Relational Database Service

Performance White paper

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Contents

1 RDS for MySQL

1.1 Test Method

MySQL is one of the most popular open-source relational databases. It works with the Linux, Apache, and Perl/PHP/Python to establish a LAMP model for efficient web solutions. It solves problems such as poor database performance, long data replication delay, and slow fault recovery in high-concurrency scenarios.

RDS for MySQL is ready for immediate use, and provides backup and restoration, data migration, security protection, high availability, and elastic scalability. You can obtain a production database with high performance and scalability in a few minutes after simple configurations while your data integrity and service continuity are guaranteed.

Test Environment

- Elastic Cloud Server (ECS): general computing | c3.2xlarge.2 | 8 vCPUs | 16 GB, CentOS7.4 64 bit image. Bind an elastic IP (EIP) to the ECS because additional compilation tools need to be installed on stress testing tools.

  NOTE

  RDS for MySQL 8.0 test environment is as follows:

  - ECS: general computing-plus | c6.4xlarge.2 | 16 vCPUs | 32 GB, CentOS 7.6 (64-bit). Bind an EIP to the ECS because additional compilation tools need to be installed on stress testing tools.

Test Tool

Sysbench is a multi-threaded benchmark tool based on LuaJIT, allowing you to quickly get an impression of system performance by using a built-in database test model. For details, visit **https://github.com/akopytov/sysbench**.

Sysbench 1.0.18 is used in this test. Run the following commands to install it:

```
# wget -c https://github.com/akopytov/sysbench/archive/1.0.18.zip
# yum install autoconf libtool mysql mysql-devel vim unzip
# unzip 1.0.18.zip
# cd sysbench-1.0.18
# ./autogen.sh
```



```
# ./configure
# make
# make install
```

Test Procedure

Replace the database name, connection IP address, and user password based on the site requirements.

Step 1 Import data.

1. Run the following command to log in to a database and create the test database **loadtest**:
   mysql -u root -P 3306 -h <*host*> **-p -e "create database loadtest"**
2. Run the following command to import the test background data to the **loadtest** database:
   sysbench --test=/usr/local/share/sysbench/tests/include/oltp_legacy/oltp.lua --db-driver=mysql --mysql-db=loadtest --mysql-user=root --mysql-password=*<password>* **--mysql-port=3306 --mysql-host=**<*host*> **--oltp-tables-count=64 --oltp-table-size=10000000 --num-threads=20 prepare**

Step 2 Run the following command to perform a stress testing:

sysbench --test=/usr/local/share/sysbench/tests/include/oltp_legacy/oltp.lua --db-driver=mysql --mysql-db=loadtest --mysql-user=root --mysql-password=*<password>* **--mysql-port=3306 --mysql-host=**<*host*> **--oltp-tables-count=64 --oltp-table-size=10000000 --max-time=3600 --max-requests=0 --num-threads=200 --report-interval=3 --forced-shutdown=1 run**

Step 3 Run the following command to delete the test data:

sysbench --test=/usr/local/share/sysbench/tests/include/oltp_legacy/oltp.lua --db-driver=mysql --mysql-db=loadtest --mysql-user=root --mysql-password=*<password>* **--mysql-port=3306 --mysql-host=**<*host*> **--oltp-tables-count=64 --oltp-table-size=10000000 --max-time=3600 --max-requests=0 --num-threads=200 cleanup**

----End

Testing Model

1. Table structure:

```
CREATE TABLE `sbtest` (
`id` INTEGER UNSIGNED NOT NULL AUTO_INCREMENT,
`k` INTEGER UNSIGNED DEFAULT '0' NOT NULL,
`c` CHAR(120) DEFAULT '' NOT NULL,
`pad` CHAR(60) DEFAULT '' NOT NULL,
PRIMARY KEY (`id`)
) ENGINE=InnoDB
```

2. Read/write ratio:

   The default transaction submitted by sysbench contains 18 SQL statements. The details are as follows:

   - Ten primary key SELECT statements:

     ```
     SELECT c FROM ${rand_table_name} where id=${rand_id};
     ```

   - Four range SELECT statements:

     ```
     SELECT c FROM ${rand_table_name} WHERE id BETWEEN ${rand_id_start} AND ${rand_id_end};
     SELECT SUM(K) FROM ${rand_table_name} WHERE id BETWEEN ${rand_id_start} AND ${rand_id_end};
     SELECT c FROM ${rand_table_name} WHERE id BETWEEN ${rand_id_start} AND ${rand_id_end} ORDER BY c;
     SELECT DISTINCT c FROM ${rand_table_name} WHERE id BETWEEN ${rand_id_start} AND ${rand_id_end} ORDER BY c;
     ```

   - Two UPDATE statements:

     ```
     UPDATE ${rand_table_name} SET k=k+1 WHERE id=${rand_id}
     UPDATE ${rand_table_name} SET c=${rand_str} WHERE id=${rand_id}
     ```


  - One DELETE statement:
    ```
    DELETE FROM ${rand_table_name}  WHERE id=${rand_id}
    ```
  - One INSERT statement:
    ```
    INSERT INTO ${rand_table_name} (id, k, c, pad) VALUES (${rand_id},${rand_k},${rand_str_c},${rand_str_pad})
    ```

Test Metrics

- Transactions per second (TPS) refers to the number of transactions executed per second by a database. Each transaction contains 18 SQL statements.
- Queries per second (QPS) refers to the number of SQL statements, including INSERT, SELECT, UPDATE, and DELETE statements, executed per second.

1.2 RDS for MySQL 5.6 Test Data

1.2.1 General-Enhanced DB Instances

About IOPS

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

Test Data

NOTICE

The **Maximum Connections (Stress Testing)** columns in the following tables indicate the results of the RDS performance stress testing. For running services on the live network, set the parameter **max_connections**.

Table 1-1 vCPU:Memory =1:2

vCPUs	Memory (GB)	Maximum Connections (Stress Testing)	TPS	QPS	IOPS
1	2	800	197.19	3,943.85	See **About IOPS**.
2	4	1,500	470.4	9,400.32	
4	8	2,500	768.23	15,364.64	
8	16	5,000	1,728.84	34,576.84	
16	32	10,000	2,947.42	58,948.35	
32	64	18,000	3,239.9	64,798.05	

vCPUs	Memory (GB)	Maximum Connections (Stress Testing)	TPS	QPS	IOPS
60	128	30,000	4,735.63	94,712.67	

Table 1-2 vCPU:Memory = 1:4

vCPUs	Memory (GB)	Maximum Connections (Stress Testing)	TPS	QPS	IOPS
1	4	1,500	466.73	9,334.62	See **About IOPS**.
2	8	2,500	519.24	10,384.74	
4	16	5,000	1,191.98	23,839.68	
8	32	10,000	2,698.01	53,960.27	
16	64	18,000	3,148.77	62,975.44	
32	128	30,000	4,385.29	87,705.81	
60	256	60,000	4,810.94	95,117.75	

Table 1-3 vCPU:Memory = 1:8

vCPUs	Memory (GB)	Maximum Connections (Stress Testing)	TPS	QPS	IOPS
1	8	2,500	487.4	9,748.07	See **About IOPS**.
2	16	5,000	617.59	12,351.83	
4	32	10,000	1,374.01	27,480.14	
8	64	18,000	2,824.63	56,492.64	
16	128	30,000	4,215.09	84,301.79	
60	512	100,000	4,838.57	96,771.34	

Test Results

Figure 1-1 vCPU:Memory =1:2

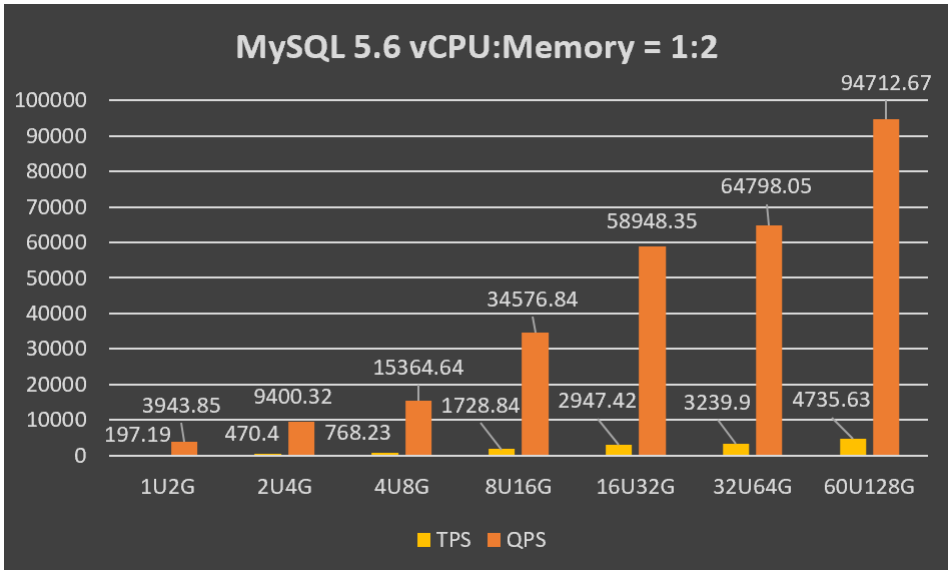


Figure 1-2 vCPU:Memory = 1:4

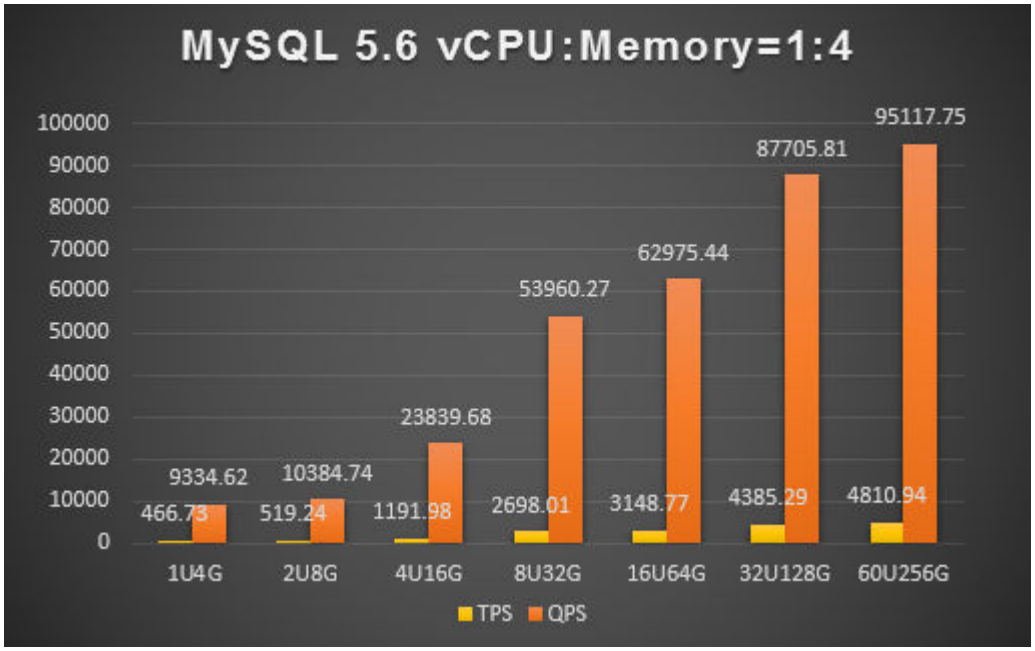
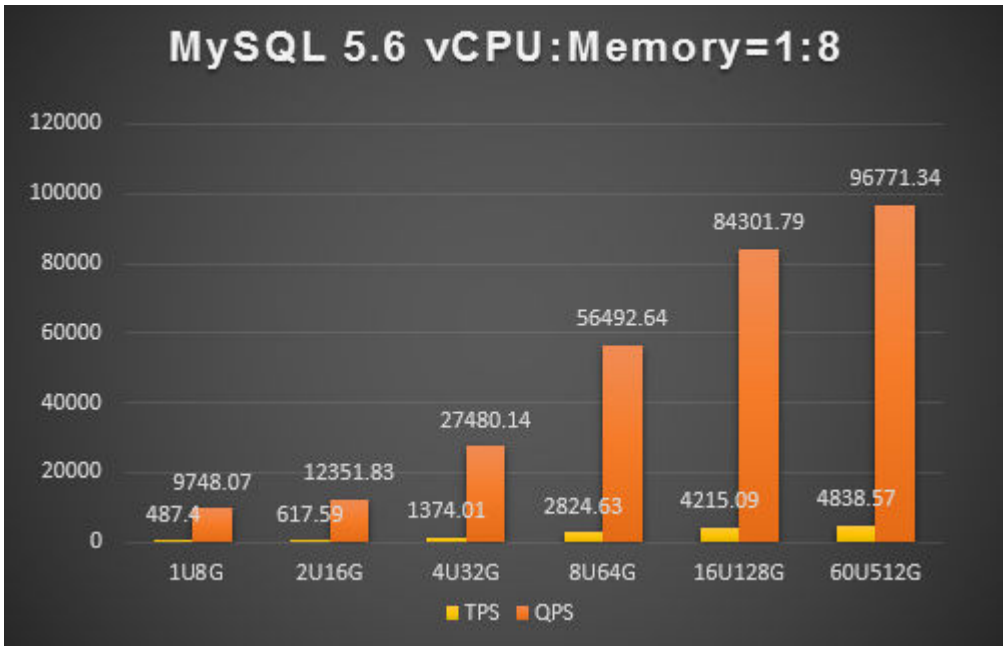


Figure 1-3 vCPU:Memory = 1:8



1.2.2 General-Purpose DB Instances

About IOPS

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

Test Data

NOTICE

The **Maximum Connections (Stress Testing)** columns in the following tables indicate the results of the RDS performance stress testing. For running services on the live network, set the parameter **max_connections**.

Table 1-4 vCPU:Memory = 1:2

vCPUs	Memory (GB)	Maximum Connections (Stress Testing)	TPS	QPS	IOPS
1	2	800	157	3,140	See **About IOPS**.
2	4	1,500	362	7,239	
4	8	2,500	834	16,672	

vCPUs	Memory (GB)	Maximum Connections (Stress Testing)	TPS	QPS	IOPS
8	16	5,000	1,701	34,016	

Table 1-5 vCPU:Memory = 1:4

vCPUs	Memory (GB)	Maximum Connections (Stress Testing)	TPS	QPS	IOPS
2	8	2,500	483	9,669	See **About IOPS**.
4	16	5,000	983	19,668	
8	32	10,000	2,045	40,902	

Test Results

Figure 1-4 vCPU:Memory = 1:2

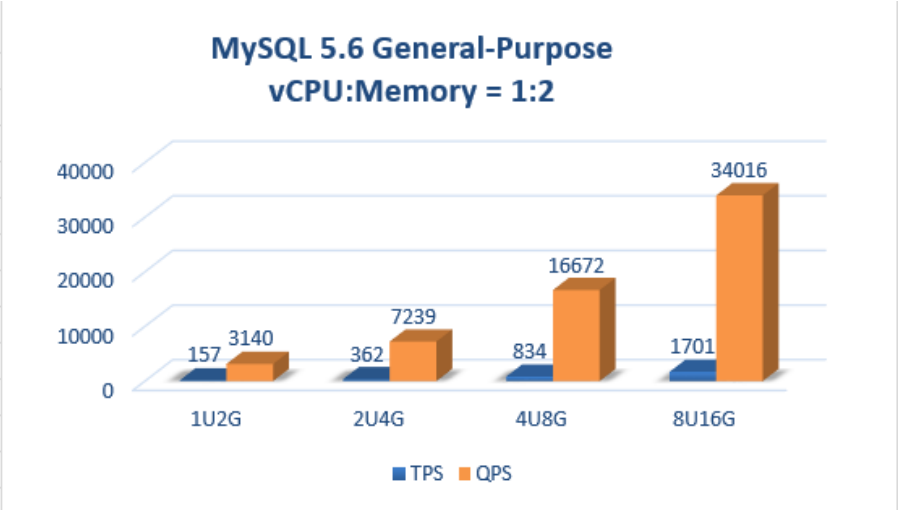
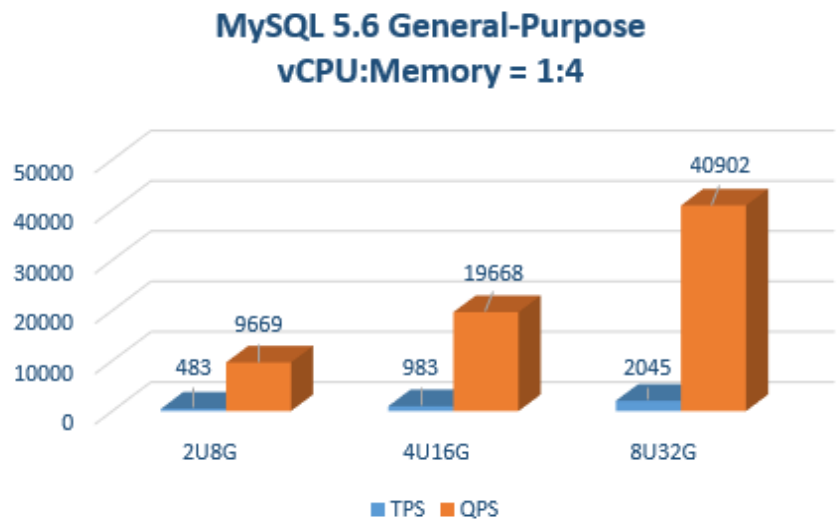


Figure 1-5 vCPU:Memory = 1:4



1.2.3 Dedicated DB Instances

About IOPS

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

Test Data

NOTICE

The **Maximum Connections (Stress Testing)** columns in the following tables indicate the results of the RDS performance stress testing. For running services on the live network, set the parameter **max_connections**.

Table 1-6 vCPU:Memory = 1:4

vCPUs	Memory (GB)	Maximum Connections (Stress Testing)	TPS	QPS	IOPS
2	8	2,500	519	10,385	See **About IOPS**.
4	16	5,000	1,192	23,840	
8	32	10,000	2,698	53,960	
16	64	18,000	3,149	62,975	

vCPUs	Memory (GB)	Maximum Connections (Stress Testing)	TPS	QPS	IOPS
32	128	30,000	4,385	87,706	
64	256	60,000	4,811	95,118	

Table 1-7 vCPU:Memory = 1:8

vCPUs	Memory (GB)	Maximum Connections (Stress Testing)	TPS	QPS	IOPS
4	32	10,000	1,374	27,480	See **About IOPS**.
8	64	18,000	2,825	56,493	
16	128	30,000	4,215	84,302	
64	512	100,000	4,839	96,771	

Test Results

Figure 1-6 vCPU:Memory = 1:4

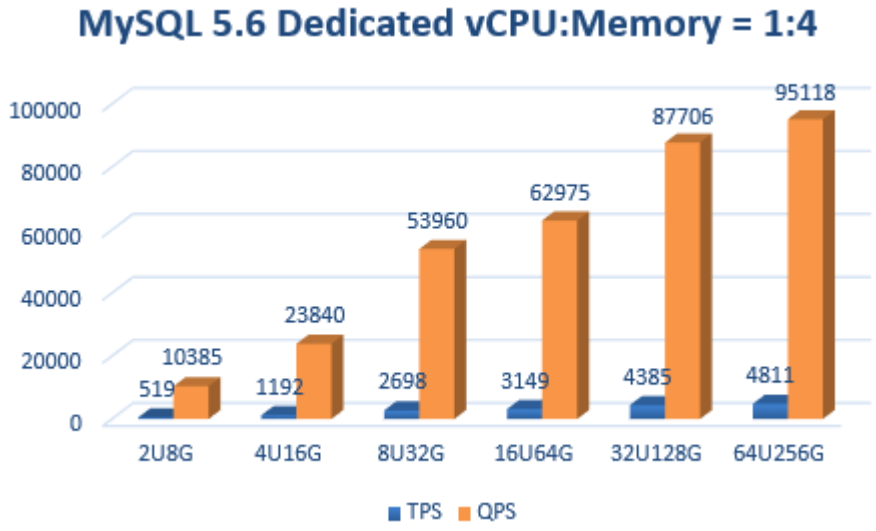
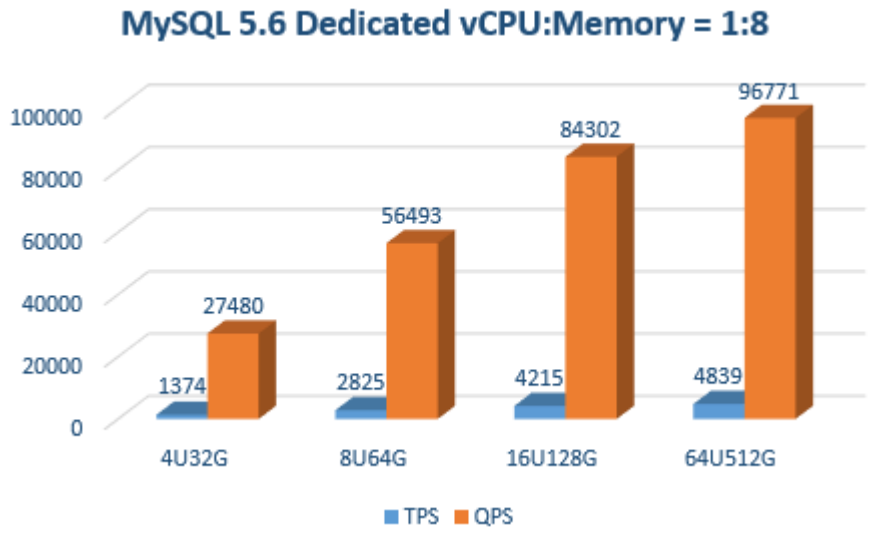


Figure 1-7 vCPU:Memory = 1:8



1.3 RDS for MySQL 5.7 Test Data

1.3.1 General-Enhanced DB Instances

About IOPS

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

Test Data

NOTICE

The **Maximum Connections (Stress Testing)** columns in the following tables indicate the results of the RDS performance stress testing. For running services on the live network, set the parameter **max_connections**.

Table 1-8 vCPU:Memory =1:2

vCPUs	Memory (GB)	Maximum Connections (Stress Testing)	TPS	QPS	IOPS
1	2	800	236.59	4,731.85	See **About IOPS**.
2	4	1,500	470.35	9,400.04	
4	8	2,500	969.14	19,382.91	

vCPUs	Memory (GB)	Maximum Connections (Stress Testing)	TPS	QPS	IOPS
8	16	5,000	1,768.01	35,360.39	
16	32	10,000	2,630.5	52,000.99	
32	64	18,000	3,011.89	60,237.87	
60	128	30,000	4,471.39	88,428.09	

Table 1-9 vCPU:Memory = 1:4

vCPUs	Memory (GB)	Maximum Connections (Stress Testing)	TPS	QPS	IOPS
1	4	1,500	468.11	9,362.23	See **About IOPS**.
2	8	2,500	620.7	12,393.97	
4	16	5,000	1,230.39	24,607.81	
8	32	10,000	2,514.48	50,289.62	
16	64	18,000	3,016.84	60,336.77	
32	128	30,000	4,367.67	87,353.69	
60	256	60,000	4,536.41	90,728.55	

Table 1-10 vCPU:Memory = 1:8

vCPUs	Memory (GB)	Maximum Connections (Stress Testing)	TPS	QPS	IOPS
1	8	2,500	612.75	12,255.01	See **About IOPS**.
2	16	5,000	675.66	13,513.18	
4	32	10,000	1,488.25	29,765.06	
8	64	18,000	2,810.79	56,215.81	
16	128	30,000	4,095.49	81,909.79	
60	512	100,000	4,626.18	96,823.95	

Test Results

Figure 1-8 vCPU:Memory =1:2

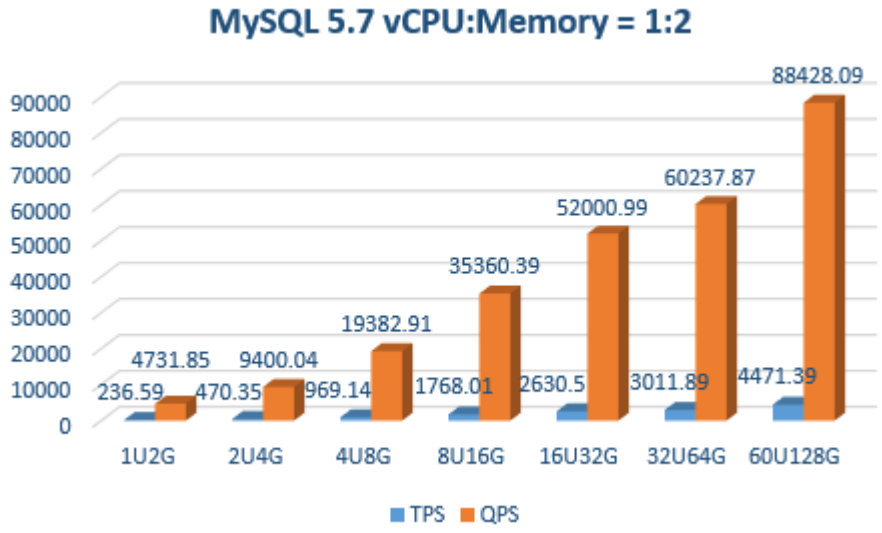


Figure 1-9 vCPU:Memory = 1:4

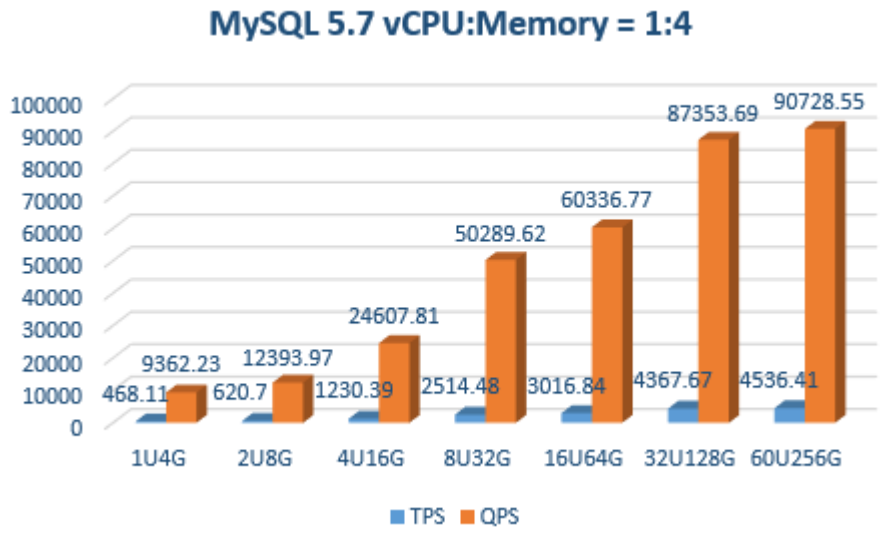
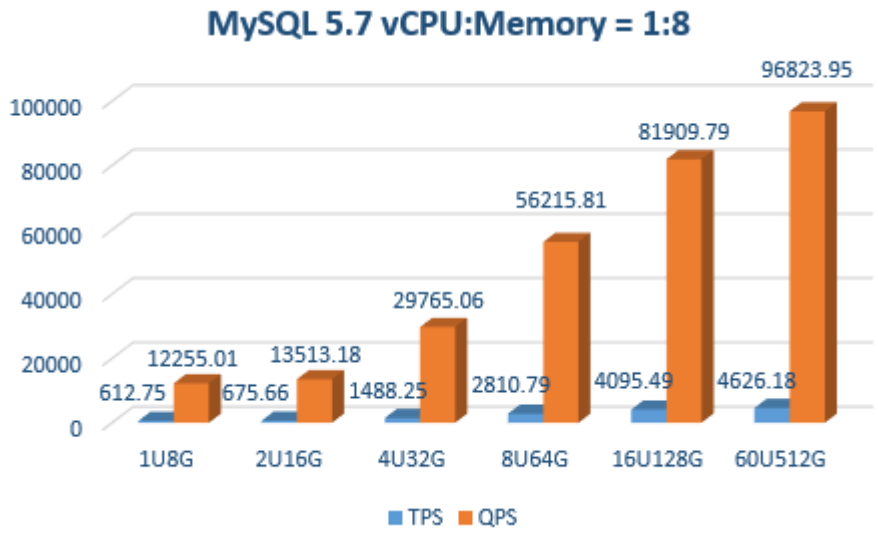


Figure 1-10 vCPU:Memory = 1:8



1.3.2 General-Purpose DB Instances

About IOPS

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

Test Data

NOTICE

The **Maximum Connections (Stress Testing)** columns in the following tables indicate the results of the RDS performance stress testing. For running services on the live network, set the parameter **max_connections**.

Table 1-11 vCPU:Memory = 1:2

vCPUs	Memory (GB)	Maximum Connections (Stress Testing)	TPS	QPS	IOPS
1	2	800	185	3,707	See **About IOPS**.
2	4	1,500	334	6,673	
4	8	2,500	756	15,122	
8	16	5,000	1,338	26,756	

Table 1-12 vCPU:Memory = 1:4

vCPUs	Memory (GB)	Maximum Connections (Stress Testing)	TPS	QPS	IOPS
2	8	2,500	552	11,039	See **About IOPS**.
4	16	5,000	1,062	21,249	
8	32	10,000	2,117	42,335	

Test Results

Figure 1-11 vCPU:Memory = 1:2

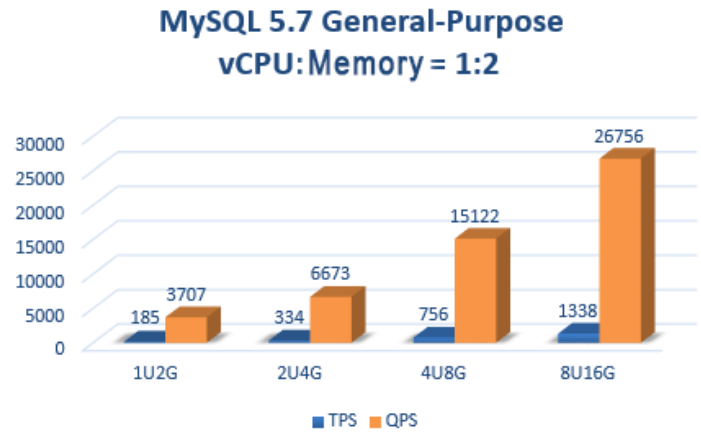
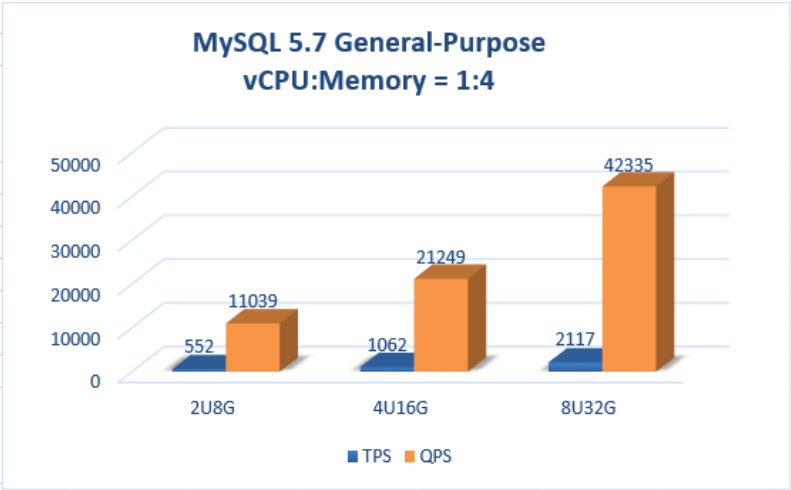


Figure 1-12 vCPU:Memory = 1:4



1.3.3 Dedicated DB Instances

About IOPS

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

Test Data

NOTICE

The **Maximum Connections (Stress Testing)** columns in the following tables indicate the results of the RDS performance stress testing. For running services on the live network, set the parameter **max_connections**.

Table 1-13 vCPU:Memory = 1:4

vCPUs	Memory (GB)	Maximum Connections (Stress Testing)	TPS	QPS	IOPS
2	8	2,500	621	12,394	See **About IOPS**.
4	16	5,000	1,230	24,608	
8	32	10,000	2,514	50,290	
16	64	18,000	3,017	60,337	
32	128	30,000	4,368	87,354	
64	256	60,000	4,536	90,729	

Table 1-14 vCPU:Memory = 1:8

vCPUs	Memory (GB)	Maximum Connections (Stress Testing)	TPS	QPS	IOPS
4	32	10,000	1,488	29,765	See **About IOPS**.
8	64	18,000	2,811	56,216	
16	128	30,000	4,095	81,910	
64	512	100,000	4,626	96,824	

Test Results

Figure 1-13 vCPU:Memory = 1:4

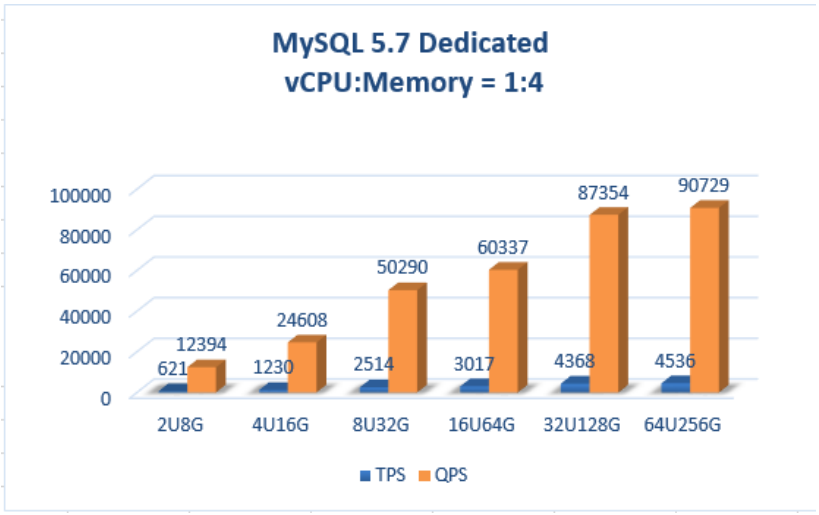
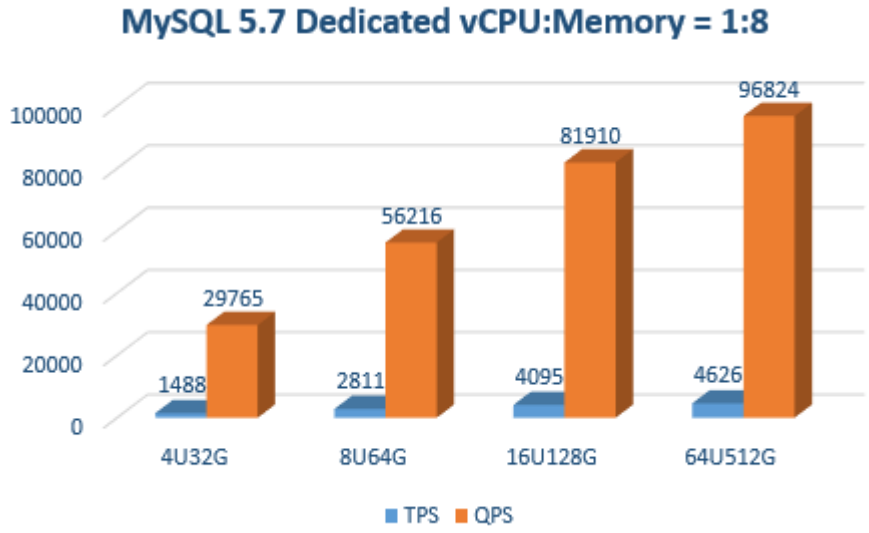


Figure 1-14 vCPU:Memory = 1:8



1.3.4 Kunpeng General-Enhanced DB Instances

About IOPS

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

Test Data

NOTICE

The **Maximum Connections (Stress Testing)** columns in the following tables indicate the results of the RDS performance stress testing. For running services on the live network, set the parameter **max_connections**.

Table 1-15 vCPU:Memory = 1:2

vCPUs	Memory (GB)	Maximum Connections (Stress Testing)	TPS	QPS	IOPS
2	4	1,200	375	7,513	See **About IOPS**.
4	8	2,200	973	19,461	
8	16	4,200	1,462	29,256	
12	24	6,000	1,909	38,182	
16	32	8,600	2,566	51,325	
24	48	13,000	2,764	55,294	
32	64	16,000	2,980	59,608	
48	96	22,000	3,334	66,701	
60	120	30,000	3,858	77,180	

Table 1-16 vCPU:Memory = 1:4

vCPUs	Memory (GB)	Maximum Connections (Stress Testing)	TPS	QPS	IOPS
2	8	2,000	495	9,918	See **About IOPS**.
4	16	4,000	1,020	20,404	
8	32	8,000	2,017	40,342	
12	48	12,000	2,628	52,565	
16	64	14,400	2,896	57,938	
24	96	21,600	3,061	61,219	
32	128	24,000	3,192	63,853	

vCPUs	Memory (GB)	Maximum Connections (Stress Testing)	TPS	QPS	IOPS
48	192	36,000	3,528	70,570	

Test Results

Figure 1-15 vCPU:Memory = 1:2

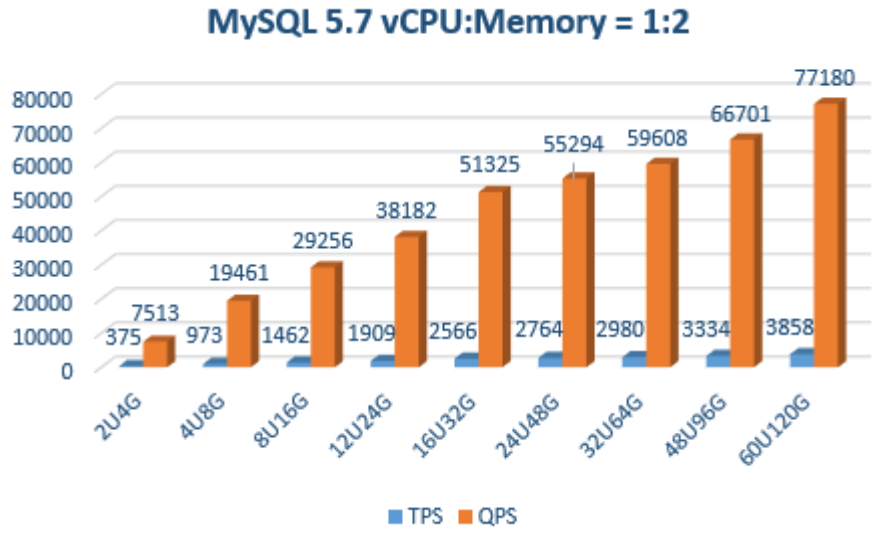
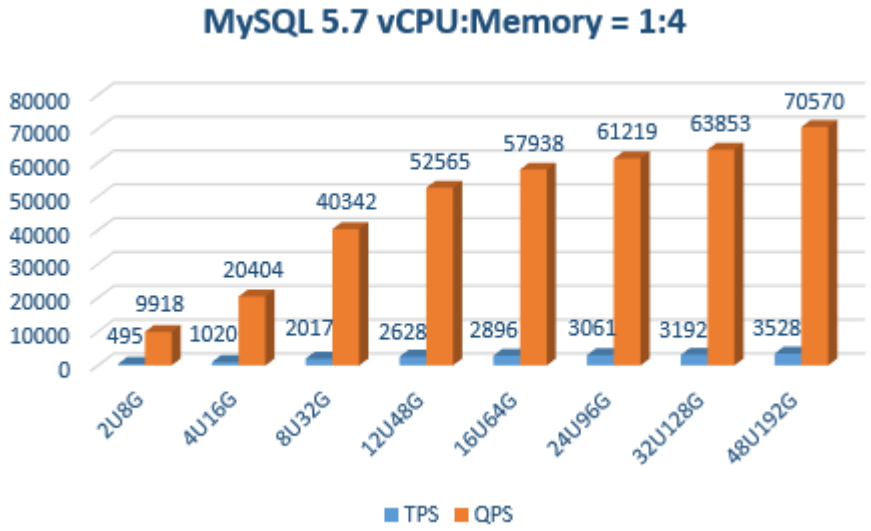


Figure 1-16 vCPU:Memory = 1:4



1.4 RDS for MySQL 8.0 Test Data

1.4.1 General-Purpose DB Instances

About IOPS

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

Test Data

Depending on service scenarios, the test results of RDS for MySQL 8.0 may be lower than those of RDS for MySQL 5.7, which is normal.

NOTICE

The **Maximum Connections (Stress Testing)** columns in the following tables indicate the results of the RDS performance stress testing. For running services on the live network, set the parameter **max_connections**.

Table 1-17 vCPU:Memory = 1:2

vCPUs	Memory (GB)	Maximum Connections (Stress Testing)	TPS	QPS	IOPS
2	4	1,500	434	8,679	See **About IOPS**.
4	8	2,500	1,363	27,252	
8	16	5,000	2,014	40,280	

Table 1-18 vCPU:Memory = 1:4

vCPUs	Memory (GB)	Maximum Connections (Stress Testing)	TPS	QPS	IOPS
2	8	2,500	645	12,899	See **About IOPS**.
4	16	5,000	1,428	28,554	
8	32	10,000	2,422	48,445	

Test Results

Figure 1-17 vCPU:Memory = 1:2

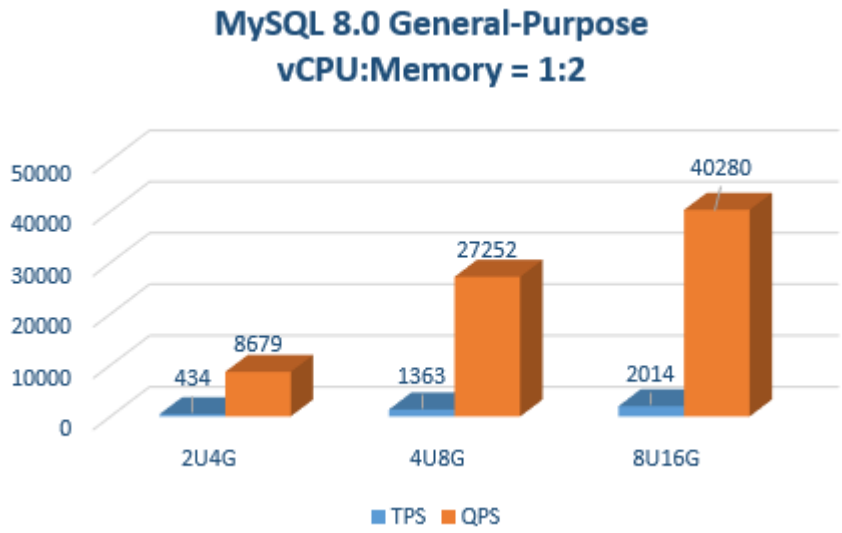
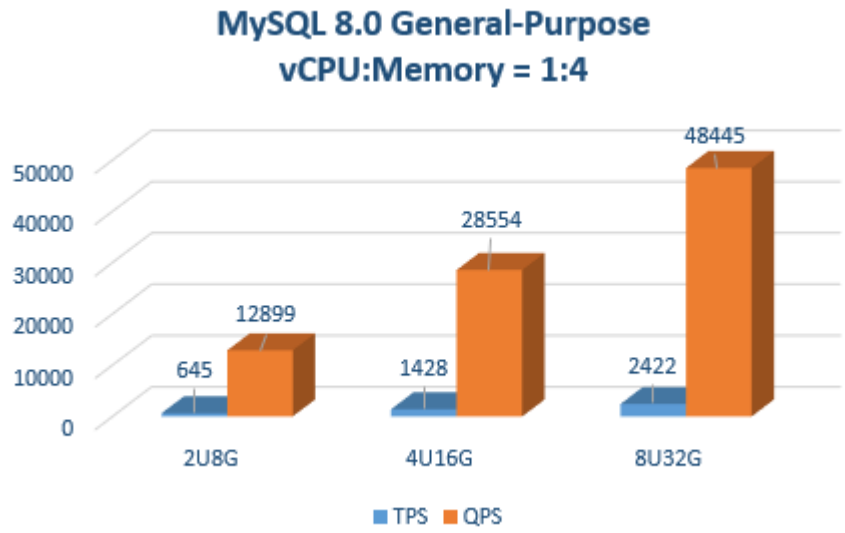


Figure 1-18 vCPU:Memory = 1:4



1.4.2 Dedicated DB Instances

About IOPS

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

Test Data

Depending on service scenarios, the test results of RDS for MySQL 8.0 may be lower than those of RDS for MySQL 5.7, which is normal.

NOTICE

The **Maximum Connections (Stress Testing)** columns in the following tables indicate the results of the RDS performance stress testing. For running services on the live network, set the parameter **max_connections**.

Table 1-19 vCPU:Memory = 1:4

vCPUs	Memory (GB)	Maximum Connections (Stress Testing)	TPS	QPS	IOPS
2	8	2,500	647	12,936	See **About IOPS**.
4	16	5,000	1,556	31,117	
8	32	10,000	2,543	50,867	
16	64	18,000	4,006	80,115	
32	128	30,000	5,979	119,575	
64	256	60,000	6,463	129,261	

Table 1-20 vCPU:Memory = 1:8

vCPUs	Memory (GB)	Maximum Connections (Stress Testing)	TPS	QPS	IOPS
4	32	10,000	1,642	32,849	See **About IOPS**.
8	64	18,000	3,102	62,045	
16	128	30,000	5,467	109,349	
64	512	100,000	6,484	129,684	

Test Results

Figure 1-19 vCPU:Memory = 1:4

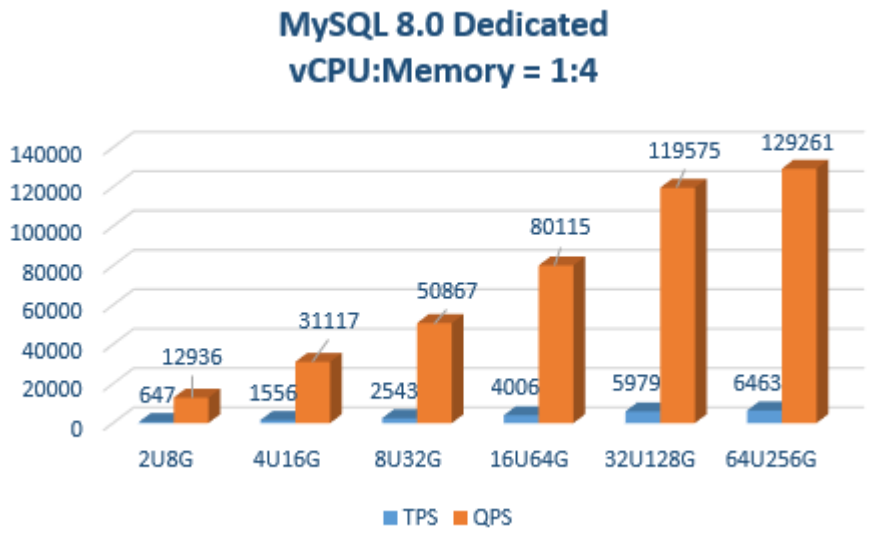
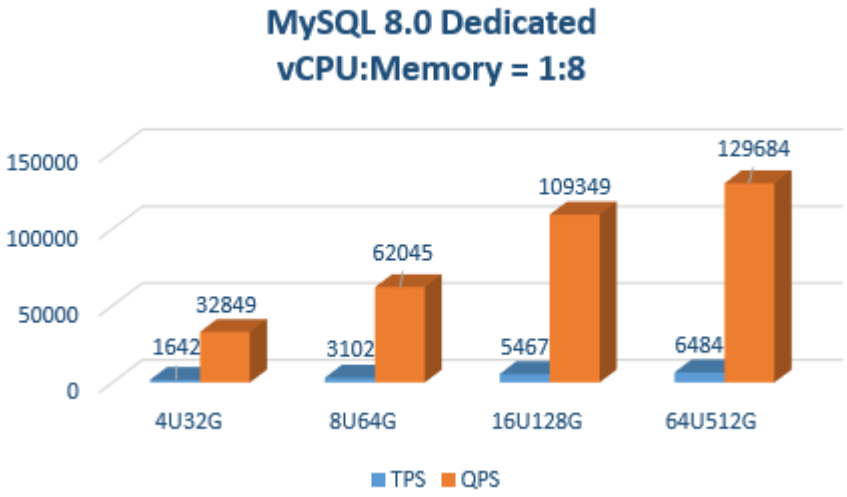


Figure 1-20 vCPU:Memory = 1:8



2 RDS for PostgreSQL

2.1 Test Method

PostgreSQL is an open-source object-relational database management system with an emphasis on extensibility and standards compliance. It is known as the most advanced open-source database. It excels in processing complex online transaction processing (OLTP) transactions and supports NoSQL (JSON, XML, or hstore) and geographic information system (GIS) data types. It has earned a reputation for reliability and data integrity, and is widely used for websites, location-based applications, and complex data object processing.

- RDS for PostgreSQL supports the PostGIS extension and provides excellent spatial performance.
- RDS for PostgreSQL is a good cost-effective solution for many different scenarios. You can flexibly scale resources based on your service requirements and pay for only what you use.

Test Environment

- ECS: general computing | c3.2xlarge.2 | 8 vCPUs | 16 GB, CentOS7.4 64 bit image. Bind an EIP to the ECS because additional compilation tools need to be installed on stress testing tools.

  NOTE

  The test environment is as follows:

  - ECS: general computing-plus | c6.4xlarge.2 | 16 vCPUs | 32 GB, CentOS 7.6 (64-bit). Bind an EIP to the ECS because additional compilation tools need to be installed on stress testing tools.

Test Tool

Sysbench is a multi-threaded benchmark tool based on LuaJIT. It is most frequently used for database benchmarks. With sysbench, you can quickly get an impression of database performance. For details, visit **https://github.com/akopytov/sysbench**.

Sysbench 1.0.18 is used as an example. Run the following commands to install it:


```
#wget -c https://github.com/akopytov/sysbench/archive/1.0.18.zip
#yum install make automake libtool pkgconfig libaio-devel postgresql-devel
#unzip 1.0.18.zip
#cd sysbench-1.0.18
#./autogen.sh
#./configure --with-pgsql --without-mysql
#make
#make install
```

Test Procedure

Replace the database name, connection IP address, and user password based on the site requirements.

Step 1 Import data.

1. Run the following commands to log in to a database and create the test database **loadtest**:

   ```
   psql -h<host> -p5432 "dbname=postgres user=root password=<password>" <<TEST
   create database loadtest;
   TEST
   ```

2. Run the following command to import the test background data to the **loadtest** database:

   ```
   sysbench --test=/usr/local/share/sysbench/tests/include/oltp_legacy/oltp.lua --db-driver=pgsql --pgsql-db=loadtest --pgsql-user=root --pgsql-password=<password> --pgsql-port=5432 --pgsql-host=<host> --oltp-tables-count=64 --oltp-table-size=10000000 --num-threads=20 prepare
   ```

Step 2 Run the following command to perform a stress testing:

```
sysbench --test=/usr/local/share/sysbench/tests/include/oltp_legacy/oltp.lua --db-driver=pgsql --pgsql-db=loadtest --pgsql-user=root --pgsql-password=<password> --pgsql-port=5432 --pgsql-host=<host> --oltp-tables-count=64 --oltp-table-size=10000000 --max-time=3600 --max-requests=0 --num-threads=64 --report-interval=3 --forced-shutdown=1 run
```

Step 3 Run the following command to delete the test data:

```
sysbench --test=/usr/local/share/sysbench/tests/include/oltp_legacy/oltp.lua --db-driver=pgsql --pgsql-db=loadtest --pgsql-user=root --pgsql-password=<password> --pgsql-port=5432 --pgsql-host=<host> --oltp-tables-count=64 --oltp-table-size=10000000 --max-time=3600 --max-requests=0 --num-threads=200 cleanup
```

----End

Testing Model

1. Table structure:

   ```
   CREATE TABLE `sbtest` (
   `id` INTEGER IDENTITY(1,1) NOT NULL,
   `k` INTEGER DEFAULT '0' NOT NULL,
   `c` CHAR(120) DEFAULT '' NOT NULL,
   `pad` CHAR(60) DEFAULT '' NOT NULL,
   PRIMARY KEY (`id`)
   )
   ```

2. Read/write ratio:

   The default transaction submitted by sysbench contains 18 SQL statements. The details are as follows:

   - Ten primary key SELECT statements:

     ```
     SELECT c FROM ${rand_table_name} where id=${rand_id};
     ```

   - Four range SELECT statements:

     ```
     SELECT c FROM ${rand_table_name} WHERE id BETWEEN ${rand_id_start} AND ${rand_id_end};
     SELECT SUM(K) FROM ${rand_table_name} WHERE id BETWEEN ${rand_id_start} AND ${rand_id_end};
     SELECT c FROM ${rand_table_name} WHERE id BETWEEN ${rand_id_start} AND ${rand_id_end}
     ```



```
ORDER BY c;
SELECT DISTINCT c FROM ${rand_table_name} WHERE id BETWEEN ${rand_id_start} AND ${rand_id_end} ORDER BY c;
```

- Two UPDATE statements:

```
UPDATE ${rand_table_name} SET k=k+1 WHERE id=${rand_id}
UPDATE ${rand_table_name} SET c=${rand_str} WHERE id=${rand_id}
```

- One DELETE statement:

```
DELETE FROM ${rand_table_name} WHERE id=${rand_id}
```

- One INSERT statement:

```
INSERT INTO ${rand_table_name} (id, k, c, pad) VALUES (${rand_id},${rand_k},${rand_str_c},${rand_str_pad})
```

Test Metrics

- Transactions per second (TPS) refers to the number of transactions executed per second by a database. Each transaction contains 18 SQL statements.
- Queries per second (QPS) refers to the number of SQL statements, including INSERT, SELECT, UPDATE, and DELETE statements, executed per second.

2.2 RDS for PostgreSQL 12 Test Data

2.2.1 General-Purpose DB Instances

About IOPS

The IOPS supported by RDS for PostgreSQL depends on the I/O performance of Elastic Volume Service (EVS) disks. For details, see **Disk Types and Performance** in the *Elastic Volume Service Service Overview*.

Test Data

Table 2-1 vCPU:Memory = 1:2

vCPUs	Memory (GB)	TPS	QPS	IOPS
1	2	172.88	3,457.69	See **About IOPS**.
2	4	387.63	7,752.63	
4	8	823.89	16,477.76	
8	16	1538.08	30761.58	

Table 2-2 vCPU:Memory = 1:4

vCPUs	Memory (GB)	TPS	QPS	IOPS
2	8	461.22	9,224.35	See **About IOPS**.
4	16	843.00	16,860.02	
8	32	1,786.72	35,734.52	

Test Results

Figure 2-1 vCPU:Memory = 1:2

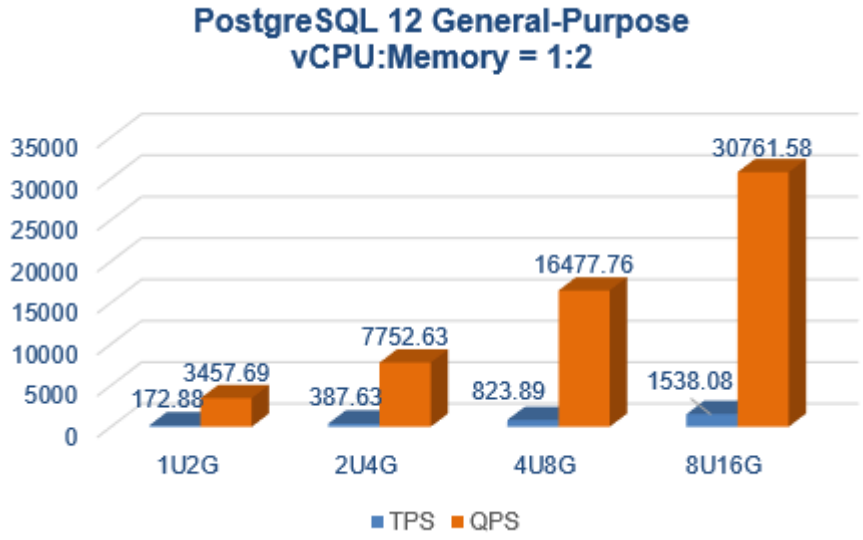
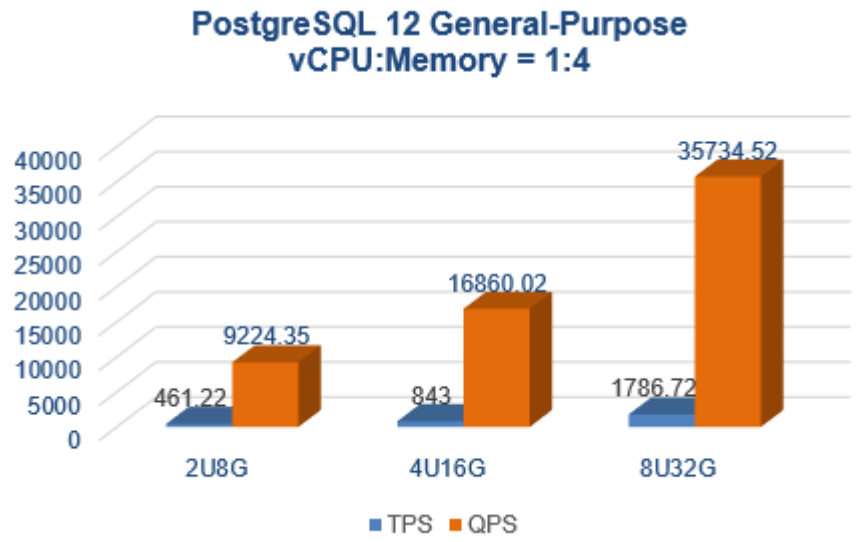


Figure 2-2 vCPU:Memory = 1:4



2.2.2 Dedicated DB Instances

About IOPS

The IOPS supported by RDS for PostgreSQL depends on the I/O performance of Elastic Volume Service (EVS) disks. For details, see **Disk Types and Performance** in the *Elastic Volume Service Service Overview*.

Test Data

Table 2-3 vCPU:Memory = 1:4

vCPUs	Memory (GB)	TPS	QPS	IOPS
2	8	435.68	8,713.58	See **About IOPS**.
4	16	938.77	18,775.34	
8	32	1,735.35	34,707.2	
16	64	2,482.57	49,652.9	
32	128	4,875.01	97,508.19	
64	256	8,839.4	176,804.32	

Table 2-4 vCPU:Memory = 1:8

vCPUs	Memory (GB)	TPS	QPS	IOPS
2	16	497.57	9,951.38	See **About IOPS**.
4	32	1,001.21	20,024.11	
8	64	1,978.29	39,566.03	
16	128	3,513.35	70,267.23	
64	512	12,032.16	240,671.39	

Test Results

Figure 2-3 vCPU:Memory = 1:4

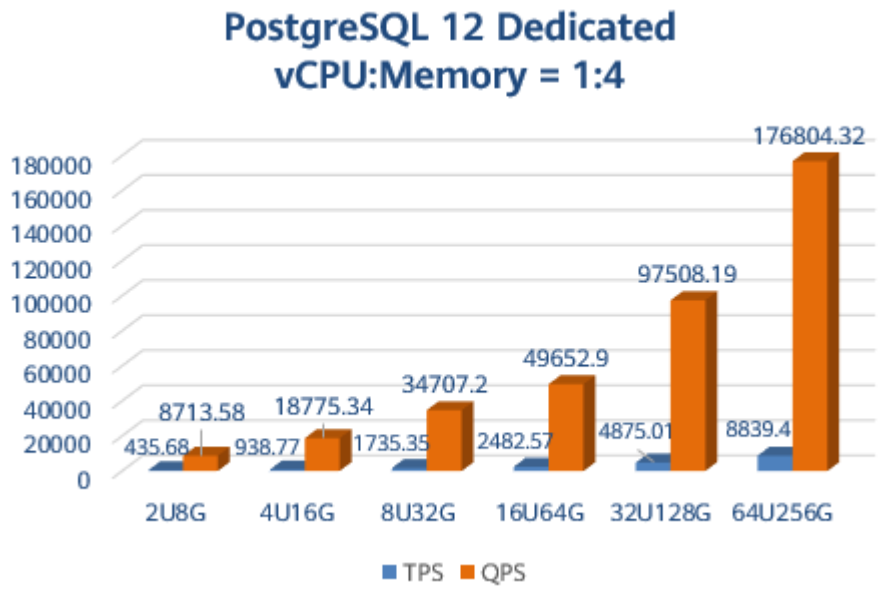
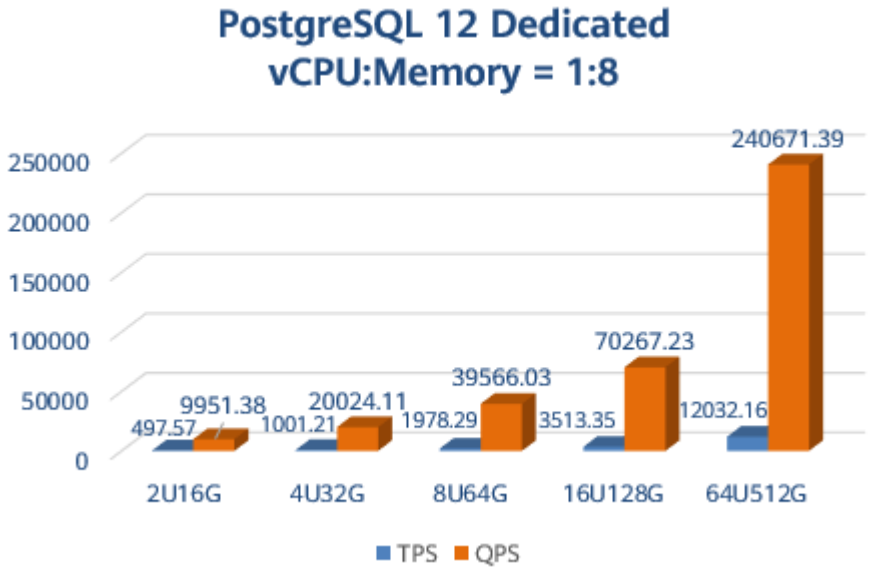


Figure 2-4 vCPU:Memory = 1:8



2.3 RDS for PostgreSQL 13 Test Data

2.3.1 General-Purpose DB Instances

About IOPS

The IOPS supported by RDS for PostgreSQL depends on the I/O performance of Elastic Volume Service (EVS) disks. For details, see **Disk Types and Performance** in the *Elastic Volume Service Service Overview*.

Test Data

Table 2-5 vCPU:Memory = 1:2

vCPUs	Memory (GB)	TPS	QPS	IOPS
1	2	178.71	3,574.29	See **About IOPS**.
2	4	372.52	7,450.35	
4	8	848.15	16,963.08	
8	16	1,505.10	30,101.94	

Table 2-6 vCPU:Memory = 1:4

vCPUs	Memory (GB)	TPS	QPS	IOPS
2	8	425.26	8,505.16	See **About IOPS**.
4	16	879.52	17,590.53	
8	32	1,764.29	35,285.91	

Test Results

Figure 2-5 vCPU:Memory = 1:2

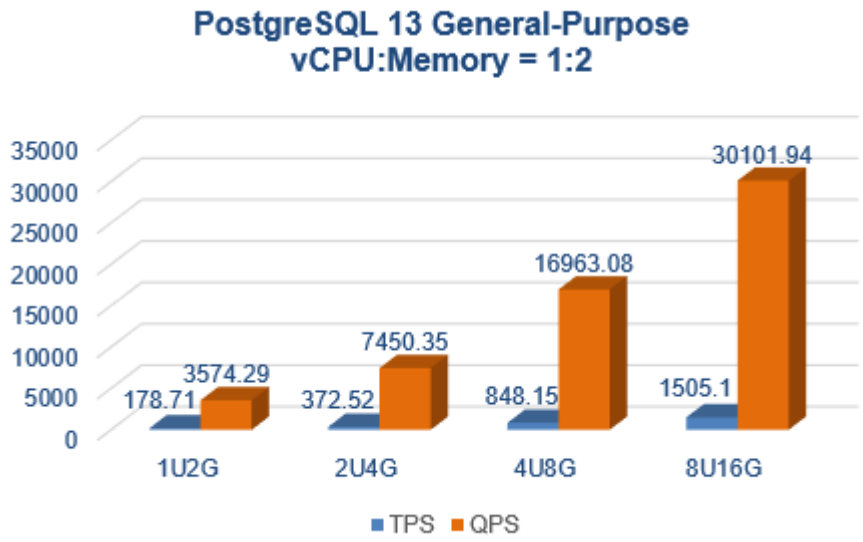
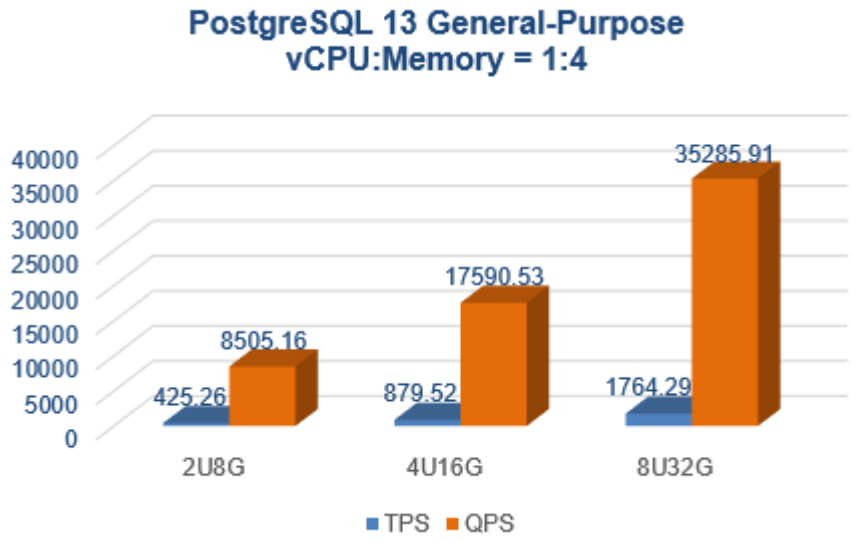


Figure 2-6 vCPU:Memory = 1:4



2.3.2 Dedicated DB Instances

About IOPS

The IOPS supported by RDS for PostgreSQL depends on the I/O performance of Elastic Volume Service (EVS) disks. For details, see **Disk Types and Performance** in the *Elastic Volume Service Service Overview*.

Test Data

Table 2-7 vCPU:Memory = 1:4

vCPUs	Memory (GB)	TPS	QPS	IOPS
2	8	437.45	8,748.99	See **About IOPS**.
4	16	896.84	17,936.72	
8	32	1,819.93	36,398.77	
16	64	2,600.93	52,018.73	
32	128	5,428.06	108,572.08	
64	256	12,102.77	242,079.30	

Table 2-8 vCPU:Memory = 1:8

vCPUs	Memory (GB)	TPS	QPS	IOPS
2	16	528.85	10,577.07	See **About IOPS**.
4	32	1,002.06	20,041.23	
8	64	1,904.04	38,080.91	
16	128	3,928.59	78,572.08	
64	512	7,485.78	149,732.20	

Test Results

Figure 2-7 vCPU:Memory = 1:4

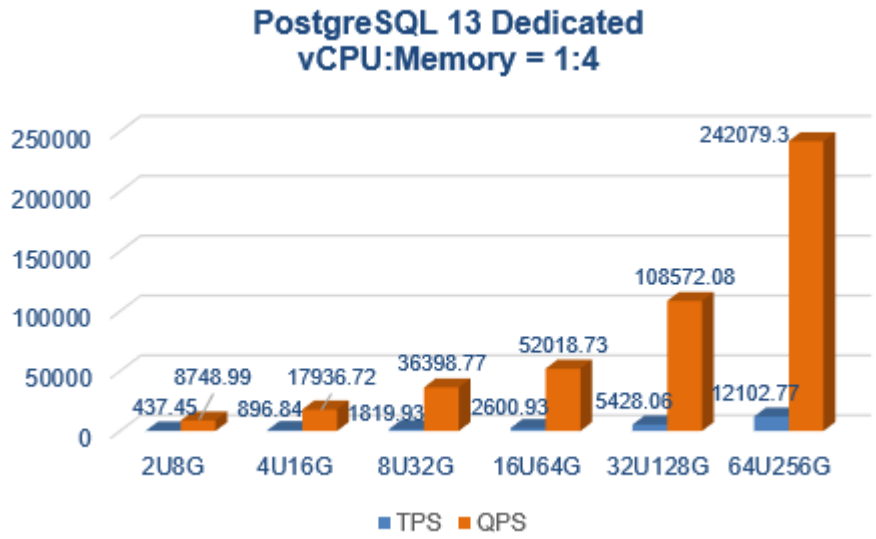
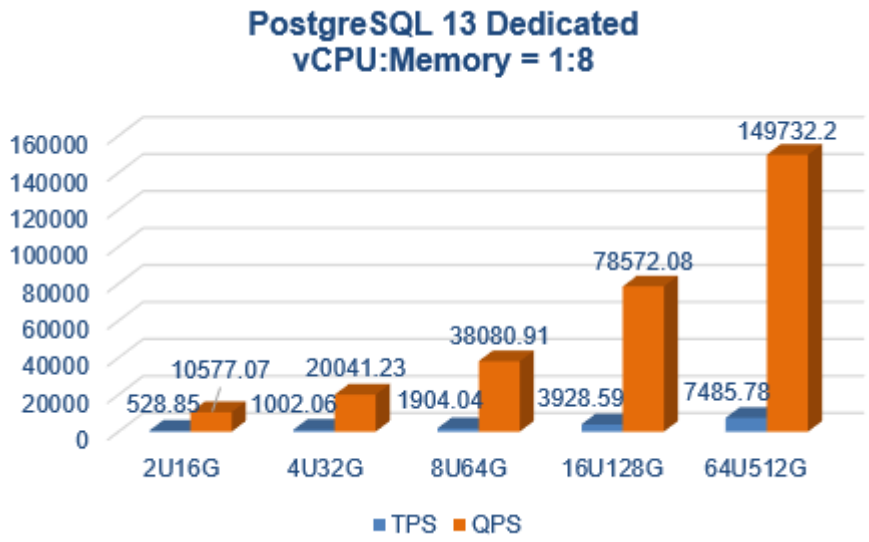


Figure 2-8 vCPU:Memory = 1:8



2.4 RDS for PostgreSQL 14 Test Data

2.4.1 General-Purpose DB Instances

This section provides test data of RDS for PostgreSQL 14 x86-based general-purpose instances using cloud SSDs.

About IOPS

The IOPS supported by RDS for PostgreSQL depends on the I/O performance of Elastic Volume Service (EVS) disks. For details, see **Disk Types and Performance** in the *Elastic Volume Service Service Overview*.

Test Data

Table 2-9 vCPU:Memory = 1:2

vCPUs	Memory (GB)	TPS	QPS	IOPS
1	2	176.26	3,525.27	See **About IOPS**.
2	4	385.70	7,713.97	
4	8	784.54	15,690.82	
8	16	1,560.41	31,208.18	

Table 2-10 vCPU:Memory = 1:4

vCPUs	Memory (GB)	TPS	QPS	IOPS
2	8	429.02	8,580.42	See **About IOPS**.
4	16	999.26	19,985.14	
8	32	1,788.29	35,765.97	

Test Results

Figure 2-9 vCPU:Memory = 1:2

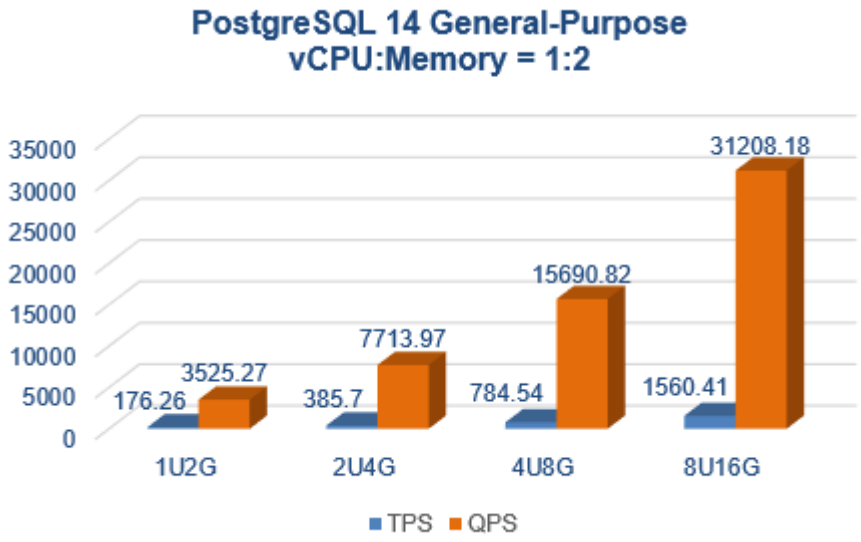
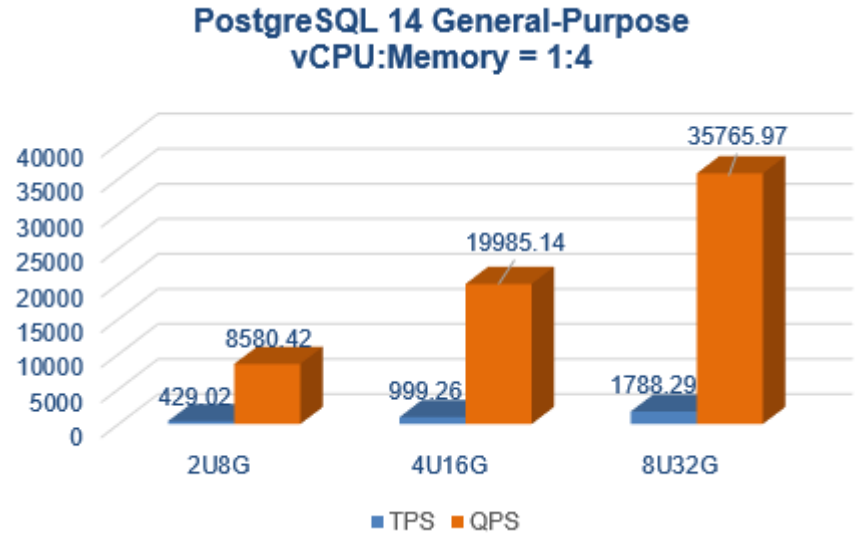


Figure 2-10 vCPU:Memory = 1:4



2.4.2 Dedicated DB Instances

This section provides test data of RDS for PostgreSQL 14 x86-based dedicated instances using cloud SSDs.

About IOPS

The IOPS supported by RDS for PostgreSQL depends on the I/O performance of Elastic Volume Service (EVS) disks. For details, see **Disk Types and Performance** in the *Elastic Volume Service Service Overview*.

Test Data

Table 2-11 vCPU:Memory = 1:2

vCPUs	Memory (GB)	TPS	QPS	IOPS
2	4	373.53	7,470.64	See **About IOPS**.
4	8	748.80	14,976.09	
8	16	1,563.35	31,266.94	
16	32	1,873.68	37,473.69	

Table 2-12 vCPU:Memory = 1:4

vCPUs	Memory (GB)	TPS	QPS	IOPS
2	8	472.01	9,440.15	See **About IOPS**.
4	16	994.46	19,889.28	
8	32	1,806.45	36,129.18	
16	64	2,551.62	51,032.43	

Table 2-13 vCPU:Memory = 1:8

vCPUs	Memory (GB)	TPS	QPS	IOPS
2	16	463.48	9,269.67	See **About IOPS**.
4	32	1,103.30	22,065.92	
8	64	1,996.53	39,930.74	
16	128	3,778.67	75,573.89	

Test Results

Figure 2-11 vCPU:Memory = 1:2

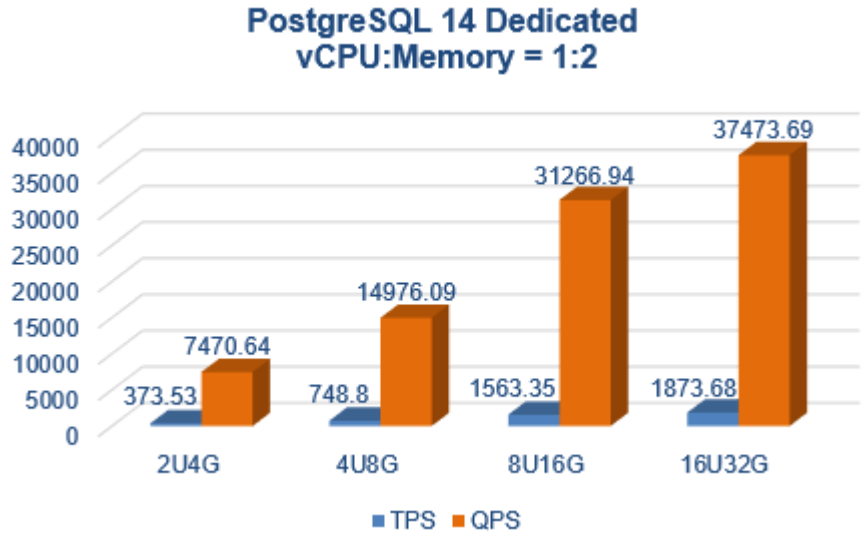


Figure 2-12 vCPU:Memory = 1:4

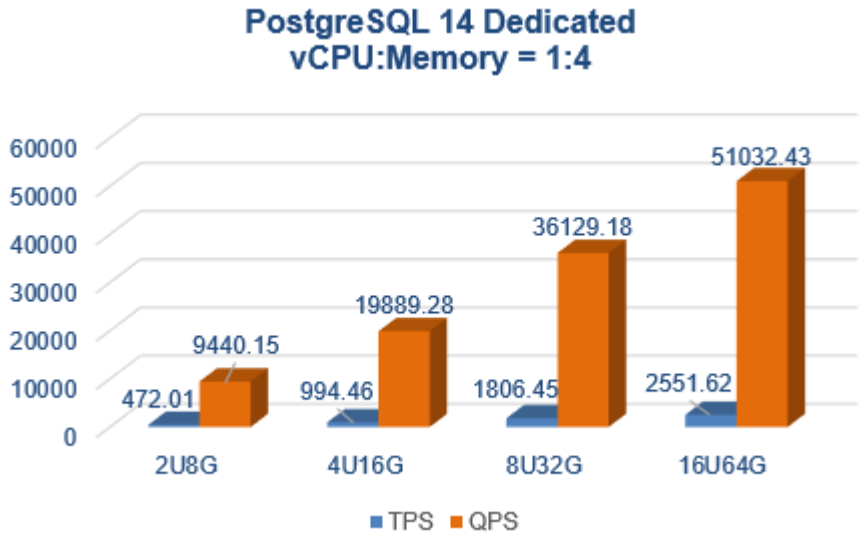
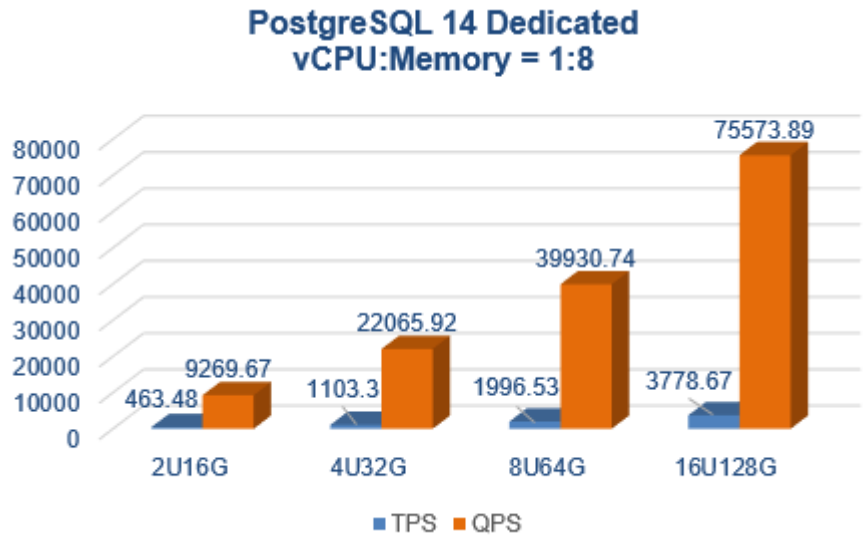


Figure 2-13 vCPU:Memory = 1:8



2.5 RDS for PostgreSQL 15 Test Data

2.5.1 General-Purpose DB Instances

This section provides test data of RDS for PostgreSQL 15 x86-based general-purpose instances using cloud SSDs.

About IOPS

The IOPS supported by RDS for PostgreSQL depends on the I/O performance of Elastic Volume Service (EVS) disks. For details, see **Disk Types and Performance** in the *Elastic Volume Service Service Overview*.

Test Data

Table 2-14 vCPU:Memory = 1:2

vCPUs	Memory (GB)	TPS	QPS	IOPS
1	2	185.21	3,704.27	See **About IOPS**.
2	4	371.97	7,439.43	
4	8	821.00	16,420.05	
8	16	1,517.95	30,358.98	

Table 2-15 vCPU:Memory = 1:4

vCPUs	Memory (GB)	TPS	QPS	IOPS
2	8	431.72	8,634.30	See **About IOPS**.
4	16	926.94	18,538.85	
8	32	1,827.36	36,547.27	

Test Results

Figure 2-14 vCPU:Memory = 1:2

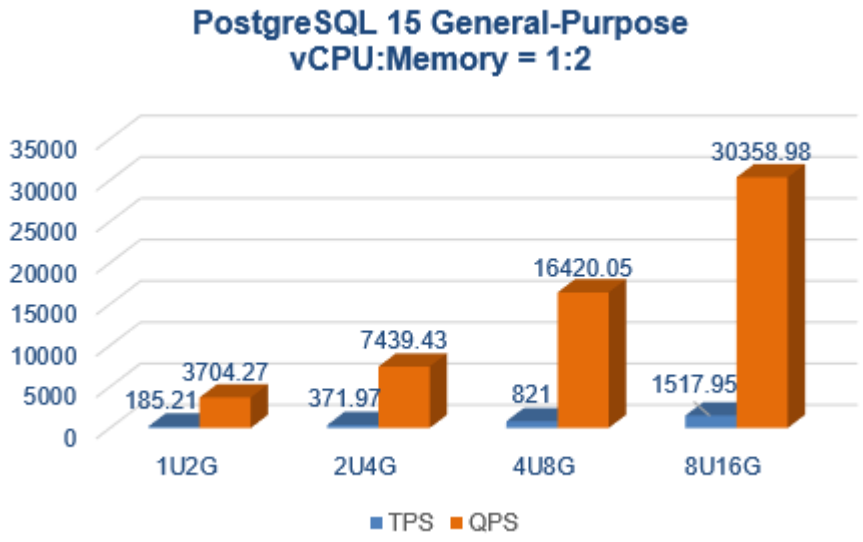
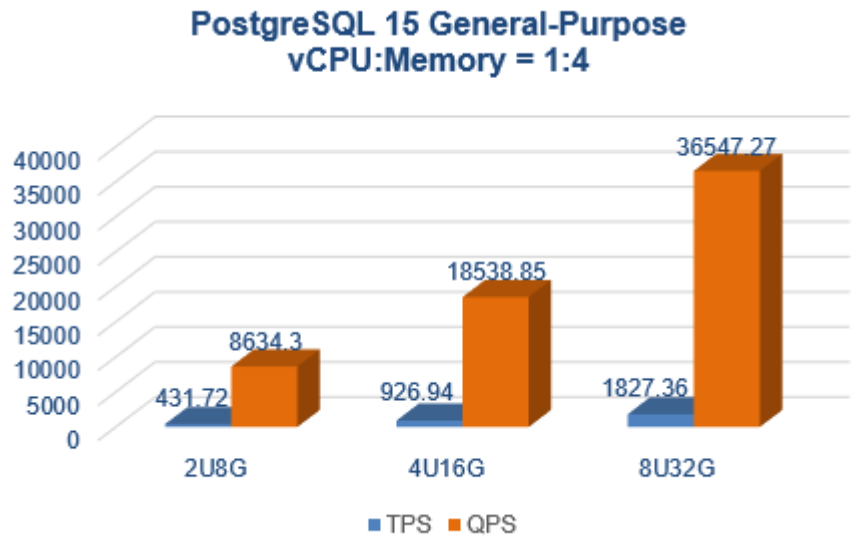


Figure 2-15 vCPU:Memory = 1:4



2.5.2 Dedicated DB Instances

This section provides test data of RDS for PostgreSQL 15 x86-based dedicated instances using cloud SSDs.

About IOPS

The IOPS supported by RDS for PostgreSQL depends on the I/O performance of Elastic Volume Service (EVS) disks. For details, see **Disk Types and Performance** in the *Elastic Volume Service Service Overview*.

Test Data

Table 2-16 vCPU:Memory = 1:2

vCPUs	Memory (GB)	TPS	QPS	IOPS
2	4	378.99	7,579.83	See **About IOPS**.
4	8	838.37	16,767.38	
8	16	1,577.04	31,540.74	
16	32	1,850.72	37,014.46	

Table 2-17 vCPU:Memory = 1:4

vCPUs	Memory (GB)	TPS	QPS	IOPS
2	8	465.93	9,318.54	See **About IOPS**.
4	16	994.98	19,899.65	
8	32	1,825.27	36,505.56	
16	64	2,582.68	51,653.81	

Table 2-18 vCPU:Memory = 1:8

vCPUs	Memory (GB)	TPS	QPS	IOPS
2	16	495.95	9,919.00	See **About IOPS**.
4	32	1,096.84	21,936.72	
8	64	1,924.42	38,488.57	
16	128	3,943.78	78,875.96	

Test Results

Figure 2-16 vCPU:Memory = 1:2

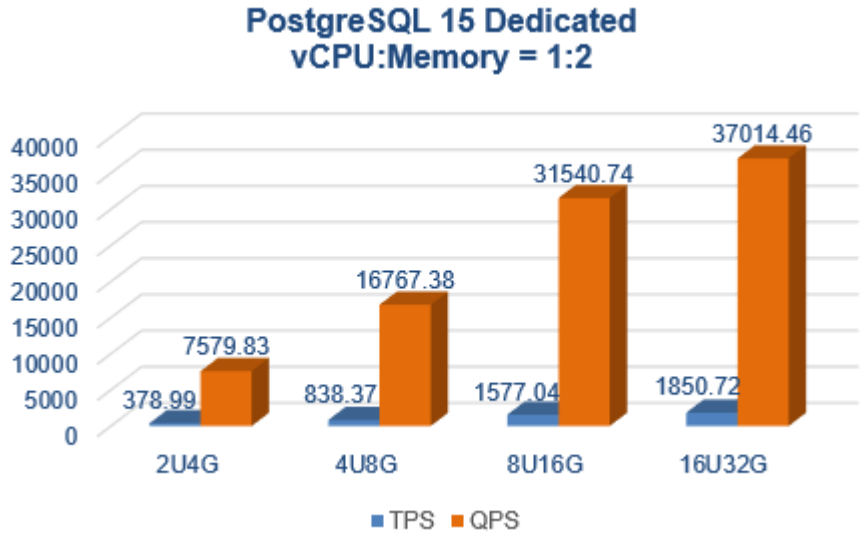


Figure 2-17 vCPU:Memory = 1:4

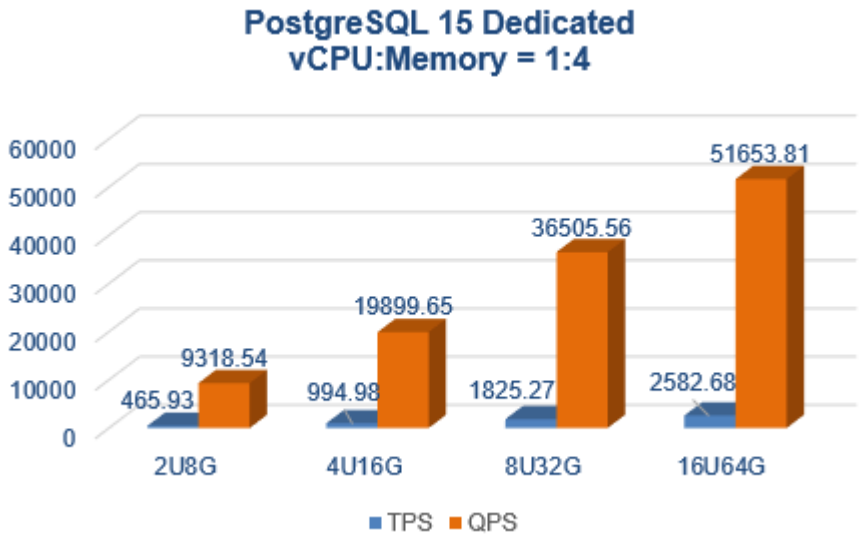
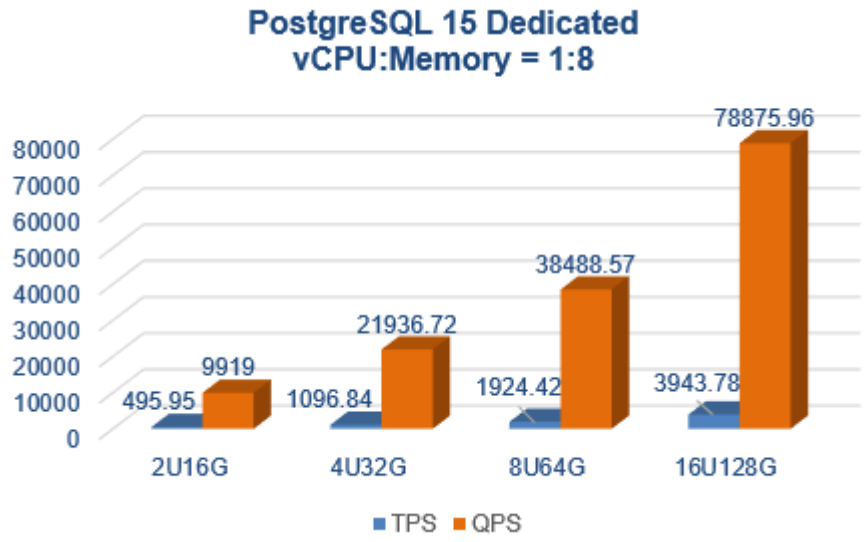


Figure 2-18 vCPU:Memory = 1:8



3 RDS for SQL Server

3.1 Test Method

Huawei Cloud RDS for SQL Server is an online Microsoft SQL Server-compatible relational database service. It is reliable, secure, scalable, inexpensive, and easy to manage. It uses a high availability (HA) architecture, provides flexible backups, guarantees data security, and recovers from faults within seconds.

Test Environment

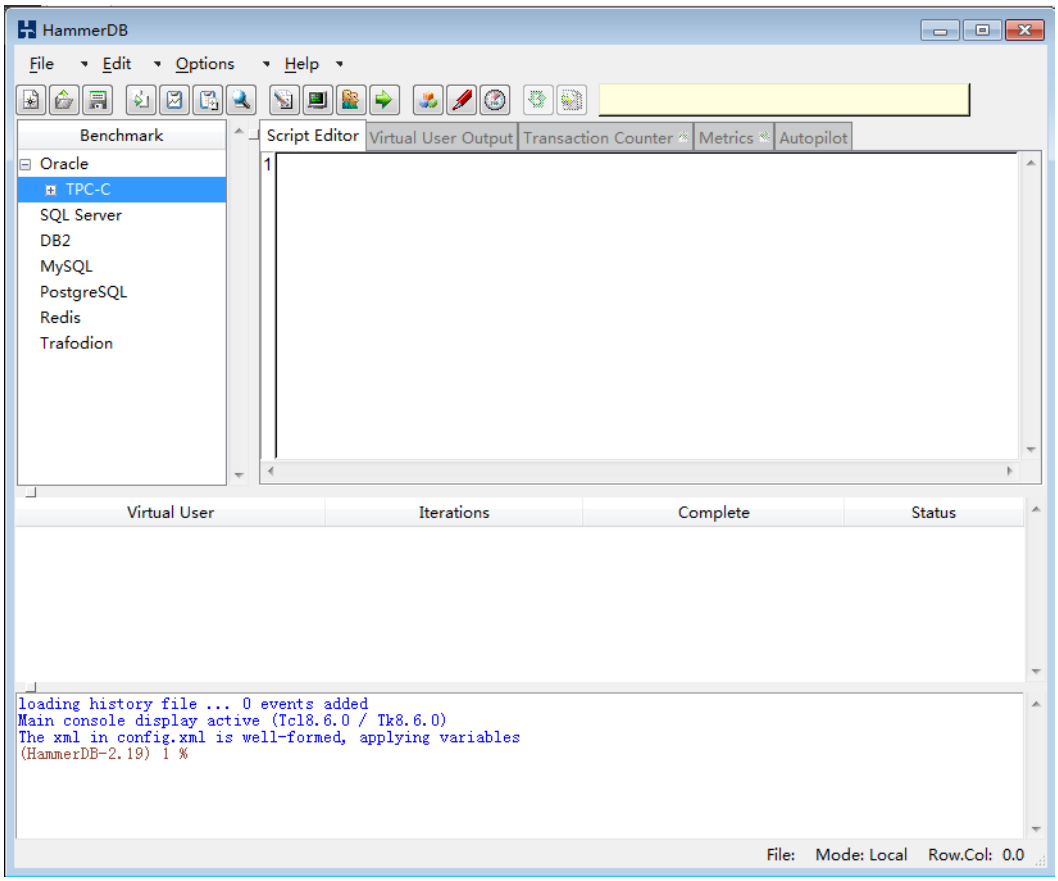
- ECS specifications: high-performance computing | hc2.2xlarge.2 | 8 vCPUs | 16 GB, SSD disk, 200 GB of storage, Windows Server 2012 R2 Standard 64 bit image and VPC network

Test Tool

HammerDB is a graphical open-source database stress testing and benchmarking tool for Linux and Windows to test databases running on any operating system. HammerDB is automated, multi-threaded and extensible with dynamic scripting support. You can use HammerDB to create a test schema, load data, and simulate workloads of multiple virtual users on databases in online transaction processing (OLTP) and online analytical processing (OLAP) scenarios.

HammerDB 2.19 is used as an example. **Download the latest version.**

HammerDB started



Test Benchmarks

The Transaction Processing Performance Council (TPC) is a non-profit corporation founded to define transaction processing and database benchmarks and to disseminate objective, verifiable performance data to the industry. TPC provides multiple test benchmarks, such as TPC-A, TPC-C, and TPC-H. For details, see the official document. TPC-C is an OLTP benchmark. It is different from and more complex than TPC-A because of its multiple transaction types, complex databases, and overall execution structure.

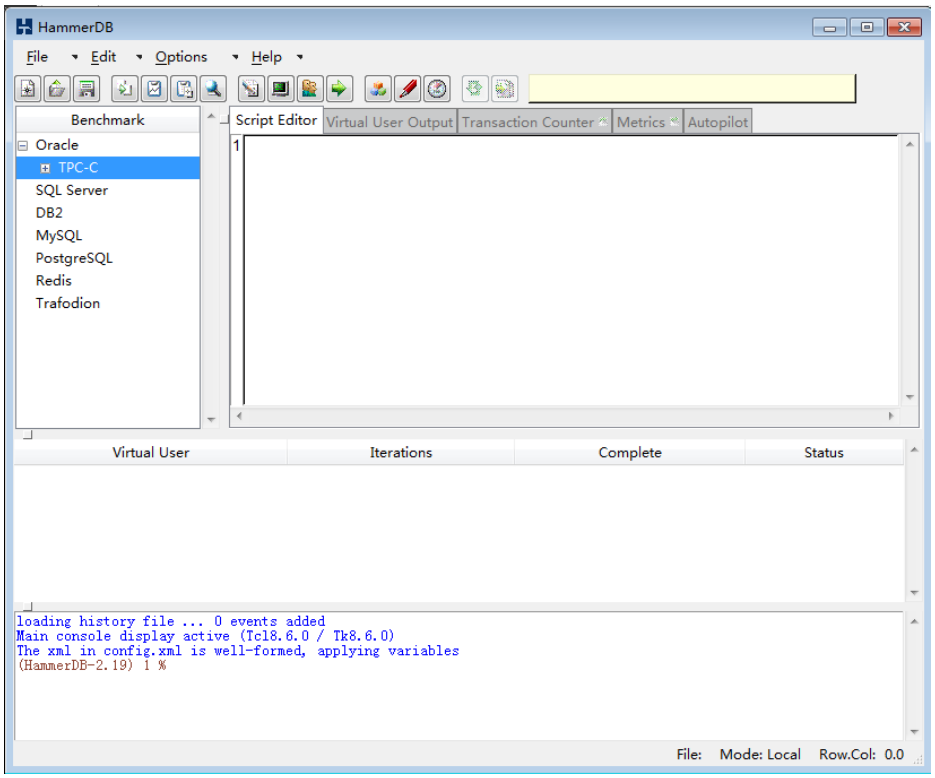
This test uses the TPC-C test benchmark.

The test model is developed by Huawei Cloud based on HammerDB without any optimization and modification on the model structure.

Test Procedure

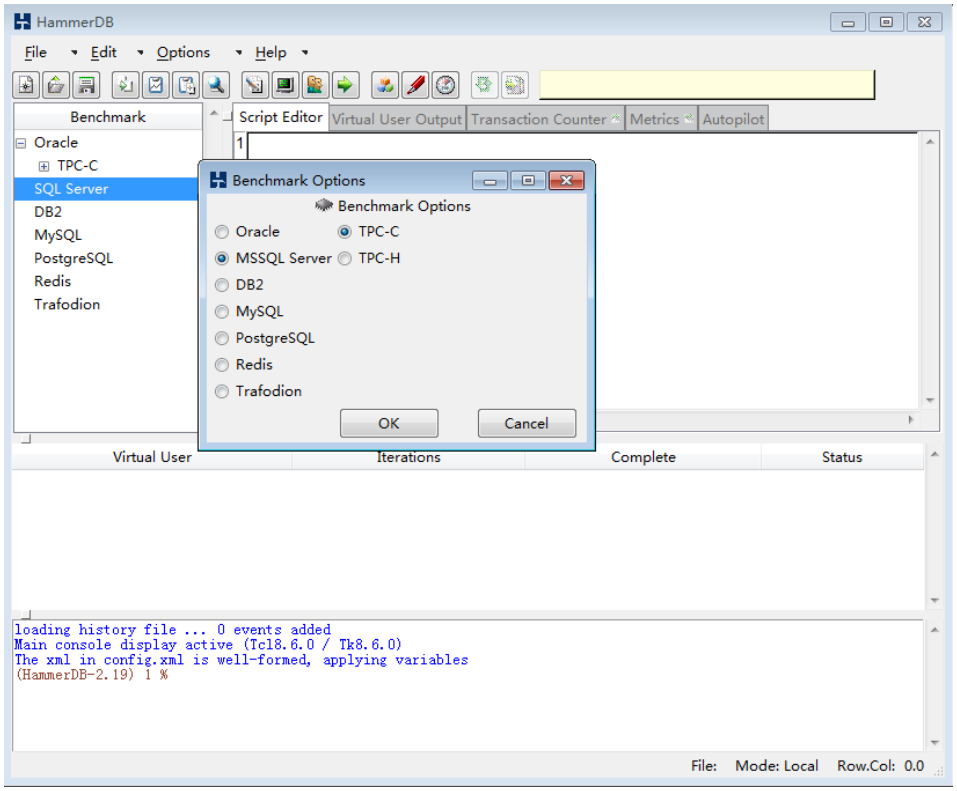
Step 1 Start HammerDB.

Figure 3-1 HammerDB started



Step 2 In the **Benchmark** area, double-click **SQL Server**. In the displayed dialog box, select **MSSQL Server** and **TPC-C**, and click **OK**.

Figure 3-2 Benchmark Options



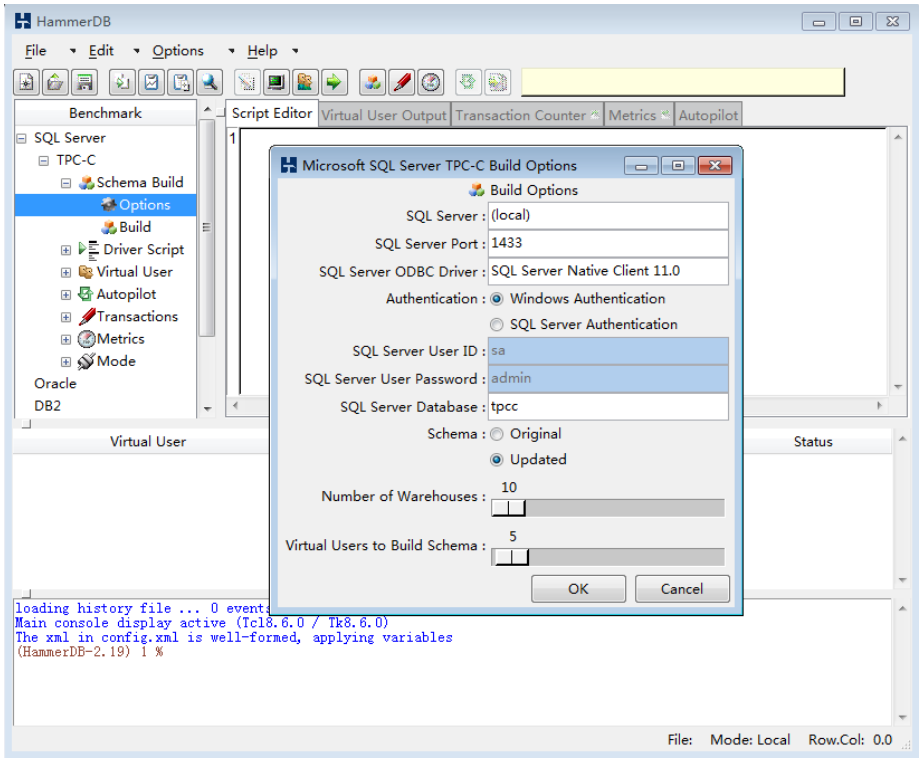
Step 3 Configure the connection information and create the object database **tpcc**.

Choose **SQL Server** > **TPC-C** > **Schema Build** and double-click **Options**.

NOTICE

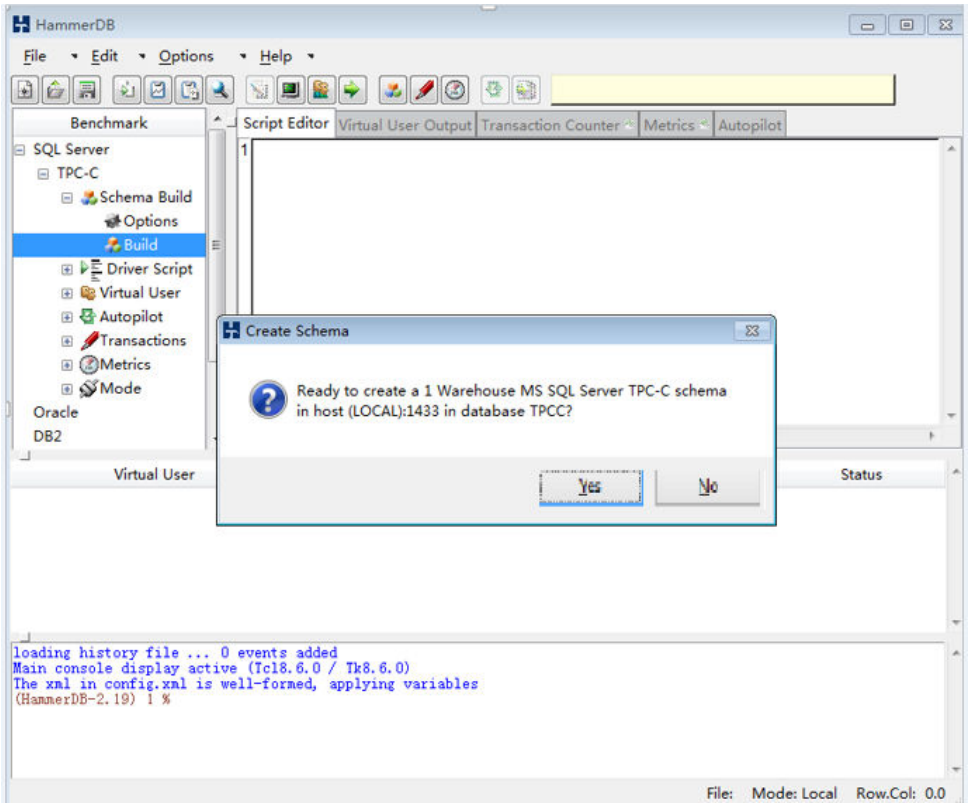
In the displayed dialog box, select **Updated** for **Schema**.

Figure 3-3 Microsoft SQL Server TPC-C Build Options



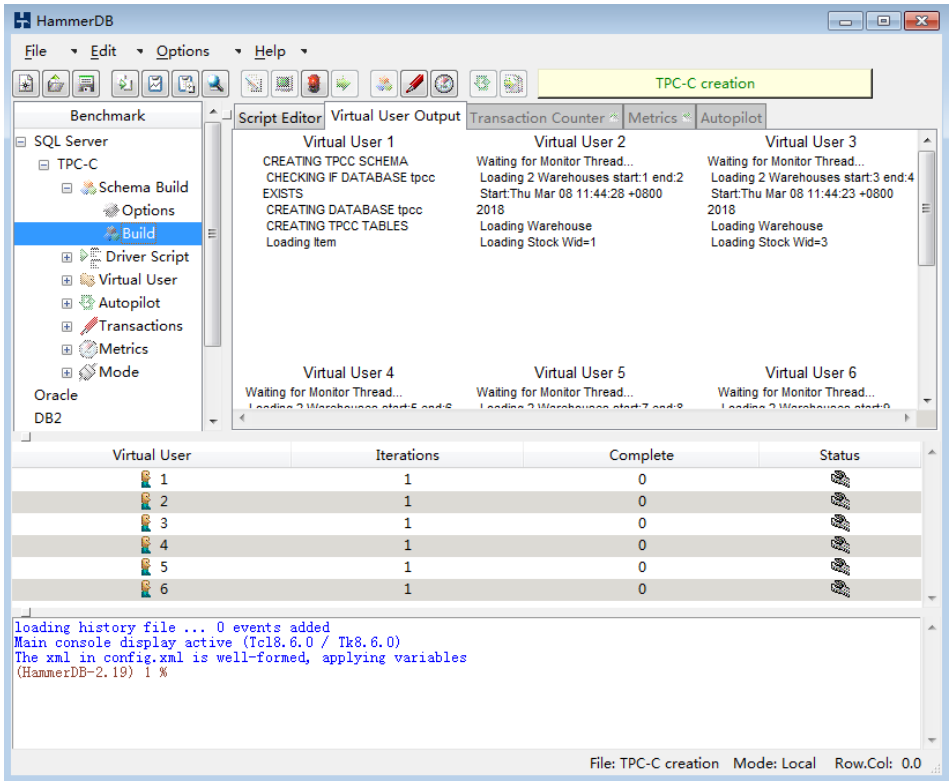
Step 4 Choose **SQL Server** > **TPC-C** > **Schema Build** > **Build**. In the displayed dialog box, click **Yes** to create a schema.

Figure 3-4 Build



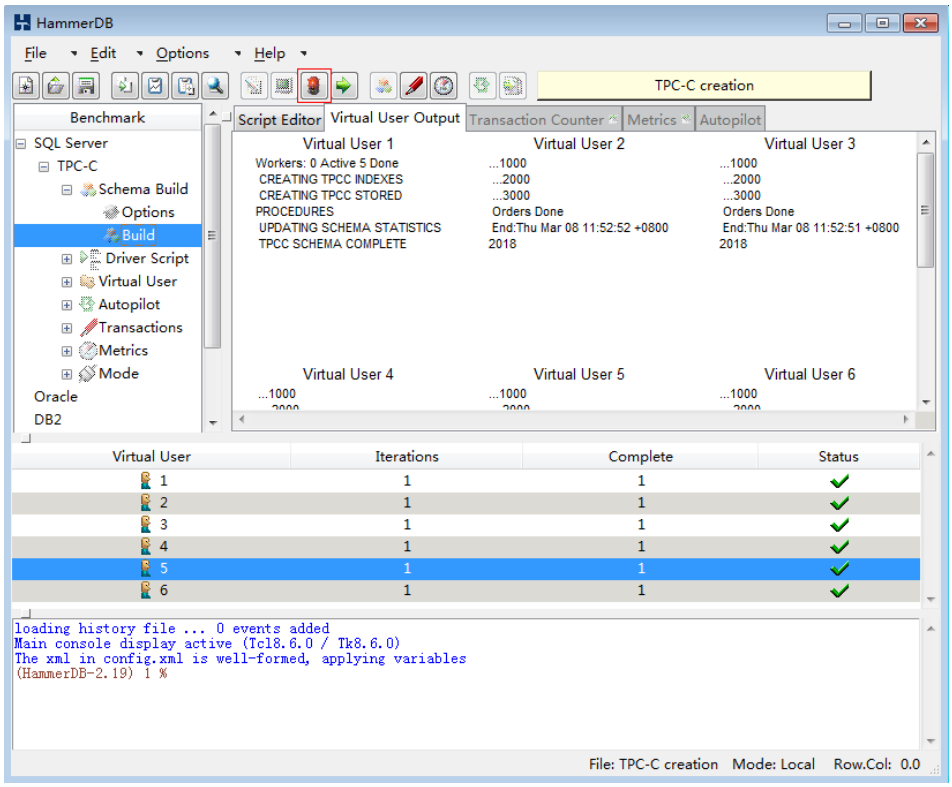
Wait until the initialization is complete.

Figure 3-5 Initialization completed



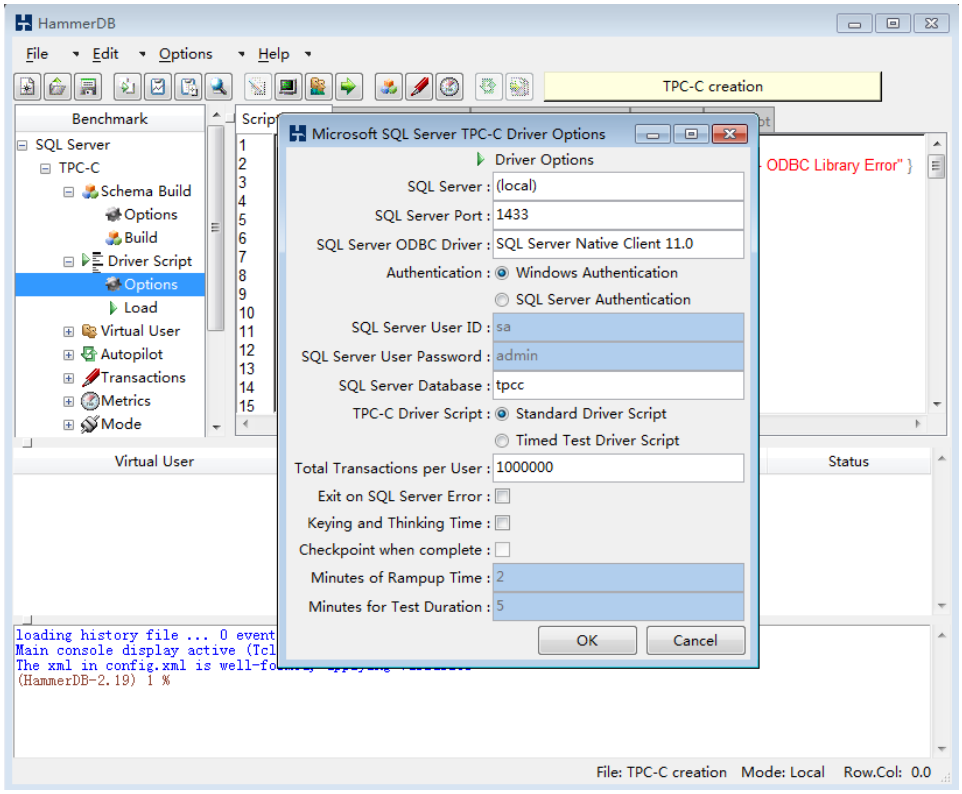
Step 5 Click  to stop the execution.

Figure 3-6 Execution stopped



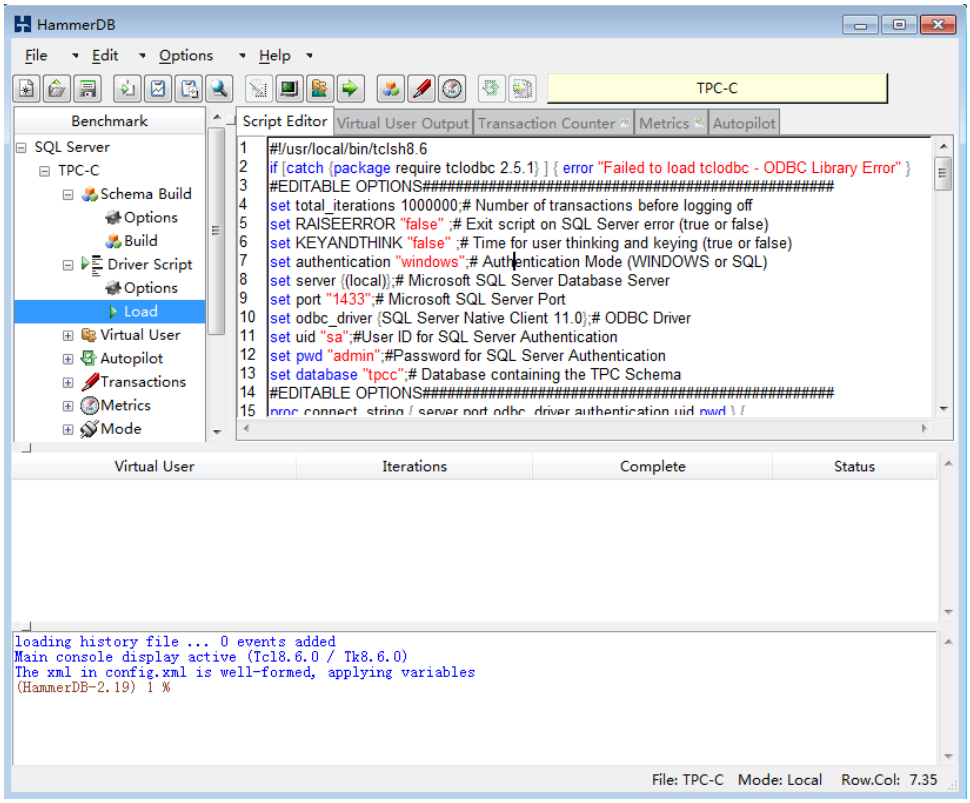
Step 6 Select **SQL Server** > **TPC-C** > **Driver Script** and double-click **Options** to ensure that the connection information is correct.

Figure 3-7 Checking the connection information



Step 7 Choose **SQL Server** > **TPC-C** > **Driver Script** and double-click **Load**.

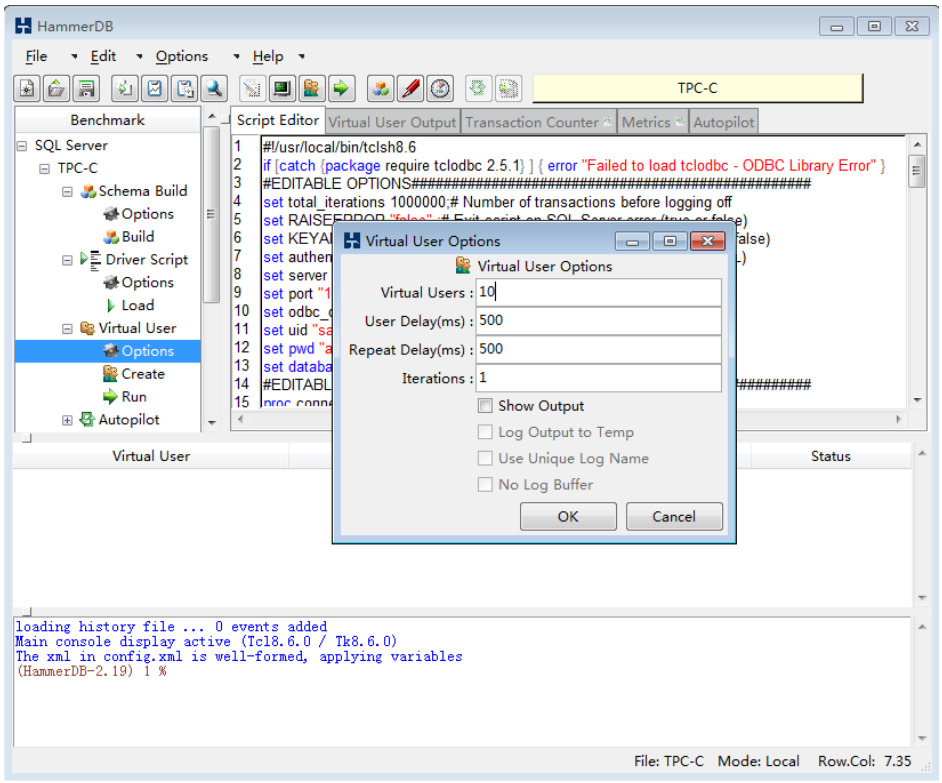
Figure 3-8 Load



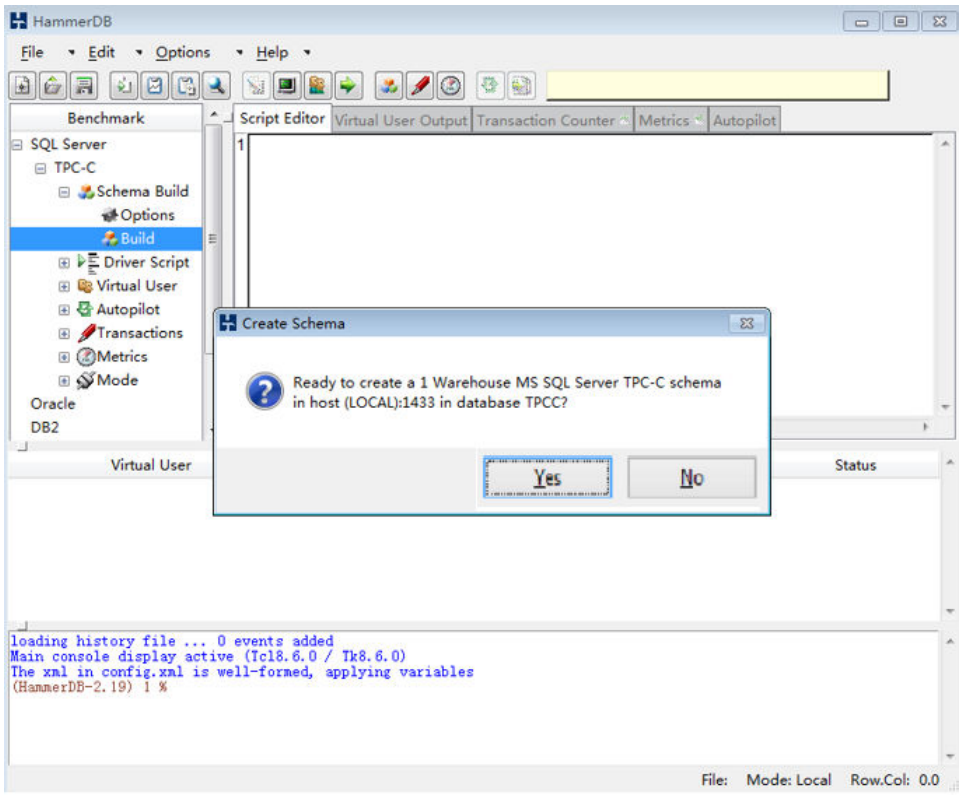
Step 8 Choose **SQL Server** > **TPC-C** > **Virtual User** and double-click **Options**. In the displayed dialog box, you can adjust the number of virtual users repeatedly to generate test results until the Transactions Per Minute (TPM) peak values become consistent. TPM is an important benchmark for measuring database performance.

NOTICE

You are advised not to select **Show Output** because the client may not respond.

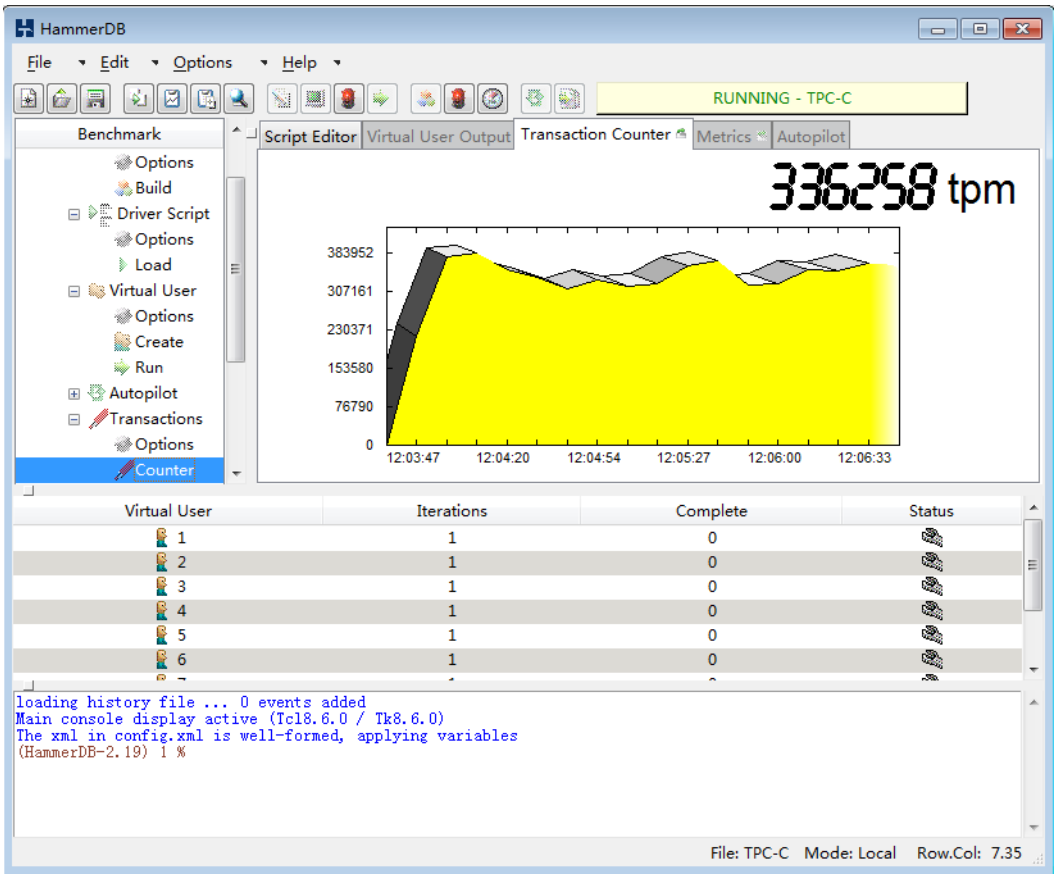


Step 9 Click **Yes**.



Step 10 Choose **Virtual User** and double-click **Run** until the TPM peak value is stable.

Figure 3-9 Stable TPM peak value



----End

3.2 Test Data

Concepts

Transactions per minute (TPM): Number of simulated orders processed by the system in the TPCC standard model per minute.

TPS: Number of simulated orders processed by the system in the TPCC standard model per second.

Input/output operations per second (IOPS): Number of disk read/write operations per second. IOPS in this document refers to the IOPS displayed when the performance reaches the peak in the stress testing, instead of the maximum IOPS capability.

NOTICE

TPM reflects more comprehensive performance than TPS. IOPS indicates the disk read/write capability in the current stress testing, which is for reference only.

Test Result

Table 3-1 Test results

DB Instance Type	Edition	vCPUs	Memory (GB)	TPM	TPS	IOPS
Primary/ Standby	2008 R2 Enterprise	2	8	300,000	5,500	4,000
	2008 R2 Enterprise	4	16	530,000	9,700	7,000
	2008 R2 Enterprise	8	32	930,000	17,050	15,000
	2008 R2 Enterprise	16	64	1,250,000	23,000	20,000
	2008 R2 Enterprise	2	16	290,000	5,300	4,000
	2008 R2 Enterprise	4	32	540,000	9,900	7,000
	2008 R2 Enterprise	8	64	960,000	17,600	15,000
	2008 R2 Enterprise	16	128	1350000	24750	20000
Single	2014 Enterprise and 2014 Standard	4	16	550,000	10,083	7,000
	2014 Enterprise and 2014 Standard	8	32	1,100,000	20,166	16,000
	2014 Enterprise and 2014 Standard	16	64	1,500,000	27,500	22,000
Primary/ Standby	2014 Enterprise and 2014 Standard	4	32	500,000	9,000	7,000
	2014 Enterprise and 2014 Standard	8	64	1,000,000	18,333	16,000

DB Instance Type	Edition	vCPUs	Memory (GB)	TPM	TPS	IOPS
	2014 Enterprise and 2014 Standard	16	128	1,400,000	24,000	21,000
Single	2014 Web	4	16	550,000	10,000	6,000
	2014 Web	8	32	1,100,000	20,000	12,000
	2014 Web	16	64	1,500,000	27,000	18,000

