Distributed Message Service for Kafka

Performance White Paper

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1 Test Scenarios

This document describes performance tests on Distributed Message Service (DMS) for Kafka. The performance is measured by the message production rate on the client side and CPU usage on the server side. The tests cover the following scenarios:

- Test scenario 1 (batch size): same Kafka instance, same topics, different **batch.size** settings
- Test scenario 2 (cross-AZ or intra-AZ production): same Kafka instance, same topics, different AZ settings for the client and server
- Test scenario 3 (number of replicas): same Kafka instance, different numbers of replicas
- Test scenario 4 (synchronous or asynchronous replication): same Kafka instance, topics with different replication settings

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2 Test Environment

Perform the following steps to set up the test environment.

Step 1: Buy a Kafka Instance

Buy a Kafka instance with the following configurations. For details about how to buy a Kafka instance, see **Buying an Instance**.

- Region: CN North-Beijing4
- Project: CN North-Beijing4
- AZ: AZ1
- Instance name: kafka-test
- Enterprise project: default
- Version: 2.3.0
- Specifications: c6.large.2 ECSs
- Brokers: 3
- Storage space: ultra-high I/O, 200 GB
- Capacity threshold policy: automatically delete
- VPC: If there is no available VPC, create one by referring to **Preparing Required Resources**.
- Security group: Select a security group that meets the requirements specified in **Preparing Required Resources**.
- Manager username: username used to log in to Kafka Manager
- Password: password used to log in to Kafka Manager
- Other settings: Do not enable public access, dumping, Kafka SASL_SSL, and automatic topic creation.

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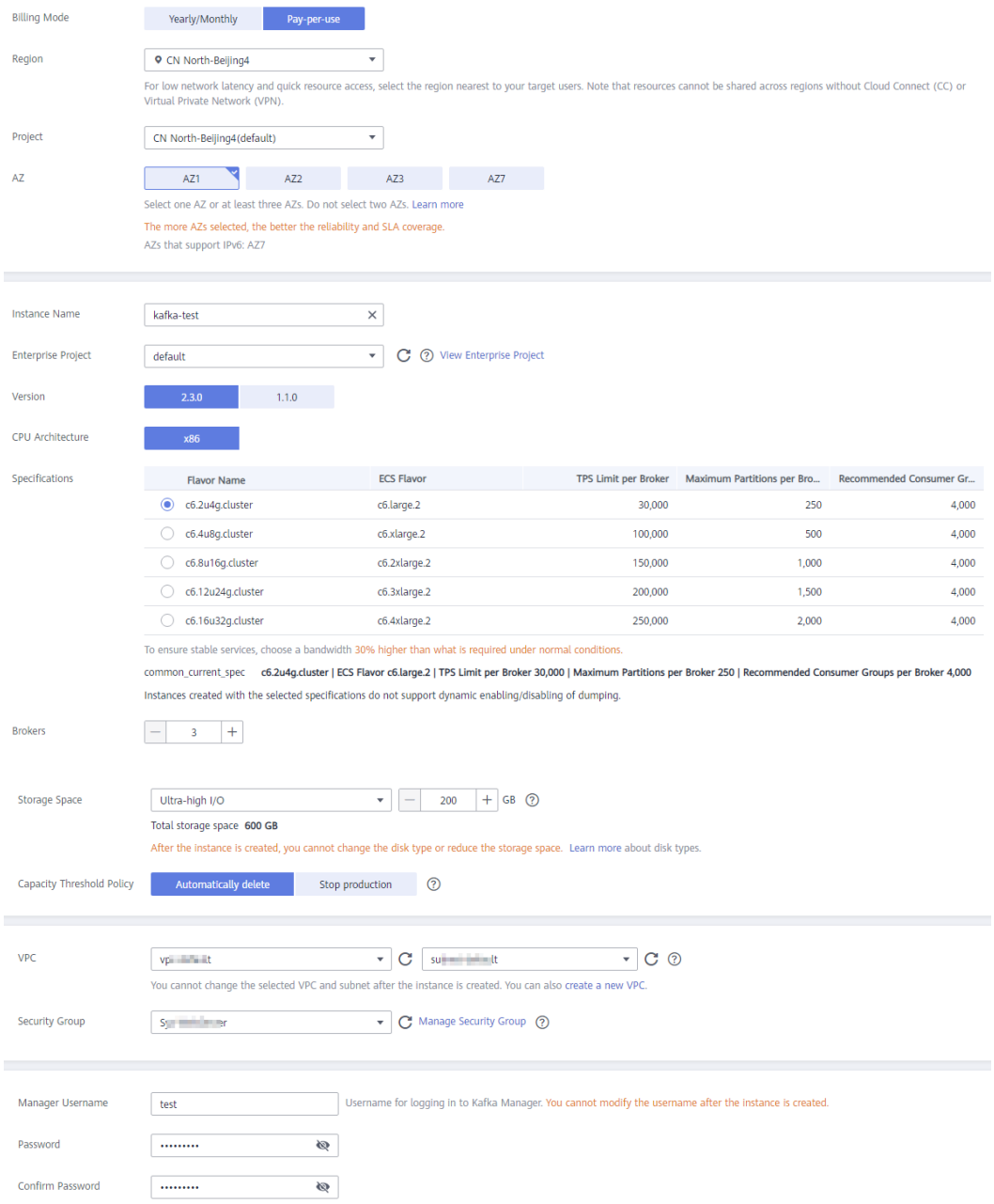

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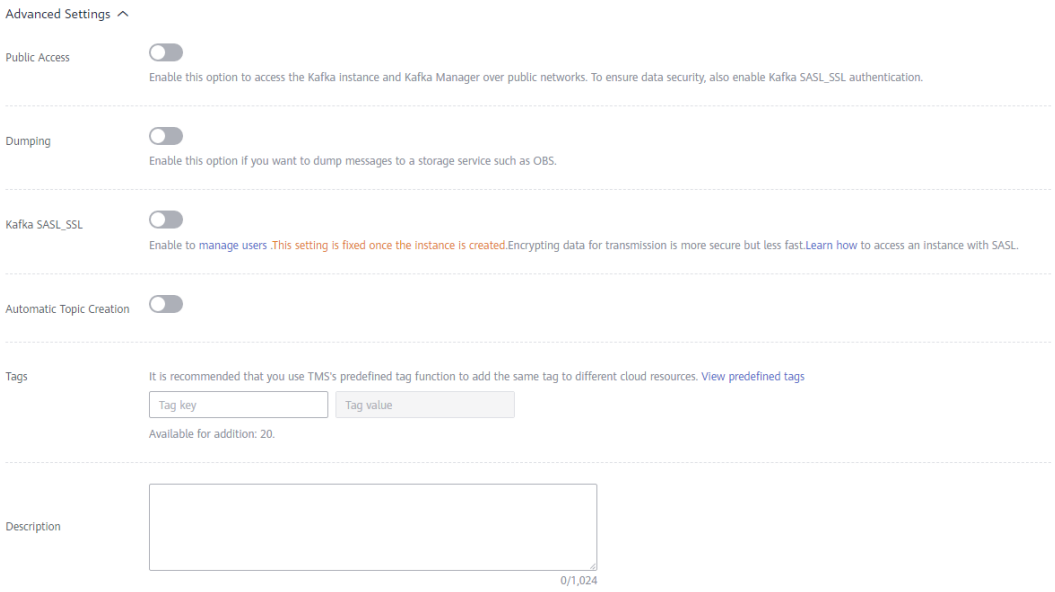
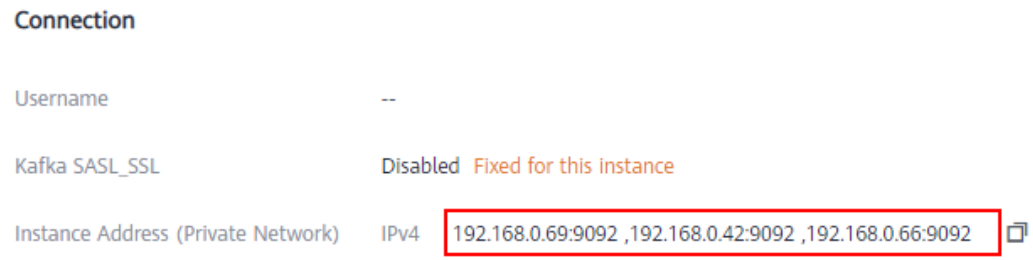


After the purchase is complete, obtain the address of the Kafka instance on the instance details page.



Step 2: Create Topics

Create the following three topics for the **Kafka instance**. For details about how to create a topic, see **Creating a Topic**.

- Topic-01: 3 partitions, 1 replica, asynchronous replication
- Topic-02: 3 partition, 3 replicas, asynchronous replication
- Topic-03: 3 partition, 3 replicas, synchronous replication

Step 3: Obtain the Testing Tool

Download **Kafka CLI v2.3.0**.

Step 4: Buy ECSs

Buy two ECSs with the following configurations. For details about how to purchase an ECS, see **Purchasing an ECS**.

- One ECS is 4 vCPUs | 8 GB, runs Linux, and is configured with the same region, AZ, VPC, subnet, and security group as the Kafka instance purchased in **Step 1: Buy a Kafka Instance**.

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- The other ECS is 4 vCPUs | 8 GB, runs Linux, and is configured with the same region, VPC, subnet, and security group but a different AZ as the Kafka instance purchased in **Step 1: Buy a Kafka Instance**.

Perform the following operations on the ECSs:

- Install **Java JDK** and configure the environment variables **JAVA_HOME** and **PATH**.
```
export JAVA_HOME=/root/jdk1.8.0_231
export PATH=$JAVA_HOME/bin:$PATH
```
- Download **Kafka CLI v2.3.0** and decompress it.
```
tar -zxf kafka_2.11-2.3.0.tgz
```

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3 Test Procedure

Test the message production rate on the client side and the CPU usage on the server side in the following scenarios:

- Test scenario 1 (batch size): same Kafka instance, same topics, different **batch.size** settings
- Test scenario 2 (cross-AZ or intra-AZ production): same Kafka instance, same topics, different AZ settings for the client and server
- Test scenario 3 (number of replicas): same Kafka instance, different numbers of replicas
- Test scenario 4 (synchronous or asynchronous replication): same Kafka instance, topics with different replication settings

Table 3-1 Test parameters

Partitions	Replicas	Synchronous Replication Enabled	batch.size	Cross-AZ Production
3	1	No	1 KB	No
3	1	No	16 KB	No
3	1	No	1 KB	Yes
3	3	Yes	1 KB	No
3	3	No	1 KB	No

Test script:

```
./kafka-producer-perf-test.sh --producer-props bootstrap.servers=${connection address} acks=1 batch.size=${batch.size} linger.ms=0 --topic ${topic name} --num-records ${num-records} --record-size 1024 --throughput -102400
```

- **bootstrap.servers**: address of the Kafka instance obtained in **Step 1: Buy a Kafka Instance**.
- **acks**: the message synchronization policy. acks=1 indicates asynchronous replication, and acks=-1 indicates synchronous replication.

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- **batch.size**: size of messages sent in each batch, in bytes.
- **linger.ms**: interval between two batches.
- **topic**: topic name set in **Step 2: Create Topics**.
- **num-records**: total number of messages to be sent.
- **record-size**: size of each message.
- **throughput**: number of messages sent per second.

Test Scenario 1: Varied Batch Sizes

Step 1 Log in to the client server, go to the **kafka_2.11-2.3.0/bin** directory, and run the following scripts.

Set **batch.size** to 1 KB, and run the following script:

```
./kafka-producer-perf-test.sh --producer-props
bootstrap.servers=192.168.0.69:9092,192.168.0.42:9092,192.168.0.66:9092 acks=1 batch.size=1024
linger.ms=0 --topic Topic-01 --num-records 8000000 --record-size 1024 --throughput 102400
```

The result is as follows:

```
8000000 records sent, 34128.673632 records/sec (33.33 MB/sec), 879.91 ms avg latency, 4102.00 ms max
latency, 697 ms 50th, 2524 ms 95th, 2888 ms 99th, 4012 ms 99.9th.
```

Message production rate: 34,128 records/second

Set **batch.size** to 16 KB, and run the following script:

```
./kafka-producer-perf-test.sh --producer-props
bootstrap.servers=192.168.0.69:9092,192.168.0.42:9092,192.168.0.66:9092 acks=1 batch.size=16384
linger.ms=0 --topic Topic-01 --num-records 100000000 --record-size 1024 --throughput 102400
```

The result is as follows:

```
100000000 records sent, 102399.318430 records/sec (100.00 MB/sec), 4.72 ms avg latency, 914.00 ms max
latency, 1 ms 50th, 5 ms 95th, 162 ms 99th, 398 ms 99.9th.
```

Message production rate: 102,399 records/second

Step 2 Log in to the Kafka console, locate the row that contains the test instance, and click to go to the Cloud Eye console.

Step 3 On the **Brokers** tab page, view the CPU usage of the server nodes.

Figure 3-1 broker-0 CPU usage (batch.size = 1 KB)



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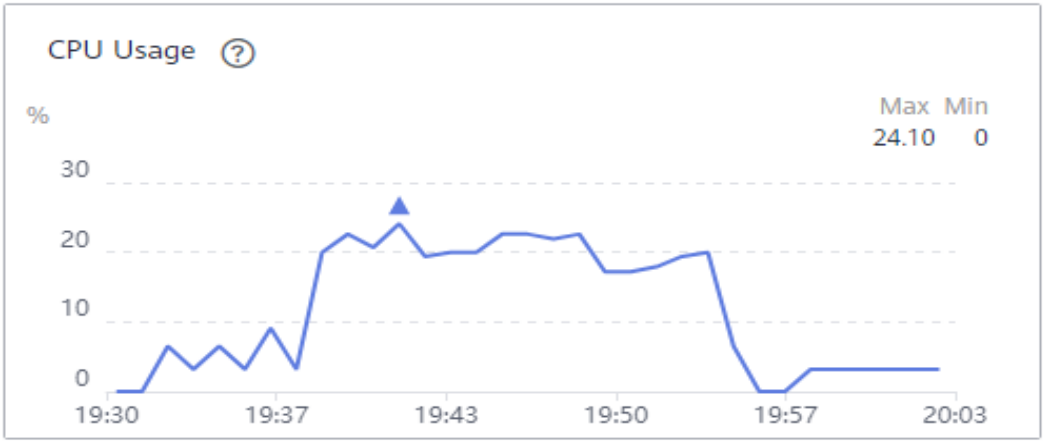
CPU usage: 58.10%

Figure 3-2 broker-0 CPU usage (batch.size = 16 KB)



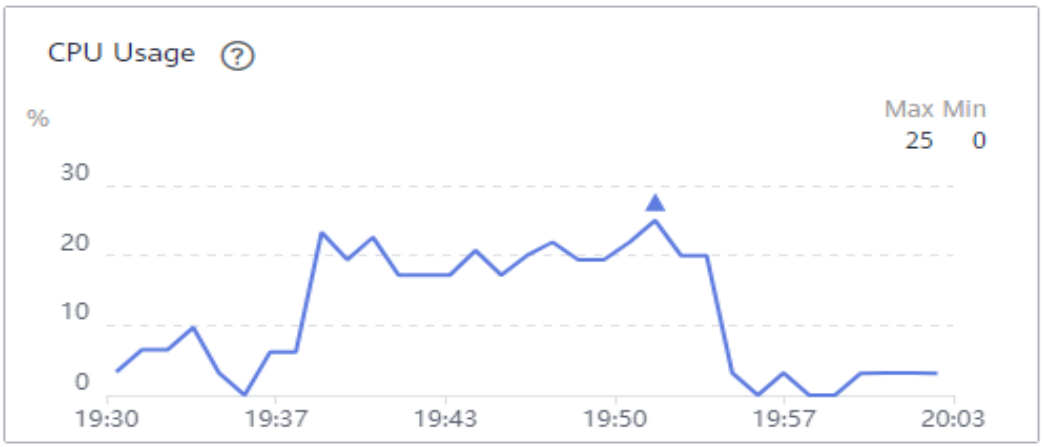
CPU usage: 24.10%

Figure 3-3 broker-1 CPU usage (batch.size = 1 KB)



CPU usage: 56.70%

Figure 3-4 broker-1 CPU usage (batch.size = 16 KB)



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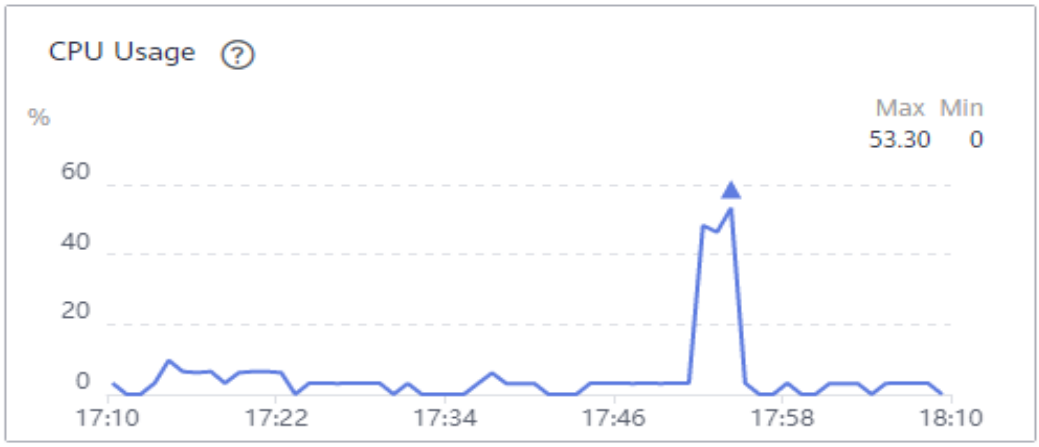
CPU usage: 25%

Figure 3-5 broker-2 CPU usage (batch.size = 1 KB)



CPU usage: 53.30%

Figure 3-6 broker-2 CPU usage (batch.size = 16 KB)



CPU usage: 23.30%

----End

Test Scenario 2: Cross-AZ or Intra-AZ Production

Step 1 Log in to the client server, go to the **kafka_2.11-2.3.0/bin** directory, and run the following scripts.

Configure the same AZ for the client and the instance, and run the following script:

```
./kafka-producer-perf-test.sh --producer-props
bootstrap.servers=192.168.0.69:9092,192.168.0.42:9092,192.168.0.66:9092 acks=1 batch.size=1024
linger.ms=0 --topic Topic-01 --num-records 8000000 --record-size 1024 --throughput 102400
```

The result is as follows:

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```
8000000 records sent, 34128.673632 records/sec (33.33 MB/sec), 879.91 ms avg latency, 4102.00 ms max latency, 697 ms 50th, 2524 ms 95th, 2888 ms 99th, 4012 ms 99.9th.
```

Message production rate: 34,128 records/second

Configure different AZs for the client and the instance, and run the following script:

```
./kafka-producer-perf-test.sh --producer-props bootstrap.servers=192.168.0.69:9092,192.168.0.42:9092,192.168.0.66:9092 acks=1 batch.size=1024 linger.ms=0 --topic Topic-01 --num-records 4000000 --record-size 1024 --throughput 102400
```

The result is as follows:

```
4000000 records sent, 8523.042044 records/sec (8.32 MB/sec), 3506.20 ms avg latency, 11883.00 ms max latency, 1817 ms 50th, 10621 ms 95th, 11177 ms 99th, 11860 ms 99.9th.
```

Message production rate: 8523 records/second

Step 2 Log in to the Kafka console, locate the row that contains the test instance, and click to go to the Cloud Eye console.

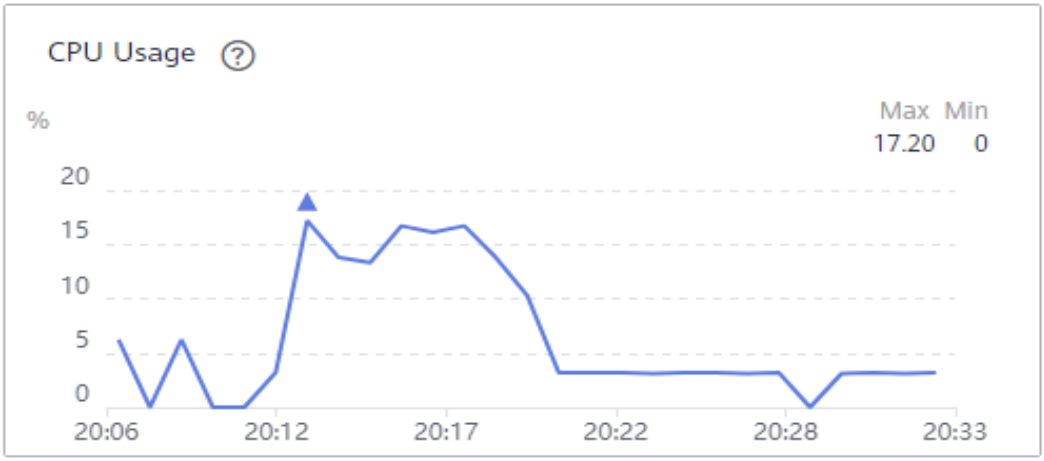
Step 3 On the **Brokers** tab page, view the CPU usage of the server nodes.

Figure 3-7 broker-0 CPU usage (same AZ)



CPU usage: 58.10%

Figure 3-8 broker-0 CPU usage (different AZs)



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CPU usage: 17.20%

Figure 3-9 broker-1 CPU usage (same AZ)



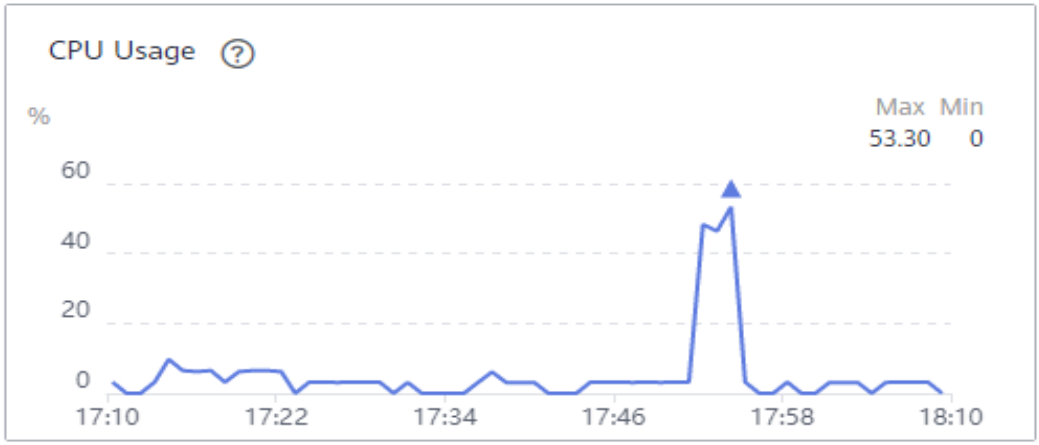
CPU usage: 56.70%

Figure 3-10 broker-1 CPU usage (different AZs)



CPU usage: 16.70%

Figure 3-11 broker-2 CPU usage (same AZ)



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CPU usage: 53.30%

Figure 3-12 broker-2 CPU usage (different AZs)



CPU usage: 18.80%

----End

Test Scenario 3: Varied Numbers of Replicas

Step 1 Log in to the client server, go to the **kafka_2.11-2.3.0/bin** directory, and run the following scripts.

For the **one-replica** topic, run the following script:

```
./kafka-producer-perf-test.sh --producer-props
bootstrap.servers=192.168.0.69:9092,192.168.0.42:9092,192.168.0.66:9092 acks=1 batch.size=1024
linger.ms=0 --topic Topic-01 --num-records 8000000 --record-size 1024 --throughput 102400
```

The result is as follows:

```
8000000 records sent, 34128.673632 records/sec (33.33 MB/sec), 879.91 ms avg latency, 4102.00 ms max
latency, 697 ms 50th, 2524 ms 95th, 2888 ms 99th, 4012 ms 99.9th.
```

Message production rate: 34,128 records/second

For the **three-replica** topic, run the following script:

```
./kafka-producer-perf-test.sh --producer-props
bootstrap.servers=192.168.0.69:9092,192.168.0.42:9092,192.168.0.66:9092 acks=1 batch.size=1024
linger.ms=0 --topic Topic-02 --num-records 4000000 --record-size 1024 --throughput 102400
```

The result is as follows:

```
4000000 records sent, 14468.325219 records/sec (14.13 MB/sec), 2069.99 ms avg latency, 7911.00 ms max
latency, 846 ms 50th, 6190 ms 95th, 6935 ms 99th, 7879 ms 99.9th.
```

Message production rate: 14,468 records/second

Step 2 Log in to the Kafka console, locate the row that contains the test instance, and click to go to the Cloud Eye console.

Step 3 On the **Brokers** tab page, view the CPU usage of the server nodes.

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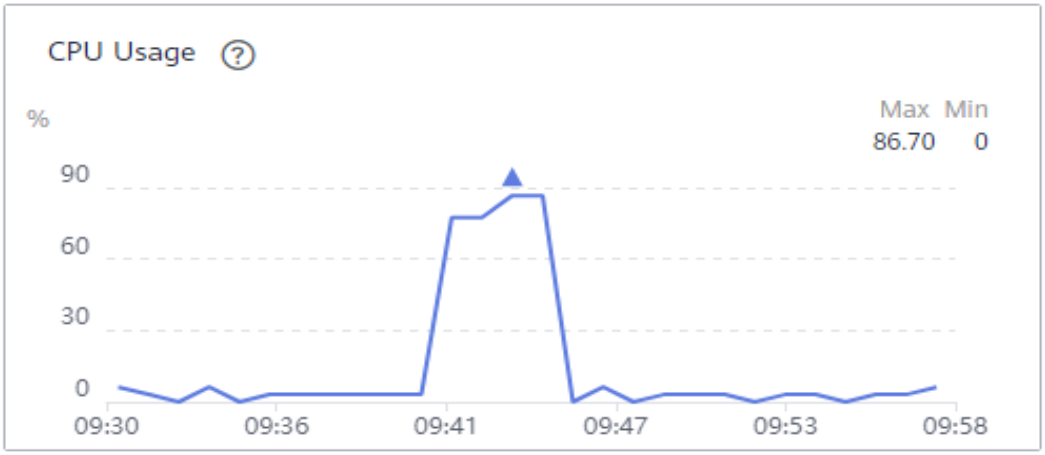
Figure 3-13 broker-0 CPU usage (one replica)



CPU usage: 58.10%

Figure 3-14 broker-0 CPU usage (three replicas)



CPU usage: 86.70%

Figure 3-15 broker-1 CPU usage (one replica)



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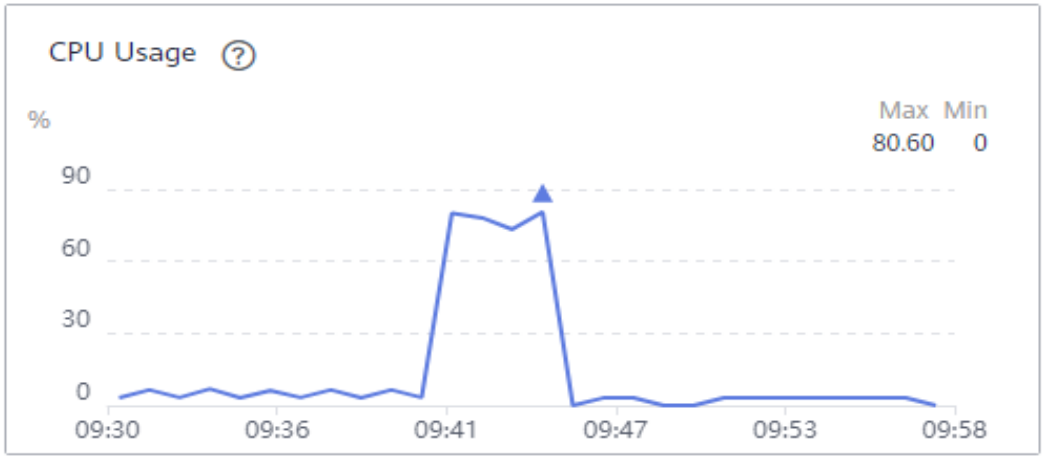
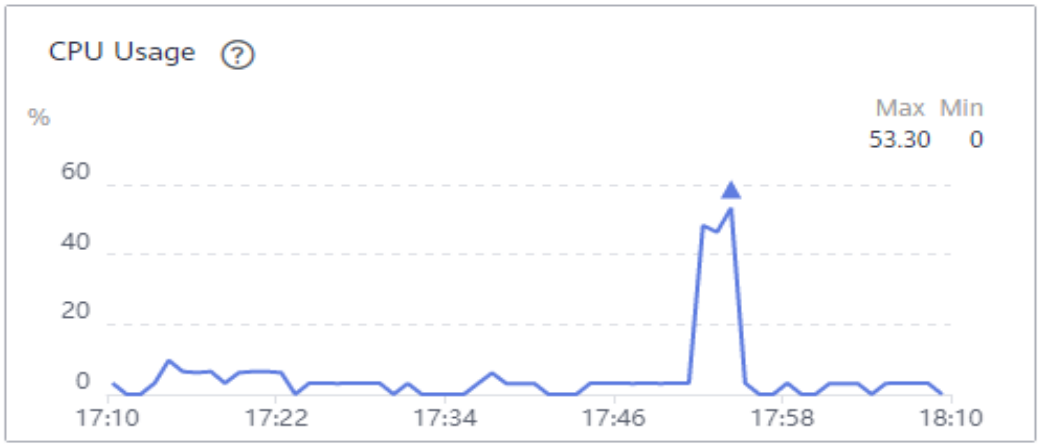
CPU usage: 56.70%

Figure 3-16 broker-1 CPU usage (three replicas)



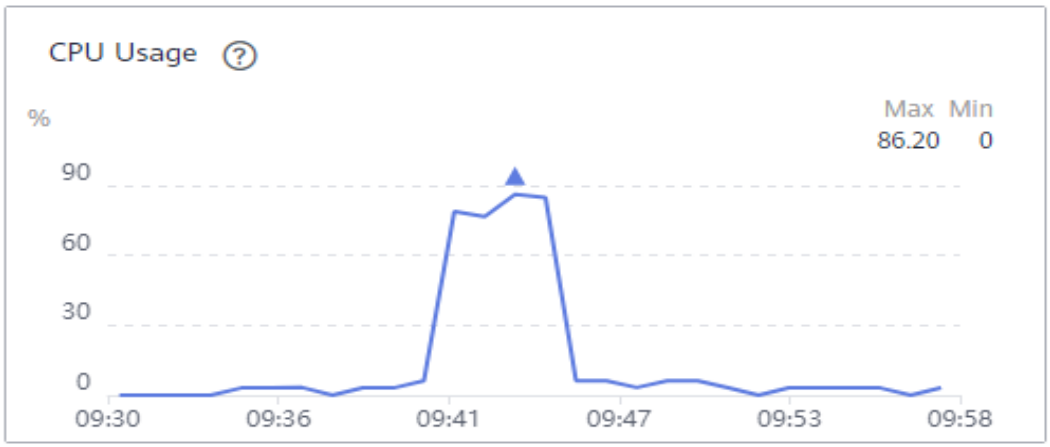
CPU usage: 80.60%

Figure 3-17 broker-2 CPU usage (one replica)



CPU usage: 53.30%

Figure 3-18 broker-2 CPU usage (three replicas)



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CPU usage: 86.20%

----End

Test Scenario 4: Synchronous/Asynchronous Replication

Step 1 Log in to the client server, go to the **kafka_2.11-2.3.0/bin** directory, and run the following scripts.

For **asynchronous replication**, run the following script:

```
./kafka-producer-perf-test.sh --producer-props
bootstrap.servers=192.168.0.69:9092,192.168.0.42:9092,192.168.0.66:9092 acks=1 batch.size=1024
linger.ms=0 --topic Topic-02 --num-records 4000000 --record-size 1024 --throughput 102400
```

The result is as follows:

```
4000000 records sent, 14468.325219 records/sec (14.13 MB/sec), 2069.99 ms avg latency, 7911.00 ms max
latency, 846 ms 50th, 6190 ms 95th, 6935 ms 99th, 7879 ms 99.9th.
```

Message production rate: 14,468 records/second

For **synchronous replication**, run the following script:

```
./kafka-producer-perf-test.sh --producer-props
bootstrap.servers=192.168.0.69:9092,192.168.0.42:9092,192.168.0.66:9092 acks=-1 batch.size=1024
linger.ms=0 --topic Topic-03 --num-records 1000000 --record-size 1024 --throughput 102400
```

The result is as follows:

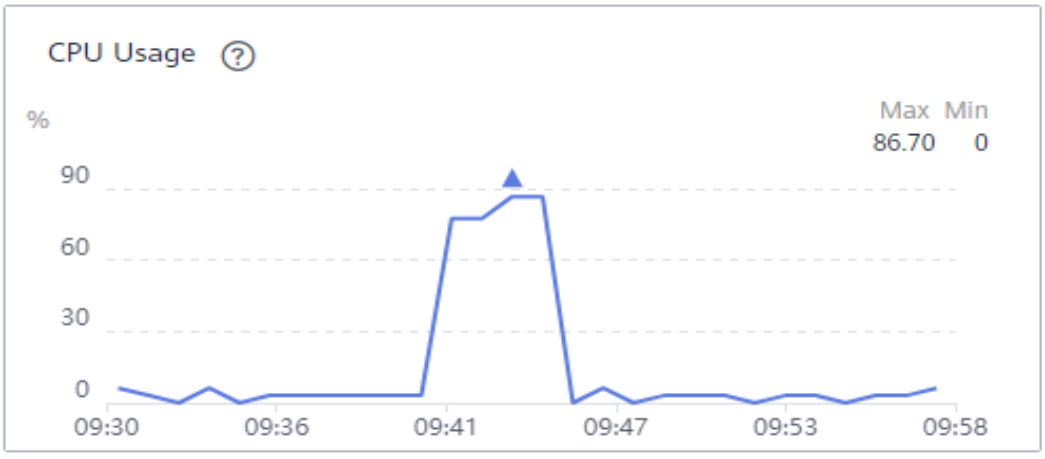
```
1000000 records sent, 3981.937930 records/sec (3.89 MB/sec), 7356.98 ms avg latency, 19013.00 ms max
latency, 6423 ms 50th, 14381 ms 95th, 18460 ms 99th, 18975 ms 99.9th.
```

Message production rate: 3981 records/second

Step 2 Log in to the Kafka console, locate the row that contains the test instance, and click to go to the Cloud Eye console.

Step 3 On the **Brokers** tab page, view the CPU usage of the server nodes.

Figure 3-19 broker-0 CPU usage (asynchronous replication)



CPU usage: 86.70%

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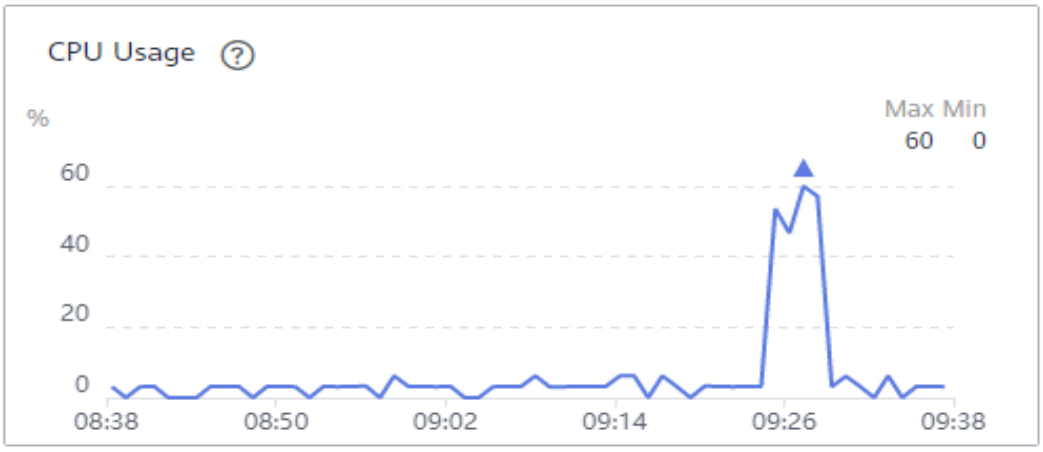
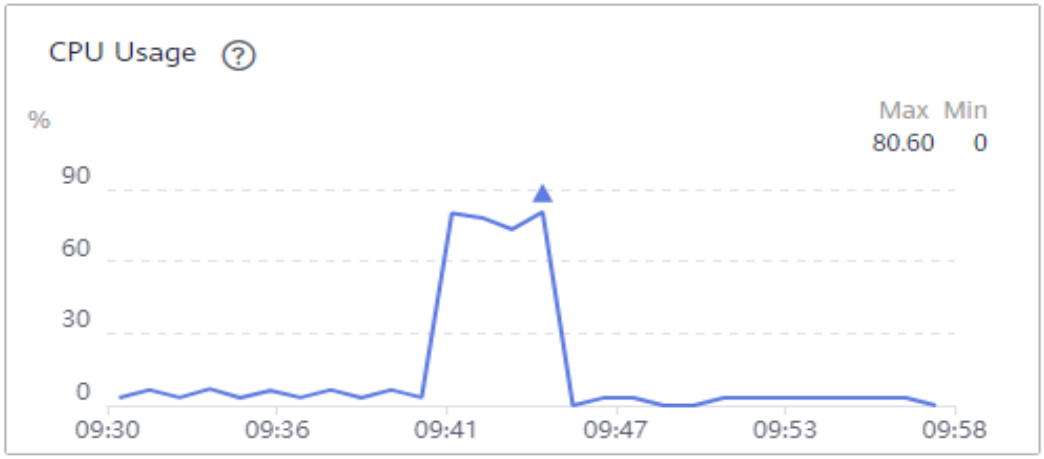
Figure 3-20 broker-0 CPU usage (synchronous replication)



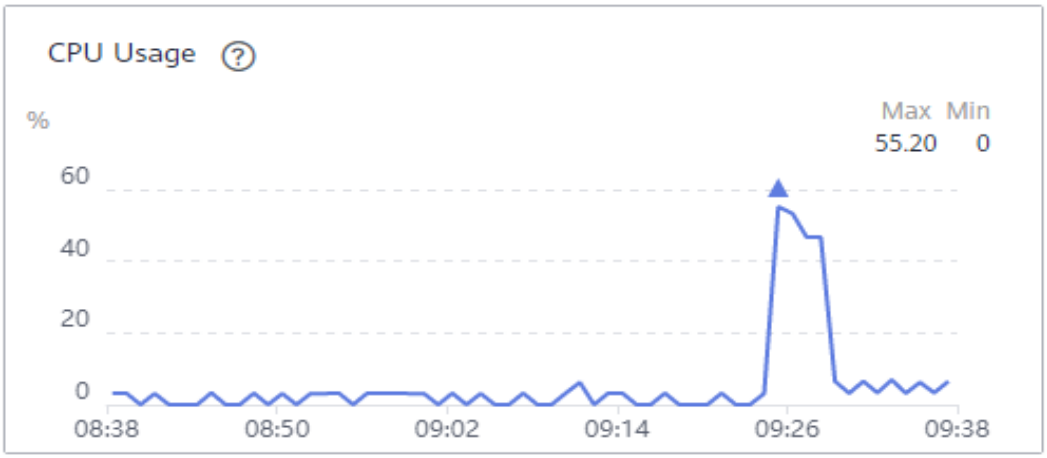
CPU usage: 60%

Figure 3-21 broker-1 CPU usage (asynchronous replication)



CPU usage: 80.60%

Figure 3-22 broker-1 CPU usage (synchronous replication)



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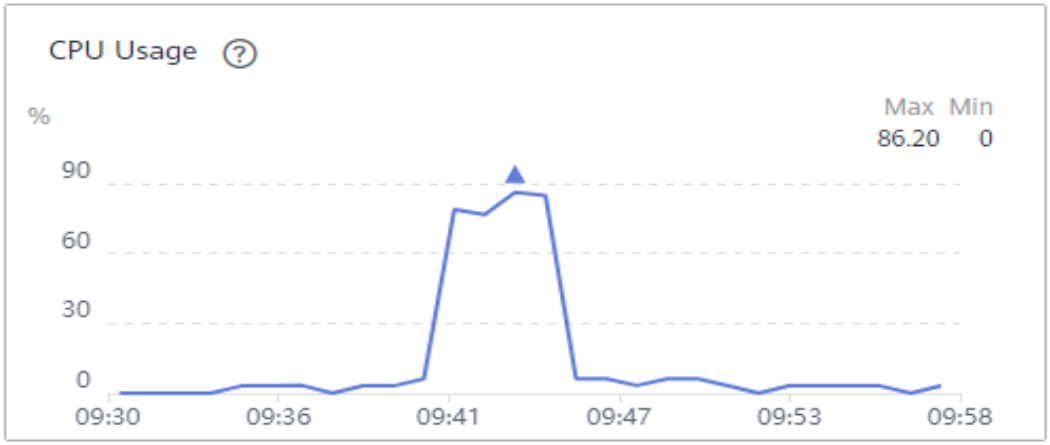
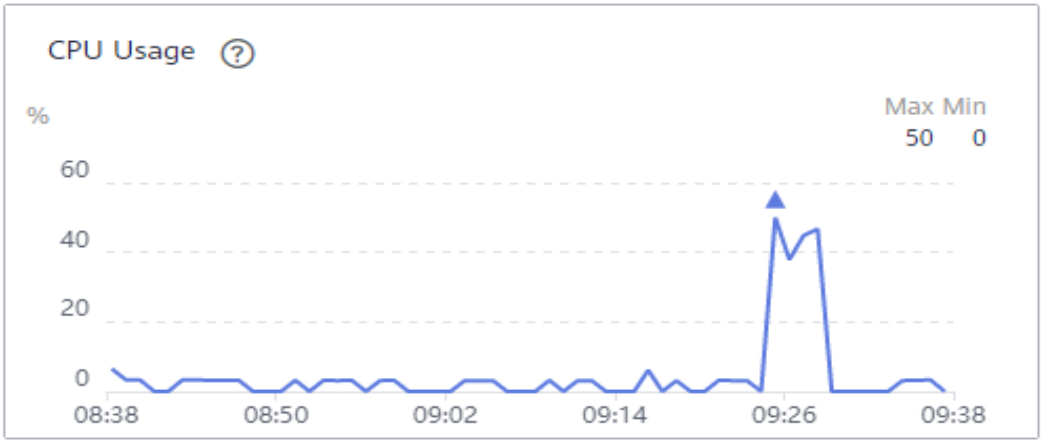
CPU usage: 55.20%

Figure 3-23 broker-2 CPU usage (asynchronous replication)



CPU usage: 86.20%

Figure 3-24 broker-2 CPU usage (synchronous replication)



CPU usage: 50%

----End

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4 Test Results

Table 4-1 Test results

Partitions	Replicas	Synchronous Replication Enabled	batch.size	Cross-AZ Production	Message Production Rate on the Client Side (Records/Second)	CPU Usage on the Server Side (broker-0)	CPU Usage on the Server Side (broker-1)	CPU Usage on the Server Side (broker-2)
3	1	No	1 KB	No	34,128	58.10%	56.70%	53.30%
3	1	No	16 KB	No	102,399	24.10%	25.00%	23.30%
3	1	No	1 KB	Yes	8523	17.20%	16.70%	18.80%
3	3	Yes	1 KB	No	3981	60.00%	55.20%	50.00%
3	3	No	1 KB	No	14,468	86.70%	80.60%	86.20%

Based on the test results, the following conclusions are drawn (for reference only):

- When the **batch.size** of production requests is 16 times larger, the message production rate increases, and the CPU usage decreases.
- Compared with cross-AZ production, intra-AZ production significantly increases message production rate and CPU usage.
- When the number of replicas changes from 1 to 3, the message production rate decreases significantly, and the CPU usage increases.
- Compared with synchronous replication, asynchronous replication increases the message production rate and the CPU usage.

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