GreatSQL TPC-H（Turbo引擎）性能测试报告

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GreatSQL 社区

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1. 概述

本次测试针对GreatSQL数据库Turbo引擎基于标准 TPC-H 场景的测试。

TPC-H（商业智能计算测试）是美国交易处理效能委员会（TPC，TransactionProcessing Performance Council）组织制定的用来模拟决策支持类应用的一个测试集。目前，学术界和工业界普遍采用 TPC-H 来评价决策支持技术方面应用的性能。这种商业测试可以全方位评测系统的整体商业计算综合能力，对厂商的要求更高，同时也具有普遍的商业实用意义，目前在银行信贷分析和信用卡分析、电信运营分析、税收分析、烟草行业决策分析中都有广泛的应用，TPC-H 查询包含八张数据表和 22 条复杂 SQL 查询，大多数查询包含多表联接（JOIN）、子查询和聚合查询等。

GreatSQL数据库是一款**开源免费**数据库，可在普通硬件上满足金融级应用场景，具有**高可用**、**高性能**、**高兼容**、**高安全**等特性，可作为MySQL或Percona Server for MySQL的理想可选替换。

2. 测试环境信息

操作系统	OS：CentOS Linux release 7.9.2009 (Core) 内核：3.10.0-1160.el7.x86_64
CPU	Intel(R) Xeon(R) Gold 6238 CPU @ 2.10GHz * 4
内存	251G
磁盘	INTEL SSDPE2KE032T8
数据库	GreatSQL 8.0.32-25, Release 25, Revision 79f57097e3f

服务器详细信息

1. 操作系统

```
$ cat /etc/os-release

NAME="CentOS Linux"
VERSION="7 (Core)"
ID="centos"
ID_LIKE="rhel fedora"
VERSION_ID="7"
PRETTY_NAME="CentOS Linux 7 (Core)"
ANSI_COLOR="0;31"
```

```
CPE_NAME="cpe:/o:centos:centos:7"
HOME_URL="https://www.centos.org/"
BUG_REPORT_URL="https://bugs.centos.org/"

CENTOS_MANTISBT_PROJECT="CentOS-7"
CENTOS_MANTISBT_PROJECT_VERSION="7"
REDHAT_SUPPORT_PRODUCT="centos"
REDHAT_SUPPORT_PRODUCT_VERSION="7"
```

2. CPU

```
$ lscpu

Architecture:          x86_64
CPU op-mode(s):        32-bit, 64-bit
Byte Order:            Little Endian
CPU(s):                176
On-line CPU(s) list:   0-175
Thread(s) per core:    2
Core(s) per socket:    22
Socket(s):             4
NUMA node(s):          4
Vendor ID:             GenuineIntel
CPU family:            6
Model:                 85
Model name:            Intel(R) Xeon(R) Gold 6238 CPU @ 2.10GHz
Stepping:              7
CPU MHz:               1000.012
CPU max MHz:           3700.0000
CPU min MHz:           1000.0000
BogoMIPS:              4200.00
Virtualization:        VT-x
L1d cache:             32K
L1i cache:             32K
L2 cache:              1024K
L3 cache:              30976K
NUMA node0 CPU(s):
0,4,8,12,16,20,24,28,32,36,40,44,48,52,56,60,64,68,72,76,80,84,88,92,96,100,104,108,112,116,120,124,128,132,136,140,144,148,152,156,160,164,168,172
NUMA node1 CPU(s):
1,5,9,13,17,21,25,29,33,37,41,45,49,53,57,61,65,69,73,77,81,85,89,93,97,101,105,109,113,117,121,125,129,133,137,141,145,149,153,157,161,165,169,173
NUMA node2 CPU(s):
2,6,10,14,18,22,26,30,34,38,42,46,50,54,58,62,66,70,74,78,82,86,90,94,98,102,106,110,114,118,122,126,130,134,138,142,146,150,154,158,162,166,170,174
```

```
NUMA node3 CPU(s):
3,7,11,15,19,23,27,31,35,39,43,47,51,55,59,63,67,71,75,79,83,87,91,95,99,103,107,111,115,119,123,127,131,135,139,143,147,151,155,159,163,167,171,175
Flags:                fpu vme de pse tsc msr pae mce cx8 apic sep mtrr pge mca cmov pat pse36 clflush dts acpi mmx fxsr sse sse2 ss ht tm pbe syscall nx pdpe1gb rdtscp lm constant_tsc art arch_perfmon pebs bts rep_good nopl xtopology nonstop_tsc aperfmperf eagerfpu pni pclmulqdq dtes64 monitor ds_cpl vmx smx est tm2 ssse3 sdbg fma cx16 xtpr pdcm pcid dca sse4_1 sse4_2 x2apic movbe popcnt tsc_deadline_timer aes xsave avx f16c rdrand lahf_lm abm 3dnowprefetch epb cat_l3 cdp_l3 invpcid_single intel_ppin intel_pt ssbd mba ibrs ibpb stibp ibrs_enhanced tpr_shadow vnmi flexpriority ept vpid fsgsbase tsc_adjust bmi1 hle avx2 smep bmi2 erms invpcid rtm cqm mpx rdt_a avx512f avx512dq    rdseed adx smap clflushopt clwb avx512cd avx512bw avx512vl xsaveopt xsavec xgetbv1 cqm_llc cqm_occup_llc cqm_mbm_total cqm_mbm_local dtherm ida arat pln pts pku ospke      avx512_vnni md_clear spec_ctrl intel_stibp flush_l1d arch_capabilities
```

3. 内存

```
$ free -ht
              total        used        free      shared  buff/cache   available
Mem:           251G        167G         22G        7.2M         61G         82G
Swap:          4.0G        1.1G        2.9G
Total:         255G        168G         24G
```

4. 磁盘

磁盘设备型号

```
$ nvme list
Node             SN                   Model                    Namespace Usage                      Format           FW Rev
---------------- -------------------- ---------- ------
-------------------- ---------------- --------
/dev/nvme0n1     PHLN018200FD3P2BGN   INTEL SSDPE2KE032T8      1
3.20  TB /   3.20  TB    512   B +  0 B   VDV10152
```

磁盘挂载参数、文件系统

```
$ df -hT | grep ssd
/dev/nvme0n1            xfs       3.0T  1.5T  1.5T  49% /ssd2
```

NVMe SSD设备简单测速

```
$ dd oflag=direct if=/dev/zero of=./zero bs=1M count=20480

20480+0 records in
20480+0 records out
21474836480 bytes (21 GB) copied, 8.69131 s, 2.5 GB/s
```

💡 **提示：在下面运行TPC-H测试时，设置了Turbo引擎最大可使用的内存及线程数。**

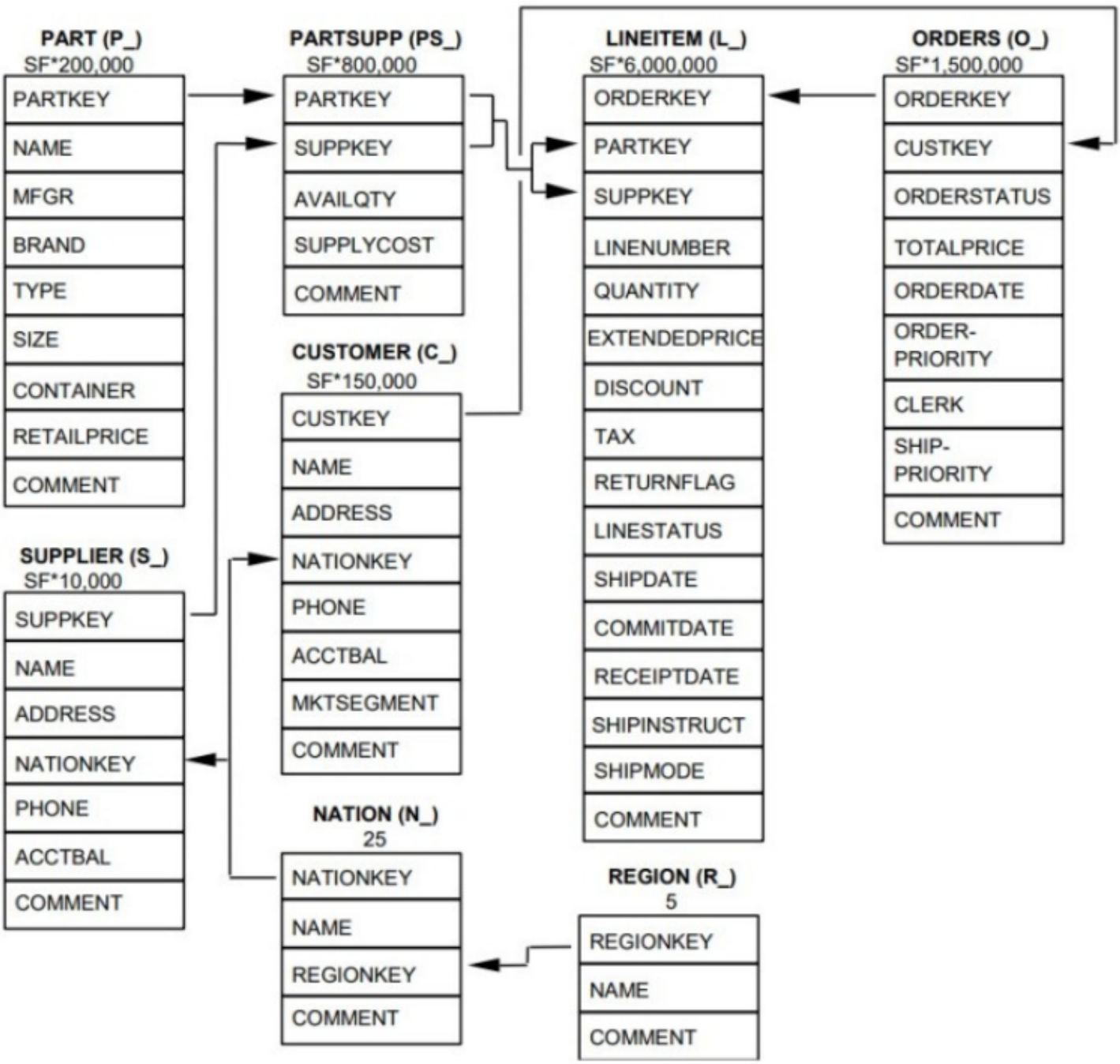
```
SET GLOBAL turbo_memory_limit=68719476736;
SET GLOBAL turbo_worker_threads=32;
```

3. 测试表结构和数据量

各表数据量对比：

表名	TPC-H SF100数据量	TPC-H SF300数据量	备注
region	5	5	地区信息
nation	25	25	国家表
supplier	1000000	3000000	供应商信息
part	20000000	60000000	零件表
customer	15000000	45000000	消费者表
partsupp	80000000	240000000	配件供应表
orders	150000000	450000000	订单表
lineitem	600037902	1799989091	订单明细表

各表结构关系如下图所示：



4. 测试结果

GreatSQL 8.0.32-27中新增的高性能并行查询引擎Turbo，使得其在实时TPC-H性能测试表现明显优于MySQL社区版、Percona Server MySQL、MariaDB等数据库。

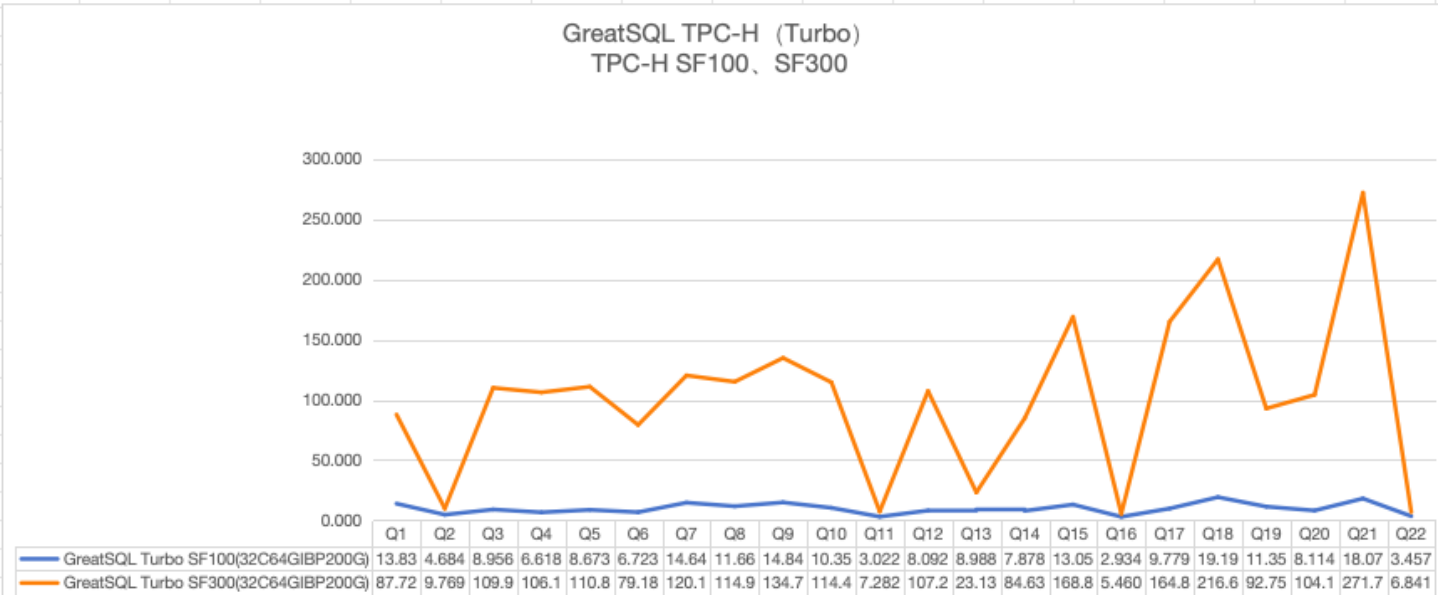
在TPC-H SF100场景下，运行完全部22个TPC-H查询SQL总耗时为 **214.951秒**。在TPC-H SF300场景下，运行完全部22个TPC-H查询SQL总耗时为**2241.448秒**。

每条SQL详细耗时如下：

TPC-H Query（Turbo）	GreatSQL TPC-H SF100（32C64G）耗时（秒）	GreatSQL TPC-H SF300（32C64G）耗时（秒）
Q1	13.839	87.722

Q2	4.684	9.769
Q3	8.956	109.921
Q4	6.618	106.168
Q5	8.673	110.856
Q6	6.723	79.182
Q7	14.645	120.183
Q8	11.669	114.955
Q9	14.845	134.707
Q10	10.359	114.493
Q11	3.022	7.282
Q12	8.092	107.227
Q13	8.988	23.133
Q14	7.878	84.632
Q15	13.051	168.845
Q16	2.934	5.460
Q17	9.779	164.819
Q18	19.197	216.600
Q19	11.355	92.757
Q20	8.114	104.129
Q21	18.073	271.767
Q22	3.457	6.841
总耗时	**214.951**	**2241.448**

GreatSQL TPC-H（Turbo）SF100 vs SF300（32C64G）对比示意图如下



	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22
GreatSQL Turbo SF100(32C64GIBP200G)	13.83	4.684	8.956	6.618	8.673	6.723	14.64	11.66	14.84	10.35	3.022	8.092	8.988	7.878	13.05	2.934	9.779	19.19	11.35	8.114	18.07	3.457
GreatSQL Turbo SF300(32C64GIBP200G)	87.72	9.769	109.9	106.1	110.8	79.18	120.1	114.9	134.7	114.4	7.282	107.2	23.13	84.63	168.8	5.460	164.8	216.6	92.75	104.1	271.7	6.841

5. 测试步骤

5.1 安装 GreatSQL

请参考GreatSQL手册内容：安装指南，完成GreatSQL安装。

5.2 生成 TPC-H 测试数据

请参考GreatSQL手册内容：TPC-H性能测试，完成TPC-H工具编译安装。

运行 TPC-H `dbgen` 工具，生成数据文件，一共会生成 8 个表对应的 tbl 数据文件，例如：

```
$ ./dbgen -vf -s 100
...

$ ls -l *tbl
-rw-r--r-- 1 root root  2463490271 Sep 26 09:20 customer.tbl
-rw-r--r-- 1 root root 79579694556 Sep 26 09:20 lineitem.tbl
-rw-r--r-- 1 root root        2224 Sep 26 09:20 nation.tbl
-rw-r--r-- 1 root root 17793116301 Sep 26 09:20 orders.tbl
-rw-r--r-- 1 root root 12209211160 Sep 26 09:20 partsupp.tbl
-rw-r--r-- 1 root root  2453234158 Sep 26 09:20 part.tbl
-rw-r--r-- 1 root root         389 Sep 26 09:20 region.tbl
-rw-r--r-- 1 root root   142869803 Sep 26 09:20 supplier.tbl
```

也可以参考 pdbgen.sh 脚本做法，并行生成测试数据。

5.3 创建 TPC-H 测试数据库表并导入数据

参考GreatSQL社区提供的TPC-H数据库表初始化脚本：tpch-create-table.sql，完成TPC-H测试数据库表创建。

```
$ mysql -f < tpch-create-table.sql
$ mysqlshow tpch100
Database: tpch100
+----------+
|  Tables  |
+----------+
| customer |
| lineitem |
| nation   |
| orders   |
| part     |
| partsupp |
| region   |
| revenue0 |
| supplier |
+----------+
```

利用GreatSQL的 **parallel load data特性** 并行导入TPC-H测试数据。

需要先修改GreatSQL选项 `secure_file_priv` 设置，指向上述 workdir 所在目录，重启GreatSQL使之生效。

参考GreatSQL社区提供的并发导入脚本：load-data-parallel.sh，完成数据导入。

也可以参考 pload.sh 脚本做法，并行导入数据。

> 💡 **提示：运行LOAD DATA导入数据时，可能会在 tmpdir 产生临时文件，因此要保证 tmpdir 有足够的剩余可用磁盘空间。**

5.4 确认Turbo引擎设置

数据导入完成后，在开始运行TPC-H测试前，要先加载Turbo引擎，并修改可用内存及并发线程数等相关设置。

1. 安装Turbo引擎

```
INSTALL PLUGIN turbo SONAME 'turbo.so';
```

2. 查看Turbo引擎已安装成功

```
greatsql> SELECT * FROM information_schema.PLUGINS WHERE PLUGIN_NAME='turbo'\G
*************************** 1. row ***************************
            PLUGIN_NAME: turbo
         PLUGIN_VERSION: 0.1
          PLUGIN_STATUS: ACTIVE
            PLUGIN_TYPE: QUERY PLAN
    PLUGIN_TYPE_VERSION: 1.0
         PLUGIN_LIBRARY: turbo.so
PLUGIN_LIBRARY_VERSION: 1.11
          PLUGIN_AUTHOR: GreatOpenSource
     PLUGIN_DESCRIPTION: turbo query plan
         PLUGIN_LICENSE: GPL
            LOAD_OPTION: ON
```

3. 修改可用内存及并发线程数等相关设置

```
greatsql> SET GLOBAL turbo_memory_limit=68719476736;
greatsql> SET GLOBAL turbo_worker_threads=32;
```

5.5 执行 TPC-H 测试

执行GreatSQL社区提供的Turbo引擎专用TPC-H性能测试脚本，完成测试，并记录各个SQL的耗时。

该测试脚本大概工作模式如下：

1. 总共有22个查询SQL，每个查询SQL分别执行。
2. 每个查询SQL先运行2次完成数据预热。
3. 每个SQL再执行3次，每次执行SQL都会记录其起止时间，及其耗时，如下面例所示：

```
[2023-09-27 01:38:45] BEGIN RUN TPC-H Q1 1 times
[2023-09-27 01:38:46] TPC-H Q1 END, COST: 1.301s


[2023-09-27 01:38:46] BEGIN RUN TPC-H Q1 2 times
[2023-09-27 01:38:47] TPC-H Q1 END, COST: 0.787s
```

上述结果中的 COST: 1.301s ，即为本SQL的运行耗时：1.301秒。

4. 继续执行下一个查询SQL，直至22个查询SQL全部执行完毕。

可以参考自动化执行脚本 run-tpch.sh 的做法，修改几个参数后即可自动执行。

📌 提示：在运行 `tpch_queries_11.sql` 这个SQL脚本时，需要根据数据量大小调整第17-20行相关的参数。例如当测试数据量是SF100时，调整成如下

```
SELECT /*+ SET_VAR(turbo_enable=ON) SET_VAR(turbo_cost_threshold=0) */ /*+ Q11 */
    ps_partkey,
    sum(ps_supplycost * ps_availqty) AS value
FROM
    partsupp,
    supplier,
    nation
WHERE
    ps_suppkey = s_suppkey
    AND s_nationkey = n_nationkey
    AND n_name = 'GERMANY'
GROUP BY
    ps_partkey
HAVING
    sum(ps_supplycost * ps_availqty) > (
        SELECT
            /* sum(ps_supplycost * ps_availqty) * 0.0001000000 /* SF1 */
            /* sum(ps_supplycost * ps_availqty) * 0.0000100000 /* SF10 */
            sum(ps_supplycost * ps_availqty) * 0.0000010000 /* SF100 */
            /* sum(ps_supplycost * ps_availqty) * 0.0000001000 /* SF1000 */
        FROM
            partsupp,
            supplier,
            nation
        WHERE
            ps_suppkey = s_suppkey
            AND s_nationkey = n_nationkey
            AND n_name = 'GERMANY')
ORDER BY
    value DESC;
```

6. 附录

6.1 创建测试表DDL

```
-- DROP DATABASE IF EXISTS tpch;
-- CREATE DATABASE IF NOT EXISTS tpch DEFAULT CHARACTER SET latin1;
```

```
-- USE tpch;

drop table if exists nation;
create table nation  ( n_nationkey  integer not null,
                                n_name       char(25) not null,
                                n_regionkey  integer not null,
                                n_comment    varchar(152),
                                primary key(n_nationkey),
                                key nation_fk1 (n_regionkey) )
secondary_engine = rapid;

drop table if exists region;
create table region  ( r_regionkey  integer not null,
                                r_name       char(25) not null,
                                r_comment    varchar(152),
                                primary key(r_regionkey) ) secondary_engine =
rapid;

drop table if exists part;
create table part  ( p_partkey     integer not null,
                                p_name        varchar(55) not null,
                                p_mfgr        char(25) not null,
                                p_brand       char(10) not null,
                                p_type        varchar(25) not null,
                                p_size        integer not null,
                                p_container   char(10) not null,
                                p_retailprice decimal(15,2) not null,
                                p_comment     varchar(23) not null,
                                primary key(p_partkey) ) secondary_engine =
rapid;

drop table if exists supplier;
create table supplier ( s_suppkey     integer not null,
                                s_name        char(25) not null,
                                s_address     varchar(40) not null,
                                s_nationkey   integer not null,
                                s_phone       char(15) not null,
                                s_acctbal     decimal(15,2) not null,
                                s_comment     varchar(101) not null,
                                primary key(s_suppkey),
                                key supplier_fk1 (s_nationkey) )
secondary_engine = rapid;

drop table if exists partsupp;
create table partsupp ( ps_partkey     integer not null,
                                ps_suppkey     integer not null,
                                ps_availqty    integer not null,
```

```
                                ps_supplycost  decimal(15,2)  not null,
                                ps_comment     varchar(199) not null,
                                primary key(ps_partkey,ps_suppkey),
                                key partsupp_fk1 (ps_suppkey),
                                key partsupp_fk2 (ps_partkey) )
secondary_engine = rapid;


drop table if exists customer;
create table customer ( c_custkey     integer not null,
                                c_name        varchar(25) not null,
                                c_address     varchar(40) not null,
                                c_nationkey   integer not null,
                                c_phone       char(15) not null,
                                c_acctbal     decimal(15,2)   not null,
                                c_mktsegment  char(10) not null,
                                c_comment     varchar(117) not null,
                                primary key(c_custkey),
                                key customer_fk1 (c_nationkey) )
secondary_engine = rapid;

drop table if exists orders;
create table orders  ( o_orderkey       integer not null,
                                o_custkey        integer not null,
                                o_orderstatus    char(1) not null,
                                o_totalprice     decimal(15,2) not null,
                                o_orderdate      date not null,
                                o_orderpriority  char(15) not null,
                                o_clerk          char(15) not null,
                                o_shippriority   integer not null,
                                o_comment        varchar(79) not null,
                                primary key(o_orderkey),
                                key orders_fk1 (o_custkey) ) secondary_engine
= rapid;

drop table if exists lineitem;
create table lineitem ( l_orderkey    integer not null,
                                l_partkey     integer not null,
                                l_suppkey     integer not null,
                                l_linenumber  integer not null,
                                l_quantity    decimal(15,2) not null,
                                l_extendedprice  decimal(15,2) not null,
                                l_discount    decimal(15,2) not null,
                                l_tax         decimal(15,2) not null,
                                l_returnflag  char(1) not null,
                                l_linestatus  char(1) not null,
                                l_shipdate    date not null,
```

```
                                l_commitdate  date not null,
                                l_receiptdate date not null,
                                l_shipinstruct char(25) not null,
                                l_shipmode     char(10) not null,
                                l_comment      varchar(44) not null,
                                primary key(l_orderkey,l_linenumber),
                                key lineitem_fk1 (l_orderkey) ,
                                key lineitem_fk2 (l_partkey,l_suppkey) )
secondary_engine = rapid;
```

6.2 22条TPC-H测试SQL

```
-- tpch_queries_1.sql
SELECT /*+ SET_VAR(use_secondary_engine=1)
SET_VAR(secondary_engine_cost_threshold=0) */ /*+ Q1 */
    l_returnflag,
    l_linestatus,
    sum(l_quantity) AS sum_qty,
    sum(l_extendedprice) AS sum_base_price,
    sum(l_extendedprice * (1 - l_discount)) AS sum_disc_price,
    sum(l_extendedprice * (1 - l_discount) * (1 + l_tax)) AS sum_charge,
    avg(l_quantity) AS avg_qty,
    avg(l_extendedprice) AS avg_price,
    avg(l_discount) AS avg_disc,
    count(*) AS count_order
FROM
    lineitem
WHERE
    l_shipdate <= CAST('1998-09-02' AS date)
GROUP BY
    l_returnflag,
    l_linestatus
ORDER BY
    l_returnflag,
    l_linestatus;



-- tpch_queries_2.sql
SELECT /*+ SET_VAR(use_secondary_engine=1)
SET_VAR(secondary_engine_cost_threshold=0) */ /*+ Q2 */
    s_acctbal,
    s_name,
    n_name,
```

```
    p_partkey,
    p_mfgr,
    s_address,
    s_phone,
    s_comment
FROM
    part,
    supplier,
    partsupp,
    nation,
    region
WHERE
    p_partkey = ps_partkey
    AND s_suppkey = ps_suppkey
    AND p_size = 15
    AND p_type LIKE '%BRASS'
    AND s_nationkey = n_nationkey
    AND n_regionkey = r_regionkey
    AND r_name = 'EUROPE'
    AND ps_supplycost = (
        SELECT
            min(ps_supplycost)
        FROM
            partsupp,
            supplier,
            nation,
            region
        WHERE
            p_partkey = ps_partkey
            AND s_suppkey = ps_suppkey
            AND s_nationkey = n_nationkey
            AND n_regionkey = r_regionkey
            AND r_name = 'EUROPE')
ORDER BY
    s_acctbal DESC,
    n_name,
    s_name,
    p_partkey
LIMIT 100;




-- tpch_queries_3.sql
SELECT /*+ SET_VAR(use_secondary_engine=1)
SET_VAR(secondary_engine_cost_threshold=0) */ /*+ Q3 */
    l_orderkey,
```

```
78      sum(l_extendedprice * (1 - l_discount)) AS revenue,
79      o_orderdate,
80      o_shippriority
81  FROM
82      customer,
83      orders,
84      lineitem
85  WHERE
86      c_mktsegment = 'BUILDING'
87      AND c_custkey = o_custkey
88      AND l_orderkey = o_orderkey
89      AND o_orderdate < CAST('1995-03-15' AS date)
90      AND l_shipdate > CAST('1995-03-15' AS date)
91  GROUP BY
92      l_orderkey,
93      o_orderdate,
94      o_shippriority
95  ORDER BY
96      revenue DESC,
97      o_orderdate
98  LIMIT 10;
99
100
101
102
103 -- tpch_queries_4.sql
104 SELECT /*+ SET_VAR(use_secondary_engine=1)
    SET_VAR(secondary_engine_cost_threshold=0) */ /*+ Q4 */
105     o_orderpriority,
106     count(*) AS order_count
107 FROM
108     orders
109 WHERE
110     o_orderdate >= CAST('1993-07-01' AS date)
111     AND o_orderdate < CAST('1993-10-01' AS date)
112     AND EXISTS (
113         SELECT
114             *
115         FROM
116             lineitem
117         WHERE
118             l_orderkey = o_orderkey
119             AND l_commitdate < l_receiptdate)
120 GROUP BY
121     o_orderpriority
122 ORDER BY
123     o_orderpriority;
```

```
124
125
126
127
128 -- tpch_queries_5.sql
129 SELECT /*+ SET_VAR(use_secondary_engine=1)
    SET_VAR(secondary_engine_cost_threshold=0) */ /*+ Q5 */
130     n_name,
131     sum(l_extendedprice * (1 - l_discount)) AS revenue
132 FROM
133     customer,
134     orders,
135     lineitem,
136     supplier,
137     nation,
138     region
139 WHERE
140     c_custkey = o_custkey
141     AND l_orderkey = o_orderkey
142     AND l_suppkey = s_suppkey
143     AND c_nationkey = s_nationkey
144     AND s_nationkey = n_nationkey
145     AND n_regionkey = r_regionkey
146     AND r_name = 'ASIA'
147     AND o_orderdate >= CAST('1994-01-01' AS date)
148     AND o_orderdate < CAST('1995-01-01' AS date)
149 GROUP BY
150     n_name
151 ORDER BY
152     revenue DESC;
153
154
155
156
157 -- tpch_queries_6.sql
158 SELECT /*+ SET_VAR(use_secondary_engine=1)
    SET_VAR(secondary_engine_cost_threshold=0) */ /*+ Q6 */
159     sum(l_extendedprice * l_discount) AS revenue
160 FROM
161     lineitem
162 WHERE
163     l_shipdate >= CAST('1994-01-01' AS date)
164     AND l_shipdate < CAST('1995-01-01' AS date)
165     AND l_discount BETWEEN 0.05
166     AND 0.07
167     AND l_quantity < 24;
168
```

```
169
170
171
172 -- tpch_queries_7.sql
173 SELECT /*+ SET_VAR(use_secondary_engine=1)
    SET_VAR(secondary_engine_cost_threshold=0) */ /*+ Q7 */
174     supp_nation,
175     cust_nation,
176     l_year,
177     sum(volume) AS revenue
178 FROM (
179     SELECT
180         n1.n_name AS supp_nation,
181         n2.n_name AS cust_nation,
182         extract(year FROM l_shipdate) AS l_year,
183         l_extendedprice * (1 - l_discount) AS volume
184     FROM
185         supplier,
186         lineitem,
187         orders,
188         customer,
189         nation n1,
190         nation n2
191     WHERE
192         s_suppkey = l_suppkey
193         AND o_orderkey = l_orderkey
194         AND c_custkey = o_custkey
195         AND s_nationkey = n1.n_nationkey
196         AND c_nationkey = n2.n_nationkey
197         AND ((n1.n_name = 'FRANCE'
198                 AND n2.n_name = 'GERMANY')
199             OR (n1.n_name = 'GERMANY'
200                 AND n2.n_name = 'FRANCE'))
201         AND l_shipdate BETWEEN CAST('1995-01-01' AS date)
202         AND CAST('1996-12-31' AS date)) AS shipping
203 GROUP BY
204     supp_nation,
205     cust_nation,
206     l_year
207 ORDER BY
208     supp_nation,
209     cust_nation,
210     l_year;
211
212
213
214
```

```
-- tpch_queries_8.sql
SELECT /*+ SET_VAR(use_secondary_engine=1)
SET_VAR(secondary_engine_cost_threshold=0) */ /*+ Q8 */
    o_year,
    sum(
        CASE WHEN nation = 'BRAZIL' THEN
            volume
        ELSE
            0
        END) / sum(volume) AS mkt_share
FROM (
    SELECT
        extract(year FROM o_orderdate) AS o_year,
        l_extendedprice * (1 - l_discount) AS volume,
        n2.n_name AS nation
    FROM
        part,
        supplier,
        lineitem,
        orders,
        customer,
        nation n1,
        nation n2,
        region
    WHERE
        p_partkey = l_partkey
        AND s_suppkey = l_suppkey
        AND l_orderkey = o_orderkey
        AND o_custkey = c_custkey
        AND c_nationkey = n1.n_nationkey
        AND n1.n_regionkey = r_regionkey
        AND r_name = 'AMERICA'
        AND s_nationkey = n2.n_nationkey
        AND o_orderdate BETWEEN CAST('1995-01-01' AS date)
        AND CAST('1996-12-31' AS date)
        AND p_type = 'ECONOMY ANODIZED STEEL') AS all_nations
GROUP BY
    o_year
ORDER BY
    o_year;



-- tpch_queries_9.sql
SELECT /*+ SET_VAR(use_secondary_engine=1)
SET_VAR(secondary_engine_cost_threshold=0) */ /*+ Q9 */
```

```
260       nation,
261       o_year,
262       sum(amount) AS sum_profit
263   FROM (
264       SELECT
265           n_name AS nation,
266           extract(year FROM o_orderdate) AS o_year,
267           l_extendedprice * (1 - l_discount) - ps_supplycost * l_quantity AS
      amount
268       FROM
269           part,
270           supplier,
271           lineitem,
272           partsupp,
273           orders,
274           nation
275       WHERE
276           s_suppkey = l_suppkey
277           AND ps_suppkey = l_suppkey
278           AND ps_partkey = l_partkey
279           AND p_partkey = l_partkey
280           AND o_orderkey = l_orderkey
281           AND s_nationkey = n_nationkey
282           AND p_name LIKE '%green%') AS profit
283   GROUP BY
284       nation,
285       o_year
286   ORDER BY
287       nation,
288       o_year DESC;
289
290
291
292
293   -- tpch_queries_10.sql
294   SELECT /*+ SET_VAR(use_secondary_engine=1)
      SET_VAR(secondary_engine_cost_threshold=0) */ /*+ Q10 */
295       c_custkey,
296       c_name,
297       sum(l_extendedprice * (1 - l_discount)) AS revenue,
298       c_acctbal,
299       n_name,
300       c_address,
301       c_phone,
302       c_comment
303   FROM
304       customer,
```

```
    orders,
    lineitem,
    nation
WHERE
    c_custkey = o_custkey
    AND l_orderkey = o_orderkey
    AND o_orderdate >= CAST('1993-10-01' AS date)
    AND o_orderdate < CAST('1994-01-01' AS date)
    AND l_returnflag = 'R'
    AND c_nationkey = n_nationkey
GROUP BY
    c_custkey,
    c_name,
    c_acctbal,
    c_phone,
    n_name,
    c_address,
    c_comment
ORDER BY
    revenue DESC
LIMIT 20;




-- tpch_queries_11.sql
SELECT /*+ SET_VAR(use_secondary_engine=1)
SET_VAR(secondary_engine_cost_threshold=0) */ /*+ Q11 */
    ps_partkey,
    sum(ps_supplycost * ps_availqty) AS value
FROM
    partsupp,
    supplier,
    nation
WHERE
    ps_suppkey = s_suppkey
    AND s_nationkey = n_nationkey
    AND n_name = 'GERMANY'
GROUP BY
    ps_partkey
HAVING
    sum(ps_supplycost * ps_availqty) > (
        SELECT
            sum(ps_supplycost * ps_availqty) * 0.0001000000 /* SF1 */
            /* sum(ps_supplycost * ps_availqty) * 0.0000100000 /* SF10 */
            /* sum(ps_supplycost * ps_availqty) * 0.0000010000 /* SF100 */
```

```
            /* sum(ps_supplycost * ps_availqty) * 0.0000001000 /* SF1000 */

        FROM
            partsupp,
            supplier,
            nation
        WHERE
            ps_suppkey = s_suppkey
            AND s_nationkey = n_nationkey
            AND n_name = 'GERMANY')
ORDER BY
    value DESC;




-- tpch_queries_12.sql
SELECT /*+ SET_VAR(use_secondary_engine=1)
SET_VAR(secondary_engine_cost_threshold=0) */ /*+ Q12 */
    l_shipmode,
    sum(
        CASE WHEN o_orderpriority = '1-URGENT'
            OR o_orderpriority = '2-HIGH' THEN
            1
        ELSE
            0
        END) AS high_line_count,
    sum(
        CASE WHEN o_orderpriority <> '1-URGENT'
            AND o_orderpriority <> '2-HIGH' THEN
            1
        ELSE
            0
        END) AS low_line_count
FROM
    orders,
    lineitem
WHERE
    o_orderkey = l_orderkey
    AND l_shipmode IN ('MAIL', 'SHIP')
    AND l_commitdate < l_receiptdate
    AND l_shipdate < l_commitdate
    AND l_receiptdate >= CAST('1994-01-01' AS date)
    AND l_receiptdate < CAST('1995-01-01' AS date)
GROUP BY
    l_shipmode
ORDER BY
```

```
    l_shipmode;



-- tpch_queries_13.sql
SELECT /*+ SET_VAR(use_secondary_engine=1)
SET_VAR(secondary_engine_cost_threshold=0) */ /*+ Q13 */
    c_count,
    count(*) AS custdist
FROM (
    SELECT
        c_custkey,
        count(o_orderkey)
    FROM
        customer
    LEFT OUTER JOIN orders ON c_custkey = o_custkey
    AND o_comment NOT LIKE '%special%requests%'
GROUP BY
    c_custkey) AS c_orders (c_custkey,
        c_count)
GROUP BY
    c_count
ORDER BY
    custdist DESC,
    c_count DESC;



-- tpch_queries_14.sql
SELECT /*+ SET_VAR(use_secondary_engine=1)
SET_VAR(secondary_engine_cost_threshold=0) */ /*+ Q14 */
    100.00 * sum(
        CASE WHEN p_type LIKE 'PROMO%' THEN
            l_extendedprice * (1 - l_discount)
        ELSE
            0
        END) / sum(l_extendedprice * (1 - l_discount)) AS promo_revenue
FROM
    lineitem,
    part
WHERE
    l_partkey = p_partkey
    AND l_shipdate >= date '1995-09-01'
    AND l_shipdate < CAST('1995-10-01' AS date);

```

```
440
441
442
443 -- tpch_queries_15.sql
444 SELECT /*+ SET_VAR(use_secondary_engine=1)
    SET_VAR(secondary_engine_cost_threshold=0) */ /*+ Q15 */
445     s_suppkey,
446     s_name,
447     s_address,
448     s_phone,
449     total_revenue
450 FROM
451     supplier,
452     (
453         SELECT
454             l_suppkey AS supplier_no,
455             sum(l_extendedprice * (1 - l_discount)) AS total_revenue
456         FROM
457             lineitem
458         WHERE
459             l_shipdate >= CAST('1996-01-01' AS date)
460             AND l_shipdate < CAST('1996-04-01' AS date)
461         GROUP BY
462             supplier_no) revenue0
463 WHERE
464     s_suppkey = supplier_no
465     AND total_revenue = (
466         SELECT
467             max(total_revenue)
468         FROM (
469             SELECT
470                 l_suppkey AS supplier_no,
471                 sum(l_extendedprice * (1 - l_discount)) AS total_revenue
472             FROM
473                 lineitem
474             WHERE
475                 l_shipdate >= CAST('1996-01-01' AS date)
476                 AND l_shipdate < CAST('1996-04-01' AS date)
477             GROUP BY
478                 supplier_no) revenue1)
479 ORDER BY
480     s_suppkey;
481
482
483
484
485 -- tpch_queries_16.sql
```

```
SELECT /*+ SET_VAR(use_secondary_engine=1)
SET_VAR(secondary_engine_cost_threshold=0) */ /*+ Q16 */
    p_brand,
    p_type,
    p_size,
    count(DISTINCT ps_suppkey) AS supplier_cnt
FROM
    partsupp,
    part
WHERE
    p_partkey = ps_partkey
    AND p_brand <> 'Brand#45'
    AND p_type NOT LIKE 'MEDIUM POLISHED%'
    AND p_size IN (49, 14, 23, 45, 19, 3, 36, 9)
    AND ps_suppkey NOT IN (
        SELECT
            s_suppkey
        FROM
            supplier
        WHERE
            s_comment LIKE '%Customer%Complaints%')
GROUP BY
    p_brand,
    p_type,
    p_size
ORDER BY
    supplier_cnt DESC,
    p_brand,
    p_type,
    p_size;
```

```
-- tpch_queries_17.sql
SELECT /*+ SET_VAR(use_secondary_engine=1)
SET_VAR(secondary_engine_cost_threshold=0) */ /*+ Q17 */
    sum(l_extendedprice) / 7.0 AS avg_yearly
FROM
    lineitem,
    part
WHERE
    p_partkey = l_partkey
    AND p_brand = 'Brand#23'
    AND p_container = 'MED BOX'
    AND l_quantity < (
        SELECT
```

```
            0.2 * avg(l_quantity)
        FROM
            lineitem
        WHERE
            l_partkey = p_partkey);



-- tpch_queries_18.sql
SELECT /*+ SET_VAR(use_secondary_engine=1)
SET_VAR(secondary_engine_cost_threshold=0) */ /*+ Q18 */
    c_name,
    c_custkey,
    o_orderkey,
    o_orderdate,
    o_totalprice,
    sum(l_quantity)
FROM
    customer,
    orders,
    lineitem
WHERE
    o_orderkey IN (
        SELECT
            l_orderkey
        FROM
            lineitem
        GROUP BY
            l_orderkey
        HAVING
            sum(l_quantity) > 300)
    AND c_custkey = o_custkey
    AND o_orderkey = l_orderkey
GROUP BY
    c_name,
    c_custkey,
    o_orderkey,
    o_orderdate,
    o_totalprice
ORDER BY
    o_totalprice DESC,
    o_orderdate
LIMIT 100;



```

```
577
578 -- tpch_queries_19.sql
579 SELECT /*+ SET_VAR(use_secondary_engine=1)
    SET_VAR(secondary_engine_cost_threshold=0) */ /*+ Q19 */
580     sum(l_extendedprice * (1 - l_discount)) AS revenue
581 FROM
582     lineitem,
583     part
584 WHERE (p_partkey = l_partkey
585     AND p_brand = 'Brand#12'
586     AND p_container IN ('SM CASE', 'SM BOX', 'SM PACK', 'SM PKG')
587     AND l_quantity >= 1
588     AND l_quantity <= 1 + 10
589     AND p_size BETWEEN 1 AND 5
590     AND l_shipmode IN ('AIR', 'AIR REG')
591     AND l_shipinstruct = 'DELIVER IN PERSON')
592     OR (p_partkey = l_partkey
593         AND p_brand = 'Brand#23'
594         AND p_container IN ('MED BAG', 'MED BOX', 'MED PKG', 'MED PACK')
595         AND l_quantity >= 10
596         AND l_quantity <= 10 + 10
597         AND p_size BETWEEN 1 AND 10
598         AND l_shipmode IN ('AIR', 'AIR REG')
599         AND l_shipinstruct = 'DELIVER IN PERSON')
600     OR (p_partkey = l_partkey
601         AND p_brand = 'Brand#34'
602         AND p_container IN ('LG CASE', 'LG BOX', 'LG PACK', 'LG PKG')
603         AND l_quantity >= 20
604         AND l_quantity <= 20 + 10
605         AND p_size BETWEEN 1 AND 15
606         AND l_shipmode IN ('AIR', 'AIR REG')
607         AND l_shipinstruct = 'DELIVER IN PERSON');
608
609
610
611
612 -- tpch_queries_20.sql
613 SELECT /*+ SET_VAR(use_secondary_engine=1)
    SET_VAR(secondary_engine_cost_threshold=0) */ /*+ Q20 */
614     s_name,
615     s_address
616 FROM
617     supplier,
618     nation
619 WHERE
620     s_suppkey IN (
621         SELECT
```

```
            ps_suppkey
        FROM
            partsupp
        WHERE
            ps_partkey IN (
                SELECT
                    p_partkey
                FROM
                    part
                WHERE
                    p_name LIKE 'forest%')
                AND ps_availqty > (
                    SELECT
                        0.5 * sum(l_quantity)
                    FROM
                        lineitem
                    WHERE
                        l_partkey = ps_partkey
                        AND l_suppkey = ps_suppkey
                        AND l_shipdate >= CAST('1994-01-01' AS date)
                        AND l_shipdate < CAST('1995-01-01' AS date)))
            AND s_nationkey = n_nationkey
            AND n_name = 'CANADA'
        ORDER BY
            s_name;



-- tpch_queries_21.sql
SELECT /*+ SET_VAR(use_secondary_engine=1)
SET_VAR(secondary_engine_cost_threshold=0) */ /*+ Q21 */
    s_name,
    count(*) AS numwait
FROM
    supplier,
    lineitem l1,
    orders,
    nation
WHERE
    s_suppkey = l1.l_suppkey
    AND o_orderkey = l1.l_orderkey
    AND o_orderstatus = 'F'
    AND l1.l_receiptdate > l1.l_commitdate
    AND EXISTS (
        SELECT
            *
```

```
668          FROM
669              lineitem l2
670          WHERE
671              l2.l_orderkey = l1.l_orderkey
672              AND l2.l_suppkey <> l1.l_suppkey)
673      AND NOT EXISTS (
674          SELECT
675              *
676          FROM
677              lineitem l3
678          WHERE
679              l3.l_orderkey = l1.l_orderkey
680              AND l3.l_suppkey <> l1.l_suppkey
681              AND l3.l_receiptdate > l3.l_commitdate)
682      AND s_nationkey = n_nationkey
683      AND n_name = 'SAUDI ARABIA'
684  GROUP BY
685      s_name
686  ORDER BY
687      numwait DESC,
688      s_name
689  LIMIT 100;
690
691
692
693
694  -- tpch_queries_22.sql
695  SELECT /*+ SET_VAR(use_secondary_engine=1)
     SET_VAR(secondary_engine_cost_threshold=0) */ /*+ Q22 */
696      cntrycode,
697      count(*) AS numcust,
698      sum(c_acctbal) AS totacctbal
699  FROM (
700      SELECT
701          substring(c_phone FROM 1 FOR 2) AS cntrycode,
702          c_acctbal
703      FROM
704          customer
705      WHERE
706          substring(c_phone FROM 1 FOR 2) IN ('13', '31', '23', '29', '30',
     '18', '17')
707          AND c_acctbal > (
708              SELECT
709                  avg(c_acctbal)
710              FROM
711                  customer
712              WHERE
```

```
713                     c_acctbal > 0.00
714                     AND substring(c_phone FROM 1 FOR 2) IN ('13', '31', '23',
    '29', '30', '18', '17'))
715                 AND NOT EXISTS (
716                     SELECT
717                         *
718                     FROM
719                         orders
720                     WHERE
721                         o_custkey = c_custkey)) AS custsale
722   GROUP BY
723       cntrycode
724   ORDER BY
725       cntrycode;
```

6.3 参考资料

- TPC-H官网 http://www.tpc.org/tpch
- GreatSQL安装指南：https://greatsql.cn/docs/4-install-guide/0-install-guide.html
- TPC-H性能测试指南：https://greatsql.cn/docs/10-optimize/3-2-benchmark-tpch.html
- TPC-H性能测试工具包：https://gitee.com/GreatSQL/tpch