the **hbase-site.xml** file in the **conf** directory of the Spark client in cluster 1 with the **hbase-site.xml** file in the **conf** directory of the Spark client in cluster 2.
- Access Kafka: Set the address of the Kafka Broker to be accessed to the Kafka Broker address in cluster 2.
- Access HDFS of two clusters at the same time:
  - Two tokens with the same NameService cannot be obtained at the same time. Therefore, the NameServices of the HDFS in two clusters must be different. For example, one is **hacluster**, and the other is **test**.
    1) Obtain the following configurations from the **hdfs-site.xml** file of cluster 2 and add them to the **hdfs-site.xml** file in the **conf** directory of the Spark client in cluster 1:

       dfs.nameservices.mappings, **dfs.nameservices**, **dfs.namenode.rpc-address.test.***, **dfs.ha.namenodes.test**, and **dfs.client.failover.proxy.provider.test**

       The following is an example:

```
<property>
<name>dfs.nameservices.mappings</name>
<value>[{"name":"hacluster","roleInstances":["14","15"]},
{"name":"test","roleInstances":["16","17"]}]</value>
</property>
<property>
<name>dfs.nameservices</name>
<value>hacluster,test</value>
</property>
<property>
<name>dfs.namenode.rpc-address.test.16</name>
<value>192.168.0.1:8020</value>
</property>
<property>
<name>dfs.namenode.rpc-address.test.17</name>
<value>192.168.0.2:8020</value>
</property>
<property>
<name>dfs.ha.namenodes.test</name>
<value>16,17</value>
</property>
<property>
<name>dfs.client.failover.proxy.provider.test</name>
<value>org.apache.hadoop.hdfs.server.namenode.ha.ConfiguredFailoverProxyProvider
</value>
</property>
```

    2) Modify **spark.yarn.extra.hadoopFileSystems = hdfs://test and spark.hadoop.hdfs.externalToken.enable = true** in the **spark-defaults.conf** configuration file under the **conf** directory on the Spark client of cluster 1.

```
spark.yarn.extra.hadoopFileSystems = hdfs://test
spark.hadoop.hdfs.externalToken.enable = true
```

3) In the application submission command, add the **--keytab** and **--principal** parameters and set them to the user who submits the task in cluster1.

4) Use the Spark client of cluster1 to submit the application. Then, the two HDFS services can be accessed at the same time.

- Access HBase of two clusters at the same time:

  i. Modify **spark.hadoop.hbase.externalToken.enable = true** in the **spark-defaults.conf** configuration file under the **conf** directory on the Spark client of cluster 1.

  ```
  spark.hadoop.hbase.externalToken.enable = true
  ```

  ii. When accessing HBase, you need to use the configuration file of the corresponding cluster to create a **Configuration** object for creating a **Connection** object.

  iii. In an MRS cluster, tokens of multiple HBase services can be obtained at the same time to solve the problem that the executor cannot access HBase. The method is as follows:

  Assume that you need to access HBase of the current cluster and HBase of cluster2. Save the **hbase-site.xml** file of cluster2 in a compressed package named **external_hbase_conf***, and use **--archives** to specify the compressed package when submitting the command.

21.7.13 Why Does the Foreign Table Query Fail When Multiple Foreign Tables Are Created in the Same Directory?

Question

Assume there is a data file path named **/test_data_path**. User A creates a foreign table named **tableA** for the directory, and user B creates a foreign table named **tableB** for the directory. When user B performs the insert operation on **tableB**, user A fails to query data using **tableA** and the error "Permission denied" is displayed.

Answer

After user B performs the insert operation on **tableB**, a new data file is generated in the foreign table path and the file belongs to user B. When user A queries data using **tableA**, all files in the foreign table directory are read. In this case, the query fails because user A does not have the read permissions on the file generated by user B.

This problem also occurs in other scenarios. For example, the **inset overwrite** operation will also duplicate other table files in this directory.

Due to the Spark SQL implementation mechanism, check restrictions in this scenario will lead to inconsistency and performance deterioration. Therefore, no restriction is added in this scenario, and this method is not recommended.

21.7.14 Why Is an Error Reported When I Access the Native Page of an Application in Spark JobHistory?

Question

Submit a Spark application that contains millions of tasks in a single job. After the application is complete, if you access the native page of the application in JobHistory, the browser will wait for a long time before the native page of the application is displayed. If the native page cannot be displayed within 10 minutes, Proxy Error is displayed.

Figure 21-20 Example error information

Answer

When you switch to the native page of an application on the JobHistory page, JobHistory needs to replay the event log of the application. If the application contains a large number of event logs, the replay takes a long time and the browser needs to wait for a long time.

When the browser accesses the JobHistory native page, the httpd proxy is required. The proxy timeout interval is 10 minutes. Therefore, if JobHistory cannot parse the event log and return the event log within 10 minutes, httpd returns the Proxy Error message to the browser.

Solution

The local disk cache function is enabled for JobHistory. When an application is accessed, the event log parsing result of the application is cached to the local disk. When the application is accessed for the second time, the response speed is greatly accelerated. In this case, you only need to wait for a while and access the original link again. In this case, you do not need to wait for a long time.

21.7.15 Why Do I Fail to Create a Table in the Specified Location on OBS After Logging to spark-beeline?

Question

When the OBS ECS/BMS image cluster is connected, after spark-beeline is logged in, an error is reported when a location is specified to create a table on OBS.

Figure 21-21 Error message

```
de-master2qCKJ:22550/> create database sparkdb location 'obs://800mrs/sparktest/sparkdb';



0.626 seconds)
de-master2qCKJ:22550/> use sparkdb;


0.072 seconds)
de-master2qCKJ:22550/> create table orc (id int,name string) using orc;
xception: Configuration problem with provider path. (state=,code=0)
```

Answer

The permission on the **ssl.jceks** file in HDFS is insufficient. As a result, the table fails to be created.

```
Caused by: org.apache.hadoop.security.AccessControlException: Permission denied: user=root, access=READ, inode="/user/spark2x/jars/8.0.2/ssl.jceks":spark2x:hadoop:-rw-------
    at org.apache.hadoop.hdfs.server.namenode.FSPermissionChecker.check(FSPermissionChecker.java:410)
    at org.apache.hadoop.hdfs.server.namenode.FSPermissionChecker.checkPermission(FSPermissionChecker.java:264)
    at com.huawei.hadoop.adapter.hdfs.plugin.HWAccessControlEnforce.checkPermission(HWAccessControlEnforce.java:54)
    at org.apache.hadoop.hdfs.server.namenode.FSPermissionChecker.checkPermission(FSPermissionChecker.java:194)
    at org.apache.hadoop.hdfs.server.namenode.FSDirectory.checkPermission(FSDirectory.java:1957)
    at org.apache.hadoop.hdfs.server.namenode.FSDirectory.checkPermission(FSDirectory.java:1941)
    at org.apache.hadoop.hdfs.server.namenode.FSDirectory.checkPathAccess(FSDirectory.java:1891)
    at org.apache.hadoop.hdfs.server.namenode.FSDirStatAndListingOp.getBlockLocations(FSDirStatAndListingOp.java:175)
    at org.apache.hadoop.hdfs.server.namenode.FSNamesystem.getBlockLocations(FSNamesystem.java:1990)
    at org.apache.hadoop.hdfs.server.namenode.NameNodeRpcServer.getBlockLocations(NameNodeRpcServer.java:762)
    at org.apache.hadoop.hdfs.protocolPB.ClientNamenodeProtocolServerSideTranslatorPB.getBlockLocations(ClientNamenodeProtocolServerSideTranslatorPB.java:445)
    at org.apache.hadoop.hdfs.protocol.proto.ClientNamenodeProtocolProtos$ClientNamenodeProtocol$2.callBlockingMethod(ClientNamenodeProtocolProtos.java)
    at org.apache.hadoop.ipc.ProtobufRpcEngine$Server$ProtoBufRpcInvoker.call(ProtobufRpcEngine.java:528)
    at org.apache.hadoop.ipc.RPC$Server.call(RPC.java:1036)
    at org.apache.hadoop.ipc.Server$RpcCall.run(Server.java:985)
    at org.apache.hadoop.ipc.Server$RpcCall.run(Server.java:913)
    at java.security.AccessController.doPrivileged(Native Method)
    at javax.security.auth.Subject.doAs(Subject.java:422)
    at org.apache.hadoop.security.UserGroupInformation.doAs(UserGroupInformation.java:1737)
    at org.apache.hadoop.ipc.Server$Handler.run(Server.java:2876)
```

Solution

1. Log in to the node where Spark is as user **omm** and run the following command:

   vi ${BIGDATA_HOME}/FusionInsight_Spark_8.1.0.1/install/FusionInsight-Spark-*/spark/sbin/fake_prestart.sh

2. Change **eval "${hdfsCmd}" -chmod 600 "${InnerHdfsDir}"/ssl.jceks >> "${PRESTART_LOG}" 2>&1** to **eval "${hdfsCmd}" -chmod 644 "${InnerHdfsDir}"/ssl.jceks >> "${PRESTART_LOG}" 2>&1**.

3. Restart the SparkResource instance.

21.7.16 Spark Shuffle Exception Handling

Question

In some scenarios, the following exception occurs in the Spark shuffle phase:

```
2021-06-18 02:53:08,364 | INFO  | [shuffle-server-6-1] | DIGEST41:Unmatched MACs | javax.security.sasl.unwrap(DigestMD5Base.java:1481)
2021-06-18 02:53:08,368 | WARN  | [shuffle-server-6-1] | Exception in connection from /[redacted] | org.apache.spark.network.server.TransportChannelHandler.exceptionCaught(TransportChannelHandler.java:87)
io.netty.handler.codec.DecoderException: javax.security.sasl.SaslException: DIGEST-MD5: Out of order sequencing of messages from server. Got: 16 Expected: 14
        at io.netty.handler.codec.MessageToMessageDecoder.channelRead(MessageToMessageDecoder.java:98)
        at io.netty.channel.AbstractChannelHandlerContext.invokeChannelRead(AbstractChannelHandlerContext.java:379)
        at io.netty.channel.AbstractChannelHandlerContext.invokeChannelRead(AbstractChannelHandlerContext.java:365)
        at io.netty.channel.AbstractChannelHandlerContext.fireChannelRead(AbstractChannelHandlerContext.java:357)
        at org.apache.spark.network.util.TransportFrameDecoder.channelRead(TransportFrameDecoder.java:102)
        at io.netty.channel.AbstractChannelHandlerContext.invokeChannelRead(AbstractChannelHandlerContext.java:379)
        at io.netty.channel.AbstractChannelHandlerContext.invokeChannelRead(AbstractChannelHandlerContext.java:365)
        at io.netty.channel.AbstractChannelHandlerContext.fireChannelRead(AbstractChannelHandlerContext.java:357)
        at io.netty.channel.DefaultChannelPipeline$HeadContext.channelRead(DefaultChannelPipeline.java:1410)
        at io.netty.channel.AbstractChannelHandlerContext.invokeChannelRead(AbstractChannelHandlerContext.java:379)
        at io.netty.channel.AbstractChannelHandlerContext.invokeChannelRead(AbstractChannelHandlerContext.java:365)
        at io.netty.channel.DefaultChannelPipeline.fireChannelRead(DefaultChannelPipeline.java:919)
        at io.netty.channel.nio.AbstractNioByteChannel$NioByteUnsafe.read(AbstractNioByteChannel.java:163)
        at io.netty.channel.nio.NioEventLoop.processSelectedKey(NioEventLoop.java:714)
        at io.netty.channel.nio.NioEventLoop.processSelectedKeysOptimized(NioEventLoop.java:650)
        at io.netty.channel.nio.NioEventLoop.processSelectedKeys(NioEventLoop.java:576)
        at io.netty.channel.nio.NioEventLoop.run(NioEventLoop.java:493)
        at io.netty.util.concurrent.SingleThreadEventExecutor$4.run(SingleThreadEventExecutor.java:989)
        at io.netty.util.internal.ThreadExecutorMap$2.run(ThreadExecutorMap.java:74)
        at io.netty.util.concurrent.FastThreadLocalRunnable.run(FastThreadLocalRunnable.java:30)
        at java.lang.Thread.run(Thread.java:748)
Caused by: javax.security.sasl.SaslException: DIGEST-MD5: Out of order sequencing of messages from server. Got: 16 Expected: 14
        at com.sun.security.sasl.digest.DigestMD5Base$DigestPrivacy.unwrap(DigestMD5Base.java:1489)
        at com.sun.security.sasl.digest.DigestMD5Base.unwrap(DigestMD5Base.java:213)
        at org.apache.spark.network.sasl.SparkSaslServer.unwrap(SparkSaslServer.java:149)
        at org.apache.spark.network.sasl.SaslEncryption$DecryptionHandler.decode(SaslEncryption.java:126)
        at org.apache.spark.network.sasl.SaslEncryption$DecryptionHandler.decode(SaslEncryption.java:101)
        at io.netty.handler.codec.MessageToMessageDecoder.channelRead(MessageToMessageDecoder.java:88)
        ... 20 more
```

Solution

For JDBC:

Log in to FusionInsight Manager, change the value of the JDBCServer parameter **spark.authenticate.enableSaslEncryption** to **false**, and restart the corresponding instance.

For client jobs:

When the client submits the application, change the value of **spark.authenticate.enableSaslEncryption** in the **spark-defaults.conf** file to **false**.

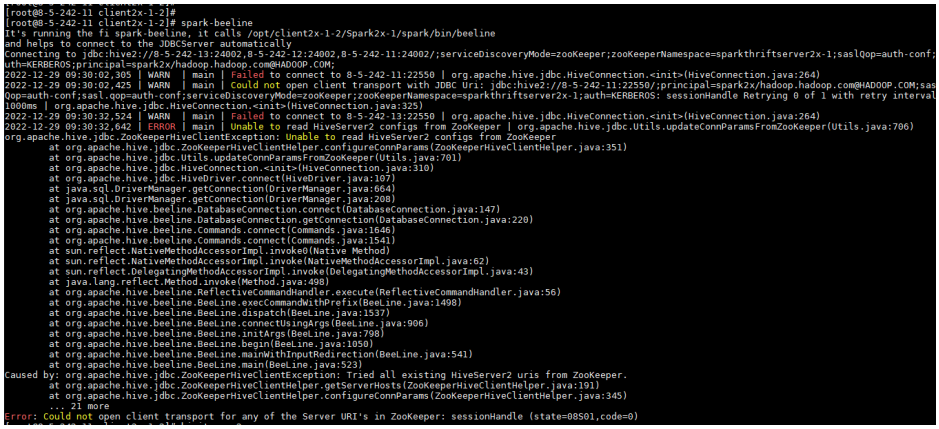
21.7.17 Why Cannot Common Users Log In to the Spark Client When There Are Multiple Service Scenarios in Spark?

NOTE

This section applies only to MRS 3.2.0 or later.

Question

When there are multiple service scenarios in Spark and multiple services are used, common users cannot log in to spark-beeline. The error information is as follows:



Causes

When there is any multi-scenario service in Hive, common users do not belong to the Hive user group and do not have permissions on the Hive directory. As a result, the login fails.

Solution

Log in to FusionInsight Manager, change the user group to which common users belong, and add common users to all user groups in Hive.

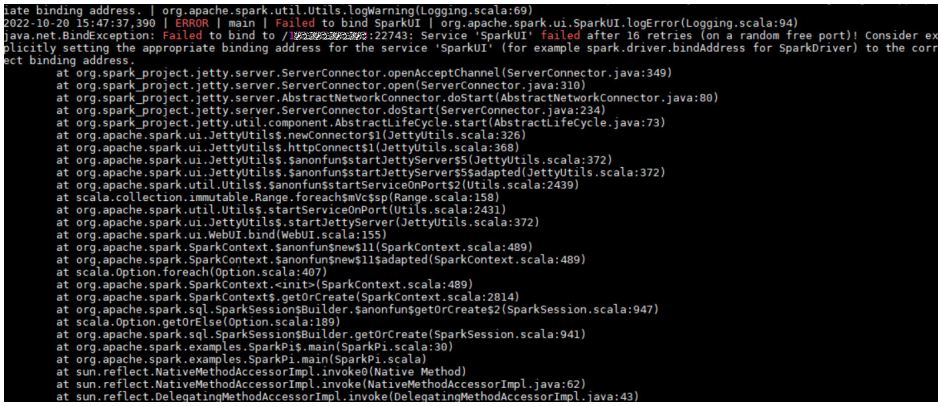
21.7.18 Why Does the Cluster Port Fail to Connect When a Client Outside the Cluster Is Installed or Used?

Question

When a client outside the cluster is installed or used, the Spark task port sometimes fails to be connected.

Exception information: **Failed to bind SparkUi**

```
Cannot assign requested address: Service 'sparkDriver' failed after 16 retries (on a random free port)! Consider explicitly setting the appropriate binding address for the service 'sparkDriver' (for example spark.driver.bindAddress for SparkDriver) to the correct binding address.
```



Causes

- The network between the cluster node and the client node is disconnected.
- The firewall on the client node is not disabled.
- If the port is occupied, each Spark task occupies a SparkUI port. The default port number is **22600**. If the port is occupied, increase the port number in sequence and try again. However, there are only 16 retries by default. After the 16 retries, this task is aborted.
- The Spark configuration parameters on the client are incorrect.
- The code is incorrect.

Solution

The application cannot access the IP address and port number of SparkUI. The possible causes are as follows:

- Check whether the cluster node communicates with the client node.

  Run the following command on the client node to check whether the cluster node mapping is configured in the **/etc/hosts** file on the client node:

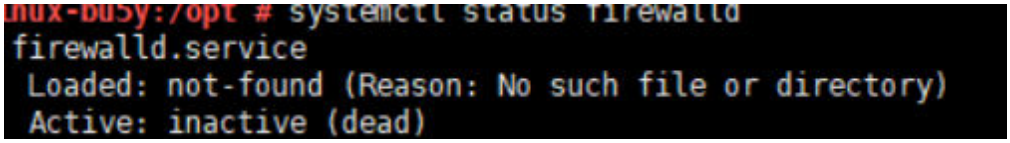
  ping *SparkUI IP address*

  If the IP address cannot be pinged, check the mapping configuration and network configuration.
- Disable the firewall on the client node.

  Run the following command to check whether the function is disabled:

systemctl status firewalld (The query command varies depending on the OS. This command uses CentOS as an example.)

As shown in the following figure, **dead** indicates that the function is disabled.



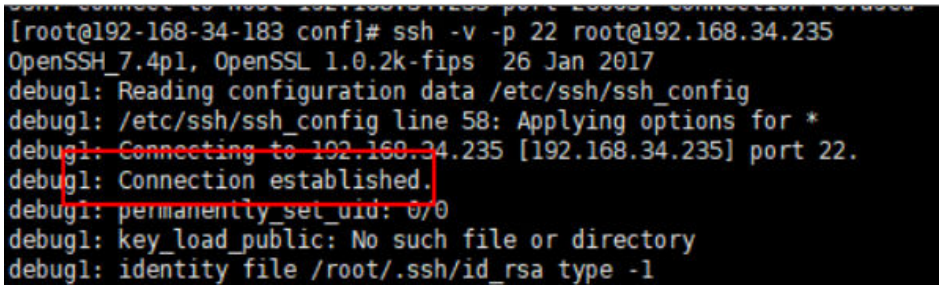
If the firewall is enabled, the communication is affected. Run the following command to disable the firewall:

service firewalld stop (The query command varies depending on the OS. This command uses CentOS as an example.)

- Check whether the port is occupied.

  ssh -v -p port username@ip

  If the message "Connection established" is displayed, it indicates that the connection is successful and the port is occupied.



  The Spark UI port range is determined by the **spark.random.port.min** and **spark.random.port.max** parameters in the **spark-defaults.conf** configuration file. If all ports in the range are used,

  No port is available and the connection fails.

  Solution: Set **spark.port.maxRetries** to **50** and adjust the random port range of the executor to **spark.random.port.max** plus 100.

- View Spark configuration parameters:

  Run the **cat spark-env.sh** command on the client node to check whether the **SPARK_LOCAL_HOSTNAME** value is the IP address of the local host.

  This problem may occur when the client is directly copied from another node and the configuration parameters are not modified.

  Change the value of **SPARK_LOCAL_HOSTNAME** to the IP address of the local host.

  Note: If the cluster uses EIPs for communication, you need to add the following configuration:

  a. Add **spark.driver.host=***Elastic IP address of the client node* to **spark-default.conf**.

  b. Add **spark.driver.bindAddress=***IP address of the local host* to **spark-default.conf**.

  c. Add **SPARK_LOCAL_HOSTNAME=***Elastic IP address of the client node* to **spark-env.sh**.

- If the communication and configuration are normal, check the code.

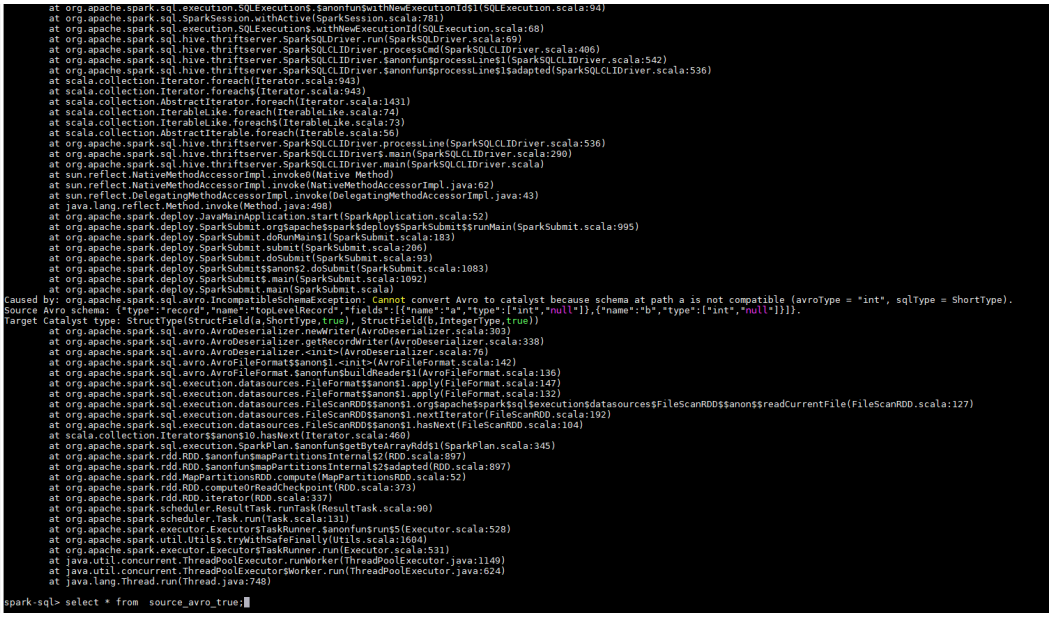
When Spark starts a task, sparkDriverEnv is created on the client and bound to DRIVER_BIND_ADDRESS. This logic does not go to the server. So, this problem occurs because sparkDriver cannot obtain the corresponding host IP address due to abnormal OS environment of the client node.

You can run the **export SPARK_LOCAL_HOSTNAME=172.0.0.1** command or set **spark.driver.bindAddress** to **127.0.0.1** so that the driver that submits tasks can load loopbackAddress.

21.7.19 How Do I Handle the Exception Occurred When I Query Datasource Avro Formats?

Symptom

An error is reported when I query Datasource Avro formats, and the message "Caused by: org.apache.spark.sql.avro.IncompatibleSchemaException" is displayed.



Solution

The datasource Avro formats are not compatible with the current data formats.

1. For new Avro files, set **spark.sql.forceConvertSchema.enabled** to **true** before you create them. This forcibly converts Avro formats to the specified data types and changes the schema at a time.
2. For existing Avro files, set **spark.sql.forceConvertSchema.enabled** to **true** before the query. If the query fails, run the **refresh table** command to clear the cache and then set query parameters. The Avro formats are forcibly converted to the specified data types, and the schema is temporarily modified on the client.

21.7.20 What Should I Do If Statistics of Hudi or Hive Tables Created Using Spark SQLs Are Empty Before Data Is Inserted?

Symptom

When Spark SQLs are used to create Hudi or Hive tables, the table statistics are empty before data is inserted.

Solution

You can use either of the following methods to collect the statistics:

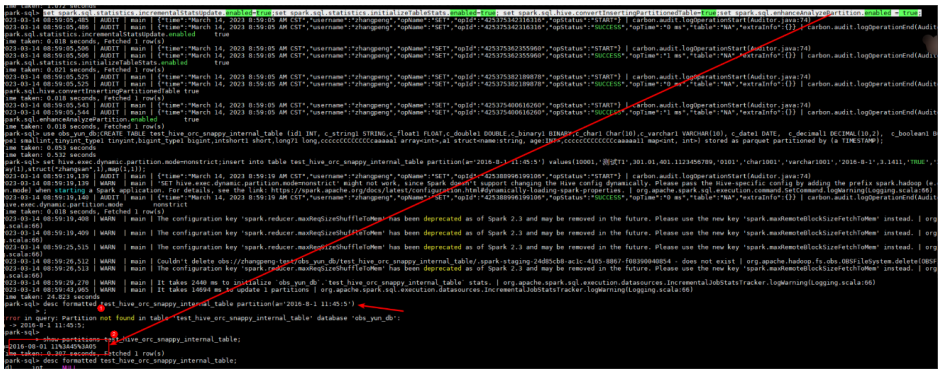
1. Run the **analyze** command to trigger statistics collection. If no data is inserted, run the **desc formatted table_name** command to check whether the value of **totalsize** is **0** after the **analyze** command is executed.
2. Set **spark.sql.statistics.size.autoUpdate.enabled** to **true** and insert data. Statistics collection will be triggered in the background.

21.7.21 Failed to Query Table Statistics by Partition Using Non-Standard Time Format When the Partition Column in the Table Creation Statement is timestamp

Symptom

When the partition column in the table creation statement is timestamp, the tabale statistics failed to be queried by partition using non-standard time format, and the result code of **show partitions table** is incorrect.

Run the **desc formatted test_hive_orc_snappy_internal_table partition(a='*2016-8-1 11:45:5*');** command to query the error. The following figures shows as an example.



Solution

The spark.sql.hive.convertInsertingPartitionedTable switch controls the insert and writing logic of Hive and Datasource tables. When Hive tables are used, timestamps are not automatically formatted. When Datasource tables are used, timestamps are automatically formatted.

If the written partition field is **a='2016-8-1 11:45:5'**, an error is reported, and it is automatically formatted to **a='2016-08-01 11:45:05'**.

To correctly query the table statistics, perform the following operation:

If the value of **spark.sql.hive.convertInsertingPartitionedTable** is set to **true**, use the data source table logic. You can run the following command to query the statistics:

desc formatted test_hive_orc_snappy_internal_table partition(a='*2016-08-01 11:45:05***');**

21.7.22 How Do I Use Special Characters with TIMESTAMP and DATE?

Symptom

In open-source Spark 3.2.0 and later versions, **TIMESTAMP(*)** or **DATE(*)** is not supported. The asterisk (*) can be any of the following characters:

- epoch
- today
- yesterday
- tomorrow
- now

By default, only the **timestamp '*'** or **data '*'** format is supported for new Spark versions. If you use the syntax of early versions to insert data into a data table, you will get the NULL value.

Solution

Set **set spark.sql.convert.special.datetime=true;** to use the syntax of early versions.

```
spark-sql> set spark.sql.convert.special.datetime=true;
spark.sql.convert.special.datetime      true
Time taken: 0.035 seconds, Fetched 1 row(s)
```

21.7.23 What Should I Do If Recycle Bin Version I Set on the Spark Client Does Not Take Effect?

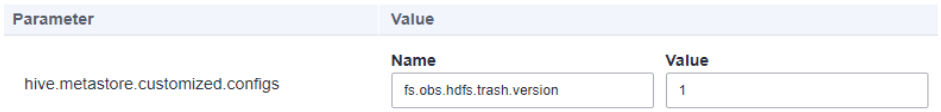
Symptom

The setting of **fs.obs.hdfs.trash.version=1** on the Spark client did not take effect. After table was dropped, the path for storing files in the recycle bin remained unchanged.

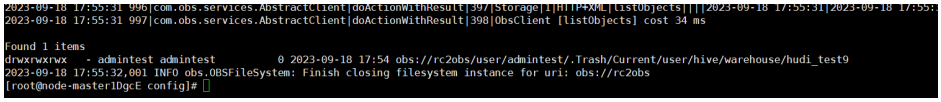
- If **fs.obs.hdfs.trash.version** is set to **2**, the recycle bin path is **/user/.Trash/${userName}/Current**.
- If **fs.obs.hdfs.trash.version** is set to **1**, the recycle bin path is **/user/${userName}/.Trash/Current**.

Procedure

Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Hive**, click **Configurations** > **All Configurations**, and select **MetaStore (Role)** > **Customization**. On the displayed page, set **hive.metastore.customized.configs**. Set **fs.obs.hdfs.trash.version** to **1**, save the settings, and restart the Metastore instance.



After Hive Metastore is configured, the recycle bin path is correct.



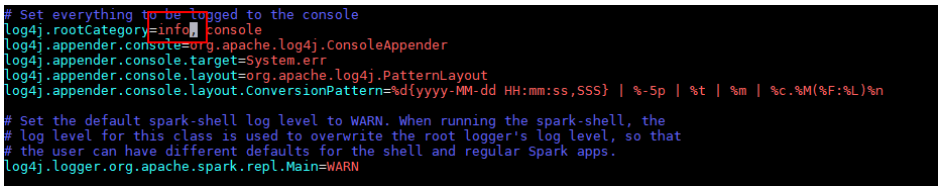
21.7.24 How Do I Change the Log Level to INFO When Using Spark yarn-client?

Symptom

How do I change the log level to INFO when using Spark yarn-client?

Procedure

Step 1 Log in to the Spark client node and change the value of **Log4j.rootCategory** in the {*Client installation directory*}**Spark/spark/conf/log4j.properties** configuration file to **INFO**.



Step 2 Restart the spark-sql client.

----End

22 Using Tez

22.1 Precautions

This section applies to MRS 3.*x* or later clusters.

22.2 Common Tez Parameters

Navigation path for setting parameters:

On Manager, choose **Cluster** > **Service** > **Tez** > **Configuration** > **All Configurations**. Enter a parameter name in the search box.

Parameter description

Table 22-1 Parameter description

Parameter	Description	Default Value
property.tez.log.dir	TezUI log directory	/var/log/Bigdata/tez/tezui
property.tez.log.level	TezUI log level	INFO

22.3 Accessing TezUI

Tez displays the Tez task execution process on a GUI. You can view the task execution details on the GUI.

Prerequisite

The TimelineServer instance of the Yarn service has been installed.

How to Use

Log in to Manager. On Manager, choose **Cluster** > **Services** > **Tez**. Click the link on the right of **Tez WebUI** in the **Basic Information** area, and go to Tez web UI. You can view the details about Tez task execution.

22.4 Log Overview

Log Description

Log path: The default save path of Tez logs is **/var/log/Bigdata/tez/***role name*.

TezUI: **/var/log/Bigdata/tez/tezui** (run logs) and **/var/log/Bigdata/audit/tez/tezui** (audit logs)

Log archive rule: The automatic compression and archiving function of Tez is enabled. By default, when the size of a log file exceeds 20 MB (which is adjustable), the log file is automatically compressed. The naming rule of the compressed log file is as follows: <*Original log file name*>-<*yyyy-mm-dd_hh-mm-ss*>.[*ID*].**log.zip** A maximum of 20 latest compressed files are retained. The number of compressed files and compression threshold can be configured.

Table 22-2 Tez log list

Log Type	Name	Description
Run log	tezui.out	Log file that records TezUI running environment information
	tezui.log	Run log of the TezUI process
	tezui-omm-<*Date*>-gc.log.<*No.*>	GC log of the TezUI process
	prestartDetail.log	Work logs generated before the TezUI is started
	check-serviceDetail.log	Log file that records whether the TezUI service starts successfully
	postinstallDetail.log	Work logs after the TezUI is installed
	startDetail.log	Startup log of the TezUI process
	stopDetail.log	Stop log of the TezUI process
Audit log	tezui-audit.log	TezUI audit log

Log Level

Table 22-3 describes the log levels supported by TezUI.

Levels of run logs are ERROR, WARN, INFO, and DEBUG from the highest to the lowest priority. Run logs of equal or higher levels are recorded. The higher the specified log level, the fewer the logs recorded.

Table 22-3 Log levels

Level	Description
ERROR	Logs of this level record error information about system running.
WARN	Exception information about the current event processing
INFO	Logs of this level record normal running status information about the system and events.
DEBUG	Logs of this level record the system information and system debugging information.

To modify log levels, perform the following operations:

Step 1 Log in to Manager.

Step 2 Choose **Cluster** > **Service** > **Tez** > **Configuration**.

Step 3 Select **All Configurations**.

Step 4 In the navigation pane, choose **TezUI** > **Log**.

Step 5 Select a desired log level.

Step 6 Click **Save**. In the dialog box that is displayed, click **OK** to save the configuration.

Step 7 Click **Instance**, select the **TezUI** role, choose **More** > **Restart Instance**, enter the user password, and click **OK** in the dialog box that is displayed.

Step 8 Wait until the instance is restarted for the configuration to take effect.

----End

Log Format

The following table lists the Tez log formats.

Table 22-4 Log formats

Log Type	Format	Example
Run log	<yyyy-MM-dd HH:mm:ss,SSS>|<LogLevel>|<Thread that generates the log>|<Message in the log>|<Location of the log event>	2020-07-31 11:44:21,378 | INFO | TezUI-health-check | Start health check | com.XXX.tez.HealthCheck.run(HealthCheck.java:30)
Audit logs	<yyyy-MM-dd HH:mm:ss,SSS>|<LogLevel>|<Thread that generates the log>|<User Name><User IP><Time><Operation><Resource><Result><Detail >|<Location of the log event >	2018-12-24 12:16:25,319 | INFO | HiveServer2-Handler-Pool: Thread-185 | UserName=hive UserIP=10.153.2.204 Time=2018/12/24 12:16:25 Operation=CloseSession Result=SUCCESS Detail= | org.apache.hive.service.cli.thrift.ThriftCLIService.logAuditEvent(ThriftCLIService.java:434)

22.5 Common Issues

22.5.1 TezUI Cannot Display Tez Task Execution Details

Question

After a user logs in to Manager and switches to the Tez web UI, the submitted Tez tasks are not displayed.

Answer

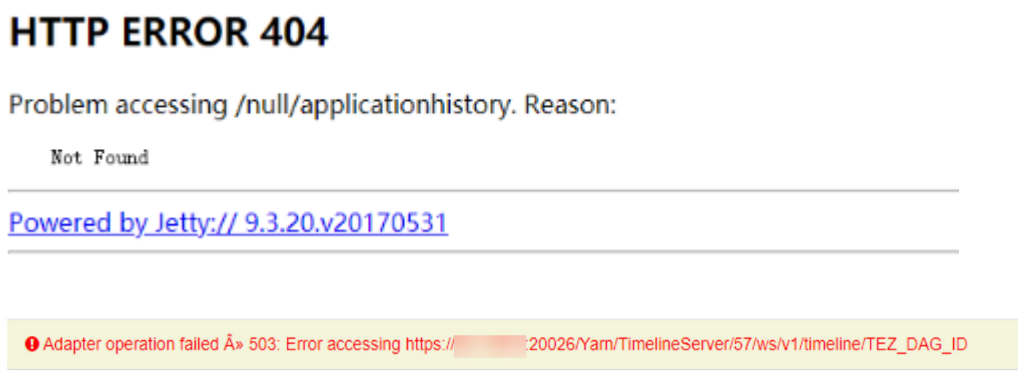
The Tez task data displayed on the Tez WebUI requires the support of TimelineServer of Yarn. Ensure that TimelineServer has been enabled and is running properly before the task is submitted.

When setting the Hive execution engine to Tez, you need to set **yarn.timeline-service.enabled** to **true**. For details, see **Switching the Hive Execution Engine to Tez**.

22.5.2 Error Occurs When a User Switches to the Tez Web UI

Question

When a user logs in to Manager and switches to the Tez web UI, error 404 or 503 is displayed.



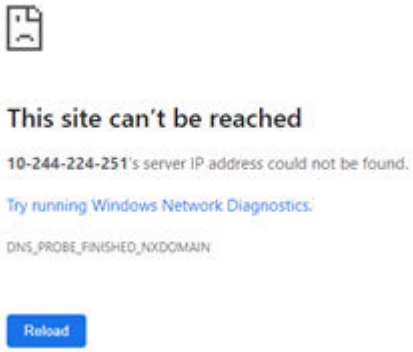
Answer

The Tez web UI depends on the TimelineServer instance of Yarn. Therefore, TimelineServer must be installed in advance and in the **Good** state.

22.5.3 Yarn Logs Cannot Be Viewed on the TezUI Page

Question

A user logs in to the Tez web UI and clicks **Logs**, but the Yarn log page fails to be displayed and data cannot be loaded.



Answer

Currently, the hostname is used for the access to the Yarn log page from the Tez web UI. Therefore, you need to configure the mapping between the hostname and IP address on the Windows host. Perform the following steps:

Modify the **C:\Windows\System32\drivers\etc\hosts** file on the Windows host and add a line indicating the mapping between the host name and IP address, for example, **10.244.224.45 10-044-224-45**. Save the modification and access the host again.

22.5.4 Table Data Is Empty on the TezUI HiveQueries Page

Question

A user logs in to Manager and switches to the Tez web UI page, but no data for the submitted task is displayed on the **Hive Queries** page.

Answer

To display task data on the **Hive Queries** page on the Tez web UI, you need to set the following parameters:

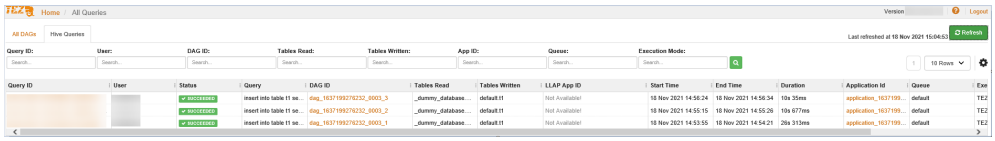
On FusionInsight Manager, choose **Cluster** > **Service** > **Hive** and click the **Configurations** tab and then **All Configurations**. In the navigation pane on the left, choose **HiveServer** > **Customization**. Add the following configuration to **hive-site.xml**:

Attribute	Attribute Value
hive.exec.pre.hooks	org.apache.hadoop.hive.ql.hooks.ATSHook
hive.exec.post.hooks	org.apache.hadoop.hive.ql.hooks.ATSHook
hive.exec.failure.hooks	org.apache.hadoop.hive.ql.hooks.ATSHook

NOTE

Data display on TezUI depends on the TimelineServer instance of Yarn. If the TimelineServer instance is faulty or not started, you need to set **yarn.timeline-service.enabled** to **false** in **yarn-site.xml**. Otherwise, the Hive task fails to be executed.

After you configure the parameters and re-execute the Hive task, data can be displayed on the **Hive Queries** page. However, data of previous tasks cannot be displayed.



23 Using YARN

23.1 Common YARN Parameters

Allocating Queue Resources

The Yarn service provides queues for users. Users allocate system resources to each queue. After the configuration is complete, you can click **Refresh Queue** or restart the Yarn service for the configuration to take effect.

Navigation path for setting parameters:

On Manager, choose **Tenant Resources** > **Dynamic Resource Plan** > **Queue Configuration**.

The following uses the **default** tenant who modifies the Superior scheduler as an example. The configurations of other queues are similar. Click **Modify** to edit the parameters.

Table 23-1 Queue configuration parameters

Parameter	Description
Max Master Shares(%)	Indicates the maximum percentage of resources occupied by all ApplicationMasters in the current queue.
Max Allocated vCores	Indicates the maximum number of cores that can be allocated to a single YARN container in the current queue. The default value is **-1**, indicating that the number of cores is not limited within the value range.
Max Allocated Memory(MB)	Indicates the maximum memory that can be allocated to a single YARN container in the current queue. The default value is **-1**, indicating that the memory is not limited within the value range.

Parameter	Description
Max Running Apps	Maximum number of tasks that can be executed at the same time in the current queue. The default value is **-1**, indicating that the number is not limited within the value range (the meaning is the same if the value is empty). The value 0 indicates that the task cannot be executed. The value ranges from -1 to 2147483647.
Max Running Apps per User	Maximum number of tasks that can be executed by each user in the current queue at the same time. The default value is **-1**, indicating that the number is not limited within the value range. If the value is **0**, the task cannot be executed. The value ranges from -1 to 2147483647.
Max Pending Apps	Maximum number of tasks that can be suspended at the same time in the current queue. The default value is **-1**, indicating that the number is not limited within the value range (the meaning is the same if the value is empty). The value **0** indicates that tasks cannot be suspended. The value ranges from -1 to 2147483647.
Resource Allocation Rule	Indicates the rule for allocating resources to different tasks of a user. The rule can be FIFO or FAIR. If a user submits multiple tasks in the current queue and the rule is FIFO, the tasks are executed one by one in sequential order; if the rule is FAIR, resources are evenly allocated to all tasks.
Default Resource Label	Indicates that tasks are executed on a node with a specified resource label.
Active	• **ACTIVE**: indicates that the current queue can receive and execute tasks. • **INACTIVE**: indicates that the current queue can receive but cannot execute tasks. Tasks submitted to the queue are suspended.
Open	• **OPEN**: indicates that the current queue is opened. • **CLOSED**: indicates that the current queue is closed. Tasks submitted to the queue are rejected.

Displaying Container Logs on the Web UI

By default, the system collects container logs to HDFS. If you do not need to collect container logs to HDFS, configure the parameters in **Table 23-2**. For details, see **Modifying Cluster Service Configuration Parameters**.

Table 23-2 Parameter description

Parameter	Description	Default Value
yarn.log-aggregation-enable	Select whether to collect container logs to HDFS. • If the parameter is set to **true**, container logs are collected to an HDFS directory. The default directory is **{yarn.nodemanager.remote-app-log-dir}/${user}/{thisParam}**. You can set the directory by setting the **yarn.nodemanager.remote-app-log-dir-suffix** parameter on the web UI. • If this parameter is set to **false**, container logs will not be collected to HDFS. After changing the parameter value, restart the Yarn service for the setting to take effect. **NOTE** The container logs that are generated before the parameter is set to **false** and the setting takes effect cannot be obtained from the web UI. You can obtain container logs from the directory specified by the **yarn.nodemanager.remote-app-log-dir-suffix** parameter before the setting takes effect. If you want to view the logs generated before on the web UI, you are advised to set this parameter to **true**.	true

Increasing the Number of Historical Jobs to Be Displayed on the web UI

By default, the Yarn web UI supports task list pagination. A maximum of 5,000 historical jobs can be displayed on each page, and a maximum of 10,000 historical jobs can be retained. If you need to view more jobs on the WebUI, configure parameters by referring to **Table 23-3**. For details, see **Modifying Cluster Service Configuration Parameters**.

Table 23-3 Parameter description

Parameter	Description	Default Value
yarn.resourcemanager.max-completed-applications	Set the total number of historical jobs to be displayed on the web UI.	10000
yarn.resourcemanager.webapp.pagination.enable	Select whether to enable the job list background pagination function for the Yarn web UI.	true

Parameter	Description	Default Value
yarn.resourcemanager.webapp.pagination.threshold	Set the maximum number of jobs displayed on each page after the job list background pagination function of the Yarn web UI is enabled.	5000

NOTE

- If a large number of historical jobs are displayed, the performance will be affected and the time for opening the Yarn web UI will be increased. Therefore, you are advised to enable the background pagination function and modify the **yarn.resourcemanager.max-completed-applications** parameter according to the actual hardware performance.
- After changing the parameter value, restart the Yarn service for the setting to take effect.

23.2 Creating Yarn Roles

Scenario

Create and configure a YARN role. The Yarn role can be assigned with Yarn administrator permission and manage Yarn queue resources.

NOTE

If the current component uses Ranger for permission control, you need to configure permission management policies based on Ranger. Refer to **Adding a Ranger Access Permission Policy for Yarn**.

Prerequisites

- The MRS cluster administrator has understood service requirements.
- You have logged in to Manager.

Procedure

Step 1 Choose System > Permission > Role.

Step 2 Click **Create Role** and set a role name and enter description.

Step 3 Refer **Table 23-4** to configure resource permissions for roles.

Yarn permissions:

- Cluster management: Yarn administrator permissions.
- Queue scheduling: queue resource management.

Table 23-4 Setting a role

Task	Operation
Setting the Yarn administrator permission	In the **Configure Resource Permission** table, choose *Name of the desired cluster* > **Yarn** > **Cluster Management**. **NOTE** The Yarn service needs to be restarted to set the Yarn administrator permission so that the saved role configuration can take effect.
Setting the permission for a user to submit tasks in a specified Yarn queue	1. In the **Configure Resource Permission** table, choose *Name of the desired cluster* > **Yarn** > **Scheduling Queue** > **root**. 2. In the **Permission** column of the specified queue, select **Submit**.
Setting the permission for a user to manage tasks in a specified Yarn queue	1. In the **Configure Resource Permission** table, choose *Name of the desired cluster* > **Yarn** > **Scheduling Queue** > **root**. 2. In the **Permission** column of the specified queue, select **Manage**.

If the Yarn role contains the **Submit** or **Manage** permission of a parent queue, the sub-queue inherits the permission by default, that is, the **Submit** or **Manage** permission is automatically added for the sub-queue. Permissions inherited by sub-queues will not be displayed as selected in the **Configure Resource Permission** table.

If you select only the **Submit** permission of a parent queue when setting the Yarn role, you need to manually specify the queue name when submitting tasks as a user with the permission of this role. Otherwise, when the parent queue has multiple sub-queues, the system does not automatically determine the queue to which the task is submitted and therefore submits the task to the **default** queue.

Step 4 Click **OK**.

----End

23.3 Using the YARN Client

Scenario

This section guides users to use a Yarn client in an O&M or service scenario.

Prerequisites

- The client has been installed.

  For example, the installation directory is **/opt/client**. The client directory in the following operations is only an example. Change it based on the actual installation directory onsite.

- Service component users have been created by the MRS cluster administrator. In security mode, machine-machine users need to download the keytab file. A human-machine user must change the password upon the first login. In common mode, you do not need to download the keytab file or change the password.

Using the Yarn Client

Step 1 Log in to the node where the client is installed as the client installation user.

Step 2 Run the following command to go to the client installation directory:

cd /opt/client

Step 3 Run the following command to configure environment variables:

source bigdata_env

Step 4 If the cluster is in security mode, run the following command to authenticate the user. In normal mode, user authentication is not required.

kinit *Component service user*

Step 5 Run the Yarn command. The following provides an example:

yarn application -list

----End

Client-related FAQs

1. What Do I Do When the Yarn Client Exits Abnormally and Error Message "java.lang.OutOfMemoryError" Is Displayed After the Yarn Client Command Is Run?

   This problem occurs because the memory required for running the Yarn client exceeds the upper limit (128 MB by default) set on the Yarn client. You can modify **CLIENT_GC_OPTS** in *<Client installation path>***/HDFS/component_env** to change the memory upper limit of the Yarn client. For example, if you want to set the maximum memory to 1 GB, run the following command:

   ```
   export CLIENT_GC_OPTS="-Xmx1G"
   ```

   After the modification, run the following command to make the modification take effect:

   source <*Client installation path*>**/bigdata_env**

2. How Can I Set the Log Level When the Yarn Client Is Running?

   By default, the logs generated during the running of the Yarn client are printed to the console. The default log level is INFO. To enable the DEBUG log level for fault locating, run the following command to export an environment variable:

   export YARN_ROOT_LOGGER=DEBUG,console

   Then run the Yarn Shell command to print DEBUG logs.

   If you want to print INFO logs again, run the following command:

   export YARN_ROOT_LOGGER=INFO,console

23.4 Configuring Resources for a NodeManager Role Instance

Scenario

If the hardware resources (such as the number of CPU cores and memory size) of the nodes for deploying NodeManagers are different but the NodeManager available hardware resources are set to the same value, the resources may be wasted or the status may be abnormal. You need to change the hardware resource configuration for each NodeManager to ensure that the hardware resources can be fully utilized.

Impact on the System

NodeManager role instances must be restarted for the new configuration to take effect, and the role instances are unavailable during restart.

Procedure

Step 1 Log in to FusionInsight Manager, choose **Cluster** > **Services** > **Yarn**, and click the **Instance** tab.

Step 2 Click the role instance name corresponding to the node where NodeManager is deployed, switch to **Instance Configuration**, and select **All Configurations**.

Step 3 Enter **yarn.nodemanager.resource.cpu-vcores** in the search box, and set the number of vCPUs that can be used by NodeManager on the current node. You are advised to set this parameter to 1.5 to 2 times the number of actual logical CPUs on the node. Enter **yarn.nodemanager.resource.memory-mb** in the search box, and set the physical memory size that can be used by NodeManager on the current node. You are advised to set this parameter to 75% of the actual physical memory size of the node.

NOTE

Enter **yarn.scheduler.maximum-allocation-vcores** in the search box, and set the maximum number of available CPUs in a container. Enter **yarn.scheduler.maximum-allocation-mb** in the search box, and set the maximum available memory of a container. The instance level cannot be changed. The parameter values need to be changed in the configuration of the Yarn service, and the Yarn service needs to be restarted for the changes to take effect.

Step 4 Click **Save**, and then click **OK**. to restart the NodeManager role instance.

A message is displayed, indicating that the operation is successful. Click **Finish**. The NodeManager role instance is started successfully.

----End

23.5 Changing NodeManager Storage Directories

Scenario

If the storage directories defined by YARN NodeManager are incorrect or the YARN storage plan changes, the MRS cluster administrator needs to modify the NodeManager storage directories on FusionInsight Manager to ensure smooth YARN running. The storage directories of NodeManager include the local storage directory **yarn.nodemanager.local-dirs** and log directory **yarn.nodemanager.log-dirs**. Changing the ZooKeeper storage directory includes the following scenarios:

- Change the storage directory of the NodeManager role. In this way, the storage directories of all NodeManager instances are changed.
- Change the storage directory of a single NodeManager instance. In this way, only the storage directory of this instance is changed, and the storage directories of other instances remain the same.

Impact on the System

- The cluster needs to stopped and restarted during the process of changing the storage directory of the NodeManager role, and the cluster cannot provide services before started.
- The NodeManager instance needs to stopped and restarted during the process of changing the storage directory of the instance, and the instance at this node cannot provide services before it is started.
- The directory for storing service parameter configurations must also be updated.
- After the storage directories of NodeManager are changed, you need to download and install the client again.

Prerequisites

- New disks have been prepared and installed on each data node, and the disks are formatted.
- New directories have been planned for storing data in the original directories.
- The MRS cluster administrator user **admin** has been prepared.

Procedure

Step 1 Check the environment.

1. Log in to FusionInsight Manager, choose **Cluster** > **Services**, and check whether **Running Status** of Yarn is **Normal**.
   - If yes, go to **1.c**.
   - If no, the Yarn status is unhealthy. In this case, go to **1.b**.
2. Rectify faults of Yarn. No further action is required.
3. Determine whether to change the storage directory of the NodeManager role or that of a single NodeManager instance:

- To change the storage directory of the NodeManager role, go to **2**.
- To change the storage directory of a single NodeManager instance, go to **3**.

Step 2 Change the storage directory of the NodeManager role.

1. Choose **Cluster** > **Services** > **Yarn** and click **Stop Service** to stop the Yarn service.
2. Log in to each data node where the Yarn service is installed as user **root** and perform the following operations:
   a. Create a target directory.

      For example, to create the target directory **${BIGDATA_DATA_HOME}/data2**, run the following command:

      mkdir ${BIGDATA_DATA_HOME}/data2

   b. Mount the target directory to the new disk.

      For example, mount **${BIGDATA_DATA_HOME}/data2** to the new disk.

   c. Modify permissions on the new directory.

      For example, to modify permissions on the **${BIGDATA_DATA_HOME}/data2** directory, run the following commands:

      chmod 750 ${BIGDATA_DATA_HOME}/data2 -R and **chown omm:wheel ${BIGDATA_DATA_HOME}/data2 -R**
3. On FusionInsight Manager, choose **Cluster** > **Services** > **Yarn**. Click **Instance**, select the NodeManager instance of the corresponding host, click **Instance Configuration**, and select **All Configurations**.

   Change the value of **yarn.nodemanager.local-dirs** or **yarn.nodemanager.log-dirs** to the new target directory.

   For example, change the value of **yarn.nodemanager.local-dirs** or **yarn.nodemanager.log-dirs** to **/srv/BigData/data2/nm/containerlogs**.
4. Click **Save**, and then click **OK**. Restart the Yarn service.

   Click **Finish** when the system displays "Operation successful". Yarn is successfully started. No further action is required.

Step 3 Change the storage directory of a single NodeManager instance.

1. Choose **Cluster** > **Services** > **Yarn** and click **Instance**. Select the NodeManager instance whose storage directory needs to be modified, click **More**, and select **Stop Instance**.
2. Log in to the NodeManager node as user **root**, and perform the following operations:
   a. Create a target directory.

      For example, to create the target directory **${BIGDATA_DATA_HOME}/data2**, run the following command:

      mkdir ${BIGDATA_DATA_HOME}/data2

   b. Mount the target directory to the new disk.

      For example, mount **${BIGDATA_DATA_HOME}/data2** to the new disk.

   c. Modify permissions on the new directory.

      For example, to modify permissions on the **${BIGDATA_DATA_HOME}/data2** directory, run the following commands:

chmod 750 ${BIGDATA_DATA_HOME}/data2 -R and **chown omm:wheel ${BIGDATA_DATA_HOME}/data2 -R**

3. On Manager, click the specified NodeManager instance, and switch to the **Instance Configuration** page.

   Change the value of **yarn.nodemanager.local-dirs** or **yarn.nodemanager.log-dirs** to the new target directory.

   For example, change the value of **yarn.nodemanager.local-dirs** or **yarn.nodemanager.log-dirs** to **/srv/BigData/data2/nm/containerlogs**.

4. Click **Save**, and then click **OK** to restart the NodeManager instance.

   Click **Finish** when the system displays "Operation successful". The NodeManager instance is successfully started.

----End

23.6 Configuring Strict Permission Control for Yarn

Scenario

In the multi-tenant scenario in security mode, a cluster can be used by multiple users, and tasks of multiple users can be submitted and executed. Users are invisible to each other. A permission control mechanism is required to prevent task information of users from being obtained by other users.

For example, if user B logs in to the system and views the application list when the application submitted by user A is running, user B should not be able to view the application information of user A.

Configuration Description

- Viewing Yarn configuration parameters

  Go to the **All Configurations** page of Yarn and enter a parameter name list in **Table 23-5** in the search box by referring to **Modifying Cluster Service Configuration Parameters**.

  Table 23-5 Parameter description

Parameter	Description	Default Value
yarn.acl.enable	Whether to enable Yarn permission control	true
yarn.webapp.filter-entity-list-by-user	Whether to enable the strict view function. After this function is enabled, a login user can view only the content that the user has the permission to view. To enable this function, set **yarn.acl.enable** to **true**.	true

- Viewing MapReduce configuration parameters

  Go to the **All Configurations** page of MapReduce and enter a parameter name in **Table 23-6** in the search box by referring to **Modifying Cluster Service Configuration Parameters**.

  Table 23-6 Parameter description

Parameter	Description	Default Value
mapreduce.cluster.acls.enabled	Whether to enable permission control of MapReduce JobHistoryServer This parameter is a client parameter and takes effect after permission control is enabled on the JobHistoryServer server.	true
yarn.webapp.filter-entity-list-by-user	Whether to enable the strict view of MapReduce JobHistoryServer. After the strict view is enabled, a login user can view only the content that the user has the permission to view. This parameter is a server parameter of JobHistoryServer. It indicates that permission control is enabled for JHS. However, whether to control a specific application is determined by the client parameter **mapreduce.cluster.acls.enabled**.	true

NOTICE

The preceding configurations affect the RESTful API and Shell command results. After the preceding configurations are enabled, the return results of RESTful API calls and shell commands contain only the information that the user has the permission to view.

If **yarn.acl.enable** or **mapreduce.cluster.acls.enabled** is set to **false**, the Yarn or MapReduce permission verification function is disabled. In this case, any user can submit tasks and view task information on Yarn or MapReduce, which poses security risks. Exercise caution when performing this operation.

23.7 Configuring Container Log Aggregation

Scenario

Yarn provides the container log aggregation function to collect logs generated by containers on each node to HDFS to release local disk space. You can collect logs in either of the following ways:

- After the application is complete, collect container logs to HDFS at a time.
- During application running, periodically collect log segments generated by containers and save them to HDFS.

Configuration Description

Navigation path for setting parameters:

Go to the **All Configurations** tab page of YARN, enter the parameters listed in **Table 23-7** in the search box, modify the parameters by referring to **Modifying Cluster Service Configuration Parameters**, and save the configuration. On the **Dashboard** tab page, choose **More** > **Synchronize Configuration**. After the synchronization is complete, restart the YARN service.

The periodic log collection function applies only to MapReduce applications, for which rolling output of log files must be configured. **Table 23-9** describes the configurations in the *Client installation path*/**Yarn/config/mapred-site.xml** configuration file on the MapReduce client node.

Table 23-7 Parameter description

Parameter	Description	Default Value
yarn.log-aggregation-enable	Whether to enable container log aggregation • If this parameter is set to **true**, logs are collected to the HDFS directory. • If this parameter is set to **false**, the function is disabled, and logs are not collected to HDFS. After changing the parameter value, restart the Yarn service for the setting to take effect. **NOTE** • The container logs that are generated before the parameter is set to **false** and the setting takes effect cannot be obtained from the web UI. • If you need to view the logs generated before on the web UI, you are advised to set this parameter to **true**.	true

Parameter	Description	Default Value
yarn.nodemanager.log-aggregation.roll-monitoring-interval-seconds	Interval for NodeManager to periodically collect logs ● If this parameter is set to **-1** or **0**, periodic log collection is disabled. Logs are collected at a time after application running is complete. ● The minimum collection interval can be set to 3,600 seconds. If this parameter is set to a value greater than 0 and less than 3,600, the collection interval is 3,600 seconds. Interval for NodeManager to wake up and upload logs. If this parameter is set to **-1** or **0**, rolling monitoring is disabled and logs are aggregated when the application task is complete. The value must be greater than or equal to **-1**.	-1

Parameter	Description	Default Value
yarn.nodemanager.disk-health-checker.log-dirs.max-disk-utilization-per-disk-percentage	Maximum percentage of the Yarn disk quota that can be occupied by the container log directory on each disk. When the space occupied by the log directory exceeds the value of this parameter, the periodic log collection service is triggered to start a log collection activity beyond the period to release the local disk space. Maximum space for container logs that can be provided on each disk. If the disk space occupied by container logs exceeds this threshold, data aggregation in rolling mode is triggered. ● The valid value range of the maximum disk quota percentage is –1 to 100. If the value is less than –1, it is forcibly reset to **25**. If the value is greater than 100, the value is forcibly reset to **25**. If you set the value to **–1**, the disk capacity detection function for Container log directory is disabled. **NOTE** ● Percentage of the available disk space of the container log directory = Percentage of the available disk space of Yarn (**yarn.nodemanager.disk-health-checker.max-disk-utilization-per-disk-percentage**) x Percentage of the available disk space of the container log directory (**yarn.nodemanager.disk-health-checker.log-dirs.max-disk-utilization-per-disk-percentage**) ● Only applications with the periodic log collection function enabled can trigger log collection when the disk quota of the log directory exceeds the threshold.	25
yarn.nodemanager.remote-app-log-dir-suffix	Name of the HDFS folder in which container logs are to be stored. This parameter and **yarn.nodemanager.remote-app-log-dir** form the full path for storing container logs. That is, **{yarn.nodemanager.remote-app-log-dir}/${user}/bucket-{yarn.nodemanager.remote-app-log-dir-suffix}-tfile**. **NOTE** *{user}* indicates the username for running the task.	logs

Parameter	Description	Default Value
yarn.nodemanager.log-aggregator.on-fail.remain-log-in-sec	Duration for retaining container logs on the local host after the logs fail to be collected, in second • If this parameter is set to **0**, local logs are deleted immediately. • If this parameter is set to a positive number, local logs are retained for this period.	604800

Go to the **All Configurations** page of MapReduce and enter a parameter name in **Table 23-8** in the search box by referring to **Modifying Cluster Service Configuration Parameters**.

Table 23-8 Parameter description

Parameter	Description	Default Value
yarn.log-aggregation.retain-seconds	Duration for retaining aggregated logs, in second • If this parameter is set to **–1**, the container logs will be retained permanently in the HDFS. • If this parameter is set to **0** or a positive integer, container logs will be stored for such a period and deleted after the period expires. **NOTE** A short period may increase load of the NameNode. Therefore, you are advised to set this parameter to a proper value.	1296000

Parameter	Description	Default Value
yarn.log-aggregation.retain-check-interval-seconds	Interval for storing container logs in HDFS, in second • If this parameter is set to **-1** or **0**, the interval will be one tenth of the period specified by **yarn.log-aggregation.retain-seconds**. **NOTE** If this parameter is set to **-1** or **0**, **yarn.log-aggregation.retain-seconds** cannot be set to **0**. • If this parameter is set to a positive number, container logs in HDFS will be scanned at such an interval. **NOTE** A short interval may increase load of the NameNode. Therefore, you are advised to set this parameter to a proper value.	86400

Go to the **All Configurations** page of Yarn and enter a parameter name list in **Table 23-9** in the search box by referring to **Modifying Cluster Service Configuration Parameters**.

Table 23-9 Configuring rolling output of MapReduce application log files

Parameter	Description	Default Value
mapreduce.task.userlog.limit.kb	Maximum size of a single task log file of the MapReduce application. When the maximum size of the log file has been reached, a new log file is generated. The value **0** indicates that the size of the log file is not limited.	51200

Parameter	Description	Default Value
yarn.app.mapreduce.task.container.log.backups	Maximum number of task logs that can be retained for the MapReduce application. If this parameter is set to **0**, rolling output is disabled. Number of task log backup files when ContainerRollingLogAppender (CRLA) is used. By default, ContainerLogAppender (CLA) is used and container logs are not rolled back. When both **mapreduce.task.userlog.limit.kb** and **yarn.app.mapreduce.task.container.log.backups** are greater than 0, CRLA is enabled. The value ranges from 0 to 999.	10
yarn.app.mapreduce.am.container.log.limit.kb	Maximum size of a single ApplicationMaster log file of the MapReduce application, in KB. When the maximum size of the log file has been reached, a new log file is generated. The value **0** indicates that the size of a single ApplicationMaster log file is not limited.	51200
yarn.app.mapreduce.am.container.log.backups	Maximum number of ApplicationMaster logs that can be retained for the MapReduce application. If this parameter is set to **0**, rolling output is disabled. Number of ApplicationMaster log backup files when CRLA is used. By default, CLA is used and container logs are not rolled back. When both **yarn.app.mapreduce.am.container.log.limit.kb** and **yarn.app.mapreduce.am.container.log.backups** are greater than 0, CRLA is enabled for the ApplicationMaster. The value ranges from 0 to 999.	20
yarn.app.mapreduce.shuffle.log.backups	Maximum number of shuffle logs that can be retained for the MapReduce application. If this parameter is set to **0**, rolling output is disabled. When both **yarn.app.mapreduce.shuffle.log.limit.kb** and **yarn.app.mapreduce.shuffle.log.backups** are greater than 0, **syslog.shuffle** uses CRLA. The value ranges from 0 to 999.	10

Parameter	Description	Default Value
yarn.app.mapreduce.shuffle.log.limit.kb	Maximum size of a single shuffle log file of the MapReduce application, in KB. When the maximum size of the log file has been reached, a new log file is generated. If this parameter is set to **0**, the size of a single shuffle log file is not limited. The value must be greater than or equal to **0**.	51200

23.8 Using CGroups with YARN

Scenario

CGroups is a Linux kernel feature. In YARN this feature allows containers to be limited in their resource usage (example, CPU usage). Without CGroups, it is hard to limit the container CPU usage. Without CGroups, it is hard to limit the container CPU usage.

NOTE

Currently, CGroups is only used for limiting the CPU usage.

Configuration Description

CGroups is a Linux kernel feature and is enabled using LinuxContainerExecutor. For details about how to configure the LinuxContainerExecutor for security, see the official website. You can learn the file system permissions assigned to users and user groups:

NOTE

- Do not modify users, user groups, and related permissions of various paths in the corresponding file system. Otherwise, functions of CGroups may become abnormal.
- If the parameter value of **yarn.nodemanager.resource.percentage-physical-cpu-limit** is too small, the number of available cores may be less than one. For example, if the parameter of a four-core node is set to 20%, the number available core is less than one. As a result, all cores will be used. The Quota mode can be used in Linux versions, for example, Cent OS, that do not support Quota mode.

The table below describes the parameter for configuring cpuset mode, that is, only configured CPUs can be used by YARN. Add the following parameters on Manager.

Table 23-10 Parameter description

Parameter	Description	Default Value
yarn.nodemanager.linux-container-executor.cgroups.cpu-set-usage	Whether to enable the cpuset mode. If this parameter is set to **true**, the cpuset mode is enabled.	false

The table below describes the parameter for configuring strictcpuset mode, that is, only configured CPUs can be used by container. Add the following parameters on Manager.

Table 23-11 Parameter description

Parameter	Description	Default Value
yarn.nodemanager.linux-container-executor.cgroups.cpu-set-usage	Whether to enable the cpuset mode. If this parameter is set to **true**, the cpuset mode is enabled.	false
yarn.nodemanager.linux-container-executor.cgroups.cpuset.strict.enabled	Whether containers use allocated CPUs. If this parameter is set to **true**, the container can use the allocated CPUs.	false

To switch from cpuset mode to quota mode, the following conditions must be met:

- Set the **yarn.nodemanager.linux-container-executor.cgroups.cpu-set-usage** parameter to **false**.
- Delete the **container** folder (if any) from the **/sys/fs/cgroup/cpuset/hadoop-yarn/** directory.
- Delete all CPUs configured in the **cpuset.cpus** file in **/sys/fs/cgroup/cpuset/hadoop-yarn/**.

Procedure

Step 1 Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Yarn**. Click **Configurations** then **All Configurations**.

Step 2 In the navigation pane on the left, choose **NodeManager** > **Customization** and find the **yarn-site.xml** file.

Step 3 Add the parameters in **Table 23-10** and **Table 23-11** as user-defined parameters.

Based on the configuration files and parameter functions, locate the row where parameter **yarn-site.xml** resides. Enter the parameter name in the **Name** column and enter the parameter value in the **Value** column.

Click **+** to add a customized parameter.

Step 4 Click **Save**. In the displayed **Save Configuration** dialog box, confirm the modification and click **OK**. Click **Finish** when the system displays "Operation succeeded". The configuration is successfully saved.

After the configuration is saved, restart the Yarn service whose configuration has expired for the configuration to take effect.

----End

23.9 Configuring the Number of ApplicationMaster Retries

Scenario

When resources are insufficient or ApplicationMaster fails to start, a client probably encounters running errors.

Configuration Description

Go to the **All Configurations** page of Yarn and enter a parameter name list in **Table 23-12** in the search box by referring to **Modifying Cluster Service Configuration Parameters**.

Table 23-12 Parameter description

Parameter	Description	Default Value
yarn.resourcemanager.am.max-attempts	Number of retries of the ApplicationMaster. Increasing the number of retries can prevent ApplicationMaster startup failures caused by insufficient resources. This applies to global settings of all ApplicationMasters. Each ApplicationMaster can use an API to set an independent maximum number of retries. However, the number of retries cannot be greater than the global maximum number of retries. If the value is greater than the global maximum number of retries, the ResourceManager overwrites the value to allow at least one retry. The value must be greater than or equal to **1**.	5

23.10 Configure the ApplicationMaster to Automatically Adjust the Allocated Memory

Scenario

During the process of starting the configuration, when the ApplicationMaster creates a container, the allocated memory is automatically adjusted according to the total number of tasks, which makes resource utilization more flexible and improves the fault tolerance of the client application.

Configuration Description

Navigation path for setting parameters:

On FusionInsight Manager, choose **Cluster** > **Services** > **Yarn**, click **Configurations** then **All Configurations**, and enter **mapreduce.job.am.memory.policy** in the search box.

Configuration description

If the default value of the parameter is left empty. In this case, the automatic adjustment policy is not enabled. The memory of ApplicationMaster is still affected by the value of **yarn.app.mapreduce.am.resource.mb**.

The value of **mapreduce.job.am.memory.policy** consists of five items, and they are separated by colons (:) and commas (,) in the following format: **baseTaskCount:taskStep:memoryStep,minMemory:maxMemory**. The format is strictly checked when the value is entered.

Table 23-13 Parameter description

Parameter	Description	Setting Requirement
baseTaskCount	Indicates the total number of tasks. The configuration of ApplicationMaster is valid only when the total number of tasks (on the sum of the Map and Reduce ends) is greater than or equal to the value of this parameter.	The value cannot be empty and must be greater than 0.
taskStep	Indicates the incremental step length of tasks. This parameter and **memoryStep** determine the memory adjustment amount.	The value cannot be empty and must be greater than 0.
memoryStep	Indicates the incremental memory step. The memory capacity is increased based on the value of **yarn.app.mapreduce.am.resource.mb**.	The value cannot be empty and must be greater than 0. The unit is MB.

Parameter	Description	Setting Requirement
minMemory	Indicates the lower limit of the memory that can be automatically adjusted. If the memory after the automatic adjustment is less than or equal to the value of this parameter, the value of **yarn.app.mapreduce.am.resource.mb** is used.	The value cannot be empty. It must be greater than 0 and cannot be greater than the value of **maxMemory**. Unit: MB
maxMemory	Indicates the upper limit of memory that can ve automatically adjusted. If the adjusted memory exceeds the upper limit, use this value as the final value.	The value cannot be empty. It must be greater than 0 and cannot be less than the value of **minMemory**. Unit: MB

Example Value

Configuration:

- yarn.app.mapreduce.am.resource.mb=1536
- mapreduce.job.am.memory.policy=100:10:50,1200:2000
- Total number of tasks of an application =120

The calculation process is as follows:

Memory after adjustment = 1536 + [(120 – 100)/10] x 50 = 1636. In this example, memory after adjustment 1636 is greater than the value of **minMemory 1200**, and less than the value of **maxMemory 2000**. Therefore, the ApplicationMaster memory is set to **1636 MB**.

If the value of **memStep** is changed to **250**, the calculation formula is as follows: Memory after adjustment = 1536 + [(120 – 100) / 10] x 250 = 2136. In this case, the memory after adjustment is greater than the value of **maxMemory 2000**. As a result, the value of **ApplicationMaster** is set to **2000 MB**.

NOTE

If the memory after adjustment is lower than the value of **minMemory**, the configuration does not take effect but the value is still printed on the backend server. This value is provided as the reference for adjusting the value of **minMemory**.

23.11 Configuring the Access Channel Protocol

Scenario

The value of the **yarn.http.policy** parameter must be consistent on both the server and clients. Web UIs on clients will be garbled if an inconsistency exists, for

example, the parameter value is **HTTPS_ONLY** on the server but it is left unspecified on a client (the parameter value **HTTP_ONLY** is applied to the client by default). Set the **yarn.http.policy** parameters on the clients and server to prevent garbled characters from being displayed on the clients.

Procedure

Step 1 On Manager, choose **Cluster** > *Name of the desired cluster* > **Services** > **Yarn** > **Configurations**. On the displayed page, select **All Configurations** and enter **yarn.http.policy**.

- In security mode, set this parameter to **HTTPS_ONLY**.
- In normal mode, set this parameter to **HTTP_ONLY**.

Step 2 Log in to the node where the client is installed as the client installation user.

Step 3 Run the following command to switch to the client installation directory:

cd /opt/client

Step 4 Run the following command to edit the **yarn-site.xml** file:

vi Yarn/config/yarn-site.xml

Change the value of **yarn.http.policy**.

In security mode, set this parameter to **HTTPS_ONLY**.

In normal mode, set this parameter to **HTTP_ONLY**.

Step 5 Run the **:wq** command to save execution.

Step 6 Restart the client for the settings to take effect.

----End

23.12 Configuring Memory Usage Detection

Scenario

If memory usage of the submitted application cannot be estimated, you can modify the configuration on the server to determine whether to check the memory usage.

If the memory usage is not checked, the container occupies the memory until the memory overflows. If the memory usage exceeds the configured memory size, the corresponding container is killed.

Configuration Description

Go to the **All Configurations** page of Yarn and enter a parameter name in the search box by referring to **Modifying Cluster Service Configuration Parameters**.

Table 23-14 Parameter description

Parameter	Description	Default Value
yarn.nodemanager.vmem-check-enabled	Whether to enable virtual memory usage detection. If the memory used by a task exceeds the allocated memory size, the task is forcibly stopped. • If the value is **true**, the virtual memory will be checked. • If the value is **false**, the virtual memory will not be checked.	true
yarn.nodemanager.pmem-check-enabled	Whether to enable physical memory usage detection. If the memory used by a task exceeds the allocated memory size, the task is forcibly stopped. • If the value is **true**, the physical memory will be checked. • If the value is **false**, the physical memory will not be checked.	true

23.13 Configuring the Additional Scheduler WebUI

Scenario

If the custom scheduler is set in ResourceManager, you can set the corresponding web page and other Web applications for the custom scheduler.

Configuration Description

Go to the **All Configurations** page of Yarn and enter a parameter name in the search box by referring to **Modifying Cluster Service Configuration Parameters**.

Table 23-15 Configuring the Additional Scheduler WebUI

Parameter	Description	Default Value
hadoop.http.rmwebapp.scheduler.page.classes	Load the corresponding web page for the custom scheduler on the RM WebUI. This parameter is valid only when **yarn.resourcemanager.scheduler.class** is set to a custom scheduler.	-
yarn.http.rmwebapp.external.classes	Load the custom web application in the RM Web service.	-

23.14 Configuring Yarn Restart

Scenario

The Yarn Restart feature includes ResourceManager Restart and NodeManager Restart.

- When ResourceManager Restart is enabled, the new active ResourceManager node loads the information of the previous active ResourceManager node, and takes over container status information on all NodeManager nodes to continue service running. In this way, status information can be saved by periodically executing checkpoint operations, avoiding data loss.
- When NodeManager Restart is enabled, NodeManager locally saves information about containers running on the node. After NodeManager is restarted, the container running progress on the node will not be lost by restoring the saved status information.

Configuration Description

Go to the **All Configurations** page of Yarn and enter a parameter name in the search box by referring to **Modifying Cluster Service Configuration Parameters**.

Configure ResourceManager Restart as follows:

Table 23-16 Parameter description of ResourceManager Restart

Parameter	Description	Default Value
yarn.resourcemanager.recovery.enabled	Whether to enable ResourceManager to restore the status after startup. If this parameter is set to **true**, **yarn.resourcemanager.store.class** must also be set.	true
yarn.resourcemanager.store.class	State-store class used to store the application and task statuses and certificate content.	org.apache.hadoop.yarn.server.resourcemanager.recovery.AsyncZKRMStateStore
yarn.resourcemanager.zk-state-store.parent-path	Directory for storing ZKRMStateStore in ZooKeeper	/rmstore
yarn.resourcemanager.work-preserving-recovery.enabled	Whether to enable ResourceManager work serving. This configuration is used only for Yarn feature verification.	true
yarn.resourcemanager.state-store.async.load	Whether to apply asynchronous restoration to completed applications.	**true**

Parameter	Description	Default Value
yarn.resourcemanager.zk-state-store.num-fetch-threads	If asynchronous restoration is enabled, increasing the number of working threads can speed up the restoration of task information stored in ZooKeeper. The value must be greater than 0.	**20**

Configure NodeManager Restart as follows:

Table 23-17 Parameter description of NodeManager Restart

Parameter	Description	Default Value
yarn.nodemanager.recovery.enabled	Whether to enable the function of collecting logs upon a log collection failure when NodeManager is restarted and whether to restore the unfinished application	true
yarn.nodemanager.recovery.dir	Local directory used by NodeManager to store container status	${SRV_HOME}/tmp/yarn-nm-recovery
yarn.nodemanager.recovery.supervised	Whether NodeManager is monitored. After this parameter is enabled, NodeManager does not clear containers after exit. NodeManager assumes that it will restart and restore containers immediately.	true

23.15 Configuring ApplicationMaster Work Preserving

Scenario

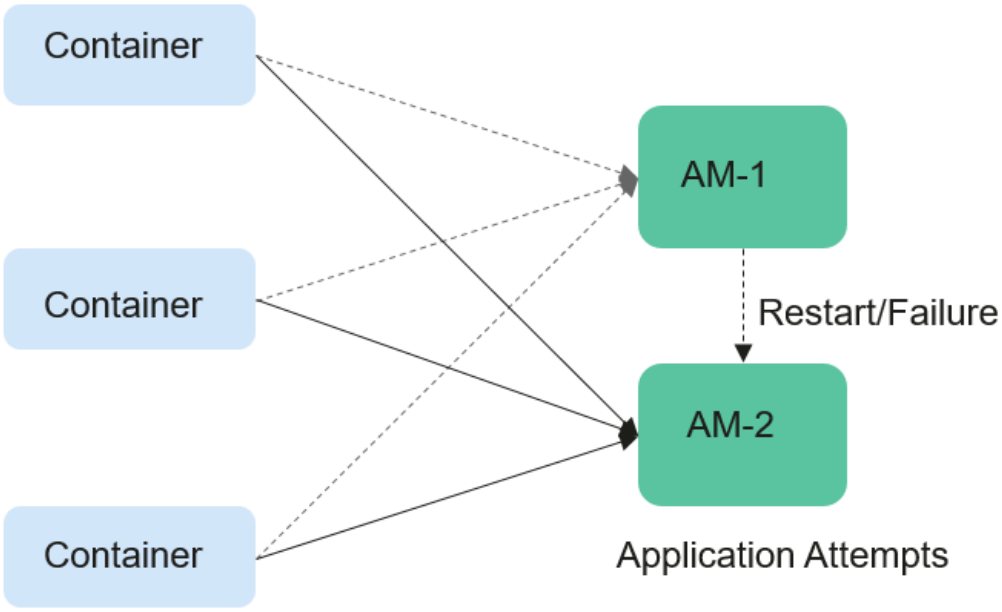
In YARN, ApplicationMasters run on NodeManagers just like every other container (ignoring unmanaged ApplicationMasters in this context). ApplicationMasters may break down, exit, or shut down. If an ApplicationMaster node goes down, ResourceManager kills all the containers of ApplicationAttempt, including containers running on NodeManager. ResourceManager starts a new ApplicationAttempt node on another compute node.

For different types of applications, we want to handle ApplicationMaster restart events in different ways. MapReduce applications aim to prevent task loss but allow the loss of the currently running container. However, for the long-period

YARN service, users may not want the service to stop due to the ApplicationMaster fault.

YARN can retain the status of the container when a new ApplicationAttempt is started. Therefore, running jobs can continue to operate without faults.

Figure 23-1 ApplicationMaster job preserving



Configuration Description

Go to the **All Configurations** page of Yarn and enter a parameter name in the search box by referring to **Modifying Cluster Service Configuration Parameters**.

Set the following parameters based on **Table 23-18**.

Table 23-18 Parameter description

Parameter	Description	Default Value
yarn.app.mapreduce.am.work-preserve	Whether to enable the ApplicationMaster job retention feature.	false
yarn.app.mapreduce.am.umbilical.max.retries	Maximum number of attempts to restore a running container in the ApplicationMaster job retention feature.	5
yarn.app.mapreduce.am.umbilical.retry.interval	Specifies the interval at which a running container attempts to recover in the ApplicationMaster job retention feature. Unit: millisecond	10000

Parameter	Description	Default Value
yarn.resourcemanager.am.max-attempts	The number of retries of ApplicationMaster. Increasing the number of retries prevents ApplicationMaster startup failures caused by insufficient resources. This applies to global settings of all ApplicationMasters. Each ApplicationMaster can use an API to set an independent maximum number of retries. However, the number of retries cannot be greater than the global maximum number of retries. If the value is greater than the global maximum number of retries, the ResourceManager overwrites the value The value must be greater than or equal to **1**.	2

23.16 Configuring the Localized Log Levels

Scenarios

The default log level of localized container is **INFO**. You can change the log level by configuring **yarn.nodemanager.container-localizer.log.level**.

Configuration Description

Log in to FusionInsight Manager and choose **Cluster** > **Services** > **Yarn**. Click **Configurations** then **All Configurations** and set the following parameters in the NodeManager configuration file **yarn-site.xml** to change the log level.

Table 23-19 Parameters

Parameter	Description	Default Value
yarn.nodemanager.container-localizer.log.level	Localized log level of the container. **NOTE** Allowed log levels are as follows: FATAL, ERROR, WARN, INFO, DEBUG, TRACE, and ALL.	INFO

23.17 Configuring Users That Run Tasks

Scenario

Currently, YARN allows the user that starts the NodeManager to run the task submitted by all other users, or the users to run the task submitted by themselves.

Configuration Description

On FusionInsight Manager, choose **Cluster** > **Services** > **Yarn** and click **Configurations** then **All Configurations**. Enter a parameter name in the search box.

Table 23-20 Parameter description

Parameter	Description	Default Value
yarn.nodemanager.linux-container-executor.user	Indicates the user who runs a task.	The value is left blank by default. **NOTE** The value is left blank by default. The user who submits a task is the actual person who runs the task.
yarn.nodemanager.container-executor.class	Indicates the executor who starts a task.	org.apache.hadoop.yarn.server.nodemanager.EnhancedLinuxContainerExecutor

NOTE

- Set **yarn.nodemanager.linux-container-executor.user** to configure the user who runs the container. This parameter is left blank by default. The user who submits the task is the person who runs the container. This parameter is valid only when **yarn.nodemanager.container-executor.class** is set to **org.apache.hadoop.yarn.server.nodemanager.EnhancedLinuxContainerExecutor**.
- In non-security mode, if **yarn.nodemanager.linux-container-executor.user** is set to **omm**, **yarn.nodemanager.linux-container-executor.nonsecure-mode.local-user** must also be set to **omm**.
- For security reasons, it is advised to retain the default values of **yarn.nodemanager.linux-container-executor.user** and **yarn.nodemanager.container-executor.class**.

23.18 Yarn Log Overview

Log Description

The default paths for saving Yarn logs are as follows:

- ResourceManager: **/var/log/Bigdata/yarn/rm** (run logs) and **/var/log/Bigdata/audit/yarn/rm** (audit logs)
- NodeManager: **/var/log/Bigdata/yarn/nm** (run logs) and **/var/log/Bigdata/audit/yarn/nm** (audit logs)
- TimelineServer: **/var/log/Bigdata/yarn/tls** (run logs) and **/var/log/Bigdata/audit/yarn/tls** (audit logs)

Log archive rule: The automatic compression and archive function is enabled for Yarn logs. By default, when the size of a log file exceeds 50 MB, the log file is automatically compressed. The naming rule of the compressed log file is as

follows: *<Original log file name>-<yyyy-mm-dd_hh-mm-ss>.[ID]*.**log.zip**. A maximum of 100 latest compressed files are retained. The number of compressed files can be configured on Manager.

Log archive rule:

Table 23-21 Yarn log list

Log Type	Log File Name	Description
Run log	hadoop-<SSH_USER>-<process_name>-<hostname>.log	Yarn component log file, which records most of the logs generated when the Yarn component is running
	hadoop-<SSH_USER>-<process_name>-<hostname>.out	Log file that records Yarn running environment information
	<process_name>-<SSH_USER>-<DATE>-<PID>-gc.log	Garbage collection log file
	yarn-haCheck.log	ResourceManager active/standby status detection log file
	yarn-service-check.log	Log file that records the health check details of the Yarn service
	yarn-start-stop.log	Log file that records the startup and stop of the Yarn service
	yarn-prestart.log	Log file that records cluster operations before the Yarn service startup
	yarn-postinstall.log	Work log file after installation and before startup of the Yarn service
	hadoop-commission.log	Yarn service entry log file
	yarn-cleanup.log	Log file that records the cleanup operation during uninstallation of the Yarn service
	yarn-refreshqueue.log	Yarn queue refresh log file
	upgradeDetail.log	Upgrade log file

Log Type	Log File Name	Description
	stderr/stdin/syslog	Container log file of the applications running on the Yarn service
	yarn-application-check.log	Check log file of applications running on the Yarn service
	yarn-appsummary.log	Running result log file of applications running on the Yarn service
	yarn-switch-resourcemanager.log	Run log file that records the Yarn active/standby switchover
	yarn-az-state.log	AZ status log of Yarn
	yarn-az-disaster-exercise.log	AZ DR drill log of Yarn
	yarn-az-check.log	Yarn AZ check log file
	ranger-yarn-plugin-enable.log	Log file that records the enabling of Ranger authentication for Yarn
	yarn-nodemanager-period-check.log	Periodic check log of Yarn NodeManager
	yarn-resourcemanager-period-check.log	Periodic check log of Yarn ResourceManager
	hadoop.log	Hadoop client logs
	env.log	Environment information log file before the instance is started or stopped.
	tls-daemon-start-stop.log	YARN daemon startup and stop log
	tls-leveldb-sync.log	Log that records LevelDB synchronization between the active and standby TimelineServer nodes
	threadDump-<process_name>-<thread pid>-<timestamp>.log	Dump log generated when YARN is stopped
Audit logs	yarn-audit-<process_name>.log ranger-plugin-audit.log	Yarn operation audit log file
	SecurityAuth.audit	Yarn security audit log file

Log Level

Table 23-22 describes the log levels supported by Yarn, including OFF, FATAL, ERROR, WARN, INFO, and DEBUG, from high priority to low. Logs whose levels are higher than or equal to the specified level are printed. The number of printed logs decreases as the specified log level increases.

Table 23-22 Log levels

Level	Description
FATAL	Logs of this level record critical error information about the current event processing.
ERROR	Logs of this level record error information about the current event processing.
WARN	Logs of this level record exception information about the current event processing.
INFO	Logs of this level record normal running status information about the system and events.
DEBUG	Logs of this level record the system as well as system debugging information.

To modify log levels, perform the following operations:

Step 1 Go to the **All Configurations** page of the Yarn service by referring to **Modifying Cluster Service Configuration Parameters**.

Step 2 On the menu bar on the left, select the log menu of the target role.

Step 3 Select a desired log level.

Step 4 Click **Save Configuration**. In the dialog box that is displayed, click **OK** to make the setting take effect.

NOTE

The configurations take effect immediately without the need to restart the service.

----End

Log Format

The following table lists the Yarn log formats.

Table 23-23 Log formats

Log Type	Format	Example
Run log	<yyyy-MM-dd HH:mm:ss,SSS>|<Log Level>|<*Thread that generates the log*>|<*Message in the log*>|<*Location of the log event*>	2014-09-26 14:18:59,109 | INFO | main | Client environment:java.compiler=<NA> | org.apache.zookeeper.Environment.logEnv(Environment.java:100)
Audit log	<yyyy-MM-dd HH:mm:ss,SSS>|<Log Level>|<*Thread that generates the log*>|<*Message in the log*>|<*Location of the log event*>	2014-09-26 14:24:43,605 | INFO | main-EventThread | USER=omm OPERATION=refreshAdminAcls TARGET=AdminService RESULT=SUCCESS | org.apache.hadoop.yarn.server.resourcemanager.RMAuditLogger$LogLevel$6.printLog(RMAuditLogger.java:91)

23.19 Yarn Performance Tuning

23.19.1 Preempting a Task

Scenario

The capacity scheduler of ResourceManager implements job preemption to simplify job running in queues and improve resource utilization. The process is as follows:

1. Assume that there are two queues (Queue A and Queue B). The capacity of Queue A is 25%, and the capacity of Queue B is 75%.
2. In the initial state, Task 1 is distributed to Queue A for processing, requiring 75% cluster resources. Task 2 is distributed to Queue B for processing, requiring 50% cluster resources.
3. Task 1 uses 25% cluster resources provided by Queue A and 50% resources from Queue B. Queue B reserves 25% cluster resources.
4. If task preemption is enabled, the resources of Task 1 will be preempted. Queue B preempts 25% cluster resources from Queue A for Task 2.
5. Task 1 will be executed when Task 2 is complete and the cluster has sufficient resources.

Procedure

Navigation path for setting parameters:

Go to the **All Configurations** page of Yarn and enter a parameter name in the search box by referring to **Modifying Cluster Service Configuration Parameters**.

Table 23-24 Parameter description

Parameter	Description	Default Value
yarn.resourcemanager.scheduler.monitor.enable	Whether to start scheduler monitoring according to **yarn.resourcemanager.scheduler.monitor.policies**. If this parameter is set to **true**, scheduler monitoring is enabled based on policies specified by **yarn.resourcemanager.scheduler.monitor.policies** and task resource preemption is enabled based on the scheduler information. If this parameter is set to **false**, scheduler monitoring is disabled.	false
yarn.resourcemanager.scheduler.monitor.policies	List of the SchedulingEditPolicy class to be used with the scheduler	org.apache.hadoop.yarn.server.resourcemanager.monitor.capacity.ProportionalCapacityPreemptionPolicy
yarn.resourcemanager.monitor.capacity.preemption.observe_only	• If this parameter is set to **true**, policies will be applied but task resource preemption will not be performed. • If this parameter is set to **false**, policies will be applied and task resource preemption will be performed based on the policies.	false
yarn.resourcemanager.monitor.capacity.preemption.monitoring_interval	Monitoring interval, in millisecond. If this parameter is set to a larger value, capacity detection will not be performed frequently.	3000

Parameter	Description	Default Value
yarn.resourcemanager.monitor.capacity.preemption.max_wait_before_kill	Interval between the time when a resource preemption request is sent and the time when the container is stopped (resources are released), in millisecond. The value must be greater than or equal to **0**. By default, if ApplicationMaster does not stop the container within 15 seconds, ResourceManager will forcibly stop the container after 15 seconds.	15000
yarn.resourcemanager.monitor.capacity.preemption.total_preemption_per_round	Maximum resource preemption ratio in a period. This value can be used to limit the speed at which containers are reclaimed from the cluster. After the expected total preemption value is calculated, the policy scales the preemption ratio back to this limit.	0.1
yarn.resourcemanager.monitor.capacity.preemption.max_ignored_over_capacity	Resource preemption dead zone = Total number of resources in the cluster x Value of this configuration item + Original resources of a queue (for example, Queue A). When resources actually used by a task in Queue A exceeds the preemption dead zone, the resource beyond the preemption dead zone is preempted. The value range is 0 to 1. **NOTE** A smaller value is recommended for effective preemption.	0

Parameter	Description	Default Value
yarn.resourcemanager.monitor.capacity.preemption.natural_termination_factor	Preemption percentage. Containers preempt only this percentage of the resources. For example, a termination factor of 0.5 will reclaim almost 95% of resources within 5 times of **yarn.resourcemanager.monitor.capacity.preemption.max_wait_before_kill**, even in the absence of natural termination. That is, 5 consecutive preemptions will be performed and each time half of the target resources will be preempted. The trend is geometric convergence. The interval of each preemption is **yarn.resourcemanager.monitor.capacity.preemption.max_wait_before_kill**. The value range is 0 to 1.	1

23.19.2 Setting the Task Priority

Scenario

The resource contention scenarios of a cluster are as follows:

1. Submit two jobs (Job 1 and Job 2) with lower priorities.
2. Some tasks of running Job 1 and Job 2 are in the running state. However, some tasks are pending due to resource deficiency because the capacity of cluster or queue resources is limited.
3. Submit a job (Job 3) with a higher priority. In this case, after the running tasks of Job 1 and Job 2 are complete, their resources will be released and then allocated to the pending tasks of Job 3.
4. After Job 3 is complete, its resources will be released and then allocated to Job 1 and Job 2.

Users can use capacity scheduler of ResourceManager to set the task priority in Yarn because the task priority is implemented by the scheduler of ResourceManager.

Procedure

Set the **mapreduce.job.priority** parameter and use CLI or API to set the task priority.

- Through the CLI

  When submitting tasks, add the **-Dmapreduce.job.priority=***<priority>* parameter.

<priority> can be set to any of the following values:

- VERY_HIGH
- HIGH
- NORMAL
- LOW
- VERY_LOW

- Through the API

  You can also set the task priority through the API.

  Set **Configuration.set("mapreduce.job.priority", <priority>)** or **Job.setPriority(JobPriority priority)**.

23.19.3 Optimizing Node Configuration

Scenario

After the scheduler of a big data cluster is properly configured, you can adjust the available memory, CPU resources, and local disk of each node to optimize the performance.

The configuration items are as follows:

- Available memory
- Number of vCPUs
- Physical CPU usage
- Coordination of memory and CPU resources
- Local disk

Procedure

For details about how to adjust parameter settings, see **Modifying Cluster Service Configuration Parameters**.

- **Available memory**

  Except the memory allocated to the OS and other services, allocate as much as possible memory to Yarn. You can adjust the following parameters to improve resource utilization.

  Assume that a container uses 512 MB memory by default, then the memory usage formula is: 512 MB x Number of containers.

  By default, the Map or Reduce container uses one vCPU and 1,024 MB memory, and ApplicationMaster uses 1,536 MB memory.

Parameter	Description	Default Value
yarn.nodemanager.resource.memory-mb	Physical memory that can be allocated to containers, in MB. The value must be greater than 0. You are advised to set the parameter value to 75% to 90% of the total physical memory of nodes. If the node has permanent processes of other services, reduce this parameter value to reserve sufficient resources for the processes. If the total physical memory space of a node is large and there is no resident process of other services, set this parameter to the total physical memory minus the memory occupied by the resident processes of NodeManager.	**16384**

- **Number of vCPUs**

  You are advised to set this parameter to 1.5 to 2 times the number of logical CPUs. If the upper layer computing applications have low computing capability requirements, you can set the parameter to two times the number of logical CPUs.

Parameter	Description	Default Value
yarn.nodemanager.resource.cpu-vcores	Number of vCPUs that can be used by Yarn on the node. The default value is **8**. You are advised to set the value to 1.5 to 2 times the number of logical CPUs. ● If the task is computing-intensive, set this parameter to the number of logical CPU cores. ● If the task is not computing-intensive, set this parameter to 1.5 to 2 times the number of logical CPU cores. ● If the number of CPU cores used by a task differs greatly from the memory resources, configure the CPU resources based on the memory resources. For example, most tasks use one core and 3 GB memory. If **yarn.nodemanager.resource.memory-mb** is 380 GB, set this parameter to **128**.	8

- **Physical CPU usage**

  You are advised to reserve appropriate CPUs for the OS and the processes, such as database and HBase, and allocate the remaining CPUs to Yarn. You can set the following parameters to adjust the physical CPU usage.

Parameter	Description	Default Value
yarn.nodemanager.resource.percentage-physical-cpu-limit	Physical CPU percentage that can be used by Yarn on a node. The default value is **90**, indicating that no CPU control is implemented and Yarn can use all CPU resources. You can only view the parameter. To change the value of this parameter, set the value of RES_CPUSET_PERCENTAGE of YARN. You are advised to set this parameter to the percentage of CPU resources that can be used by the YARN cluster. For example, If 20% of CPU resources are used by other services (such as HBase, HDFS, and Hive) and system processes on the node, the CPU resources can be scheduled for Yarn is 1 - 20% = 80%. Therefore, you can set this parameter to **80**.	90

- **Local disk**

  MapReduce writes the intermediate job execution results in local disks. Therefore, configure disks as much as possible and disk space as large as possible. A simple way is to configure the same number of disks as DataNode except for the last directory.

  NOTE

  Use commas (,) to separate multiple disks.

Parameter	Description	Default Value
yarn.nodemanager.log-dirs	Directories in which logs are stored. Multiple directories can be specified. Storage location of container logs. The default value is **%{@auto.detect.datapart.nm.logs}**. If there is a data partition, a path list similar to **/srv/BigData/hadoop/data1/nm/containerlogs,/srv/BigData/hadoop/data2/nm/containerlogs** is generated based on the data partition. If there is no data partition, the default path **/srv/BigData/yarn/data1/nm/containerlogs** is generated. In addition to using expressions, you can enter a complete list of paths, such as **/srv/BigData/yarn/data1/nm/containerlogs** or **/srv/BigData/yarn/data1/nm/containerlogs,/srv/BigData/yarn/data2/nm/containerlogs**. In this way, data is stored in all the configured directories, which are usually on different devices. To ensure disk I/O load balancing, you are advised to provide several paths and each path corresponds to an independent disk. The localized log directory of the application exists in the relative path **/application_%{appid}**. The log directory of an independent container, that is, **container_{$contid}**, is the subdirectory of this directory. Each container directory contains the **stderr**, **stdin**, and **syslog** files generated by the container. To add a directory, for example, **/srv/BigData/yarn/data2/nm/containerlogs**, you need to delete the files in **/srv/BigData/yarn/data2/nm/containerlogs** first. Then, assign the same read and write permissions to **/srv/BigData/yarn/data2/nm/containerlogs** as those of **/srv/**	%{@auto.detect.datapart.nm.logs}

Parameter	Description	Default Value
	BigData/yarn/data1/nm/containerlogs, and change **/srv/BigData/yarn/data1/nm/containerlogs** to **/srv/BigData/yarn/data1/nm/containerlogs,/srv/BigData/yarn/data2/nm/containerlogs**. You can add directories, but do not modify or delete existing directories. Otherwise, NodeManager data will be lost and services will be unavailable. Default value: **%{@auto.detect.datapart.nm.logs}** Exercise caution when modifying this parameter. If the configuration is incorrect, the services are unavailable. If the value of this configuration item at the role level is changed, the value of this configuration item at all instance levels will be changed. If the value of this configuration item at the instance level is changed, the value of this configuration item of other instances remains unchanged.	

Parameter	Description	Default Value
yarn.nodemanager.local-dirs	Storage location of files after localization. The default value is **%{@auto.detect.datapart.nm.localdir}**. If there is a data partition, a path list similar to **/srv/BigData/hadoop/data1/nm/localdir,/srv/BigData/hadoop/data2/nm/localdir** is generated based on the data partition. If there is no data partition, the default path **/srv/BigData/yarn/data1/nm/localdir** is generated. In addition to using expressions, you can enter a complete list of paths, such as **/srv/BigData/yarn/data1/nm/localdir** or **/srv/BigData/yarn/data1/nm/localdir,/srv/BigData/yarn/data2/nm/localdir**. In this way, data is stored in all the configured directories, which are usually on different devices. To ensure disk I/O load balancing, you are advised to provide several paths and each path corresponds to an independent disk. The localized file directory of the application is stored in the relative path **/usercache/%{user}/appcache/application_%{appid}**. The working directory of an independent container, that is, **container_%{contid}**, is the subdirectory of the directory. To add a directory, for example, **/srv/BigData/yarn/data2/nm/localdir**, you need to delete the files in **/srv/BigData/yarn/data2/nm/localdir** first. Then, assign the same read and write permissions to **/srv/BigData/hadoop/data2/nm/localdir** as those of **/srv/BigData/hadoop/data1/nm/localdir**, and change **/srv/BigData/yarn/data1/nm/localdir** to **/srv/BigData/yarn/data1/nm/localdir,/srv/BigData/yarn/data2/nm/localdir**. You can add	%{@auto.detect.datapart.nm.localdir}

Parameter	Description	Default Value
	directories, but do not modify or delete existing directories. Otherwise, NodeManager data will be lost and services will be unavailable. Default value: **%{@auto.detect.datapart.nm.localdir}** Exercise caution when modifying this parameter. If the configuration is incorrect, the services are unavailable. If the value of this configuration item at the role level is changed, the value of this configuration item at all instance levels will be changed. If the value of this configuration item at the instance level is changed, the value of this configuration item of other instances remains unchanged.	

23.20 Common Issues About Yarn

23.20.1 Why Mounted Directory for Container is Not Cleared After the Completion of the Job While Using CGroups?

Question

Why mounted directory for Container is not cleared after the completion of the job while using CGroups?

Answer

The mounted path for the Container should be cleared even if job is failed.

This happens due to the deletion timeout. Some task takes more time to complete than the deletion time.

To avoid this scenario, you can go to the **All Configurations** page of Yarn by referring to **Modifying Cluster Service Configuration Parameters**. Search for the **yarn.nodemanager.linux-container-executor.cgroups.delete-timeout-ms** configuration item in the search box to change the deletion interval. The value is in milliseconds.

23.20.2 Why the Job Fails with HDFS_DELEGATION_TOKEN Expired Exception?

Question

Why is the HDFS_DELEGATION_TOKEN expired exception reported when a job fails in security mode?

Answer

HDFS_DELEGATION_TOKEN expires because the token is not updated or it is accessed after max. lifetime.

Ensure the following parameter value of max. lifetime of the token is greater than the job running time.

dfs.namenode.delegation.token.max-lifetime=**604800000** (1 week by default)

Go to the **All Configurations** page of HDFS by referring to **Modifying Cluster Service Configuration Parameters** and search for this parameter in the search box.

NOTE

You are advised to set this parameter to a value that is multiple times of the number of hours within the max. lifecycle of the token.

23.20.3 Why Are Local Logs Not Deleted After YARN Is Restarted?

Question

If Yarn is restarted in either of the following scenarios, local logs will not be deleted as scheduled and will be retained permanently:

- When Yarn is restarted during task running, local logs are not deleted.
- When the task is complete and logs fail to be collected, restart Yarn before the logs are cleared as scheduled. In this case, local logs are not deleted.

Answer

NodeManager has a restart recovery mechanism.

Go to the **All Configurations** tab page of YARN by referring to **Modifying Cluster Service Configuration Parameters**. Set **yarn.nodemanager.recovery.enabled** of NodeManager to **true** to make the configuration take effect. The default value is **true**. In this way, redundant local logs are periodically deleted when the YARN is restarted.

23.20.4 Why the Task Does Not Fail Even Though AppAttempts Restarts for More Than Two Times?

Question

Why the task does not fail even though AppAttempts restarts due to failure for more than two times?

Answer

During the task execution process, if the **ContainerExitStatus** returns value **ABORTED**, **PREEMPTED**, **DISKS_FAILED**, or **KILLED_BY_RESOURCEMANAGER**, the system will not count it as a failed attempt. Therefore, the task fails only when the AppAttempts fails actually, that is, the return value is not **ABORTED**, **PREEMPTED**, **DISKS_FAILED**, or **KILLED_BY_RESOURCEMANAGER** for two times.

23.20.5 Application Moved Back to the Original Queue After the ResourceManager Is Restarted?

Symptom

If an application is moved from one queue to another, the application moved back to the original queue after the ResourceManager is restarted.

Answer

This is a usage restriction of the ResourceManager. If an application is moved to another queue during running, the RM restarts and does not store the information about the new queue.

Assume that a user submits a MapReduce task to the leaf queue **test11**. The leaf queue **test11** is deleted when the task is running. In this case, the submission queue automatically changes to the **lost_and_found** queue (tasks that are not included in queues are placed in the **lost_and_found** queue) and the task is suspended. To start the task, the user moves the task to the leaf queue **test21**. If the ResourceManager restarts, the displayed submission queue is **lost_and_found** instead of **test21**.

If the task is not complete, the ResourceManager only stores the queue information before the task is moved. To solve this problem, move the application again after the ResourceManager is restarted to write information about the new queue to the ResourceManager.

23.20.6 Why Does Yarn Not Release the Blacklist Even All Nodes Are Added to the Blacklist?

Question

Why does Yarn not release the blacklist even all nodes are added to the blacklist?

Answer

In Yarn, when the number of application nodes added to the blacklist by ApplicationMaster (AM) reaches a certain proportion (the default value is 33% of the total number of nodes), the AM automatically releases the blacklist. In this way, all available nodes are added to the blacklist and tasks can obtain node resources.

Assume that there are 8 nodes in a cluster and they are divided in to pool A and pool B by NodeLabel. There are two nodes in pool B. A user submits a task App1 to pool B, but there is not sufficient HDFS space and App1 fails to run. As a result, two nodes in pool B are added to the blacklist by the AM of App1. According to the preceding principles, 2 is less than the 33% of 8. Therefore, Yarn does not release the blacklist, and App1 cannot obtain resources and keeps running. Even if the node that is added to the blacklisted is recovered, App1 still cannot obtain resources.

The preceding principles do not apply to resource pool scenarios. You can change the value of **yarn.resourcemanager.am-scheduling.node-blacklisting-disable-threshold** to **(nodes number of the pool / total nodes) x 33%** to solve this problem. The path is *Client installation path*/**Yarn/config/yarn-site.xml**.

23.20.7 Why Does the Switchover of ResourceManager Occur Continuously?

Question

The switchover of ResourceManager occurs continuously when multiple, for example 2,000, tasks are running concurrently, causing the Yarn service unavailable.

Answer

The cause is that the time of full GabageCollection exceeds the interaction duration threshold between the ResourceManager and ZooKeeper duration threshold. As a result, the connection between the ResourceManager and ZooKeeper fails and the switchover of ResourceManager occurs continuously.

When there are multiple tasks, ResourceManager saves the authentication information about multiple tasks and transfers the information to NodeManagers through heartbeat, which is called heartbeat response. The lifecycle of heartbeat response is short. The default value is 1s. Normally, heartbeat response can be reclaimed during the JVM minor GabageCollection. However, if there are multiple tasks and there are a lot of nodes, for example 5000 nodes, in the cluster, the heartbeat response of multiple nodes occupy a large amount of memory. As a result, the JVM cannot completely reclaim the heartbeat response during minor GabageCollection. The heartbeat response failed to be reclaimed accumulate and the JVM full GabageCollection is triggered. The JVM GabageCollection is in a blocking mode, in other words, no jobs are performed during the GabageCollection. Therefore, if the duration of full GabageCollection exceeds the periodical interaction duration threshold between the ResourceManager and ZooKeeper, the switchover occurs.

Log in to FusionInsight Manager, choose **Cluster** > **Services** > **Yarn**, and click the **Configurations** tab and then **All Configurations**. In the navigation pane on the

left, choose **Yarn** > **Customization**, and add the **yarn.resourcemanager.zk-timeout-ms** parameter to the **yarn.yarn-site.customized.configs** file to increase the threshold of the periodic interaction duration between ResourceManager and ZooKeeper (the value range is less than or equal to 90,000 ms). In this way, the problem of continuous active/standby ResourceManager switchover can be solved.

23.20.8 Why Does a New Application Fail If a NodeManager Has Been in Unhealthy Status for 10 Minutes?

Question

Why does a new application fail if a NodeManager has been in unhealthy status for 10 minutes?

Answer

When **nodeSelectPolicy** is set to **SEQUENCE** and the first NodeManager connected to the ResourceManager is unavailable, the ResourceManager attempts to assign tasks to the same NodeManager in the period specified by **yarn.nm.liveness-monitor.expiry-interval-ms**.

You can use either of the following methods to avoid the preceding problem:

- Use another nodeSelectPolicy, for example, **RANDOM**.
- Go to the **All Configurations** page of Yarn by referring to **Modifying Cluster Service Configuration Parameters**. Search for the following parameters in the search box and modify the following attributes in the **yarn-site.xml** file:

  yarn.resourcemanager.am-scheduling.node-blacklisting-enabled = **true**;

  yarn.resourcemanager.am-scheduling.node-blacklisting-disable-threshold = **0.5**.

23.20.9 Why Does an Error Occur When I Query the ApplicationID of a Completed or Non-existing Application Using the RESTful APIs?

Question

Why does an error occur when I query the applicationID of a completed or non-existing application using the RESTful APIs?

Answer

The Superior scheduler only stores the applicationIDs of running applications. If you view the applicationID of a completed or non-existing application by accessing the RESTful API at **https://<SS_REST_SERVER>/ws/v1/sscheduler/applications/{application_id}**. the 404 error is returned by the server. If Chrome web browser is used, the **Error Occurred** message is displayed because chrome preferentially responds in the application/xml format. If Internet Explorer is used, the **404** error code is displayed because IE web browser preferentially responds in the application/json format.

23.20.10 Why May A Single NodeManager Fault Cause MapReduce Task Failures in the Superior Scheduling Mode?

Question

In Superior scheduling mode, if a single NodeManager is faulty, why may the MapReduce tasks fail?

Answer

In normal cases, when the attempt of a single task of an application fails on a node for three consecutive times, the AppMaster of the application adds the node to the blacklist. Then, the AppMaster instructs the scheduler not to schedule the task to the node to avoid task failure.

However, by default, if 33% nodes in the cluster are added to the blacklist, the scheduler ignores the blacklisted nodes. Therefore, the blacklist feature is prone to become invalid in small cluster scenarios. For example, there are only three nodes in the cluster. If one node is faulty, the blacklist mechanism becomes invalid. The scheduler continues to schedule the task to the node no matter how many times the attempt of the task fails on the node. As a result, the number of attempts of the task reaches the maximum (4 times by default for MapReduce). And the MapReduce tasks failed.

Workaround:

In the *Client installation path*/**Yarn/config/yarn-site.xml** file, modify the **yarn.resourcemanager.am-scheduling.node-blacklisting-disable-threshold** parameter to configure the threshold (in percentage) for ignoring blacklisted nodes. You are advised to increase the value of this parameter based on the cluster scale. For example, you are advised to set this parameter to **50%** for a three-node cluster.

NOTE

The framework design of the Superior scheduler is time-based asynchronous scheduling. When the NodeManager is faulty, ResourceManager cannot quickly detect that the NodeManager is faulty (10 minutes by default). Therefore, the Superior scheduler still schedules tasks to the node, causing task failures.

23.20.11 Why Are Applications Suspended After They Are Moved From Lost_and_Found Queue to Another Queue?

Question

When a queue is deleted when there are applications running in it, these applications are moved to the "lost_and_found" queue. When these applications are moved back to another healthy queue, some tasks are suspended.

Answer

If no label expression is set for the current application, the default label expression of the queue is used as label expression for new container/resource demands

requested by the application. If there is no default label expression of the queue, then **default label** is considered as the label expression for new container/ resource demands requested by the application.

When application app1 is submitted to the queue Q1, **label1**, the default label expression of the queue, is used for the application's new resource requests/ containers. If Q1 is deleted when app1 is running, app1 is moved to the "lost_and_found" queue. Because there is no label expression of the "lost_and_found" queue, **default label** is used as the label expression of app1's new resource requests/containers. Assume that app1 is moved to another normal queue Q2. If Q2 supports **label1** and **default label**, app1 can run properly. If Q2 does not support **label1** or **default label**, the resource request with **label1** or **default label** cannot obtain resources, causing task suspension.

To solve this problem, ensure that the queue to which the application is moved from "lost_and_found" queue supports label expression of the moved application.

You are not advised to delete a queue in which there are running applications.

23.20.12 How Do I Limit the Size of Application Diagnostic Messages Stored in the ZKstore?

Question

How do I limit the size of application diagnostic messages stored in the ZKstore?

Answer

In some cases, it has been observed that diagnostic messages may grow infinitely. Because diagnostic messages are stored in the ZKstore, it is not recommended that you allow diagnostic messages to grow indefinitely. Therefore, a property parameter is needed to set the maximum size of the diagnostic message.

If you need to set **yarn.app.attempt.diagnostics.limit.kc**, go to the **All Configurations** page by referring to **Modifying Cluster Service Configuration Parameters** and search for the following parameters in the search box:

Table 23-25 Parameter description

Parameter	Description	Default Value
yarn.app.attempt.diagnostics.limit.kc	Data size of the diagnosis message for each application connection, in kilobytes (number of characters x 1,024). When ZooKeeper is used to store the behavior status of applications, the size of diagnosis messages needs to be limited to prevent Yarn from overloading ZooKeeper. If **yarn.resourcemanager.state-store.max-completed-applications** is set to a large value, you need to decrease the value of this property to limit the total size of stored data.	64

23.20.13 Why Does a MapReduce Job Fail to Run When a Non-ViewFS File System Is Configured as ViewFS?

Question

Why does a MapReduce job fail to run when a non-ViewFS file system is configured as ViewFS?

Answer

When a non-ViewFS file system is configured as a ViewFS using cluster, the user permissions on folders in the ViewFS file system are different from those of non-ViewFS folders in the default NameService. The submitted MapReduce job fails to be executed because the directory permissions are inconsistent.

When configuring the ViewFS user in the cluster, you need to check and verify the directory permissions. Before submitting a job, change the ViewFS folder permissions based on the default NameService folder permissions.

The following table lists the default permission structure of directories configured in ViewFS. If the configured directory permissions are not included in the following table, you must change the directory permissions accordingly.

Table 23-26 Default permission structure of directories configured in ViewFS

Parameter	Description	Default Value	Default value and default permissions on the parent directory
yarn.nodemanager.remote-app-log-dir	On the default file system (usually HDFS), specify the directory to which the NM aggregates logs.	logs	777
yarn.nodemanager.remote-app-log-archive-dir	Directory for archiving logs	-	777
yarn.app.mapreduce.am.staging-dir	Staging directory used when a job is submitted	/tmp/hadoop-yarn/staging	777
mapreduce.jobhistory.intermediate-done-dir	Directory for storing historical files of MapReduce jobs	${yarn.app.mapreduce.am.staging-dir}/history/done_intermediate	777

Parameter	Description	Default Value	Default value and default permissions on the parent directory
mapreduce.jobhistory.done-dir	Directory of historical files managed by the MR JobHistory Server.	${yarn.app.mapreduce.am.staging-dir}/history/done	777

23.20.14 Why Do Reduce Tasks Fail to Run in Some OSs After the Native Task Feature is Enabled?

Question

After the Native Task feature is enabled, Reduce tasks fail to run in some OSs.

Answer

When **-Dmapreduce.job.map.output.collector.class=org.apache.hadoop.mapred.nativetask.NativeMapOutputCollectorDelegator** is executed to enable the Native Task feature during the running of MapReduce tasks that contain Reduce tasks, the tasks fail to run in some OSs, and the error message "version 'GLIBCXX_3.4.20' not found" is displayed in logs. The cause is that the GLIBCXX version of the OSs is too early. As a result, the libnativetask.so.1.0.0 library on which the feature depends cannot be loaded, leading to task failures.

Workaround:

Set **mapreduce.job.map.output.collector.class** to **org.apache.hadoop.mapred.MapTask$MapOutputBuffer**.

24 Using ZooKeeper

24.1 Using ZooKeeper from Scratch

ZooKeeper is an open-source, highly reliable, and distributed consistency coordination service. ZooKeeper is designed to solve the problem that data consistency cannot be ensured for complex and error-prone distributed systems. There is no need to develop dedicated collaborative applications, which is suitable for high availability services to ensure data consistency.

Background Information

Before using the client, you need to download and update the client configuration file on all clients except the client of the active management node.

Procedure

Step 1 Download the client configuration file.

1. Log in to FusionInsight Manager.
2. In the upper right corner of the homepage, click **More** and select **Download Client**.
3. Download the cluster client.

   Set **Select Client Type** to **Configuration Files Only**, select a platform type, and click **OK** to generate the client configuration file which is then saved in the **/tmp/FusionInsight-Client/** directory on the active management node by default.

Step 2 Log in to the active management node of Manager.

1. Log in to any node where Manager is deployed as user **root**.
2. Run the following command to identify the active and standby nodes:

   sh ${BIGDATA_HOME}/om-server/om/sbin/status-oms.sh

   In the command output, the value of **HAActive** for the active management node is **active**, and that for the standby management node is **standby**. In the following example, **node-master1** is the active management node, and **node-master2** is the standby management node.

```
HAMode
double
NodeName            HostName        HAVersion       StartTime           HAActive
HAAllResOK          HARunPhase
192-168-0-30        node-master1    V100R001C01     2020-05-01 23:43:02 active
normal              Actived
192-168-0-24        node-master2    V100R001C01     2020-05-01 07:14:02 standby
normal              Deactived
```

3. Log in to the primary management node as user **root** and run the following command to switch to user **omm**:

   sudo su - omm

Step 3 Run the following command to switch to the client installation directory, for example, **/opt/client**:

cd /opt/client

Step 4 Run the following command to update the client configuration for the active management node.

sh refreshConfig.sh /opt/client *Full path of the client configuration file package*

For example, run the following command:

sh refreshConfig.sh /opt/client /tmp/FusionInsight-Client/FusionInsight_Cluster_1_Services_Client.tar

If the following information is displayed, the configurations have been updated successfully:

```
ReFresh components client config is complete.
Succeed to refresh components client config.
```

Step 5 Use the client on a Master node.

1. On the active management node where the client is updated, for example, node **192-168-0-30**, run the following command to go to the client directory:

   cd /opt/client

2. Run the following command to configure environment variables:

   source bigdata_env

3. If Kerberos authentication has been enabled for the current cluster, run the following command to authenticate the current user.. If Kerberos authentication is disabled for the current cluster, skip this step:

   kinit *MRS cluster user*

   Example: **kinit zookeeperuser**.

4. Run the following Zookeeper client command:

   zkCli.sh -server <zookeeper installation node IP>:<port>

   Example: **zkCli.sh -server node-master1DGhZ:2181**

Step 6 Run the ZooKeeper client command.

1. Create a ZNode.
   ```
   create /test
   ```
2. View ZNode information.
   ```
   ls /
   ```
3. Write data to the ZNode.
   ```
   set /test "zookeeper test"
   ```

4. View the data written to the ZNode.
   ```
   get /test
   ```
5. Delete the created ZNode.
   ```
   delete /test
   ```

----End

24.2 Common ZooKeeper Parameters

Navigation path for setting parameters:

Go to the **All Configurations** page of ZooKeeper by referring to **Modifying Cluster Service Configuration Parameters**. Enter a parameter name in the search box.

Table 24-1 Parameters

Parameter	Description	Default Value
skipACL	Specifies whether to skip the permission check of the ZooKeeper node.	no
maxClientCnxns	Specifies the maximum number of connections of ZooKeeper. It is recommended this parameter is set to a larger value in scenarios with a large number of connections.	2000
LOG_LEVEL	Specifies the log level. This parameter can be set to **DEBUG** during commissioning.	INFO
acl.compare.shortName	Specifies whether to perform ACL authentication only by principal username when the Znode ACL authentication type is SASL.	true
synclimit	Specifies the interval of synchronization between the follower and leader (unit: tick). If the leader does not respond within the specified time range, the connection cannot be established.	15

Parameter	Description	Default Value
tickTime	Specifies the duration of a tick (in milliseconds). It is the basic time unit used by ZooKeeper, which defines heartbeat and timeout durations.	4000

NOTE

The ZooKeeper internal time is determined by **ticktime** and **synclimit**. To increase the ZooKeeper internal timeout interval, increase the timeout interval for the client to connect to ZooKeeper.

24.3 Using a ZooKeeper Client

Scenario

Use a ZooKeeper client in an O&M scenario or service scenario.

Prerequisites

You have installed the client. For example, the installation directory is **/opt/client**. The client directory in the following operations is only an example. Change it based on the actual installation directory onsite.

Procedure

Step 1 Log in to the node where the client is installed as the client installation user.

Step 2 Run the following command to go to the client installation directory:

cd /opt/client

Step 3 Run the following command to configure environment variables:

source bigdata_env

Step 4 Run the following command to authenticate the user: (skip this step in common mode):

kinit *Component service user*

Step 5 Run the following command to log in to the client tool:

zkCli.sh -server *service IP address of the node where the ZooKeeper role instance locates*:*client port*

----End

24.4 Configuring the ZooKeeper Permissions

Scenario

Configure znode permission of ZooKeeper.

ZooKeeper uses an access control list (ACL) to implement znode access control. The ZooKeeper client specifies a znode ACL, and the ZooKeeper server determines whether a client that requests for a znode has related operation permission according to the ACL. ACL configuration involves the following four operations:

- Check znode ACLs in ZooKeeper.
- Add znode ACLs to ZooKeeper.
- Modify znode ACLs in ZooKeeper.
- Delete znode ACLs from ZooKeeper.

  The ZooKeeper ACL permission is described as follows:

  ZooKeeper supports five types of permission, create, delete, read, write, and admin. ZooKeeper permission control is of a znode level. That is, the permission configuration for a parent znode is not inherited by its child znodes. The ZooKeeper znode default permission is **world:anyone: cdrwa**. That is, any user has all permissions.

NOTE

ACL has three parts:

The first part is the authentication type. For example, **world** indicates all authentication types and **sasl** indicates the kerberos authentication type.

The second part is the account. For example, anyone indicates any user.

The third part is permission. For example, **cdrwa** indicates all permissions.

In particular, because starting the client in common mode does not need authentication, ACL with **sasl** authentication type cannot be used in common mode. Authentications of **sasl** scheme in this document are performed in clusters that have the security mode enabled.

Table 24-2 Five types of ZooKeeper ACLs

Permission Description	Permission Name	Permission Details
Create permission	create(c)	Users with this permission can create child znodes in the current znode.
Delete permission	delete(d)	Users with this permission can delete the current znode.
Read permission	read(r)	Users with this permission can obtain data of the current znode and list all the child znodes of the current znode.
Write permission	write(w)	Users with this permission can write data to the current znode and its child znodes.

Permission Description	Permission Name	Permission Details
Administration permission	admin(a)	Users with this permission can set permission for the current znode.

Impact on the System

NOTICE

Modifying ZooKeeper ACLs is a critical operation. If znode permission is modified in ZooKeeper, other users may have no permission to access the znode and some system functions are abnormal. In 3.5.6 and later versions, users must have the read permission for the **getAcl** operation.

Prerequisites

- The ZooKeeper client has been installed in a directory, for example, **/opt/client**.
- You have obtained the username and password of an MRS cluster administrator.

Procedure

Start the ZooKeeper client.

Step 1 Log in to the server where the ZooKeeper client is installed as user **root**.

Step 2 Run the following command to go to the client installation directory:

cd /opt/client

Step 3 Run the following command to configure environment variables:

source bigdata_env

Step 4 Run the following command and enter the user password to authenticate the user's identity (This step is required only for clusters in security mode, and user **userA** is provided as an example of an authorized user.):

kinit userA

Step 5 On the ZooKeeper client, run the following command to go to the ZooKeeper command-line interface (CLI):

sh zkCli.sh -server *ZooKeeper plane IP address of any instance*:*clientPort*

The default **clientPort** is **2181**.

Example: **sh zkCli.sh -server 192.168.0.151:2181**

Step 6 Run the **ls** command to view the znode list in ZooKeeper. For example, you can view the list of znodes in the root directory.

ls /

```
[zk: 192.168.0.151:2181(CONNECTED) 1] ls /
[hadoop-flag, hadoop-ha, test, test2, test3, test4, test5, test6, zookeeper]
```

View the ZooKeeper znode ACL.

Step 7 Start the ZooKeeper client.

Step 8 Run the **getAcl** command to view znodes. The following command can be used to view the created znode ACL named **test**:

getAcl */znode name*

```
[zk: 192.168.0.151:2181(CONNECTED) 2] getAcl /test
'world,'anyone
: cdrwa
```

Add a ZooKeeper znode ACL.

Step 9 Start the ZooKeeper client.

Step 10 View the old ACL information to check whether the current account has the permission to modify the znode ACL information (a permission). If no, use kinit to switch to a user that has the permission and restart the ZooKeeper client.

getAcl */znode name*

```
 [zk: 192.168.0.151:2181(CONNECTED) 3] getAcl /test
'world,'anyone
: cdrwa
```

Step 11 Run the **setAcl** command to add an ACL. The command for adding an ACL is as follows:

setAcl /test world:anyone:cdrwa,sasl: *username*@: *<system domain name>:ACL value*

For example, to create the ACL of user **admin** to the test znode, run the following command:

setAcl /test world:anyone:cdrwa,sasl:userA@HADOOP.COM:cdrwa

NOTE

When adding a new ACL, reserve the existing ones. The new and old ACLs are separated by a comma. The newly added ACL has three parts:

- The first part is the authentication type. For example, **sasl** indicates kerberos authentication.
- The second part is the account. For example, **userA@HADOOP.COM** indicates user **userA**.
- The third part is permission. For example, **cdrwa** indicates all permissions.

Step 12 After adding the ACL, run the **getAcl** command to check whether the permission is added successfully:

getAcl */znode name*

```
[zk: 192.168.0.151:2181(CONNECTED) 4] getAcl /test
'world,'anyone
: cdrwa
'sasl,'userA@<System domain name>
: cdrwa
```

Modify the ZooKeeper znode ACL.

Step 13 Start the ZooKeeper client.

Step 14 View the old ACL information to check whether the current account has the permission to modify the znode ACL information (a permission). If no, use kinit to switch to a user that has the permission and restart the ZooKeeper client.

getAcl */znode name*

```
[zk: 192.168.0.151:2181(CONNECTED) 5] getAcl /test
'world,'anyone
: cdrwa
'sasl,'userA@<System domain name>
: cdrwa
```

Step 15 Run the **setAcl** command to modify an ACL. The command for adding an ACL is as follows:

s**etAcl /test sasl:***Username@<System domain name>:ACL value*

For example, to reserve all permissions of user **userA** and delete the rw permission of user **anyone**, run the following command:

setAcl /test sasl:userA@HADOOP.COM:cdrwa

Step 16 After modifying the ACL, run the **getAcl** command to check whether the permission is modified successfully:

getAcl */znode name*

```
[zk: 192.168.0.151:2181(CONNECTED) 6] getAcl /test
'sasl,'userA@<System domain name>
: cdrwa
```

Delete the ZooKeeper znode ACL.

Step 17 Start the ZooKeeper client.

Step 18 View the old ACL information to check whether the current account has the permission to modify the znode ACL information (a permission). If no, use kinit to switch to a user that has the permission and restart the ZooKeeper client.

getAcl */znode name*

```
[zk: 192.168.0.151:2181(CONNECTED) 5] getAcl /test
'world,'anyone
: rw
'sasl,'userA@<System domain name>
: cdrwa
```

Step 19 Run the **setAcl** command to add an ACL. The command for adding an ACL is as follows:

s**etAcl /test sasl:***Username@<System domain name>:ACL value*

For example, to reserve all permissions of user **userA** and delete the rw permission of user **anyone**, run the following command:

setAcl /test sasl:userA@HADOOP.COM:cdrwa

Step 20 After modifying the ACL, run the **getAcl** command to check whether the permission is modified successfully:

getAcl */znode name*

```
[zk: 192.168.0.151:2181(CONNECTED) 6] getAcl /test
'sasl,'userA@<System domain name>
: cdrwa
```

----End

24.5 ZooKeeper Log Overview

Log Description

Log path: **/var/log/Bigdata/zookeeper/quorumpeer** (Run log), **/var/log/Bigdata/audit/zookeeper/quorumpeer** (Audit log)

Log archive rule: The automatic ZooKeeper log compression function is enabled. By default, when the size of logs exceeds 30 MB, logs are automatically compressed into a log file. A maximum of 20 compressed files can be reserved. The number of compressed files can be configured on Manager.

Table 24-3 ZooKeeper log list

Log Type	Log File Name	Description
Run logs	zookeeper-<SSH_USER>-<process_name>-<hostname>.log	ZooKeeper system log file, which records most of the logs generated when the ZooKeeper system is running.
	check-serviceDetail.log	Log that records whether the ZooKeeper service starts successfully.
	zookeeper-<SSH_USER>-<DATA>-<PID>-gc.log	ZooKeeper garbage collection log file
	instanceHealthDetail.log	Log that records the health check details of ZooKeeper instance
	zookeeper-omm-server-<hostname>.out	Log indicating that ZooKeeper unexpectedly quits
	zk-err-<zkpid>.log	ZooKeeper fatal error log
	java_pid<zkpid>.hprof	ZooKeeper memory overflow log
	funcDetail.log	ZooKeeper instance startup log
	zookeeper-period-check.log	Health check log of the ZooKeeper instance
	zookeeper-period-check-java.log	ZooKeeper quota monitoring period check log

Log Type	Log File Name	Description
	threadDump-<process_name>-<thread pid>-<timestamp>.log	Dump log generated when ZooKeeper is stopped
Audit Log	zk-audit-quorumpeer.log	ZooKeeper operation audit log

Log levels

Table 24-4 describes the log levels supported by ZooKeeper. The priorities of log levels are FATAL, ERROR, WARN, INFO, and DEBUG in descending order. Logs whose levels are higher than or equal to the specified level are printed. The number of printed logs decreases as the specified log level increases.

Table 24-4 Log levels

Level	Description
FATAL	Logs of this level record fatal error information about the current event processing that may result in a system crash.
ERROR	Error information about the current event processing, which indicates that system running is abnormal.
WARN	Abnormal information about the current event processing. These abnormalities will not result in system faults.
INFO	Logs of this level record normal running status information about the system and events.
DEBUG	Logs of this level record the system information and system debugging information.

To modify log levels, perform the following operations:

Step 1 Go to the **All Configurations** page of the ZooKeeper service by referring to **Modifying Cluster Service Configuration Parameters**.

Step 2 On the menu bar on the left, select the log menu of the target role.

Step 3 Select a desired log level.

Step 4 Click **Save**. In the displayed dialog box, click **OK** to make the configuration take effect.

NOTE

The configurations take effect immediately without the need to restart the service.

----End

Log Format

The following table lists the ZooKeeper log formats.

Table 24-5 Log Format

Log Type	Component	Format	Example
Run logs	zookeeper quorumpeer	<*yyyy-MM-dd HH:mm:ss,SSS*>|<*Log level*>|<*Name of the thread that generates the log*>|<*Message in the log*>|<*Location where the log event occurs*>	2020-01-20 16:33:43,816 | INFO | main | Defaulting to majority quorums | org.apache.zookeeper.server.quorum.QuorumPeerConfig.parseProperties(QuorumPeerConfig.java:335)
Audit logs	zookeeper quorumpeer	<*yyyy-MM-dd HH:mm:ss,SSS*>|<*Log level*>|<*Name of the thread that generates the log*>|<*Message in the log*>|<*Location where the log event occurs*>	2020-01-20 16:33:54,313 | INFO | CommitProcessor:13 | session=0xd4b0679daea0000 ip=10.177.112.145 operation=create znode target=ZooKeeperServer znode=/zk-write-test-2 result=success | org.apache.zookeeper.ZKAuditLogger$LogLevel$5.printLog(ZKAuditLogger.java:70)

24.6 Common Issues About ZooKeeper

24.6.1 Why Do ZooKeeper Servers Fail to Start After Many znodes Are Created?

Question

After a large number of znodes are created, ZooKeeper servers in the ZooKeeper cluster become faulty and cannot be automatically recovered or restarted.

Logs of followers:

```
2016-06-23 08:00:18,763 | WARN  | QuorumPeer[myid=26](plain=/10.16.9.138:2181)(secure=disabled) |
Exception when following the leader |
org.apache.zookeeper.server.quorum.Follower.followLeader(Follower.java:93)
java.net.SocketTimeoutException: Read timed out
    at java.net.SocketInputStream.socketRead0(Native Method)
    at java.net.SocketInputStream.socketRead(SocketInputStream.java:116)
    at java.net.SocketInputStream.read(SocketInputStream.java:170)
    at java.net.SocketInputStream.read(SocketInputStream.java:141)
    at java.io.BufferedInputStream.fill(BufferedInputStream.java:246)
    at java.io.BufferedInputStream.read(BufferedInputStream.java:265)
    at java.io.DataInputStream.readInt(DataInputStream.java:387)
    at org.apache.jute.BinaryInputArchive.readInt(BinaryInputArchive.java:63)
    at org.apache.zookeeper.server.quorum.QuorumPacket.deserialize(QuorumPacket.java:83)
    at org.apache.jute.BinaryInputArchive.readRecord(BinaryInputArchive.java:99)
    at org.apache.zookeeper.server.quorum.Learner.readPacket(Learner.java:156)
    at org.apache.zookeeper.server.quorum.Learner.registerWithLeader(Learner.java:276)
    at org.apache.zookeeper.server.quorum.Follower.followLeader(Follower.java:75)
    at org.apache.zookeeper.server.quorum.QuorumPeer.run(QuorumPeer.java:1094)
2016-06-23 08:00:18,764 | INFO  | QuorumPeer[myid=26](plain=/10.16.9.138:2181)(secure=disabled) |
shutdown called | org.apache.zookeeper.server.quorum.Follower.shutdown(Follower.java:198)
java.lang.Exception: shutdown Follower
    at org.apache.zookeeper.server.quorum.Follower.shutdown(Follower.java:198)
    at org.apache.zookeeper.server.quorum.QuorumPeer.stopFollower(QuorumPeer.java:1141)
    at org.apache.zookeeper.server.quorum.QuorumPeer.run(QuorumPeer.java:1098)
```

Logs of the leader:

```
2016-06-23 07:30:57,481 | WARN  | QuorumPeer[myid=25](plain=/10.16.9.136:2181)(secure=disabled) |
Unexpected exception | org.apache.zookeeper.server.quorum.QuorumPeer.run(QuorumPeer.java:1108)
java.lang.InterruptedException: Timeout while waiting for epoch to be acked by quorum
    at org.apache.zookeeper.server.quorum.Leader.waitForEpochAck(Leader.java:1221)
    at org.apache.zookeeper.server.quorum.Leader.lead(Leader.java:487)
    at org.apache.zookeeper.server.quorum.QuorumPeer.run(QuorumPeer.java:1105)
2016-06-23 07:30:57,482 | INFO  | QuorumPeer[myid=25](plain=/10.16.9.136:2181)(secure=disabled) |
Shutdown called | org.apache.zookeeper.server.quorum.Leader.shutdown(Leader.java:623)
java.lang.Exception: shutdown Leader! reason: Forcing shutdown
    at org.apache.zookeeper.server.quorum.Leader.shutdown(Leader.java:623)
    at org.apache.zookeeper.server.quorum.QuorumPeer.stopLeader(QuorumPeer.java:1149)
    at org.apache.zookeeper.server.quorum.QuorumPeer.run(QuorumPeer.java:1110)
```

Answer

After a large number of znodes are created, a large volume of data needs to be synchronized between the follower and leader. If the data synchronization is not complete within the specified time, all ZooKeeper servers fail to start.

Go to the **All Configurations** page of the ZooKeeper service by referring to **Modifying Cluster Service Configuration Parameters**. To recover ZooKeeper servers, increase the values of **syncLimit** and **initLimit** in the ZooKeeper configuration file **zoo.cfg** until ZooKeeper servers are successfully started.

Table 24-6 Parameters

Parameter	Description	Default Value
syncLimit	Interval (unit: tick) at which data is synchronized between the follower and the leader. If the leader does not respond to the follower within the specified time, the connection between the leader and follower cannot be set up.	15

Parameter	Description	Default Value
initLimit	Interval (unit: tick) within which the connection and synchronization between the follower and leader must be completed.	15

If ZooKeeper servers do not recover even after **initLimit** and **syncLimit** are set to **300** ticks, check that no other application is killing the ZooKeeper. For example, if the parameter value is **300** and the ticket duration is 2000 ms, the maximum synchronization duration is 600s (300 x 2000 ms).

There may exist the situation where an overwhelming amount of data is created in ZooKeeper and it takes long to synchronize data between the follower and the leader and to save data to the hard disk. This means that ZooKeeper needs to run for a long time. Ensure that no other monitoring application kills the ZooKeeper while ZooKeeper is running.

24.6.2 Why Does the ZooKeeper Server Display the java.io.IOException: Len Error Log?

Question

After a large number of znodes are created in a parent directory, the ZooKeeper client will fail to fetch all child nodes of this parent directory in a single request.

Logs of client:

```
2017-07-11 13:17:19,610 [myid:] - WARN  [New I/O worker #3:ClientCnxnSocketNetty
$ZKClientHandler@468] - Exception caught: [id: 0xb66cbb85, /10.18.97.97:49192 :>
10.18.97.97/10.18.97.97:2181] EXCEPTION: java.nio.channels.ClosedChannelException
java.nio.channels.ClosedChannelException
at org.jboss.netty.handler.ssl.SslHandler$6.run(SslHandler.java:1580)
at org.jboss.netty.channel.socket.ChannelRunnableWrapper.run(ChannelRunnableWrapper.java:40)
at org.jboss.netty.channel.socket.nio.AbstractNioWorker.executeInIoThread(AbstractNioWorker.java:71)
at org.jboss.netty.channel.socket.nio.NioWorker.executeInIoThread(NioWorker.java:36)
at org.jboss.netty.channel.socket.nio.AbstractNioWorker.executeInIoThread(AbstractNioWorker.java:57)
at org.jboss.netty.channel.socket.nio.NioWorker.executeInIoThread(NioWorker.java:36)
at org.jboss.netty.channel.socket.nio.AbstractNioChannelSink.execute(AbstractNioChannelSink.java:34)
at org.jboss.netty.handler.ssl.SslHandler.channelClosed(SslHandler.java:1566)
at org.jboss.netty.channel.Channels.fireChannelClosed(Channels.java:468
at org.jboss.netty.channel.socket.nio.AbstractNioWorker.close(AbstractNioWorker.java:376)
at org.jboss.netty.channel.socket.nio.NioWorker.read(NioWorker.java:93)
at org.jboss.netty.channel.socket.nio.AbstractNioWorker.process(AbstractNioWorker.java:109)
at org.jboss.netty.channel.socket.nio.AbstractNioSelector.run(AbstractNioSelector.java:312)
at org.jboss.netty.channel.socket.nio.AbstractNioWorker.run(AbstractNioWorker.java:90)
at org.jboss.netty.channel.socket.nio.NioWorker.run(NioWorker.java:178)
at java.util.concurrent.ThreadPoolExecutor.runWorker(ThreadPoolExecutor.java:1142)
at java.util.concurrent.ThreadPoolExecutor$Worker.run(ThreadPoolExecutor.java:617)
at java.lang.Thread.run(Thread.java:745)
```

Logs of leader:

```
2017-07-11 13:17:33,043 [myid:1] - WARN  [New I/O worker #7:NettyServerCnxn@445] - Closing
connection to /10.18.101.110:39856
java.io.IOException: Len error 45
at org.apache.zookeeper.server.NettyServerCnxn.receiveMessage(NettyServerCnxn.java:438)
at org.apache.zookeeper.server.NettyServerCnxnFactory
$CnxnChannelHandler.processMessage(NettyServerCnxnFactory.java:267)
```

```
at org.apache.zookeeper.server.NettyServerCnxnFactory
$CnxnChannelHandler.messageReceived(NettyServerCnxnFactory.java:187)
at org.jboss.netty.channel.SimpleChannelHandler.handleUpstream(SimpleChannelHandler.java:88)
at org.jboss.netty.channel.DefaultChannelPipeline.sendUpstream(DefaultChannelPipeline.java:564)
at org.jboss.netty.channel.DefaultChannelPipeline.sendUpstream(DefaultChannelPipeline.java:559)
at org.jboss.netty.channel.Channels.fireMessageReceived(Channels.java:268)
at org.jboss.netty.channel.Channels.fireMessageReceived(Channels.java:255)
at org.jboss.netty.channel.socket.nio.NioWorker.read(NioWorker.java:88)
at org.jboss.netty.channel.socket.nio.AbstractNioWorker.process(AbstractNioWorker.java:109)
at org.jboss.netty.channel.socket.nio.AbstractNioSelector.run(AbstractNioSelector.java:312)
at org.jboss.netty.channel.socket.nio.AbstractNioWorker.run(AbstractNioWorker.java:90)
at org.jboss.netty.channel.socket.nio.NioWorker.run(NioWorker.java:178)
at org.jboss.netty.util.ThreadRenamingRunnable.run(ThreadRenamingRunnable.java:108)
at org.jboss.netty.util.internal.DeadLockProofWorker$1.run(DeadLockProofWorker.java:42)
at java.util.concurrent.ThreadPoolExecutor.runWorker(ThreadPoolExecutor.java:1142)
at java.util.concurrent.ThreadPoolExecutor$Worker.run(ThreadPoolExecutor.java:617)
at java.lang.Thread.run(Thread.java:745)
```

Answer

After a large number of znodes are created in a single parent directory and the client tries to fetch all the child znodes in a single request, the server will fail to return because the results exceed the data size that can be stored in a znode.

To avoid this problem, set **jute.maxbuffer** to a larger value based on the client application.

jute.maxbuffer can only be set to a Java system property without the Zookeeper prefix. To set **jute.maxbuffer** to *X*, set **Djute.maxbuffer** to *X* when starting the ZooKeeper client or the service.

For example, set the parameter to 4 MB: **-Djute.maxbuffer=0x400000**.

Table 24-7 Parameters

Parameter	Description	Default Value
jute.maxbuffer	Specifies the maximum length of data that can be stored in znode. The unit is byte. Default value: 0xfffff, which is less than 1 MB. **NOTE** If this option is changed, the system property must be set on all servers and clients, otherwise problems will arise.	0xfffff

24.6.3 Why Four Letter Commands Don't Work With Linux netcat Command When Secure Netty Configurations Are Enabled at Zookeeper Server?

Question

Why four letter commands do not work with linux netcat command when secure netty configurations are enabled at Zookeeper server?

For example,

echo stat /netcat host port

Answer

Linux ***netcat*** command does not have option to communicate Zookeeper server securely, so it cannot support Zookeeper four letter commands when secure netty configurations are enabled.

To avoid this problem, user can use below Java API to execute four letter commands.

```
org.apache.zookeeper.client.FourLetterWordMain
```

For example,

```
String[] args = new String[]{host, port, "stat"};
org.apache.zookeeper.client.FourLetterWordMain.main(args);
```

NOTE

netcat command should be used only with non secure netty configuration.

24.6.4 How Do I Check Which ZooKeeper Instance Is a Leader?

Question

How to check whether the role of a ZooKeeper instance is a leader or follower.

Answer

Log in to FusionInsight Manager and choose **Cluster** > **Services** > **ZooKeeper**. Click **Instance** then the name of the quorumpeer instance. On the instance details page, view the server status of the instance.

24.6.5 Why Cannot the Client Connect to ZooKeeper using the IBM JDK?

Question

When the IBM JDK is used, the client fails to connect to ZooKeeper.

Answer

The possible cause is that the **jaas.conf** file format of the IBM JDK is different from that of the common JDK.

If IBM JDK is used, use the following **jaas.conf** template. The **useKeytab** file path must start with **file://**, followed by an absolute path.

```
Client {
com.ibm.security.auth.module.Krb5LoginModule required
useKeytab="file://D:/install/HbaseClientSample/conf/user.keytab"
principal="hbaseuser1"
credsType="both";
};
```

24.6.6 What Should I Do When the ZooKeeper Client Fails to Refresh a TGT?

Question

The ZooKeeper client fails to refresh a TGT and therefore ZooKeeper cannot be accessed. The error message is as follows:

```
Login: Could not renew TGT due to problem running shell command: '***/kinit -R'; exception was:org.apache.zookeeper.Shell$ExitCodeException: kinit: Ticket expired while renewing credentials
```

Answer

ZooKeeper uses the system command **kinit – R** to refresh a ticket. In the current version of MRS, the function of this command is canceled. If a long-term task needs to be executed, you are advised to implement the authentication function in keytab mode.

In the *Client installation path*/**ZooKeeper/zookeeper/conf/jaas.conf** file, set **useTicketCache** to **false**, set **useKeyTab** to **true**, and specify the keytab path.

24.6.7 Why Is Message "Node does not exist" Displayed when A Large Number of Znodes Are Deleted Using the deleteall Command

Question

When the client connects to a non-leader instance, run the **deleteall** command to delete a large number of znodes, the error message "Node does not exist" is displayed, but run the **stat** command, the node status can be obtained.

Answer

The leader and follower data is not synchronized due to network problems or large data volume. To solve this problem, connect the client to the leader instance and delete the instance. To delete the leader node, view the IP address of the node where the leader resides by referring to **How Do I Check Which ZooKeeper Instance Is a Leader?**, run the **zkCli.sh -server leader** *node IP address* **2181** command to connect to the client, and then run the **deleteall** command to delete the leader node. For details, see **Using a ZooKeeper Client**.

25 Appendix

25.1 Modifying Cluster Service Configuration Parameters

- You can modify service configuration parameters on the cluster management page of the MRS management console for versions earlier than MRS 3.*x*.
  a. Log in to the MRS console. In the left navigation pane, choose **Clusters** > **Active Clusters**, and click a cluster name.
  b. Choose **Components** > *Name of the desired service* > **Service Configuration**.

     The **Basic Configuration** tab page is displayed by default. To modify more parameters, click the **All Configurations** tab. The navigation tree displays all configuration parameters of the service. The level-1 nodes in the navigation tree are service names or role names. The parameter category is displayed after the level-1 node is expanded.
  c. In the navigation tree, select the specified parameter category and change the parameter values on the right.

     If you are not sure about the location of a parameter, you can enter the parameter name in search box in the upper right corner. The system searches for the parameter in real time and displays the result.
  d. Click **Save Configuration**. In the displayed dialog box, click **OK**.
  e. Wait until the message **Operation successful** is displayed. Click **Finish**.

     The configuration is modified.

     Check whether there is any service whose configuration has expired in the cluster. If yes, restart the corresponding service or role instance for the configuration to take effect. You can also select **Restart the affected services or instances** when saving the configuration. .
- For MRS 3.*x* or earlier: You can log in to MRS Manager to modify service configuration parameters.
  a. Log in to MRS Manager.
  b. Click **Services**.

c. Click the specified service name on the service management page.

d. Click **Service Configuration**.

The **Basic Configuration** tab page is displayed by default. To modify more parameters, click the **All Configurations** tab. The navigation tree displays all configuration parameters of the service. The level-1 nodes in the navigation tree are service names or role names. The parameter category is displayed after the level-1 node is expanded.

e. In the navigation tree, select the specified parameter category and change the parameter values on the right.

If you are not sure about the location of a parameter, you can enter the parameter name in search box in the upper right corner. The system searches for the parameter in real time and displays the result.

f. Click **Save**. In the confirmation dialog box, click **OK**.

g. Wait until the message **Operation successful** is displayed. Click **Finish**.

The configuration is modified.

Check whether there is any service whose configuration has expired in the cluster. If yes, restart the corresponding service or role instance for the configuration to take effect. You can also select **Restart the affected services or instances** when saving the configuration.

- For MRS 3.*x* or later: You can log in to FusionInsight Manager to modify service configuration parameters.

a. You have logged in to FusionInsight Manager.

b. Choose **Cluster** > **Service**.

c. Click the specified service name on the service management page.

d. Click **Configuration**.

The **Basic Configuration** tab page is displayed by default. To modify more parameters, click the **All Configurations** tab. The navigation tree displays all configuration parameters of the service. The level-1 nodes in the navigation tree are service names or role names. The parameter category is displayed after the level-1 node is expanded.

e. In the navigation tree, select the specified parameter category and change the parameter values on the right.

If you are not sure about the location of a parameter, you can enter the parameter name in search box in the upper right corner. The system searches for the parameter in real time and displays the result.

f. Click **Save**. In the confirmation dialog box, click **OK**.

g. Wait until the message **Operation successful** is displayed. Click **Finish**.

The configuration is modified.

Check whether there is any service whose configuration has expired in the cluster. If yes, restart the corresponding service or role instance for the configuration to take effect.

25.2 Change History

Release Date	What's New
2024-11-30	This issue is the first official release.