

**GaussDB**

# **Performance White Paper**

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# 1 Test Method

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This section describes BenchmarkSQL performance tests and test reports for GaussDB.

BenchmarkSQL is a JDBC benchmark test tool and runs a TPC-C. It can be used for many databases, such as PostgreSQL, Oracle, and MySQL.

TPC-C is a specification for online transaction processing (OLTP) systems. Generally, such systems are called service processing systems. Almost all mainstream international vendors that provide software and hardware platforms in the OLTP market have released TPC-C test results. With the development of computer technologies, these test results are continuously updated.

## Test Environments

- JDK: JDK 1.8 or later is recommended.
- Apache Ant: apache-ant-1.10 or later is recommended.
- BenchmarkSQL: BenchmarkSQL 5.0 is recommended.
- ECS client: 32 vCPUs | 64 GB or larger specifications are recommended.
- Database: Prepare a GaussDB instance before the test and create a **\$db\_name** database and **\$db\_user** user for load testing.

## Installing BenchmarkSQL

1. Download the installation package.  
`wget https://sourceforge.net/projects/benchmarksql/files/latest/download`
2. Decompress the installation package.  
`unzip download -d /home`
3. Go to the directory created after decompressing the BenchmarkSQL installation package, and use Apache Ant to compile BenchmarkSQL.  
`cd /home/benchmarksql-5.0`  
`ant`

If the following information is displayed, the compilation is successful.

```
[root@test benchmarksql-5.0]# ant
Buildfile: /tools/benchmarksql-5.0/build.xml

init:
[mkdir] Created dir: /tools/benchmarksql-5.0/build

compile:
[javac] Compiling 11 source files to /tools/benchmarksql-5.0/build

dist:
[mkdir] Created dir: /tools/benchmarksql-5.0/dist
[jar] Building jar: /tools/benchmarksql-5.0/dist/BenchmarkSQL-5.0.jar

BUILD SUCCESSFUL
Total time: 1 second
```

## Adapting GaussDB to BenchmarkSQL

1. Replace the driver package.

Obtain the **driver package** based on the DB engine version, instance type, and OS of your instance. In this example, the driver package for distributed instances of version V2.0-8.x running on EulerOS 2.5 is used.

```
cd /home
wget https://dbs-download.obs.cn-north-1.myhuaweicloud.com/GaussDB/1716897684140/GaussDB_driver.zip
unzip GaussDB_driver.zip
cd GaussDB_driver/Distributed/Euler2.5_X86_64
tar -zxvf GaussDB-Kernel_505.1.0_Euler_64bit_Jdbc.tar.gz
rm -rf /home/benchmarksql-5.0/lib/postgres/postgresql-9.3-1102.jdbc41.jar
cp -rp gsjdbc4.jar /home/benchmarksql-5.0/lib/postgres/
```

2. Modify the configuration file.

Back up and rewrite the **/home/benchmarksql-5.0/run/props.pg** file.

```
db=postgres
driver=org.postgresql.Driver
// Centralized instances
// conn=jdbc:postgresql://$host_ip:$host_port/$db_name?targetServerType=master&loggerLevel=OFF
// Distributed instances
conn=jdbc:postgresql://$host_ip1:$host_port1,$host_ip2:$host_port2,$host_ip3:$host_port3/$db_name?
autoBalance=true&loggerLevel=OFF
user=$db_user
password=$db_user_passwd
warehouses=10
loadWorkers=10
terminals=5
// To run specified transactions per terminal- runMins must equal zero
runTxnsPerTerminal=0
// To run for specified minutes- runTxnsPerTerminal must equal zero
runMins=3
// Number of total transactions per minute
limitTxnsPerMin=0
// Set to true to run in 4.x compatible mode. Set to false to use the
// entire configured database evenly.
terminalWarehouseFixed=true
// The following five values must add up to 100.
// The default percentages of 45, 43, 4, 4 & 4 match the TPC-C spec.
newOrderWeight=45
paymentWeight=43
orderStatusWeight=4
deliveryWeight=4
stockLevelWeight=4
// Directory name to create for collecting detailed result data.
// Comment this out to suppress.
resultDirectory=my_result_%tY-%tm-%td_%tH%M%S
// osCollectorScript=/misc/os_collector_linux.py
// osCollectorInterval=1
// osCollectorSSHAddr=user@dbhost
// osCollectorDevices=net_eth0 blk_sda
```

## NOTE

Key parameters in **prop.pg**:

- **conn**: JDBC connection string. Use either of the following connection strings based on the type of your instance:
  - For centralized instances: **conn=jdbc:postgresql://\$host\_ip:\$host\_port/\$db\_name?targetServerType=master&loggerLevel=OFF**
  - For distributed instances: **conn=jdbc:postgresql://\$host\_ip1:\$host\_port1,\$host\_ip2:\$host\_port2,\$host\_ip3:\$host\_port3/\$db\_name?autoBalance=true&loggerLevel=OFF**
- **warehouses/loadWorkers**: the amount of data to be imported. Set this parameter as required.
- **terminals/runMins**: the number of concurrent connections for load testing and the testing duration. Set this parameter as required.  
The value of **terminals** must meet the following requirement:  $0 < \text{terminals} \leq 10 \times \text{warehouses}$ . Otherwise, there will be an error.
- Comment out **osCollector**-related parameters if necessary.

### 3. Modify the SQL statements in BenchmarkSQL 5.0.

- a. Create the **/home/benchmarksql-5.0/run/sql.postgres/tableCreates.sql** file.

- Statement for creating a table in a centralized instance:

```
create table bmsql_config (
    cfg_name  varchar(30),
    cfg_value varchar(50)
);

create table bmsql_warehouse (
    w_id      integer not null,
    w_ytd     decimal(12,2),
    w_tax     decimal(4,4),
    w_name     varchar(10),
    w_street_1 varchar(20),
    w_street_2 varchar(20),
    w_city     varchar(20),
    w_state    char(2),
    w_zip      char(9)
)WITH (FILLFACTOR=80);

create table bmsql_district (
    d_w_id      integer not null,
    d_id         integer not null,
    d_ytd       decimal(12,2),
    d_tax       decimal(4,4),
    d_next_o_id integer,
    d_name       varchar(10),
    d_street_1   varchar(20),
    d_street_2   varchar(20),
    d_city       varchar(20),
    d_state      char(2),
    d_zip        char(9)
)WITH (FILLFACTOR=80);

create table bmsql_customer (
    c_w_id      integer not null,
    c_d_id      integer not null,
    c_id        integer not null,
    c_discount  decimal(4,4),
    c_credit    char(2),
    c_last      varchar(16),
    c_first     varchar(16),
    c_credit_lim decimal(12,2),
    c_balance   decimal(12,2),
```

```
c_ytd_payment decimal(12,2),
c_payment_cnt integer,
c_delivery_cnt integer,
c_street_1 varchar(20),
c_street_2 varchar(20),
c_city varchar(20),
c_state char(2),
c_zip char(9),
c_phone char(16),
c_since timestamp,
c_middle char(2),
c_data varchar(500)
)WITH (FILLFACTOR=80) ;

create sequence bmsql_hist_id_seq cache 1000;

create table bmsql_history (
hist_id integer,
h_c_id integer,
h_c_d_id integer,
h_c_w_id integer,
h_d_id integer,
h_w_id integer,
h_date timestamp,
h_amount decimal(6,2),
h_data varchar(24)
)WITH (FILLFACTOR=80);

create table bmsql_new_order (
no_w_id integer not null,
no_d_id integer not null,
no_o_id integer not null
)WITH (FILLFACTOR=80) ;

create table bmsql_oorder (
o_w_id integer not null,
o_d_id integer not null,
o_id integer not null,
o_c_id integer,
o_carrier_id integer,
o_ol_cnt integer,
o_all_local integer,
o_entry_d timestamp
)WITH (FILLFACTOR=80) ;

create table bmsql_order_line (
ol_w_id integer not null,
ol_d_id integer not null,
ol_o_id integer not null,
ol_number integer not null,
ol_i_id integer not null,
ol_delivery_d timestamp,
ol_amount decimal(6,2),
ol_supply_w_id integer,
ol_quantity integer,
ol_dist_info char(24)
)WITH (FILLFACTOR=80) ;

create table bmsql_item (
i_id integer not null,
i_name varchar(24),
i_price decimal(5,2),
i_data varchar(50),
i_im_id integer
);

create table bmsql_stock (
s_w_id integer not null,
s_i_id integer not null,
```

```
s_quantity integer,
s_ytd integer,
s_order_cnt integer,
s_remote_cnt integer,
s_data varchar(50),
s_dist_01 char(24),
s_dist_02 char(24),
s_dist_03 char(24),
s_dist_04 char(24),
s_dist_05 char(24),
s_dist_06 char(24),
s_dist_07 char(24),
s_dist_08 char(24),
s_dist_09 char(24),
s_dist_10 char(24)
)WITH (FILLFACTOR=80) ;
```

■ Statement for creating a table in a distributed instance:

```
create table bmsql_config (
    cfg_name varchar(30),
    cfg_value varchar(50)
) DISTRIBUTE BY REPLICATION;

create table bmsql_warehouse (
    w_id integer not null,
    w_ytd decimal(12,2),
    w_tax decimal(4,4),
    w_name varchar(10),
    w_street_1 varchar(20),
    w_street_2 varchar(20),
    w_city varchar(20),
    w_state char(2),
    w_zip char(9)
)WITH (FILLFACTOR=80) DISTRIBUTE BY hash(w_id);

create table bmsql_district (
    d_w_id integer not null,
    d_id integer not null,
    d_ytd decimal(12,2),
    d_tax decimal(4,4),
    d_next_o_id integer,
    d_name varchar(10),
    d_street_1 varchar(20),
    d_street_2 varchar(20),
    d_city varchar(20),
    d_state char(2),
    d_zip char(9)
)WITH (FILLFACTOR=80) DISTRIBUTE BY hash(d_w_id);

create table bmsql_customer (
    c_w_id integer not null,
    c_d_id integer not null,
    c_id integer not null,
    c_discount decimal(4,4),
    c_credit char(2),
    c_last varchar(16),
    c_first varchar(16),
    c_credit_lim decimal(12,2),
    c_balance decimal(12,2),
    c_ytd_payment decimal(12,2),
    c_payment_cnt integer,
    c_delivery_cnt integer,
    c_street_1 varchar(20),
    c_street_2 varchar(20),
    c_city varchar(20),
    c_state char(2),
    c_zip char(9),
    c_phone char(16),
    c_since timestamp,
    c_middle char(2),
```

```
c_data      varchar(500)
)WITH (FILLFACTOR=80) DISTRIBUTE BY hash(c_w_id);

create sequence bmsql_hist_id_seq cache 1000;

create table bmsql_history (
  hist_id integer,
  h_c_id integer,
  h_c_d_id integer,
  h_c_w_id integer,
  h_d_id integer,
  h_w_id integer,
  h_date timestamp,
  h_amount decimal(6,2),
  h_data varchar(24)
)WITH (FILLFACTOR=80) DISTRIBUTE BY hash(h_w_id);

create table bmsql_new_order (
  no_w_id integer not null,
  no_d_id integer not null,
  no_o_id integer not null
)WITH (FILLFACTOR=80) DISTRIBUTE BY hash(no_w_id);

create table bmsql_oorder (
  o_w_id integer not null,
  o_d_id integer not null,
  o_id integer not null,
  o_c_id integer,
  o_carrier_id integer,
  o_ol_cnt integer,
  o_all_local integer,
  o_entry_d timestamp
)WITH (FILLFACTOR=80) DISTRIBUTE BY hash(o_w_id);

create table bmsql_order_line (
  ol_w_id integer not null,
  ol_d_id integer not null,
  ol_o_id integer not null,
  ol_number integer not null,
  ol_i_id integer not null,
  ol_delivery_d timestamp,
  ol_amount decimal(6,2),
  ol_supply_w_id integer,
  ol_quantity integer,
  ol_dist_info char(24)
)WITH (FILLFACTOR=80) DISTRIBUTE BY hash(ol_w_id);

create table bmsql_item (
  i_id integer not null,
  i_name varchar(24),
  i_price decimal(5,2),
  i_data varchar(50),
  i_im_id integer
) DISTRIBUTE BY REPLICATION;

create table bmsql_stock (
  s_w_id integer not null,
  s_i_id integer not null,
  s_quantity integer,
  s_ytd integer,
  s_order_cnt integer,
  s_remote_cnt integer,
  s_data varchar(50),
  s_dist_01 char(24),
  s_dist_02 char(24),
  s_dist_03 char(24),
  s_dist_04 char(24),
  s_dist_05 char(24),
  s_dist_06 char(24),
```

```
s_dist_07 char(24),
s_dist_08 char(24),
s_dist_09 char(24),
s_dist_10 char(24)
)WITH (FILLFACTOR=80) DISTRIBUTE BY hash(s_w_id);
```

- b. Create the **/home/benchmarksql-5.0/run/sql.postgres/tableDrops.sql** file.

```
drop table bmsql_config;
drop table bmsql_new_order;
drop table bmsql_order_line;
drop table bmsql_oorder;
drop table bmsql_history;
drop table bmsql_customer;
drop table bmsql_stock;
drop table bmsql_item;
drop table bmsql_district;
drop table bmsql_warehouse;
drop sequence bmsql_hist_id_seq;
```

- c. Create the **/home/benchmarksql-5.0/run/sql.postgres/indexCreates.sql** file.

```
set maintenance_work_mem='4GB';
alter table bmsql_warehouse add constraint bmsql_warehouse_pkey
primary key (w_id);

alter table bmsql_district add constraint bmsql_district_pkey
primary key (d_w_id, d_id);

alter table bmsql_customer add constraint bmsql_customer_pkey
primary key (c_w_id, c_d_id, c_id);

alter table bmsql_oorder add constraint bmsql_oorder_pkey
primary key (o_w_id, o_d_id, o_id);

alter table bmsql_new_order add constraint bmsql_new_order_pkey
primary key (no_w_id, no_d_id, no_o_id);

alter table bmsql_order_line add constraint bmsql_order_line_pkey
primary key (ol_w_id, ol_d_id, ol_o_id, ol_number);

alter table bmsql_stock add constraint bmsql_stock_pkey
primary key (s_w_id, s_i_id);

alter table bmsql_item add constraint bmsql_item_pkey
primary key (i_id);

create index bmsql_oorder_idx1 on bmsql_oorder(o_w_id, o_d_id, o_c_id, o_id);

create index bmsql_customer_idx1
on bmsql_customer (c_w_id, c_d_id, c_last, c_first);
```

- d. Create the **/home/benchmarksql-5.0/run/sql.postgres/indexDrops.sql** file.

```
set statement_timeout=0;
set maintenance_work_mem='4GB';
alter table bmsql_warehouse drop constraint bmsql_warehouse_pkey;
alter table bmsql_district drop constraint bmsql_district_pkey;
alter table bmsql_customer drop constraint bmsql_customer_pkey;
drop index bmsql_customer_idx1;
alter table bmsql_oorder drop constraint bmsql_oorder_pkey;
drop index bmsql_oorder_idx1;
drop index bmsql_oorder_idx2;
alter table bmsql_new_order drop constraint bmsql_new_order_pkey;
alter table bmsql_order_line drop constraint bmsql_order_line_pkey;
alter table bmsql_stock drop constraint bmsql_stock_pkey;
alter table bmsql_item drop constraint bmsql_item_pkey;
alter table bmsql_history drop constraint bmsql_history_pkey;
```

4. Update **./runDatabaseBuild.sh**.

Run the following command to open the **runDatabaseBuild.sh** file:

```
vim /home/benchmarksq-5.0/run/runDatabaseBuild.sh
```

Move the cursor to the first character of **foreignKeys** in

**AFTER\_LOAD="indexCreates foreignKeys extraHistID buildFinish"**, press **x** to delete **foreignKeys** and the space following it, and run **:wq** to save the modification and exit. The string after the deletion is as follows:

```
AFTER_LOAD="indexCreates extraHistID buildFinish"
```

## Running BenchmarkSQL

1. Import data.  
`./runDatabaseBuild.sh props.pg`
2. Perform load testing.  
`./runBenchmark.sh props.pg`



You can tune the involved parameters as required.

- 
3. Delete data.  
`./runDatabaseDestroy.sh props.pg`

# 2 Test Data

## About IOPS

The input/output operations per second (IOPS) supported by GaussDB depends on the I/O performance of Elastic Volume Service (EVS) disks. For details, see [Disk Types and Performance](#) in the *EVS Service Overview*.

## Test Data

- 1. Instance type: distributed and centralized
- 2. Instance specifications: 16 vCPUs | 128 GB and 32 vCPUs | 256 GB
- 3. Cluster scale: 3 CNs, 3 shards, and 3 replicas for a distributed instance; 1 primary node and 2 standby nodes for a centralized instance
- 4. Data volume: 1,000 warehouses
- 5. Stress test duration: 30 minutes (5 minutes for warm-up)

Table 2-1 Performance data

| Instance Type | Deployment Model           | Instance Specifications | Concurrent Requests | tpmC    |
|---------------|----------------------------|-------------------------|---------------------|---------|
| Centralized   | HA (1 primary + 2 standby) | 16 vCPUs   128 GB       | 256                 | 156,180 |
|               |                            | 32 vCPUs   256 GB       | 256                 | 236,109 |
| Distributed   | Independent                | 16 vCPUs   128 GB       | 1,024               | 466,930 |
|               |                            | 32 vCPUs   256 GB       | 2,048               | 658,805 |

## Test Metrics

According to the Transaction Processing Performance Council (TPC), the throughput metric, tpmC, describes the number of new transactions processed per

minute while the system is performing four types of transactions: payment operations, order status queries, deliveries, and stock status queries. The response time of all transactions and the proportion of each type of transactions must meet the requirements of the TPC-C test specifications. In this case, the larger the tpmC value is, the higher the online transaction processing (OLTP) capability of the system is.