openGauss RISC-V 专项报告

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摘　要

在本次测试中，openGauss 数据库在 RISC-V 平台上表现出了初步的可用性。我们在 Milk-V Pioneer Box 和 Sipeed LicheePi 4A 两个典型平台上进行了测试。结果表明，Milk-V Pioneer Box 能够稳定运行 openGauss，并支持本地及远程连接，表现出较好的用户体验。然而，Sipeed LicheePi 4A 由于硬件性能的限制，无法正常启动 openGauss 服务。测试采用 openEuler 24.03 LTS 系统，并手动编译 openGauss 6.0.0 版本。功能测试涵盖了基本的数据库操作，确认了 openGauss 的基本功能正常可用。在性能测试中，通过 sysbench 工具，我们评估了数据库在多线程读写和只读场景下的性能。虽然 Milk-V Pioneer Box 在只读负载下表现相对较好，但整体性能仍不及 x86_64 平台。本次测试为 openGauss 在 RISC-V 平台的进一步优化和支持提供了参考。未来的优化方向包括提升在低性能硬件平台上的表现，以及增加对更多操作系统和环境的支持，以提升其广泛性和竞争力。

目录

1 简介 **3**
1.1 软件说明 . . . 3
1.2 测试目的 . . . 3
1.3 测试概述 . . . 3
1.4 测试总结 . . . 3

2 环境说明 **4**
2.1 硬件环境 . . . 4
2.2 软件环境 . . . 4
2.3 测试环境搭建 . . . 5
2.3.1 安装 openEuler . . . 5
2.3.2 安装 openGauss 数据库 . . . 6
2.3.3 功能测试 . . . 7
2.3.4 性能测试 . . . 7

3 测试内容 **8**
3.1 手动测试 . . . 8
3.1.1 本地测试 . . . 8
3.1.2 远程测试 . . . 9
3.2 性能测试 . . . 9

4 测试结果 **15**
4.1 功能测试 . . . 15
4.2 性能测试 . . . 15
4.2.1 已知问题 . . . 16

5 总结 **16**

A 附录 **17**

1 简介

1.1 软件说明

openGauss 是一个免费的开源关系型数据库管理系统，主要由华为开发和维护。它是一个广泛使用的代码库，为企业级应用提供了高性能、高可用性和高安全性的数据库解决方案。

1.2 测试目的

本次测试旨在验证 openGauss 在 RISC-V 平台上的可用性，特别是在 Milk-V Pioneer Box 和 Sipeed LicheePi 4A 两个典型平台上的表现。本报告通过手动测试的方法，从目前的平台兼容性及用户的日常使用体验两个角度评估了 openGauss 当前在 RISC-V 平台上的可用性，并给出了定性和定量的结论，为其未来进一步的优化和支持提供参考。

1.3 测试概述

在本次测试中，我们评估了 openGauss 数据库在 RISC-V 平台上的可靠性和性能表现，尤其是在 Milk-V Pioneer Box 和 Sipeed LicheePi 4A 这两个平台上。Milk-V Pioneer Box 具备较强的处理能力，可以成功安装和运行 openGauss 数据库，并支持本地和远程连接。测试使用了 openEuler 24.03 LTS 系统并手动编译 openGauss 6.0.0 版本。在功能测试部分，我们首先通过 gsql 和 dbeaver 工具验证了基本的数据库操作，包括用户和数据库的创建、基本的表操作等。在性能测试中，我们使用 sysbench 工具进行了读写和只读性能测试。为了进行比较，也在 x86_64 平台上进行同样的测试。

1.4 测试总结

目前 openGauss 在 riscv 上仅支持使用 openEuler 系统进行编译与安装,licheepi 4a 因为性能不足而无法启动 openGauss 服务, Pioneer Box 可以正常本地和远程连接与使用.

使用 sysbench 在 Pioneer Box 上性能测试结果如下:

SQL statistics

rw: oltp 测试, 包含读写 r:select 测试, 仅读

Platform	read	write	other	total	transactions	transactions/s	quer
SG2042 @ 10 Threads rw	278796	79654	39828	398278	11913	331.56	3982
SG2042 @ 64 Threads rw	952280	272041	136057	1360378	68009	1128.35	1360
SG2042 @ 64 Threads r	1851630	0	0	1851630	1851630	30766.50	1851
X86_64 @ 10 Threads rw	584472	166989	83497	834958	41747	695.69	8349

Latency

Platform	min	avg	max	95th percentile	sum
SG2042 @ 10 Threads rw	25.62	30.13	99.91	33.72	599938.70
SG2042 @ 64 Threads rw	38.63	56.49	421.75	70.55	3842023.49
SG2042 @ 64 Threads rw	1.12	2.06	353.15	3.30	3822093.08
X86_64 @ 10 Threads rw	5.23	14.37	1569.33	21.50	599913.47

Threads fairness

Platform	events avg	events stddev	execution time avg	execution time stddev
SG2042 @ 10 Threads rw	1991.3000	32.68	59.9939	0.01
SG2042 @ 64 Threads rw	1062.6406	24.58	60.0316	0.03
SG2042 @ 64 Threads r	28931.7188	1217.10	59.7202	0.03
X86_64 @ 10 Threads rw	4174.7000	12.74	59.9913	0.00

2 环境说明

2.1 硬件环境

本次测试主要在 Milk-V Pioneer Box 和 Sipeed LicheePi 4A 上进行，机器硬件配置为：
Milk-V Pioneer Box:

- CPU: SG2042 64 Core C920@2.0GHz
- RAM: 4 channel 3200Hz 128GB DDR4 SODIMM (32GB * 4)
- SSD: PCIe 3.0 x 4 1TB
- GPU: AMD R5 230

Sipeed LicheePi 4A:

- CPU: TH1520, RISC-V 2.0G C910 x4
- RAM: 16 GB 64bit LPDDR4X-3733
- Storage: 128 GB eMMC

x86_64:

- CPU: Xeon Gold 5215L CPU @ 2.50GHz, 10*vCPU (Proxmox VE 8.0 虚拟化环境)
- RAM: 8 GiB

2.2 软件环境

本次测试涵盖的系统版本和 openGauss 版本如下：
openEuler[1] 24.03 LTS
openGauss[2] 6.0.0

[1] https://www.openeuler.org/zh/download/?version=openEuler%2024.03%20LTS
[2] https://gitee.com/opengauss/riscv

2.3 测试环境搭建

2.3.1 安装 openEuler

Sipeed LicheePi 4A

从 官网 [3] 下载镜像：

选择 RISC-V - 嵌入式 - lpi4a。

使用 fastboot 刷写镜像到板载 eMMC

由于 LPi4A 默认的 USB VID/PID 通常不在默认 udev 规则内，在 Linux 下烧写时可能需要在 fastboot 前添加 sudo。

按住板上的 **BOOT** 按键不放，然后插入 USB-C 线缆上电（线缆另一头接 PC），即可进入 USB 烧录模式。

在 Windows 下使用设备管理器查看，会出现 USB download gadget 设备。

在 Linux 下，使用 lsusb 查看设备，会显示以下设备：ID 2345:7654 T-HEAD USB download gadget。

使用如下指令刷写镜像。

```
fastboot flash ram u-boot-with-spl-lpi4a-16g.bin
fastboot reboot
# 稍等几秒，等待开发板重启后重新连接至电脑
fastboot flash uboot u-boot-with-spl-lpi4a-16g.bin
fastboot flash boot openEuler-24.03-LTS-riscv64-lpi4a-base-boot.ext4
fastboot flash root openEuler-24.03-LTS-riscv64-lpi4a-base-root.ext4
```

Milk-V Pioneer Box

下载系统镜像 [4]，解压，使用 dd 烧录至 NVMe 硬盘。下载固件 [5]，解压，使用 dd 烧录至 microSD 卡。

请将下面的 /dev/sda /dev/sdb 替换成实际使用的硬盘和存储卡位置。

```
unzip openEuler-24.03-LTS-riscv64-sg2042.img.zip
sudo wipefs -af /dev/sda
sudo dd if=openEuler-24.03-LTS-riscv64-sg2042.img of=/dev/sda bs=1M status=progress
sudo eject /dev/sda
unzip sg2042_firmware_linuxboot.img.zip
sudo dd if=sg2042_firmware_linuxboot.img of=/dev/sdb bs=1M status=progress
```

将存储卡和硬盘插入系统上电开机。

[3] https://www.openeuler.org/zh/download/?version=openEuler%2024.03%20LTS

[4] https://mirrors.hust.edu.cn/openeuler/openEuler-24.03-LTS/embedded_img/riscv64/SG2042/openEuler-24.03-LTS-riscv64-sg2042.img.zip

[5] https://mirrors.hust.edu.cn/openeuler/openEuler-24.03-LTS/embedded_img/riscv64/SG2042/sg2042_firmware_linuxboot.img.zip

2.3.2 安装 openGauss 数据库

因为官网提供的下载中[6]没有 riscv 架构的，所以需要手动构建并安装 opengauss 数据库
此文档针对 riscv 平台编写，在其他平台下使用请自行配置 qemu

编译

使用 openEuler 容器编译可参考 https://github.com/QA-Team-lo/dbtest/blob/main/opengauss/install.md
以下使用 Pioneer Box 裸机编译:
下载源码

```
su
mkdir /root/rpmbuild
cd /root/rpmbuild
git clone https://gitee.com/opengauss/riscv SOURCES
cd SOURCES
```

配置编译环境

```
# 安装必要工具
dnf install -y rpm-build rpmdevtools dnf-plugins-core
# 安装编译依赖
yum-builddep -y opengauss-server.spec
# 下载源码
spectool -g opengauss-server.spec
```

编译 rpm 包

```
rpmbuild -ba opengauss-server.spec
```

安装

等待一段时间，编译完成后，安装

```
cd ../RPMS/riscv64/
dnf install -y opengauss-server-6.0.0-1.riscv64.rpm
```

初始化 & 启动

[6] https://opengauss.org/zh/download/

```
systemctl enable --now opengauss-server
```

2.3.3 功能测试

在 PostgreSQL 中创建数据库和用户：

```
# 切换至 opengauss 用户
su opengauss

# 连接数据库
gsql -d postgres
```

当 gsql 连接数据库成功后，在 gsql 交互界面中输入

```
alter role "opengauss" password "openGauss@2024"; -- 修改默认用户密码

CREATE USER testuser WITH PASSWORD 'openEuler12#$'; -- 创建用户

CREATE DATABASE testdb owner testuser; -- 创建数据库
```

修改 opengauss 配置文件

```
vim /var/lib/opengauss/data/postgresql.conf
# 配置 listen_addresses = '*'
# 配置 password_encryption_type = 1

vim /var/lib/opengauss/data/pg_hba.conf
# 末尾增加:
# host     all          testuser          0.0.0.0/0              md5

gs_ctl -D $HOME/data reload
# reload 后即可生效
```

2.3.4 性能测试

安装 sysbench

```
sudo dnf install sysbench
```

修改 opengauss 配置文件

```
vim /var/lib/opengauss/data/postgresql.conf
# 配置 listen_addresses = '*'
# 配置 password_encryption_type = 1
```

```
gs_ctl -D $HOME/data reload
# reload 后即可生效
```

在 openGauss 中创建数据库和用户 (在修改密码规则后必须新建用户或修改密码才能使用)

```
su - opengauss

gsql -d postgres

CREATE USER testuser WITH PASSWORD 'openEuler12#$';

CREATE DATABASE testdb owner testuser;
```

授予权限用于测试

3 测试内容

3.1 手动测试

3.1.1 本地测试

使用 `gsql -U testuser -d testdb` 连接数据库，创建表，并作简单的增删查操作

```
create table phonebook (
    id serial primary key,
    name varchar(20),
    phone varchar(20)
);

insert into phonebook (name, phone) values ('工商银行', '95588');
insert into phonebook (name, phone) values ('招商银行', '95555');
insert into phonebook (name, phone) values ('农业银行', '95599');

insert into phonebook (name, phone) values ('邮政快递', '11183');
insert into phonebook (name, phone) values ('顺丰快递', '95338');
insert into phonebook (name, phone) values ('京东物流', '95311');

select * from phonebook where name like '%银行';
select count(*) from phonebook;
delete from phonebook where name = '农业银行';
select * from phonebook;
```

远程连接测试

3.1.2 远程测试

下载 JDBC_6.0.0[7] 数据库驱动并解压

启动 Dbeaver, 并选择菜单->数据库->驱动管理器，在弹出对话框中，选择新建

填写新建驱动名称->选择 JDBC 驱动文件, 添加解压出来的 `opengauss-jdbc-6.0.0.jar`->选择 JDBC Driver 类

填写 URL 模板，值为:`jdbc:opengauss://{host}:{port}/{database}`, 勾选嵌入，其他复选框不选择，然后确认，添加驱动即完成

选择菜单->数据库->新建连接，在弹出的框中搜索上一步中新建的 JDBC 驱动名, 选择后点击下一步, 如下图示

在弹出框中填写 openGauss 主机地址、端口、将要连接的数据库以及认证用户名和密码，点击测试链接验证是否可正确连接

3.2 性能测试

初始化数据库

```
sysbench --db-driver=pgsql --oltp-table-size=100000 --oltp-tables-count=24 --threads=1 --pgsql-host=127.0.0.1
↪  --pgsql-port=5432 --pgsql-user=testuser --pgsql-password=openEuler12#$ --pgsql-db=testdb
↪  /usr/share/sysbench/tests/include/oltp_legacy/parallel_prepare.lua run
```

使用下列命令验证生成的数据

执行读/写测试

```
sysbench --db-driver=pgsql --report-interval=2 --oltp-table-size=100000 --oltp-tables-count=24 --threads=64 --time=60
↪  --pgsql-host=127.0.0.1 --pgsql-port=5432 --pgsql-user=testuser --pgsql-password=openEuler12#$ --pgsql-db=testdb
↪  /usr/share/sysbench/tests/include/oltp_legacy/oltp.lua run
```

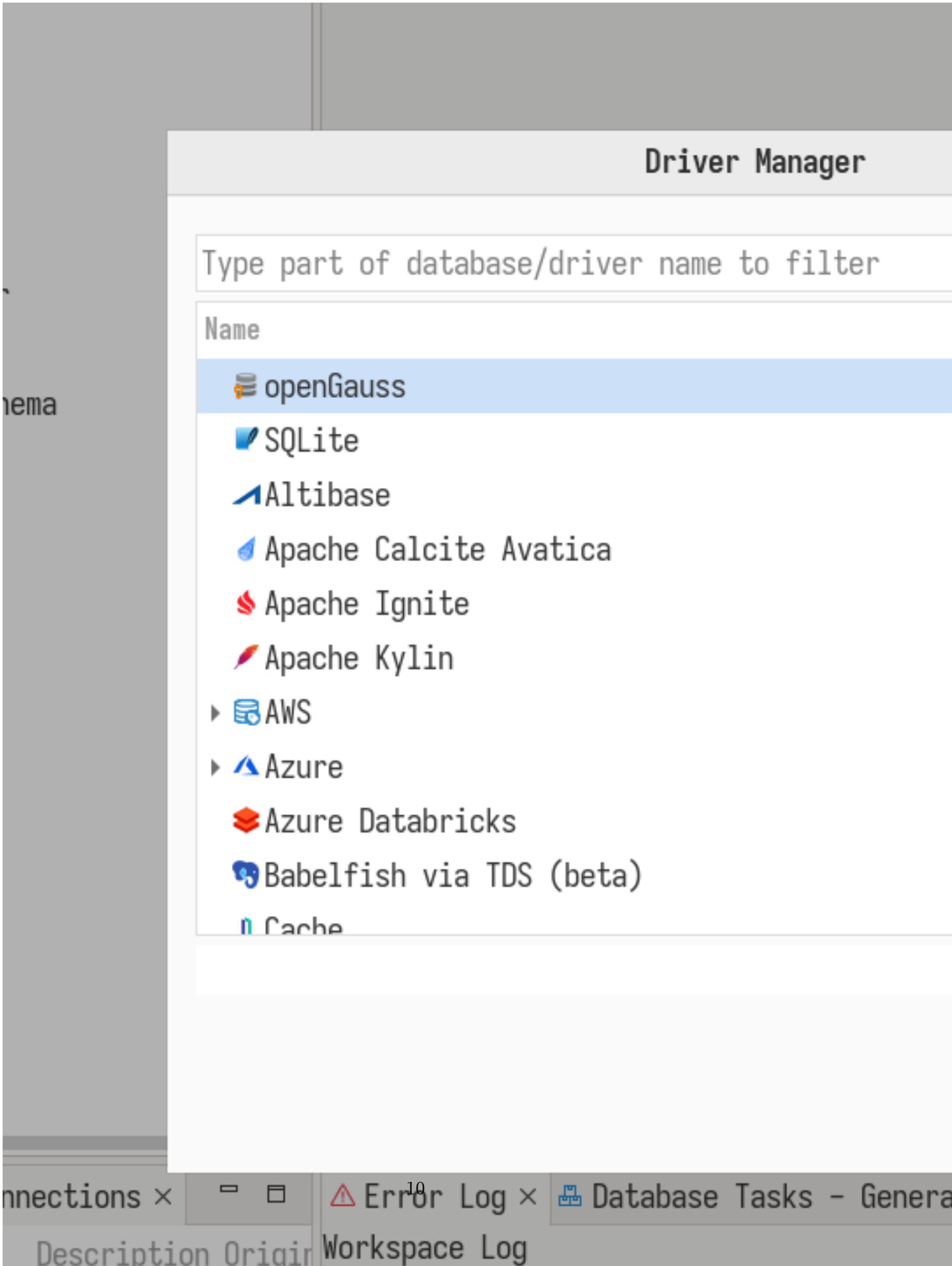
上述命令将从名为 /usr/share/sysbench/tests/include/oltp_legacy/oltp.lua 的 LUA 脚本生成 OLTP 工作负载，针对主服务器上 24 个表的 100,000 行（具有 64 个工作线程）持续 60 秒)。每 2 秒，sysbench 将报告中间统计信息（– report-interval=2)。

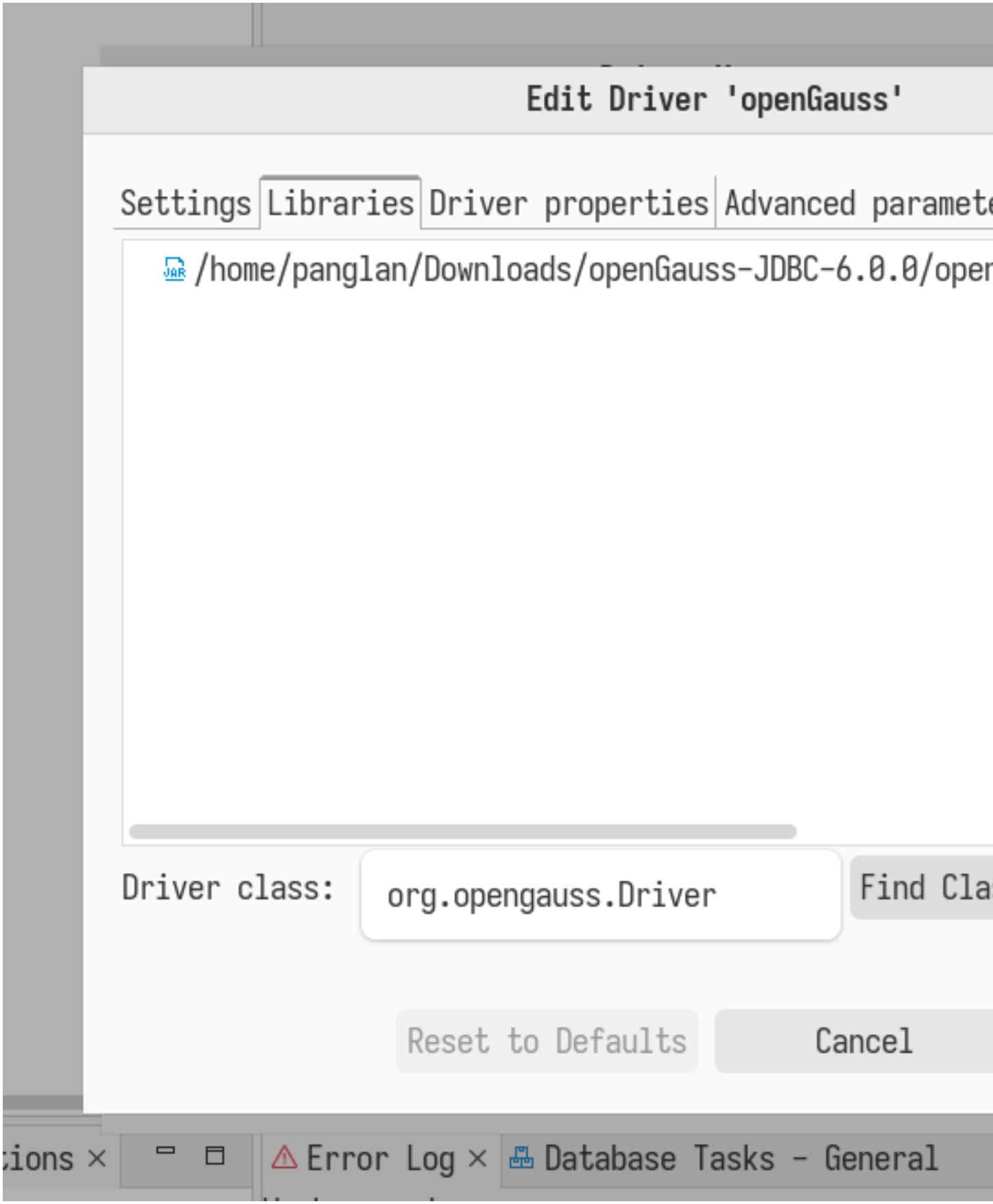
执行只读测试

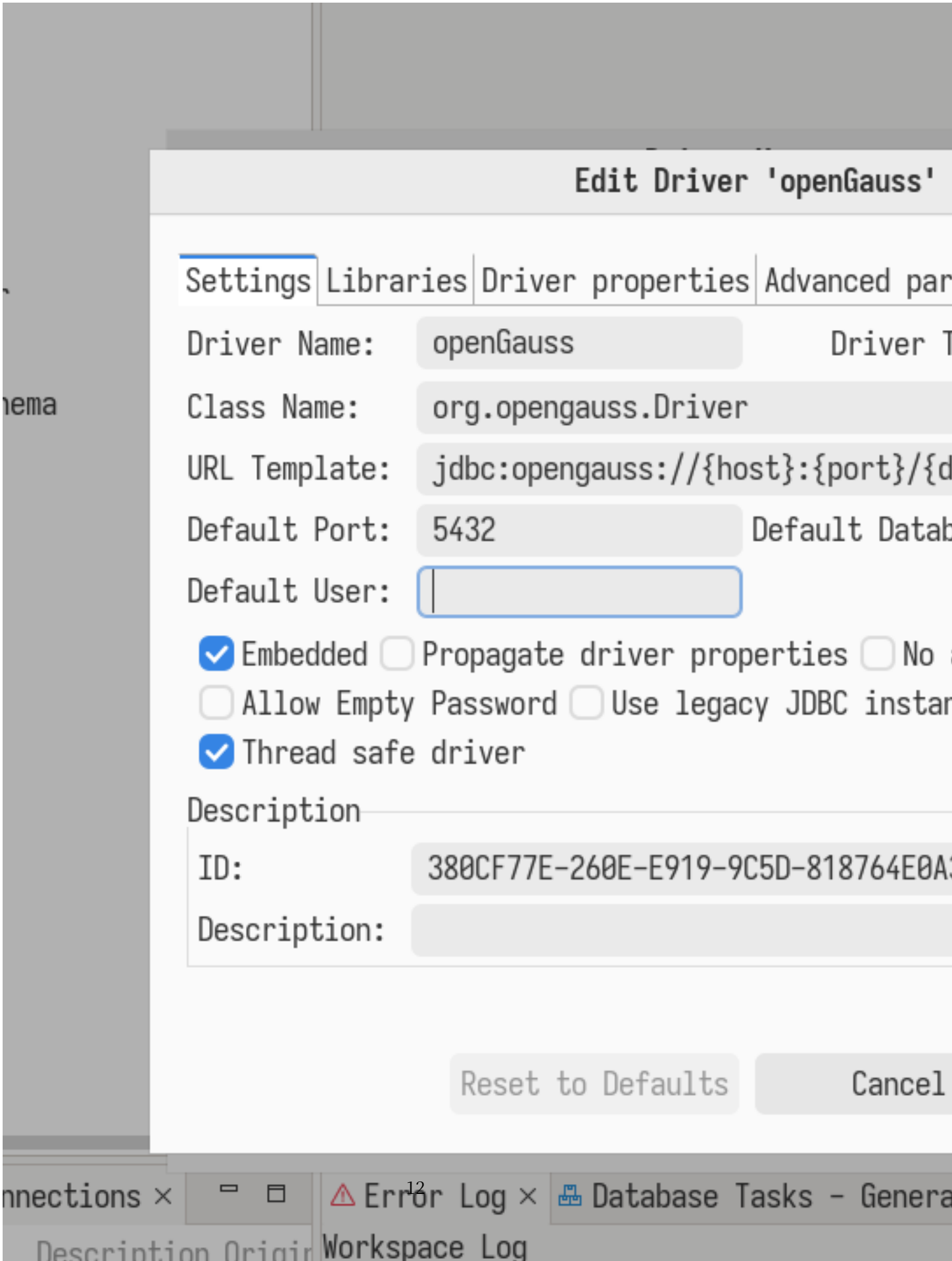
```
sysbench --db-driver=pgsql --report-interval=2 --oltp-table-size=100000 --oltp-tables-count=24 --threads=64 --time=60
↪  --pgsql-host=127.0.0.1 --pgsql-port=5432 --pgsql-user=testuser --pgsql-password=openEuler12#$ --pgsql-db=testdb
↪  /usr/share/sysbench/tests/include/oltp_legacy/select.lua run
```

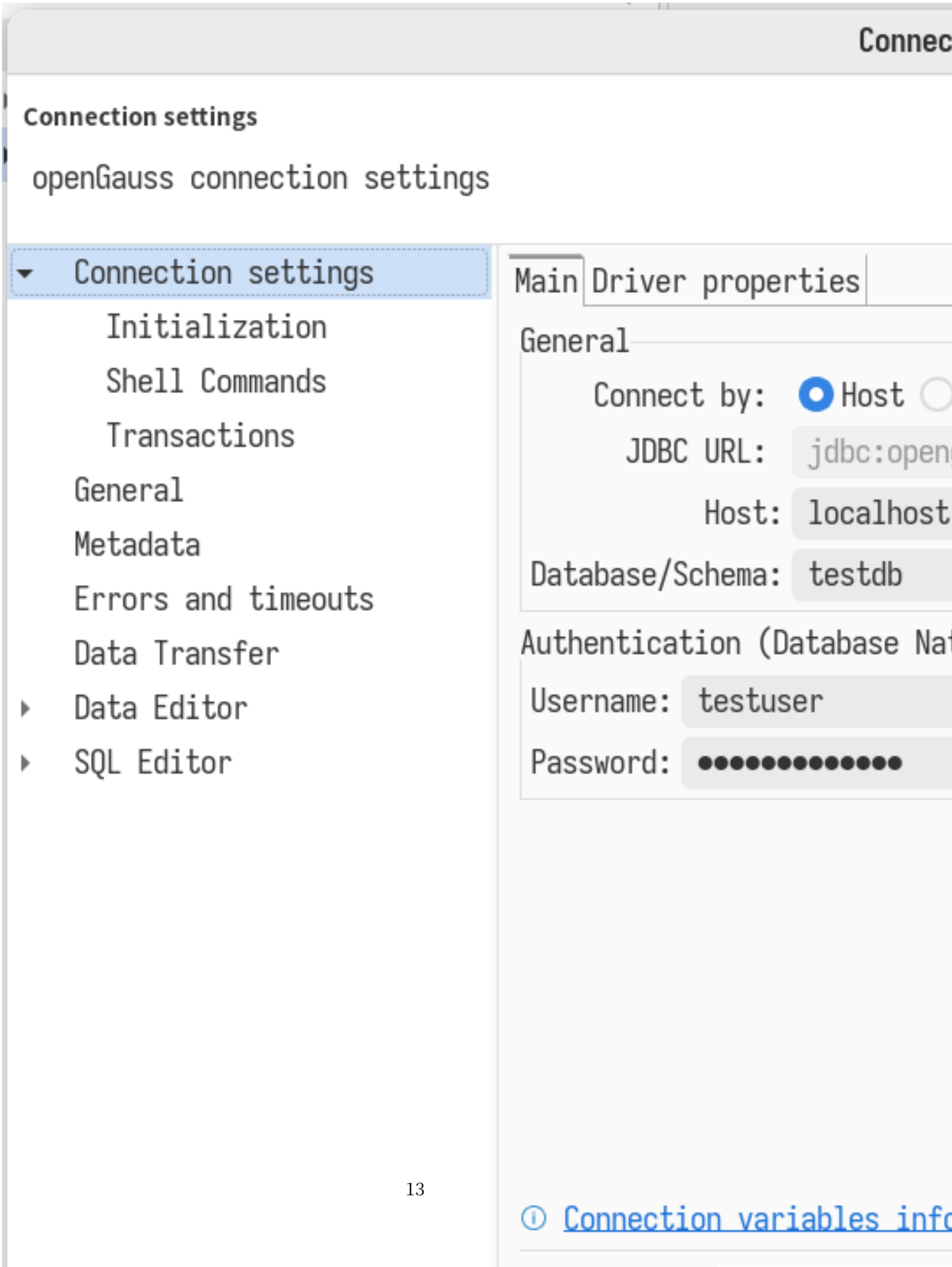
清理测试数据

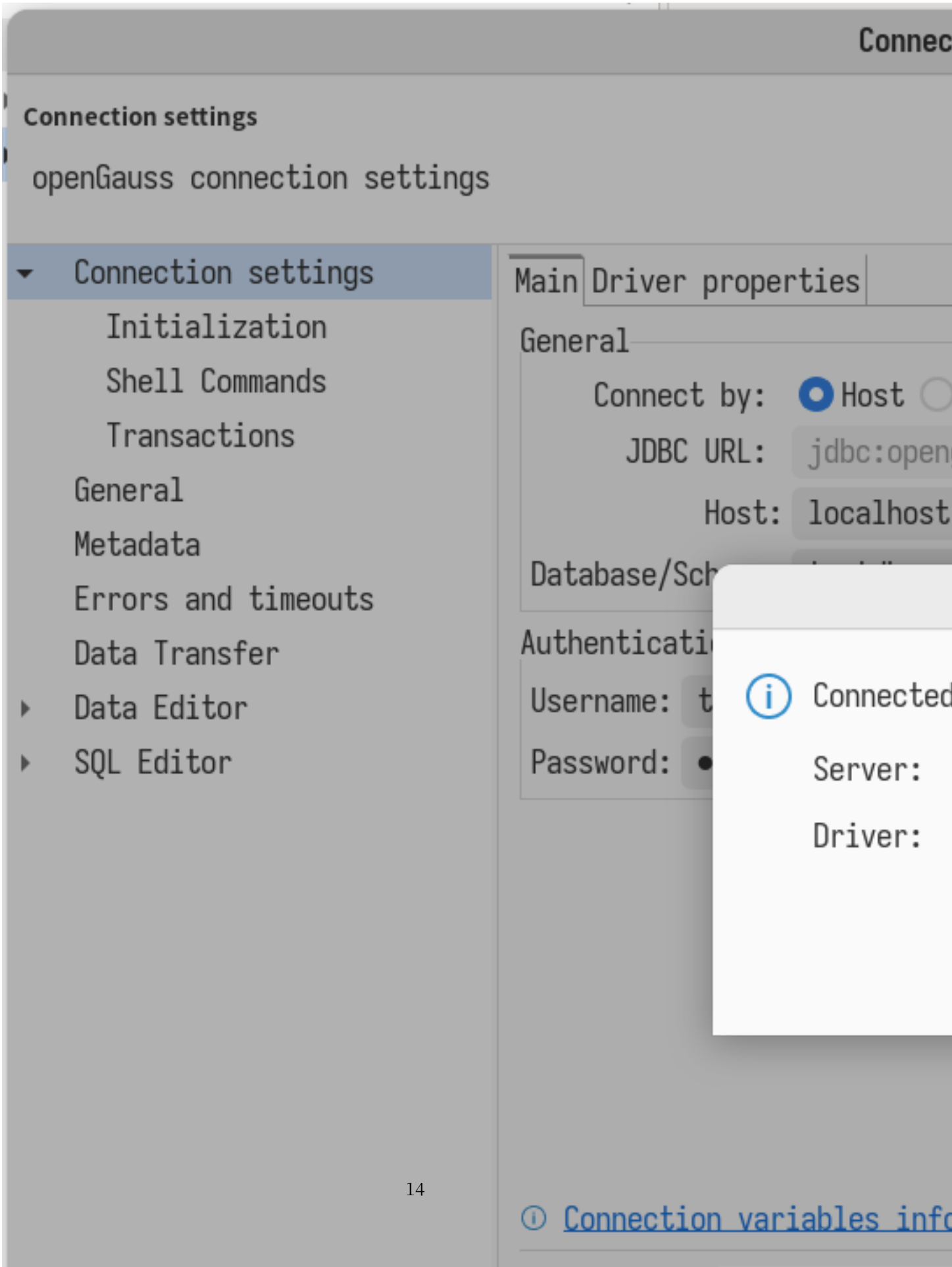
[7] https://opengauss.org/zh/download/


Driver Manager
Type part of database/driver name to filter
Name
openGauss
SQLite
Altibase
Apache Calcite Avatica
Apache Ignite
Apache Kylin
AWS
Azure
Azure Databricks
Babelfish via TDS (beta)
Cache
nnections
Error Log
Database Tasks - Genera
Description Origin
Workspace Log


Edit Driver 'openGauss'
Settings
Libraries
Driver properties
Advanced paramete
/home/panglan/Downloads/openGauss-JDBC-6.0.0/oper
Driver class:
org.opengauss.Driver
Find Cla
Reset to Defaults
Cancel
ions
Error Log
Database Tasks - General


Edit Driver 'openGauss'
Settings
Libraries
Driver properties
Advanced par
Driver Name:
openGauss
Driver T
Class Name:
org.opengauss.Driver
URL Template:
jdbc:opengauss://{host}:{port}/{d
Default Port:
5432
Default Datab
Default User:
Embedded
Propagate driver properties
No
Allow Empty Password
Use legacy JDBC instan
Thread safe driver
Description
ID:
380CF77E-260E-E919-9C5D-818764E0A
Description:
Reset to Defaults
Cancel
nnections
Error Log
Database Tasks - Genera
Description Origin
Workspace Log


Connec
Connection settings
openGauss connection settings
Connection settings
Initialization
Shell Commands
Transactions
General
Metadata
Errors and timeouts
Data Transfer
Data Editor
SQL Editor
Main
Driver properties
General
Connect by:
Host
JDBC URL:
jdbc:open
Host:
localhost
Database/Schema:
testdb
Authentication (Database Na
Username:
testuser
Password:
Connection variables info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SQL Editor
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Driver properties
General
Connect by:
Host
JDBC URL:
jdbc:open
Host:
localhost
Database/Sch
Authenticati
Username:
Password:
Connected
Server:
Driver:
Connection variables info

```
sysbench --db-driver=pgsql --report-interval=2 --oltp-table-size=100000 --oltp-tables-count=24 --threads=64 --time=60
↪  --pgsql-host=127.0.0.1 --pgsql-port=5432 --pgsql-user=testuser --pgsql-password=openEuler12#$ --pgsql-db=testdb
↪  /usr/share/sysbench/tests/include/oltp_legacy/select.lua cleanup
```

4 测试结果

4.1 功能测试

licheepi 4a 由于性能较弱, 在启动 openGauss 服务时超时, 而 Pioneer Box 可以正常进行本地和远程连接

使用 dbeaver 远程连接 openGauss 数据库结果如图所示:

4.2 性能测试

详细结果参见 logs[8] 目录或附录。

性能对比

SQL statistics

rw: oltp 测试, 包含读写 r:select 测试, 仅读

Platform	read	write	other	total	transactions	transactions/s	quer
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SG2042 @ 64 Threads r	1851630	0	0	1851630	1851630	30766.50	1851
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Latency

Platform	min	avg	max	95th percentile	sum
SG2042 @ 10 Threads rw	25.62	30.13	99.91	33.72	599938.70
SG2042 @ 64 Threads rw	38.63	56.49	421.75	70.55	3842023.49
SG2042 @ 64 Threads rw	1.12	2.06	353.15	3.30	3822093.08
X86_64 @ 10 Threads rw	5.23	14.37	1569.33	21.50	599913.47

Threads fairness

Platform	events avg	events stddev	execution time avg	execution time stddev
SG2042 @ 10 Threads rw	1991.3000	32.68	59.9939	0.01
SG2042 @ 64 Threads rw	1062.6406	24.58	60.0316	0.03
SG2042 @ 64 Threads r	28931.7188	1217.10	59.7202	0.03
X86_64 @ 10 Threads rw	4174.7000	12.74	59.9913	0.00

[8] https://github.com/QA-Team-lo/dbtest/tree/main/opengauss/logs

4.2.1 已知问题

时间所限，笔者暂时没有找到合适的测试机，文中所使用的 Openeuler X86_64 机器运行在 Hdd 上，I/O 性能会有严重瓶颈。这可能会影响 openGauss 的性能表现。

x86_64 机器运行在 PVE 虚拟化环境下。通常来说，KVM 虚拟化会有性能损失，但不会很大。这也可能会影响性能表现。

此外，内存大小不同也可能影响性能。

5 总结

本次测试确认了 openGauss 在 RISC-V 平台上的初步可用性。在 Milk-V Pioneer Box 上，openGauss 能够稳定运行并提供良好的用户体验，而在性能更低的 Sipeed LicheePi 4A 上，由于硬件的限制，无法顺利启动服务。性能测试结果显示，在多线程操作下，Milk-V Pioneer Box 的性能与 x86_64 平台相比仍有差距。具体来说，在读写混合负载下，x86_64 平台的事务和查询处理能力明显高于 Pioneer Box。

A 附录

SG2042 openEuler 2403 10 线程

```
sysbench 1.0.20 (using system LuaJIT 2.1.ROLLING)

Running the test with following options:
Number of threads: 10
Report intermediate results every 2 second(s)
Initializing random number generator from current time

Initializing worker threads...

Threads started!

[ 2s ] thds: 10 tps: 309.76 qps: 6252.70 (r/w/o: 4385.71/1242.51/624.48) lat (ms,95%): 34.95 err/s: 0.0
[ 4s ] thds: 10 tps: 332.75 qps: 6657.07 (r/w/o: 4660.05/1331.51/665.51) lat (ms,95%): 34.33 err/s: 0.0
[ 6s ] thds: 10 tps: 324.53 qps: 6499.64 (r/w/o: 4552.45/1297.13/650.06) lat (ms,95%): 35.59 err/s: 0.5
[ 8s ] thds: 10 tps: 332.51 qps: 6644.63 (r/w/o: 4649.59/1331.03/664.01) lat (ms,95%): 33.12 err/s: 0.0
[ 10s ] thds: 10 tps: 332.99 qps: 6654.26 (r/w/o: 4656.33/1330.95/666.98) lat (ms,95%): 33.72 err/s: 0.
[ 12s ] thds: 10 tps: 324.51 qps: 6499.60 (r/w/o: 4552.57/1298.02/649.01) lat (ms,95%): 34.33 err/s: 0.
[ 14s ] thds: 10 tps: 333.51 qps: 6668.63 (r/w/o: 4667.09/1334.53/667.01) lat (ms,95%): 33.72 err/s: 0.
[ 16s ] thds: 10 tps: 324.82 qps: 6477.44 (r/w/o: 4530.01/1297.79/649.64) lat (ms,95%): 34.33 err/s: 0.
[ 18s ] thds: 10 tps: 328.18 qps: 6561.13 (r/w/o: 4593.54/1311.73/655.86) lat (ms,95%): 36.89 err/s: 0.
[ 20s ] thds: 10 tps: 335.49 qps: 6735.39 (r/w/o: 4718.92/1344.98/671.49) lat (ms,95%): 31.94 err/s: 0.
[ 22s ] thds: 10 tps: 331.51 qps: 6628.14 (r/w/o: 4641.60/1323.53/663.01) lat (ms,95%): 34.33 err/s: 0.
[ 24s ] thds: 10 tps: 336.49 qps: 6707.86 (r/w/o: 4689.40/1345.47/672.99) lat (ms,95%): 31.94 err/s: 0.
[ 26s ] thds: 10 tps: 338.87 qps: 6789.99 (r/w/o: 4755.24/1357.00/677.75) lat (ms,95%): 31.94 err/s: 0.
[ 28s ] thds: 10 tps: 333.13 qps: 6652.01 (r/w/o: 4652.76/1333.00/666.25) lat (ms,95%): 33.12 err/s: 0.
[ 30s ] thds: 10 tps: 326.43 qps: 6546.03 (r/w/o: 4585.47/1307.71/652.85) lat (ms,95%): 33.12 err/s: 0.
[ 32s ] thds: 10 tps: 329.41 qps: 6575.12 (r/w/o: 4599.18/1317.12/658.81) lat (ms,95%): 33.72 err/s: 0.
[ 34s ] thds: 10 tps: 339.17 qps: 6785.93 (r/w/o: 4754.40/1353.18/678.34) lat (ms,95%): 31.94 err/s: 0.
[ 36s ] thds: 10 tps: 333.20 qps: 6674.90 (r/w/o: 4672.23/1336.27/666.40) lat (ms,95%): 31.94 err/s: 0.
[ 38s ] thds: 10 tps: 337.83 qps: 6747.99 (r/w/o: 4721.02/1352.32/674.65) lat (ms,95%): 32.53 err/s: 0.
[ 40s ] thds: 10 tps: 335.00 qps: 6709.08 (r/w/o: 4702.56/1335.52/671.01) lat (ms,95%): 31.94 err/s: 0.
[ 42s ] thds: 10 tps: 334.88 qps: 6691.17 (r/w/o: 4681.37/1340.03/669.77) lat (ms,95%): 33.12 err/s: 0.
[ 44s ] thds: 10 tps: 331.59 qps: 6605.82 (r/w/o: 4616.77/1325.86/663.18) lat (ms,95%): 33.12 err/s: 0.
[ 46s ] thds: 10 tps: 330.48 qps: 6638.00 (r/w/o: 4651.65/1325.90/660.45) lat (ms,95%): 36.24 err/s: 0.
[ 48s ] thds: 10 tps: 336.55 qps: 6744.42 (r/w/o: 4725.14/1345.68/673.59) lat (ms,95%): 31.94 err/s: 0.
[ 50s ] thds: 10 tps: 337.01 qps: 6728.15 (r/w/o: 4707.10/1347.03/674.01) lat (ms,95%): 32.53 err/s: 0.
```

```
[ 52s ] thds: 10 tps: 332.57 qps: 6646.48 (r/w/o: 4651.03/1330.29/665.15) lat (ms,95%): 33.12 err/s: 0.
[ 54s ] thds: 10 tps: 333.61 qps: 6683.78 (r/w/o: 4680.59/1335.95/667.23) lat (ms,95%): 33.12 err/s: 0.
[ 56s ] thds: 10 tps: 326.45 qps: 6505.01 (r/w/o: 4546.31/1305.80/652.90) lat (ms,95%): 34.95 err/s: 0.
[ 58s ] thds: 10 tps: 333.98 qps: 6690.57 (r/w/o: 4688.70/1333.91/667.96) lat (ms,95%): 31.94 err/s: 0.
[ 60s ] thds: 10 tps: 332.89 qps: 6658.81 (r/w/o: 4660.46/1333.06/665.28) lat (ms,95%): 33.12 err/s: 0.
SQL statistics:
    queries performed:
        read:                            278796
        write:                           79654
        other:                           39828
        total:                           398278
    transactions:                        19913  (331.56 per sec.)
    queries:                             398278 (6631.51 per sec.)
    ignored errors:                      1      (0.02 per sec.)
    reconnects:                          0      (0.00 per sec.)

General statistics:
    total time```text
    total time:                          60.0473s
    total number of events:              19913

Latency (ms):
         min:                                    25.62
         avg:                                    30.13
         max:                                    99.91
         95th percentile:                        33.72
         sum:                                599938.70

Threads fairness:
    events (avg/stddev):           1991.3000/32.68
    execution time (avg/stddev):   59.9939/0.01
```

SG2042 openEuler 2403 64 线程

```
sysbench 1.0.20 (using system LuaJIT 2.1.ROLLING)

Running the test with following options:
Number of threads: 64
Report intermediate results every 2 second(s)
Initializing random number generator from current time
```

```
Initializing worker threads...

Threads started!

[ 2s ] thds: 64 tps: 908.23 qps: 18469.12 (r/w/o: 12975.05/3646.67/1847.40) lat (ms,95%): 77.19 err/s:
[ 4s ] thds: 64 tps: 1133.28 qps: 22709.17 (r/w/o: 15898.34/4542.24/2268.59) lat (ms,95%): 70.55 err/s:
[ 6s ] thds: 64 tps: 1175.54 qps: 23535.38 (r/w/o: 16473.12/4709.18/2353.09) lat (ms,95%): 63.32 err/s:
[ 8s ] thds: 64 tps: 1093.53 qps: 21849.17 (r/w/o: 15298.47/4363.14/2187.57) lat (ms,95%): 77.19 err/s:
[10s ] thds: 64 tps: 1067.83 qps: 21403.96 (r/w/o: 14993.02/4273.31/2137.64) lat (ms,95%): 81.48 err/s:
[12s ] thds: 64 tps: 913.50 qps: 18252.31 (r/w/o: 12764.69/3660.61/1827.01) lat (ms,95%): 287.38 err/s:
[14s ] thds: 64 tps: 1138.09 qps: 22758.33 (r/w/o: 15933.28/4546.87/2278.18) lat (ms,95%): 70.55 err/s:
[16s ] thds: 64 tps: 1183.26 qps: 23643.64 (r/w/o: 16549.10/4729.03/2365.52) lat (ms,95%): 64.47 err/s:
[18s ] thds: 64 tps: 1135.01 qps: 22797.18 (r/w/o: 15971.12/4554.54/2271.53) lat (ms,95%): 70.55 err/s:
[20s ] thds: 64 tps: 1157.61 qps: 23076.14 (r/w/o: 16140.99/4620.43/2314.72) lat (ms,95%): 69.29 err/s:
[22s ] thds: 64 tps: 1112.28 qps: 22233.18 (r/w/o: 15561.48/4446.64/2225.06) lat (ms,95%): 74.46 err/s:
[24s ] thds: 64 tps: 1151.87 qps: 23063.98 (r/w/o: 16148.74/4609.49/2305.75) lat (ms,95%): 70.55 err/s:
[26s ] thds: 64 tps: 1147.43 qps: 22931.02 (r/w/o: 16049.95/4587.21/2293.85) lat (ms,95%): 69.29 err/s:
[28s ] thds: 64 tps: 1145.66 qps: 22909.15 (r/w/o: 16040.21/4577.13/2291.82) lat (ms,95%): 70.55 err/s:
[30s ] thds: 64 tps: 1176.85 qps: 23516.09 (r/w/o: 16454.97/4705.91/2355.20) lat (ms,95%): 65.65 err/s:
[32s ] thds: 64 tps: 1138.65 qps: 22778.07 (r/w/o: 15942.65/4557.11/2278.31) lat (ms,95%): 71.83 err/s:
[34s ] thds: 64 tps: 1131.28 qps: 22671.64 (r/w/o: 15874.95/4533.63/2263.06) lat (ms,95%): 70.55 err/s:
[36s ] thds: 64 tps: 1139.27 qps: 22804.42 (r/w/o: 15974.31/4552.07/2278.04) lat (ms,95%): 74.46 err/s:
[38s ] thds: 64 tps: 1179.87 qps: 23597.88 (r/w/o: 16508.17/4727.97/2361.74) lat (ms,95%): 65.65 err/s:
[40s ] thds: 64 tps: 1127.22 qps: 22572.91 (r/w/o: 15799.59/4518.88/2254.44) lat (ms,95%): 75.82 err/s:
[42s ] thds: 64 tps: 1179.72 qps: 23602.94 (r/w/o: 16530.10/4713.90/2358.95) lat (ms,95%): 65.65 err/s:
[44s ] thds: 64 tps: 1146.00 qps: 22918.55 (r/w/o: 16038.03/4587.01/2293.51) lat (ms,95%): 70.55 err/s:
[46s ] thds: 64 tps: 1157.01 qps: 23117.66 (r/w/o: 16189.10/4614.04/2314.51) lat (ms,95%): 68.05 err/s:
[48s ] thds: 64 tps: 1205.76 qps: 24106.18 (r/w/o: 16869.63/4825.54/2411.02) lat (ms,95%): 63.32 err/s:
[50s ] thds: 64 tps: 1138.44 qps: 22797.83 (r/w/o: 15967.67/4552.77/2277.39) lat (ms,95%): 69.29 err/s:
[52s ] thds: 64 tps: 1140.39 qps: 22755.29 (r/w/o: 15918.43/4554.06/2282.79) lat (ms,95%): 71.83 err/s:
[54s ] thds: 64 tps: 1139.00 qps: 22813.16 (r/w/o: 15974.22/4562.43/2276.51) lat (ms,95%): 69.29 err/s:
[56s ] thds: 64 tps: 1196.97 qps: 23889.99 (r/w/o: 16713.71/4780.32/2395.96) lat (ms,95%): 65.65 err/s:
[58s ] thds: 64 tps: 1139.29 qps: 22812.75 (r/w/o: 15972.02/4563.15/2277.57) lat (ms,95%): 70.55 err/s:
[60s ] thds: 64 tps: 1167.62 qps: 23345.45 (r/w/o: 16338.22/4669.99/2337.24) lat (ms,95%): 68.05 err/s:
SQL statistics:
    queries performed:
        read:                            952280
        write:                           272041
        other:                           136057
```

```
        total:                          1360378
    transactions:                       68009  (1128.35 per sec.)
    queries:                            1360378 (22570.22 per sec.)
    ignored errors:                     11     (0.18 per sec.)
    reconnects:                         0      (0.00 per sec.)

General statistics:
    total time:                         60.2661s
    total number of events:             68009

Latency (ms):
         min:                                   38.63
         avg:                                   56.49
         max:                                  421.75
         95th percentile:                       70.55
         sum:                                 3842023.49

Threads fairness:
    events (avg/stddev):           1062.6406/24.58
    execution time (avg/stddev):   60.0316/0.03
```

SG2042 openEuler 2403 64 线程 仅读

```
sysbench 1.0.20 (using system LuaJIT 2.1.ROLLING)

Running the test with following options:
Number of threads: 64
Report intermediate results every 2 second(s)
Initializing random number generator from current time

Initializing worker threads...

Threads started!

[ 2s ] thds: 64 tps: 26520.23 qps: 26520.72 (r/w/o: 26520.72/0.00/0.00) lat (ms,95%): 3.30 err/s: 0.00
[ 4s ] thds: 64 tps: 30936.92 qps: 30936.42 (r/w/o: 30936.42/0.00/0.00) lat (ms,95%): 3.19 err/s: 0.00
[ 6s ] thds: 64 tps: 30838.62 qps: 30839.12 (r/w/o: 30839.12/0.00/0.00) lat (ms,95%): 3.25 err/s: 0.00
[ 8s ] thds: 64 tps: 30584.49 qps: 30584.49 (r/w/o: 30584.49/0.00/0.00) lat (ms,95%): 3.25 err/s: 0.00
[10s ] thds: 64 tps: 28539.22 qps: 28539.22 (r/w/o: 28539.22/0.00/0.00) lat (ms,95%): 3.49 err/s: 0.00
[12s ] thds: 64 tps: 30937.69 qps: 30937.69 (r/w/o: 30937.69/0.00/0.00) lat (ms,95%): 3.30 err/s: 0.00
```

```
[14s ] thds: 64 tps: 31212.48 qps: 31212.48 (r/w/o: 31212.48/0.00/0.00) lat (ms,95%): 3.25 err/s: 0.00
[16s ] thds: 64 tps: 31466.14 qps: 31466.14 (r/w/o: 31466.14/0.00/0.00) lat (ms,95%): 3.25 err/s: 0.00
[18s ] thds: 64 tps: 30756.22 qps: 30755.73 (r/w/o: 30755.73/0.00/0.00) lat (ms,95%): 3.36 err/s: 0.00
[20s ] thds: 64 tps: 32332.23 qps: 32332.23 (r/w/o: 32332.23/0.00/0.00) lat (ms,95%): 3.25 err/s: 0.00
[22s ] thds: 64 tps: 32277.47 qps: 32278.48 (r/w/o: 32278.48/0.00/0.00) lat (ms,95%): 3.19 err/s: 0.00
[24s ] thds: 64 tps: 31847.74 qps: 31846.74 (r/w/o: 31846.74/0.00/0.00) lat (ms,95%): 3.25 err/s: 0.00
[26s ] thds: 64 tps: 31205.84 qps: 31206.34 (r/w/o: 31206.34/0.00/0.00) lat (ms,95%): 3.25 err/s: 0.00
[28s ] thds: 64 tps: 30860.64 qps: 30860.14 (r/w/o: 30860.14/0.00/0.00) lat (ms,95%): 3.30 err/s: 0.00
[30s ] thds: 64 tps: 31713.07 qps: 31713.57 (r/w/o: 31713.57/0.00/0.00) lat (ms,95%): 3.25 err/s: 0.00
[32s ] thds: 64 tps: 31504.72 qps: 31504.22 (r/w/o: 31504.22/0.00/0.00) lat (ms,95%): 3.25 err/s: 0.00
[34s ] thds: 64 tps: 31218.52 qps: 31218.52 (r/w/o: 31218.52/0.00/0.00) lat (ms,95%): 3.25 err/s: 0.00
[36s ] thds: 64 tps: 31555.87 qps: 31555.87 (r/w/o: 31555.87/0.00/0.00) lat (ms,95%): 3.25 err/s: 0.00
[38s ] thds: 64 tps: 31282.89 qps: 31282.89 (r/w/o: 31282.89/0.00/0.00) lat (ms,95%): 3.30 err/s: 0.00
[40s ] thds: 64 tps: 31200.90 qps: 31201.40 (r/w/o: 31201.40/0.00/0.00) lat (ms,95%): 3.25 err/s: 0.00
[42s ] thds: 64 tps: 31218.27 qps: 31218.77 (r/w/o: 31218.77/0.00/0.00) lat (ms,95%): 3.25 err/s: 0.00
[44s ] thds: 64 tps: 30811.74 qps: 30810.74 (r/w/o: 30810.74/0.00/0.00) lat (ms,95%): 3.30 err/s: 0.00
[46s ] thds: 64 tps: 30317.17 qps: 30317.17 (r/w/o: 30317.17/0.00/0.00) lat (ms,95%): 3.36 err/s: 0.00
[48s ] thds: 64 tps: 30283.46 qps: 30283.46 (r/w/o: 30283.46/0.00/0.00) lat (ms,95%): 3.36 err/s: 0.00
[50s ] thds: 64 tps: 30143.05 qps: 30143.05 (r/w/o: 30143.05/0.00/0.00) lat (ms,95%): 3.36 err/s: 0.00
[52s ] thds: 64 tps: 30486.58 qps: 30486.58 (r/w/o: 30486.58/0.00/0.00) lat (ms,95%): 3.36 err/s: 0.00
[54s ] thds: 64 tps: 31213.42 qps: 31213.42 (r/w/o: 31213.42/0.00/0.00) lat (ms,95%): 3.25 err/s: 0.00
[56s ] thds: 64 tps: 31230.31 qps: 31230.31 (r/w/o: 31230.31/0.00/0.00) lat (ms,95%): 3.25 err/s: 0.00
[58s ] thds: 64 tps: 30470.09 qps: 30470.59 (r/w/o: 30470.59/0.00/0.00) lat (ms,95%): 3.30 err/s: 0.00
[60s ] thds: 64 tps: 30453.40 qps: 30452.90 (r/w/o: 30452.90/0.00/0.00) lat (ms,95%): 3.30 err/s: 0.00
SQL statistics:
    queries performed:
        read:                            1851630
        write:                           0
        other:                           0
        total:                           1851630
    transactions:                        1851630 (30766.50 per sec.)
    queries:                             1851630 (30766.50 per sec.)
    ignored errors:                      0      (0.00 per sec.)
    reconnects:                          0      (0.00 per sec.)

General statistics:
    total time:                          60.1761s
    total number of events:              1851630

Latency (ms):
```

```
         min:                                  1.12
         avg:                                  2.06
         max:                                353.15
         95th percentile:                      3.30
         sum:                               3822093.08

Threads fairness:
    events (avg/stddev):           28931.7188/1217.10
    execution time (avg/stddev):   59.7202/0.03
```