PHP

2017·北京
全球开发者大会

高可用的 PHP

MySQL 5.7优化不求人

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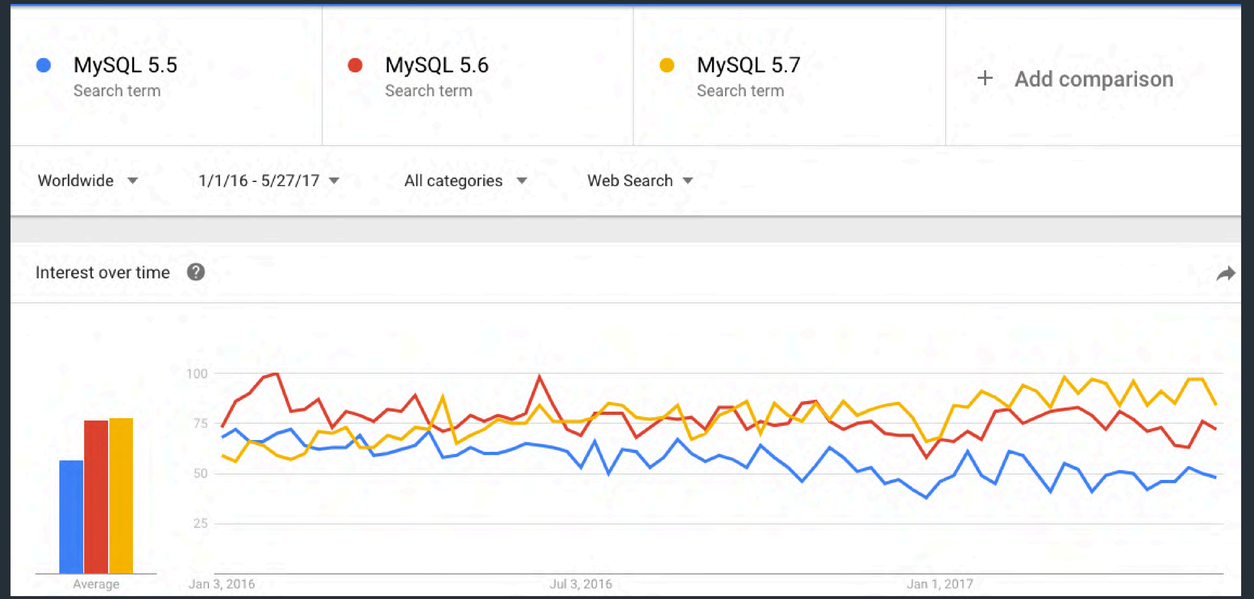
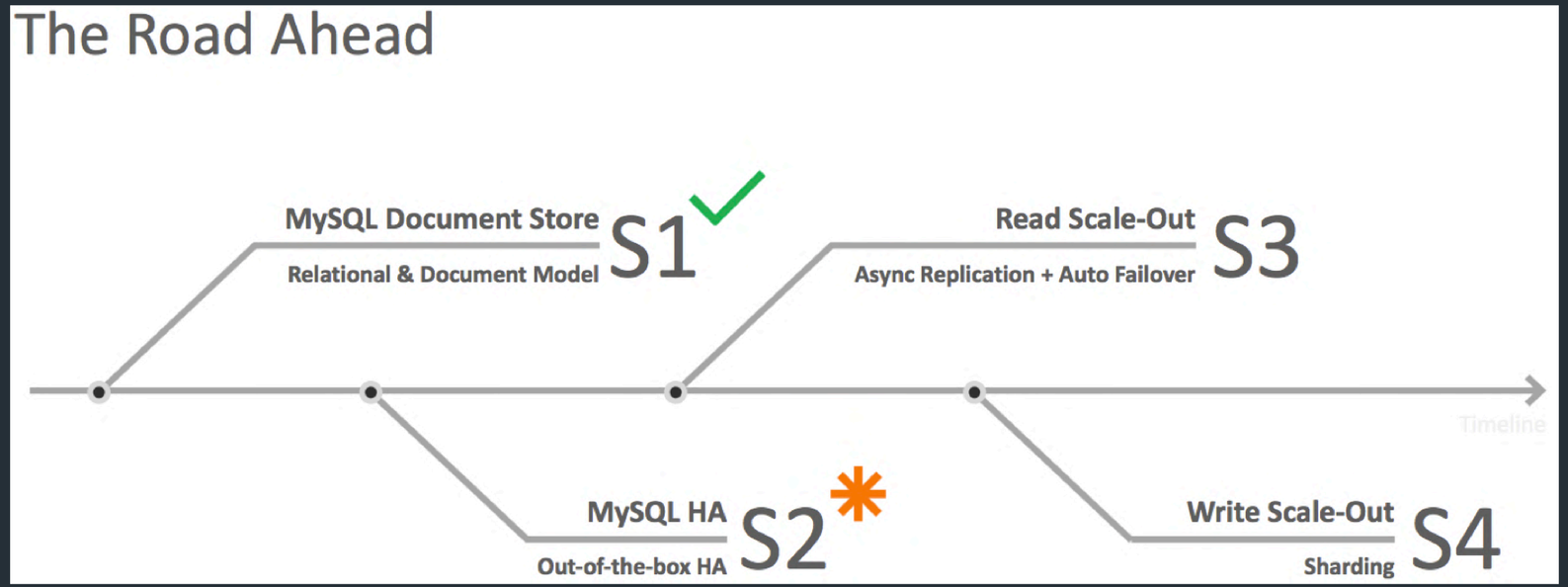
DevLink

MySQL 5.7搜索趋势



- 2016.11月开始，5.7占绝对优势
- 2016.12月，5.7.17版本发布，支持group replication
- 事实上，2013.4.23发布5.7，至今已过去4年多

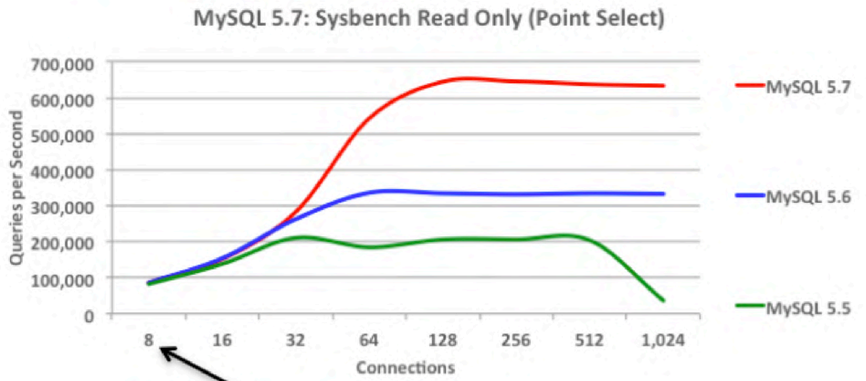
The Road Ahead



官方号称5.7比5.6性能提升3倍以上

2x Faster than MySQL 5.6
3x Faster than MySQL 5.5

645,000 QPS



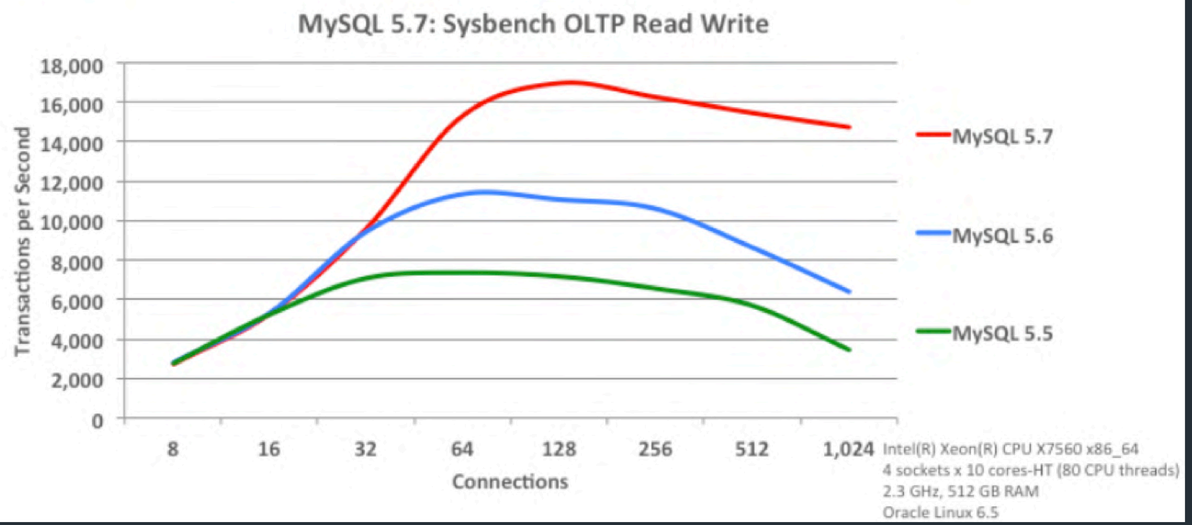
Intel(R) Xeon(R) CPU E7-4860 x86_64
4 sockets x 10 cores-HT (80 CPU threads)
2.3 GHz, 512 GB RAM
Oracle Linux 6.5

Starts with 8 Threads
What about 2-4 threads?

1.5x Faster than MySQL 5.6

2.5x Faster than MySQL 5.5

17,000 TPS



InnoDB引擎增强

1

性能提升

只读事务性能提升；临时表性能提升；page clean效率提升；索引更新效率提升

2

功能提升

buffer pool online resize；varchar in-place enlarge；设备原子写特性检测；

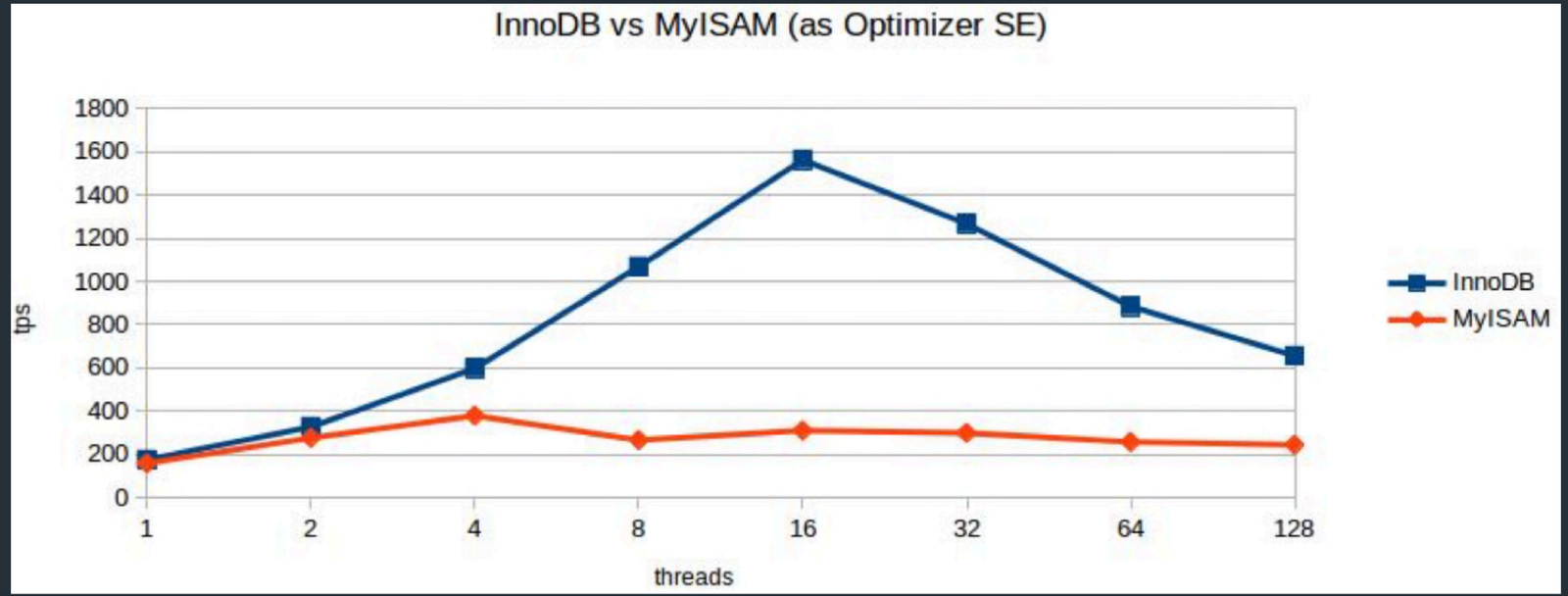
3

其他增强

monitor增强；undo log truncate；原生支持表分区；支持通用表空间；

是时候放弃MyISAM了

Feature	MyISAM	InnoDB
Full Text Indexes	yes	Since MySQL 5.6
Portable tables (tablespaces)	yes	Since MySQL 5.6
Spatial Indexes/RTREE (GIS)	yes	*Since MySQL 5.7*
Last update for table	yes	*Since MySQL 5.7* *(http://dev.mysql.com/worklog/task/?id=6658)*
Suitable for temp tables	yes	*Since MySQL 5.7* *Also complex selects uses InnoDB ondisk temp tables*
Fast count(*)	yes	**Faster in MySQL 5.7 but does not store counter*


InnoDB vs MyISAM (as Optimizer SE)
tps
1800
1600
1400
1200
1000
800
600
400
200
0
1
2
4
8
16
32
64
128
threads
InnoDB
MyISAM

InnoDB buffer pool功能增强

Online buffer pool resize

- 由小改大几乎无影响；
- 由大改小需要释放部分内存，不过影响也不大，秒级完成。

Buffer pool dump增强

- 设置innodb_buffer_pool_dump_pct，只导出最热那部分数据；
- 系统负载高的时候，会根据innodb_io_capacity设置自动限制buffer pool dump的速度。

VARCHAR in-place enlarge

mysql> ALTER TABLE t1 ALGORITHM=INPLACE,
CHANGE COLUMN c1 c1 VARCHAR(255);

- 255字节长度是个门槛；
- 不跨越255长度门槛即可在线调整；
- 这使得增加VARCHAR列长度毫无压力；
- 也就没必要再为VARCHAR列预留太大长度了；
- 不过，不支持VARCHAR列长度in-place缩减。

其他InnoDB增强

临时表增强

1

临时表使用独立表空间、不记录redo、没有change buffer、锁更少

UNDO log 清除

2

执行innodb_undo_log_truncate=1选项，当undo log超过innodb_max_undo_log_size时自动truncate

page clean 效率提升

3

支持多个page cleaner线程，提高dirty page flush效率

其他增强

4

索引批量更新效率提升3倍；InnoDB原生支持分区，效率更高；自动检测设备是否支持原子写

MySQL复制增强

多源复制

1

支持一从多主，由多个主服务器汇聚到一个从服务器，可用于数据分析或异地容灾、集中备份

并行复制

2

基于LOGICAL_CLOCK时序组提交的并行复制，同时进入PREPARE状态的事务都可以在SLAVE并行应用

组复制

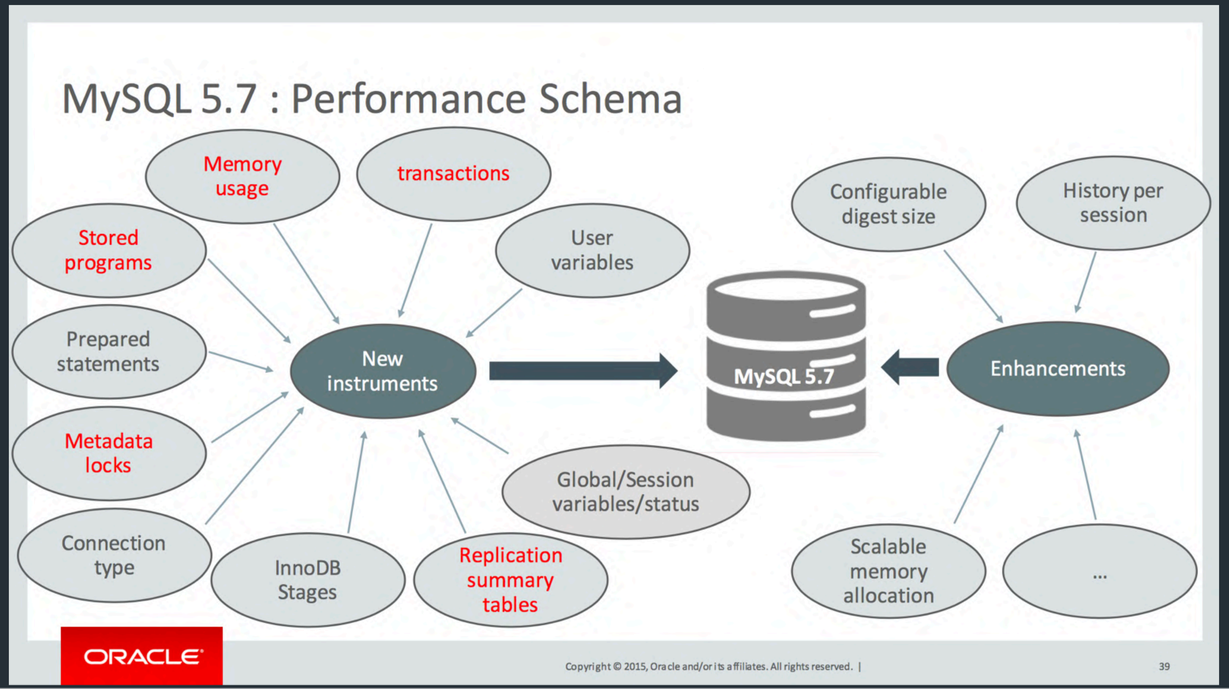
3

类似Gelera Cluster（PXC）架构，支持多点并行写入，同时提供读负载均衡，只支持InnoDB引擎，所有表必须都有主键，RBR

半同步增强

4

设置master事务提交点AFTER_SYNC 或AFTER_COMMIT，提高复制可靠性；接收、发送信号线程分离（串行变并行），提高复制效率


MySQL 5.7 : Performance Schema
Memory usage
transactions
Stored programs
User variables
Prepared statements
New instruments
Metadata locks
Global/Session variables/status
Connection type
InnoDB Stages
Replication summary tables
MySQL 5.7
Configurable digest size
History per session
Enhancements
Scalable memory allocation
...
ORACLE
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sys schema增强

schema table相关统计视图

```
yejr@zhishutang.com (15:24)[sys]> show tables like 'schema%';
+-----------------------------------+
| Tables_in_sys (schema%)           |
+-----------------------------------+
| schema_auto_increment_columns     |
| schema_index_statistics           |
| schema_object_overview            |
| schema_redundant_indexes          |
| schema_table_lock_waits           |
| schema_table_statistics           |
| schema_table_statistics_with_buffer |
| schema_tables_with_full_table_scans |
| schema_unused_indexes             |
+-----------------------------------+
```

sys schema增强

table DML统计

```
yejr@zhishutang.com[sys]> select table_name, rows_fetched, rows_inserted, rows_updated, rows_deleted,
                          io_read_requests, io_read, io_write_requests, io_write from schema_table_statistics
                          where table_schema = 'world' and table_name = 'city';
+------------+--------------+---------------+--------------+--------------+-------------------+----------+--------------------+------------+
| table_name | rows_fetched | rows_inserted | rows_updated | rows_deleted | io_read_requests  | io_read  | io_write_requests  | io_write   |
+------------+--------------+---------------+--------------+--------------+-------------------+----------+--------------------+------------+
| city       |        17037 |          4079 |            0 |            0 |                16 | 1.49 KiB |                 67 | 660.73 KiB |
+------------+--------------+---------------+--------------+--------------+-------------------+----------+--------------------+------------+
```

sys schema增强

table index usage统计

```
yejr@zhishutang.com[sys]> select index_name,rows_selected, rows_inserted, rows_updated,
                          rows_deleted from schema_index_statistics where
                          table_schema = 'world' and table_name = 'city' and
                          index_name = 'CountryCode';
+-------------+---------------+---------------+--------------+--------------+
| index_name  | rows_selected | rows_inserted | rows_updated | rows_deleted |
+-------------+---------------+---------------+--------------+--------------+
| ID          |         18131 |             0 |            0 |            0 |
+-------------+---------------+---------------+--------------+--------------+
| CountryCode |             2 |             0 |            2 |            0 |
+-------------+---------------+---------------+--------------+--------------+
```

sys schema增强

redundant indexes

```
yejr@zhishutang.com[sys]> select * from schema_redundant_indexes\G
*************************** 1. row ***************************
              table_schema: world
                table_name: countrylanguage
      redundant_index_name: CountryCode
   redundant_index_columns: CountryCode
redundant_index_non_unique: 1
       dominant_index_name: PRIMARY
    dominant_index_columns: CountryCode,Language
 dominant_index_non_unique: 0
             subpart_exists: 0
             sql_drop_index: ALTER TABLE `world`.`countrylanguage` DROP INDEX `CountryCode`
```

sys schema增强

unused indexes

```
yejr@zhishutang.com[sys]> select * from schema_unused_indexes;
+---------------+-----------------+-----------------------------+
| object_schema | object_name     | index_name                  |
+---------------+-----------------+-----------------------------+
| sakila        | actor           | idx_actor_last_name         |
| sakila        | address         | idx_fk_city_id              |
| sakila        | address         | idx_location                |
| sakila        | city            | idx_fk_country_id           |
| sakila        | customer        | idx_fk_store_id             |
| sakila        | customer        | idx_fk_address_id           |
| sakila        | customer        | idx_last_name               |
| sakila        | film            | idx_title                   |
| sakila        | film            | idx_fk_language_id          |
| sakila        | film            | idx_fk_original_language_id |
| sakila        | film_actor      | idx_fk_film_id              |
| sakila        | film_category   | fk_film_category_category   |
| sakila        | film_text       | idx_title_description       |
```

sys schema增强

row lock wait

```
yejr@imysql.com [sys]>select * from sys.innodb_lock_waits\G
*************************** 1. row ***************************
                wait_started: 2017-02-13 15:32:54
                    wait_age: 00:00:30
               wait_age_secs: 30
                locked_table: `test`.`t1`
                locked_index: PRIMARY
                 locked_type: RECORD
              waiting_trx_id: 248632
         waiting_trx_started: 2017-02-13 15:32:54
             waiting_trx_age: 00:00:30
     waiting_trx_rows_locked: 1
   waiting_trx_rows_modified: 0
                 waiting_pid: 24
               waiting_query: select * from t1 where c1=2 for update
             waiting_lock_id: 248632:293:3:3
           waiting_lock_mode: X
             blocking_trx_id: 248631
                blocking_pid: 22
              blocking_query: NULL
            blocking_lock_id: 248631:293:3:3
          blocking_lock_mode: X
        blocking_trx_started: 2017-02-13 15:32:37
            blocking_trx_age: 00:00:47
    blocking_trx_rows_locked: 1
  blocking_trx_rows_modified: 0
     sql_kill_blocking_query: KILL QUERY 22
sql_kill_blocking_connection: KILL 22
```

sys schema增强

metadata lock wait

```
yejr@zhishutang.com[sys]> select * from schema_table_lock_waits limit 4\G
*************************** 1. row ***************************
               object_schema: world
                 object_name: city
           waiting_thread_id: 108
                 waiting_pid: 72
             waiting_account: root@localhost
           waiting_lock_type: SHARED_READ
       waiting_lock_duration: TRANSACTION
               waiting_query: select * from city limit 4
          waiting_query_secs: 21
 waiting_query_rows_affected: 0
 waiting_query_rows_examined: 0
           blocking_thread_id: 106
                 blocking_pid: 70
           blocking_account: root@localhost
         blocking_lock_type: SHARED_NO_READ_WRITE
      blocking_lock_duration: TRANSACTION
     sql_kill_blocking_query: KILL QUERY 70
sql_kill_blocking_connection: KILL 70

yejr@zhishutang.com[sys]> show processlist;
+----+------+-----------+-------+---------+------+---------------------------------+---------------------------+
| Id | User | Host      | db    | Command | Time | State                           | Info                      |
+----+------+-----------+-------+---------+------+---------------------------------+---------------------------+
| 70 | root | localhost | world | Sleep   |   49 |                                 | NULL                      |
| 71 | root | localhost | sys   | Query   |    0 | starting                        | show processlist          |
| 72 | root | localhost | world | Query   |   31 | Waiting for table metadata lock | select * from city limit 4 |
+----+------+-----------+-------+---------+------+---------------------------------+---------------------------+
```

sys schema增强

I/O写最多的文件

```
yejr@imysql.com [sys]>select * from x$io_global_by_file_by_bytes
    -> order by total_written desc limit 1\G
*************************** 1. row ***************************
         file: /Volumes/DATA/mysql/test/sid.ibd
   count_read: 3046
   total_read: 49954816
     avg_read: 16400.1366
  count_write: 4054
total_written: 95322112
    avg_write: 23513.1011
        total: 145276928
    write_pct: 65.61
```

sys schema增强

热门SQL TOP 10

```
yejr@zhishuedu.com [sys]>select db,exec_count,query from statement_analysis order by exec_count desc limit 10;
+--------------------+------------+-----------------------------------------------------------------------+
| db                 | exec_count | query                                                                 |
+--------------------+------------+-----------------------------------------------------------------------+
| yejr               |     299993 | SET @? = `round` ( `rand` ( ) * ? ) ;                                 |
| yejr               |     299987 | SET @? = `round` ( `rand` ( ) * ? ) ;                                 |
| test               |      15997 | SELECT @@`version_comment` LIMIT ?                                    |
| test               |      14004 | UPDATE `t1` SET `c4` = ? WHERE `c1` = ?                               |
| test               |       2000 | INSERT INTO `t1` SELECT ?, ...                                        |
| information_schema |         92 | SHOW ENGINE `innodb` STATUS                                           |
| test               |         54 | SELECT ?                                                              |
| sys                |         37 | SELECT IF ( `isnull` ( `perfor ... _host_by_event_name` GROUP BY      |
| NULL               |         32 | SHOW PROCESSLIST                                                      |
| test               |         29 | SHOW TABLES                                                           |
+--------------------+------------+-----------------------------------------------------------------------+
```

sys schema增强

查看实例消耗内存

```
yejr@zhishutang.com[sys]> select * from memory_global_total;
+-----------------+
| total_allocated |
+-----------------+
| 3.48 GiB        |
+-----------------+
```

sys schema增强

查看内部对象内存消耗

```
yejr@imysql> select event_name,SUM_NUMBER_OF_BYTES_ALLOC  from
  memory_summary_global_by_event_name
    order by SUM_NUMBER_OF_BYTES_ALLOC desc LIMIT 10;
```

event_name	SUM_NUMBER_OF_BYTES_ALLOC
memory/innodb/mem0mem	23839472166
memory/sql/Filesort_buffer::sort_k	2754080008
memory/memory/HP_PTRS	2632950064
memory/sql/thd::main_mem_root	1830295888
memory/mysys/IO_CACHE	977629336
memory/sql/String::value	946131984
memory/sql/TABLE	409615108
memory/mysys/MY_DIR	300412224
memory/sql/test_quick_select	178511200
memory/sql/QUICK_RANGE_SELEC	173118272

sys schema增强

查看线程内存消耗

```
yejr@imysql>select event_name, SUM_NUMBER_OF_BYTES_ALLOC from
  memory_summary_by_thread_by_event_name
    order by SUM_NUMBER_OF_BYTES_ALLOC desc limit 20;
```

thread_id	event_name	SUM_NUMBER_OF_BYTES_ALLOC
1	memory/innodb/buf_buf_pool	139722752
1	memory/sql/Log_event	41576778
1	memory/sql/THD::Session_tracker	35384895
1	memory/sql/thd::main_mem_root	33832032
1	memory/sql/NET::buff	33402726
1239	memory/innodb/mem0mem	30407948
2327	memory/innodb/mem0mem	30407948
1220	memory/innodb/mem0mem	30407948

Optimizer增强

- UNION ALL不再产生临时表（除非需要排序）
- IN子查询效率提升
- 全文检索效率提升
- 排序效率提升

EXPLAIN增强

- 查看当前活跃SESSION的SQL执行计划
  - EXPLAIN FOR CONNECTION 3306
- JSON格式的输出结果中，还能看到执行计划代价信息
- 总是启用PARTITIONS/EXTENDED选项

JSON & Generated Columns

```
Create Table: CREATE TABLE `json_test` (
  `id` int(11) NOT NULL AUTO_INCREMENT,
  `data` json DEFAULT NULL,
  PRIMARY KEY (`id`)
) ENGINE=InnoDB AUTO_INCREMENT=3 DEFAULT CHARSET=utf8
```

```
yejr@imysql.com [test]>select * from json_test where data->'$.type' = 'line';
+----+-------------------------------------------------------------+
| id | data                                                        |
+----+-------------------------------------------------------------+
|  2 | {"type": "line", "coordinates": [-87.9101245, 41.7585879]} |
+----+-------------------------------------------------------------+
1 row in set (0.00 sec)

yejr@imysql.com [test]>select * from json_test where json_extract(data,'$.type') = 'line';
+----+-------------------------------------------------------------+
| id | data                                                        |
+----+-------------------------------------------------------------+
|  2 | {"type": "line", "coordinates": [-87.9101245, 41.7585879]} |
+----+-------------------------------------------------------------+
```

JSON & Generated Columns

```
yejr@imysql.com [test]>explain select * from json_test where data->'$.type' = 'line'\G
*************************** 1. row ***************************
           id: 1
  select_type: SIMPLE
        table: json_test
   partitions: NULL
         type: ALL
possible_keys: NULL
          key: NULL
      key_len: NULL
          ref: NULL
         rows: 2
     filtered: 100.00
        Extra: Using where
```

JSON & Generated Columns

```
yejr@imysql.com [test]>alter table json_test add data_type varchar(255) GENERATED ALWAYS AS (data->'$.type') VIRTUAL;
Query OK, 0 rows affected (0.04 sec)
Records: 0  Duplicates: 0  Warnings: 0

yejr@imysql.com [test]>alter table json_test add key (data_type);
Query OK, 0 rows affected (0.03 sec)
Records: 0  Duplicates: 0  Warnings: 0

yejr@imysql.com [test]>explain select * from json_test where data_type = 'line';
+----+-------------+-----------+------------+------+---------------+-----------+---------+-------+------+----------+-------+
| id | select_type | table     | partitions | type | possible_keys | key       | key_len | ref   | rows | filtered | Extra |
+----+-------------+-----------+------------+------+---------------+-----------+---------+-------+------+----------+-------+
|  1 | SIMPLE      | json_test | NULL       | ref  | data_type     | data_type | 768     | const |    1 |   100.00 | NULL  |
+----+-------------+-----------+------------+------+---------------+-----------+---------+-------+------+----------+-------+
```

JSON & Generated Columns

```
Create Table: CREATE TABLE `sid` (
  `id` int(10) unsigned NOT NULL DEFAULT '0',
  `name` varchar(50) NOT NULL DEFAULT '',
  `aid` int(10) unsigned NOT NULL AUTO_INCREMENT,
  `nid` int(11) unsigned GENERATED ALWAYS AS ((`id` + 1)) VIRTUAL NOT NULL,
  `nnid` int(11) unsigned GENERATED ALWAYS AS ((`id` + 1)) STORED NOT NULL,
  PRIMARY KEY (`aid`),
  KEY `name` (`name`),
  KEY `id` (`id`),
  KEY `nid` (`nid`)
) ENGINE=InnoDB AUTO_INCREMENT=893210 DEFAULT CHARSET=utf8
```

JSON & Generated Columns

```
yejr@imysql.com [test]>desc select * from sid where id+1=1024\G
*************************** 1. row ***************************
           id: 1
  select_type: SIMPLE
        table: sid
   partitions: NULL
         type: ref
possible_keys: nid
          key: nid
      key_len: 4
          ref: const
         rows: 8
     filtered: 100.00
        Extra: NULL
```

设定SELECT SQL超时

- SELECT /*+ MAX_EXECUTION_TIME(1) */ * FROM t
- 也可修改 max_statement_time 选项
- 这个特性非常实用，有效避免某个垃圾SQL引发雪崩
- 参考：MariaDB/Percona版本选项 innodb_kill_idle_transaction

其他新特性

单表支持多个触发器

- 可以设定 trigger_order， 调整不同触发器的优先级
- 兼容 pt-osc 等工具

默认启用严格SQL_MODE

- STRICT_ALL_TABLES、STRICT_TRANS_TABLES
- 规避一些容易混淆的操作，比如超长内容自动被截断、除零、用’0000-00-00’表示日期、写入不同类型的数据、不能在GRANT中同时创建用户等

MySQL 8.0新特性

- Optimizer增强，如JOIN优化（可能支持hash join）、HINT增强
- 新增支持不可见索引、倒序索引
- CTE(公用表表达式，Common Table Expression)功能及windowing统计函数
- 直方图、UUID优化、减少handler API调用执行计划缓存（可能）
- 所有metadata全部存储到InnoDB中
- 增加user role特性，权限管理更方便
- InnoDB表自增列最大值持久化，再也不用担心实例重启后最大自增Id丢失了

MySQL 8.0新特性

- InnoDB memcached支持mget指令
- innodb_deadlock_detect在线动态调整，在高负载环境下，建议关闭死锁检测
- InnoDB加密除了支持data page外，增加支持redo log和undo log，提高保密性
- SELECT ... FOR SHARE/UPDATE增加NOWAIT 和 SKIP LOCKED选项
- JSON功能增强，JSON列更新、数据排序效率提升
- 默认使用utf8mb4字符集
- SET PERSIST语法支持修改options后持久化

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