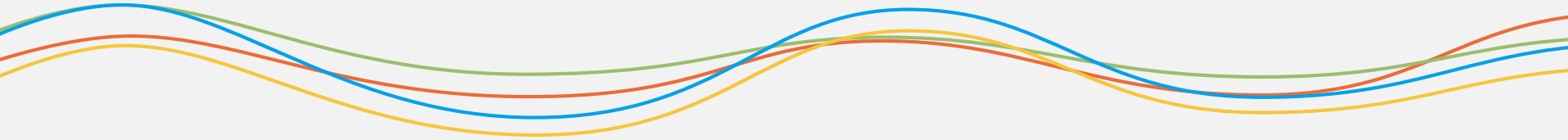
APMCon

MySQL 5.7让优化更轻松

叶金荣



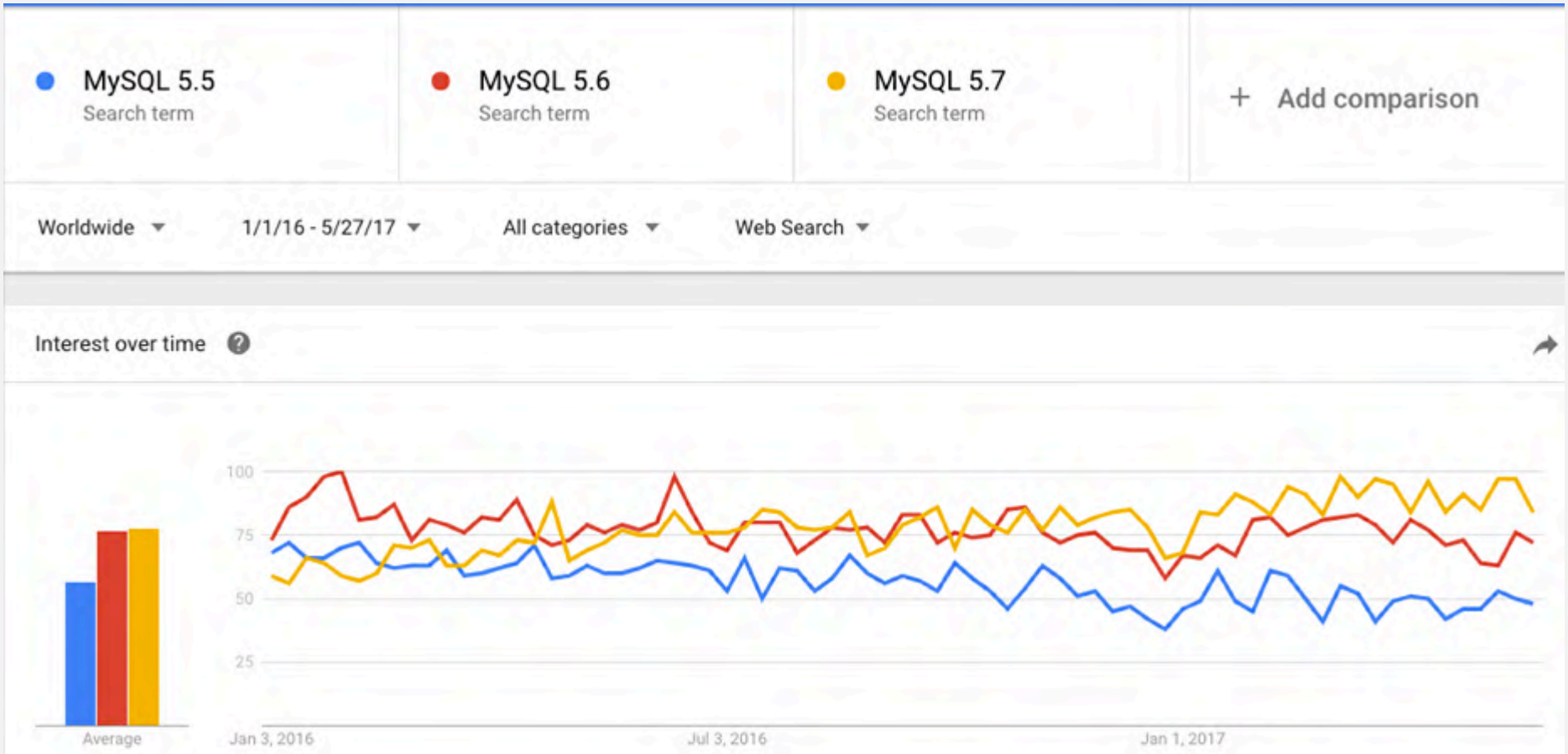
关于我

APMCon

- 知数堂联合创始人
- Oracle MySQL ACE
- 公众号 老叶茶馆(imysql_wx)
- 个人网站 http://imysql.com

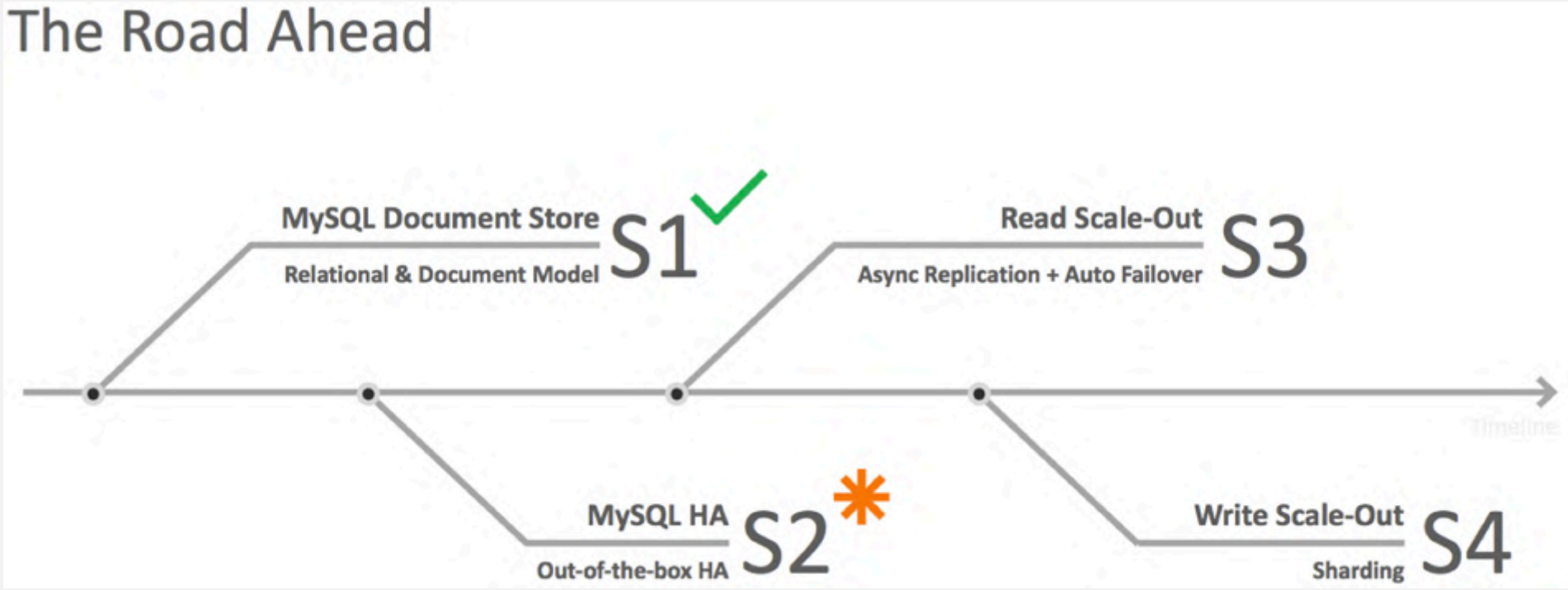
MySQL 5.7搜索趋势

APMCon



MySQL roadmap

APMCon

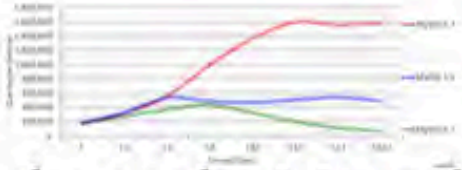


官方号称5.7比5.6性能提升3倍以上

MySQL 5.7 Sysbench Benchmark: SQL Point Selects / sec

3x Faster than MySQL 5.6

4x Faster than MySQL 5.5

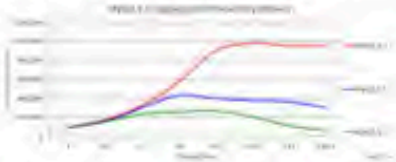


1,600,000 QPS

MySQL 5.7 Sysbench Benchmark: Mixed OLTP Read Only

3x Faster than MySQL 5.6

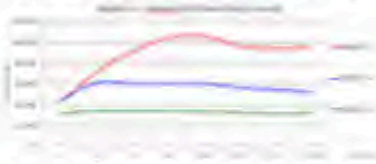
6x Faster than MySQL 5.5



Near 1M QPS

MySQL 5.7 Sysbench Benchmark: Connect / sec

82% Faster than MySQL 5.6

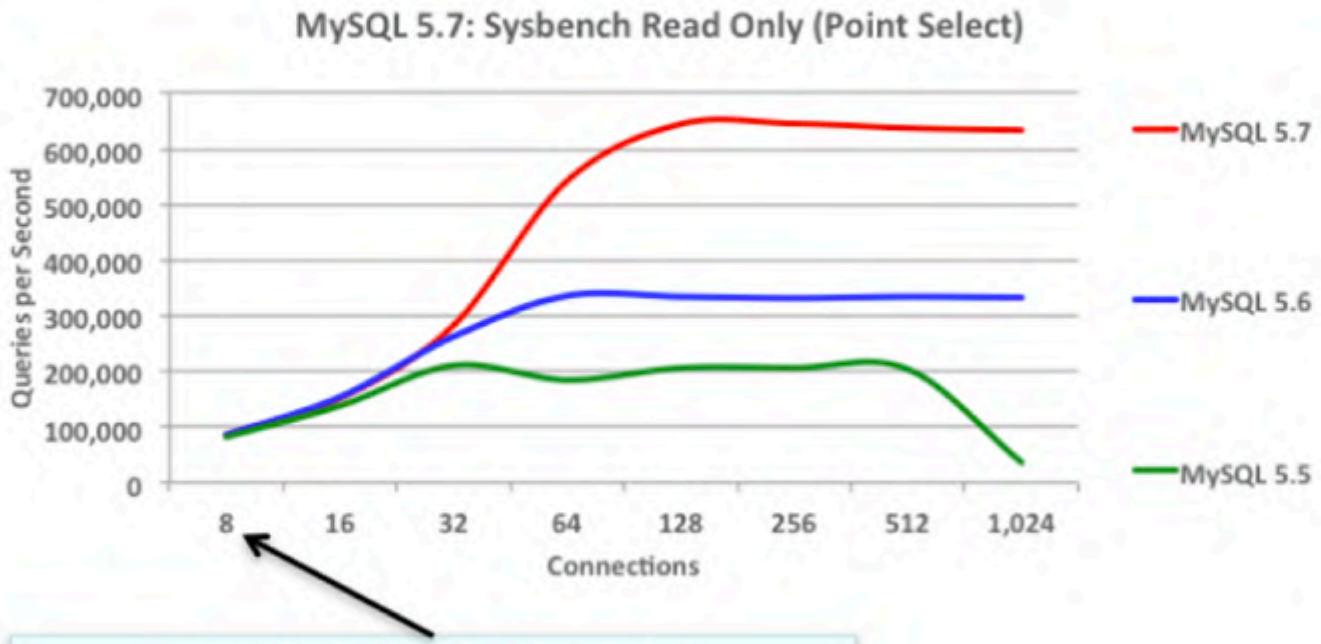


100K Connect / Sec

图片来源《Whats New in MySQL 5.7》by Geir Høydalsvik & Simon Mudd

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

645,000 QPS

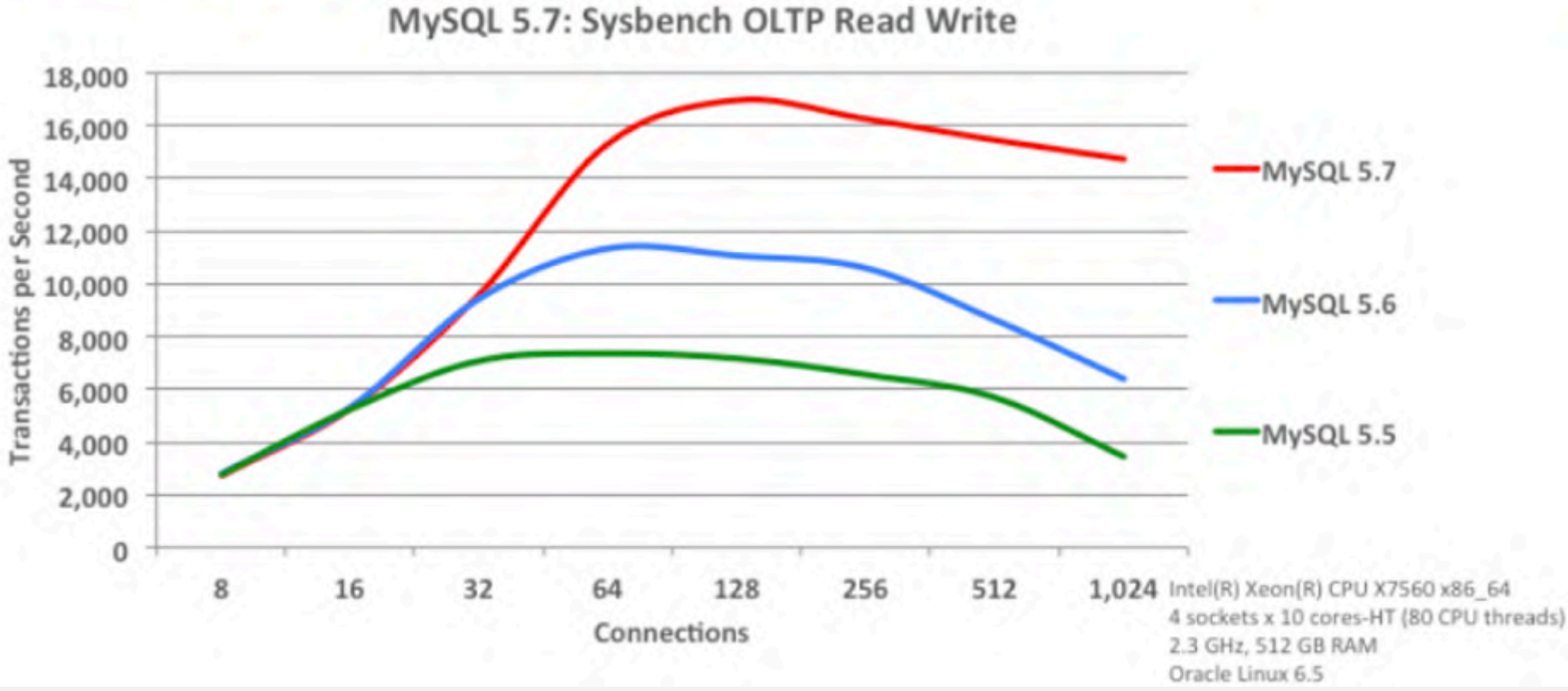


Intel(R) Xeon(R) CPU E7-4860 x86_64
4 sockets x 10 cores-HT (80 CPU threads)
2.3 GHz, 512 GB RAM
Oracle Linux 6.5

Starts with 8 Threads
What about 2-4 threads?

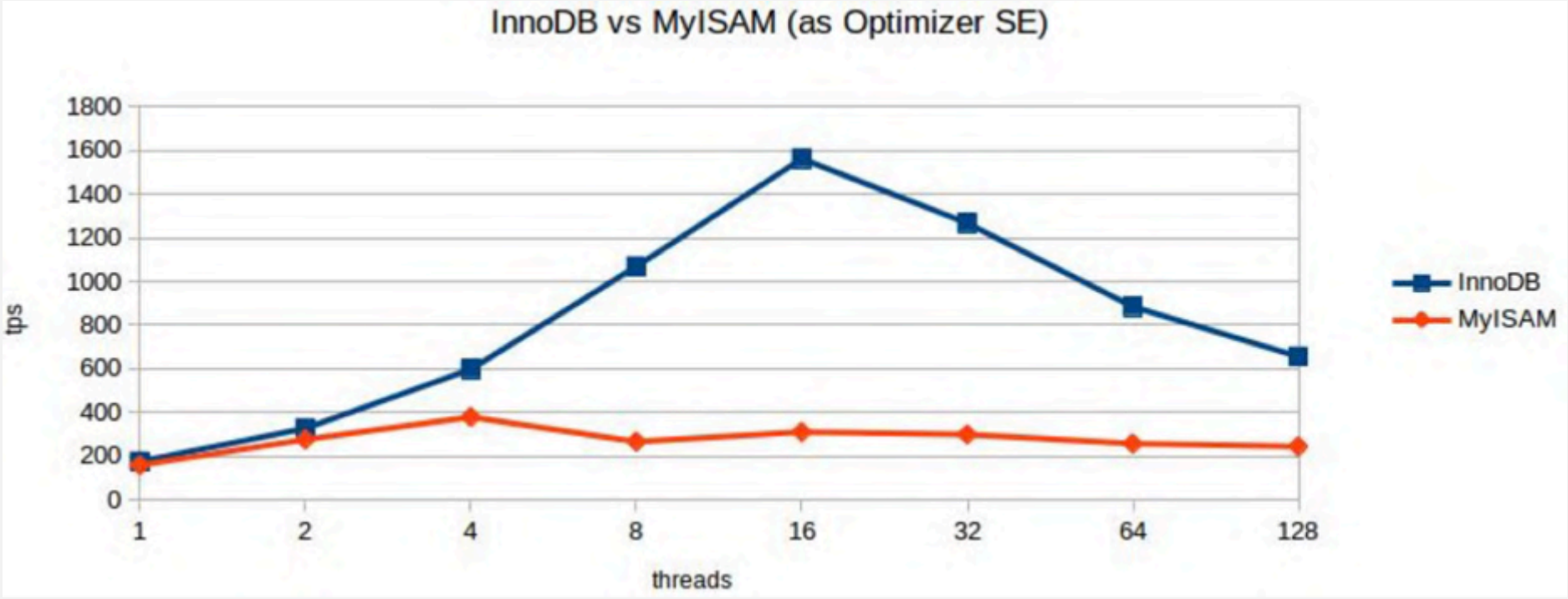
1.5x Faster than MySQL 5.6
2.5x Faster than MySQL 5.5

17,000 TPS



是时候全面放弃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增强

1、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，有一定代价。

resize innodb buffer pool from 64G to 16G

```
09:22:55.591669Z 0 [Note] InnoDB: Resizing buffer pool from 17179869184 to 1073741824.
(unit=134217728)
09:22:55.680836Z 0 [Note] InnoDB: disabled adaptive hash index.
09:22:55.680864Z 0 [Note] InnoDB: buffer pool 0 : start to withdraw the last 491511
blocks.
09:22:55.765778Z 0 [Note] InnoDB: buffer pool 0 : withdrew 489812 blocks from free
list. Tried to relocate 1698 pages (491510/491511).
09:22:55.774492Z 0 [Note] InnoDB: buffer pool 0 : withdrew 0 blocks from free list.
Tried to relocate 1 pages (491511/491511).
...
09:22:56.308997Z 0 [Note] InnoDB: buffer pool 1 : 60 chunks (491520 blocks) were freed.
09:22:56.316258Z 0 [Note] InnoDB: buffer pool 0 : hash tables were resized.
...
09:22:56.393589Z 0 [Note] InnoDB: Resized hash tables at lock_sys, adaptive hash
index, dictionary.
09:22:56.393616Z 0 [Note] InnoDB: Completed to resize buffer pool from 17179869184 to
1073741824.
09:22:56.393628Z 0 [Note] InnoDB: Re-enabled adaptive hash index.
```

2、VARCHAR in-place enlarge

- 255字节长度是个门槛；
- 不跨越255长度门槛即可在线调大；
- 没必要再为VARCHAR列预留更大长度；
- 缩短长度不能in-place。

- 成功

#enlarge c1 length from 30 to 50

mysql> ALTER TABLE t1 ALGORITHM=INPLACE, modify email VARCHAR(50);

Query OK, 0 rows affected (0.68 sec)

- 失败

#enlarge c1 length from 30 to 300

mysql> alter table t1 ALGORITHM=INPLACE, modify char_col varchar(300) not null default '';

ERROR 1846 (0A000): ALGORITHM=INPLACE is not supported. Reason: Cannot change column type INPLACE. Try ALGORITHM=COPY.

3、临时表空间增强

- 使用独立表空间，不写redo、无change buffer；

4、支持在线清除undo log

- 避免undo log积累过多；

复制增强

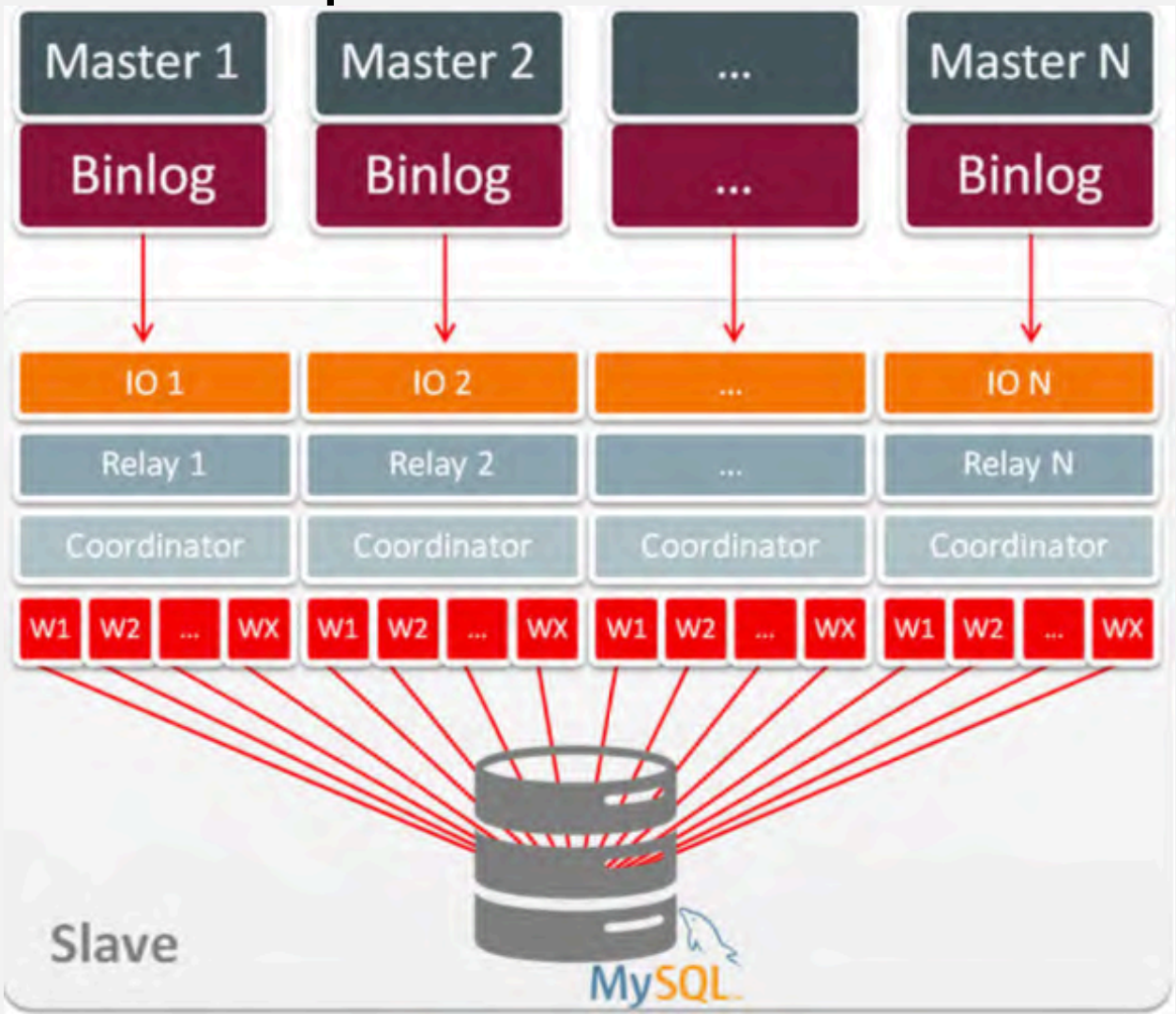
1、multi source replication/多源复制

- 支持多主一从，从多个master汇聚到一个slave；
- 特别适合数据集中分析、集中备份、异地容灾。

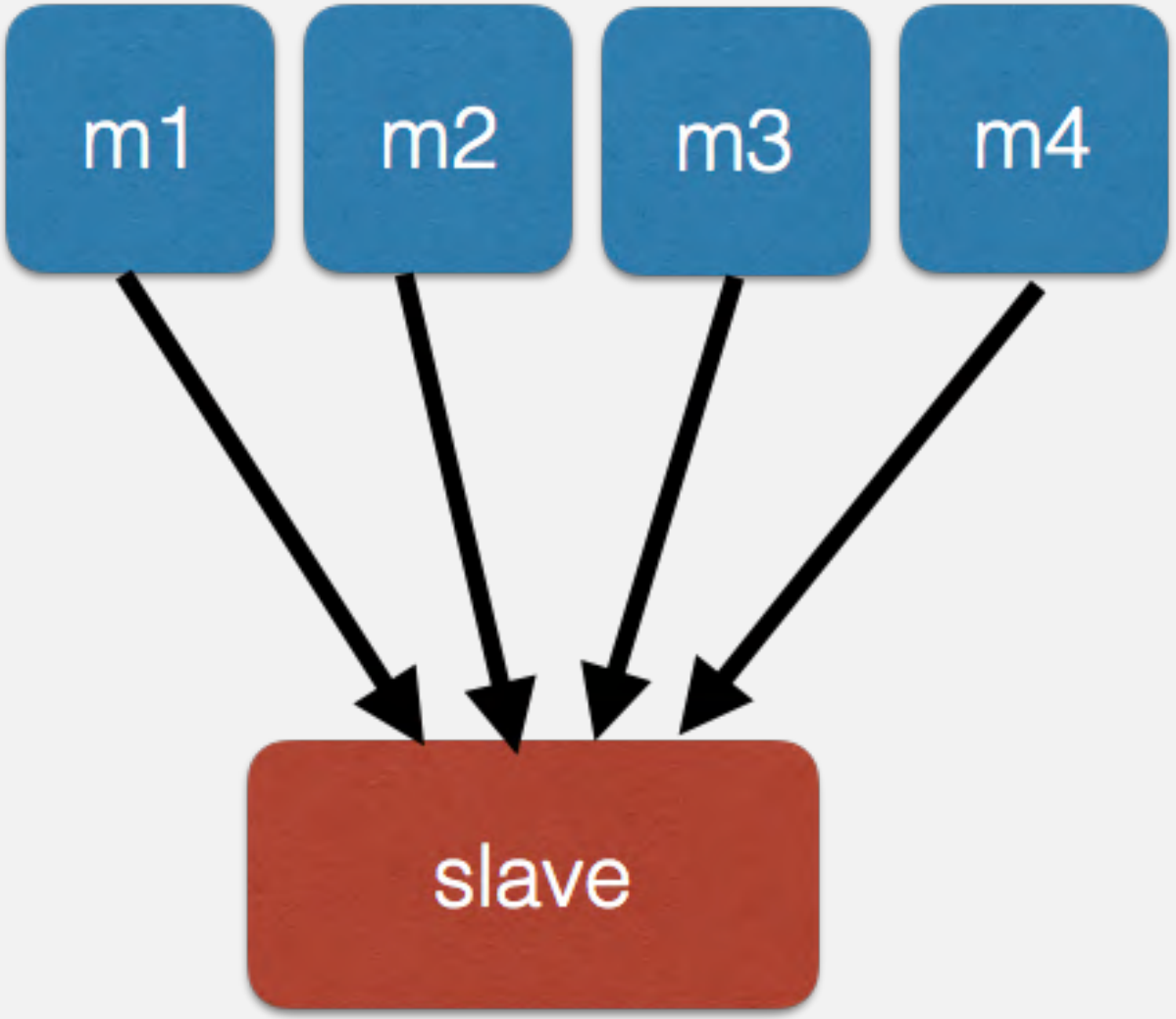
2、multi-threaded replication/并行复制

- 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；
- 可解决除大事务外的大部分复制延迟问题。

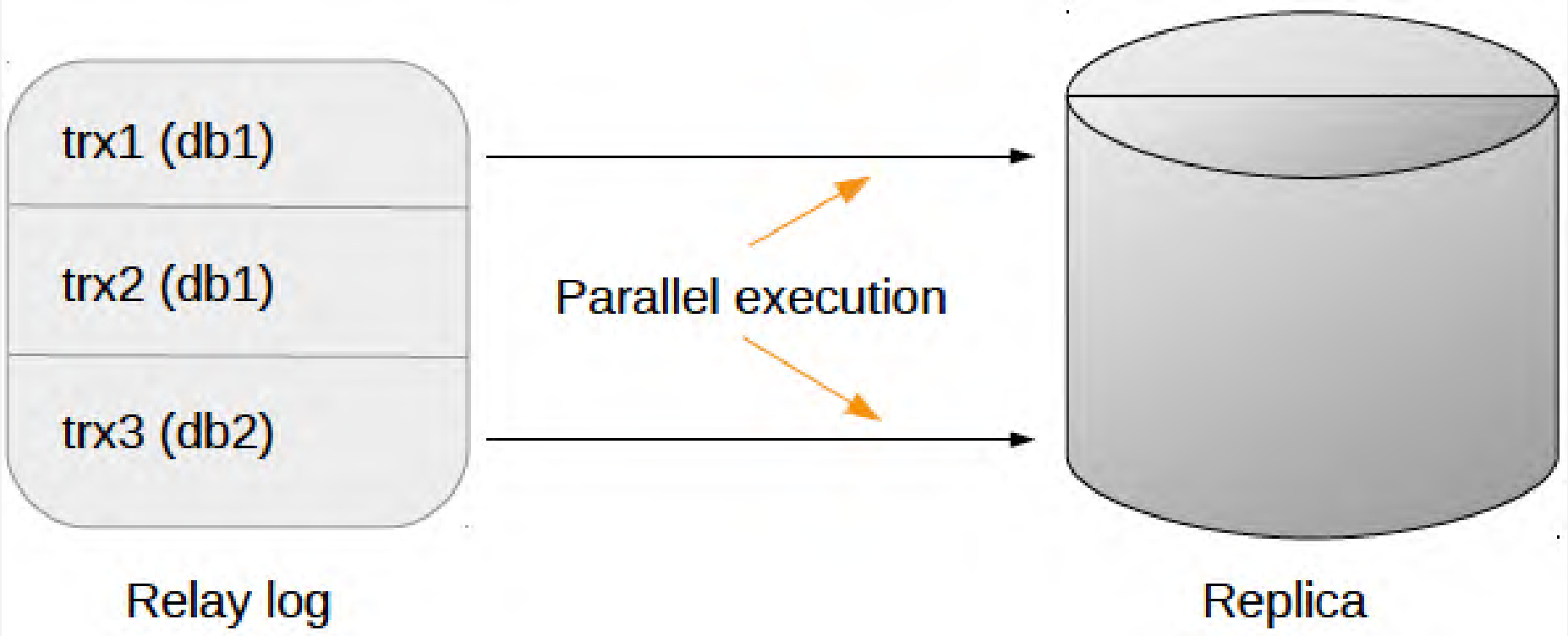
multi-threaded replication



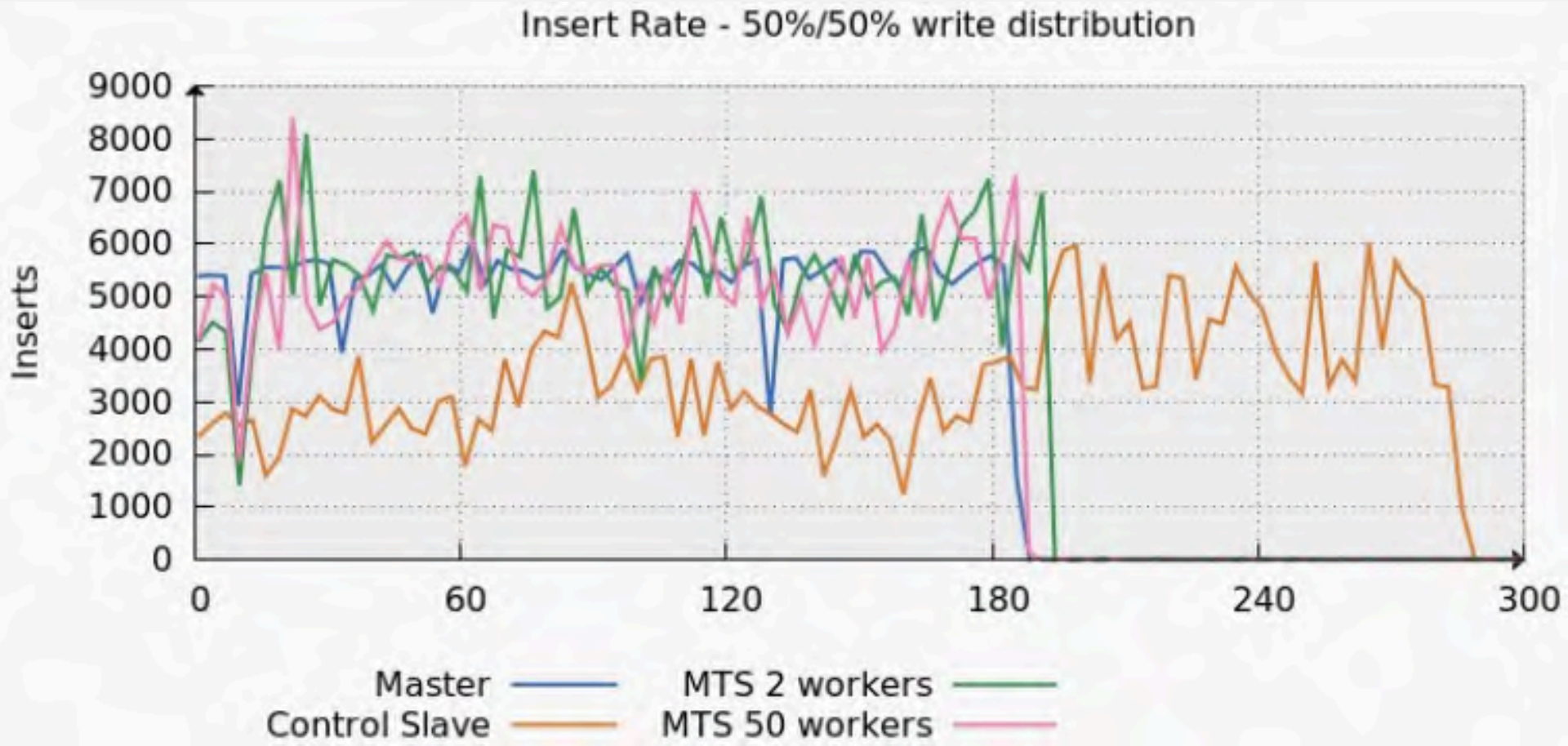
multi source replication



multi-threaded replication



multi-threaded replication

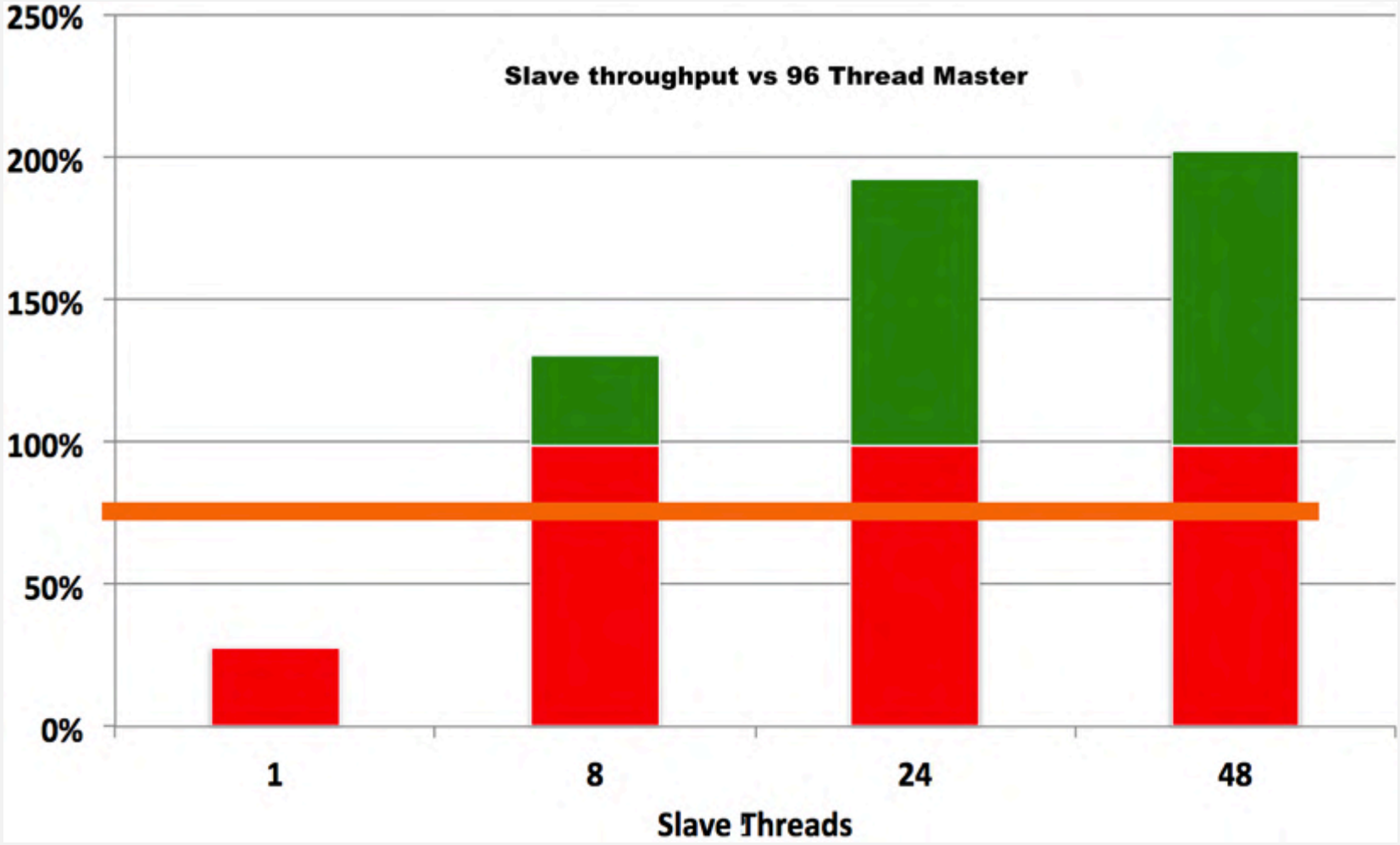


图片来源《Multi-Threaded Replication in MySQL 5.6 and MySQL 5.7》by Stéphane Combaudon

multi-threaded replication

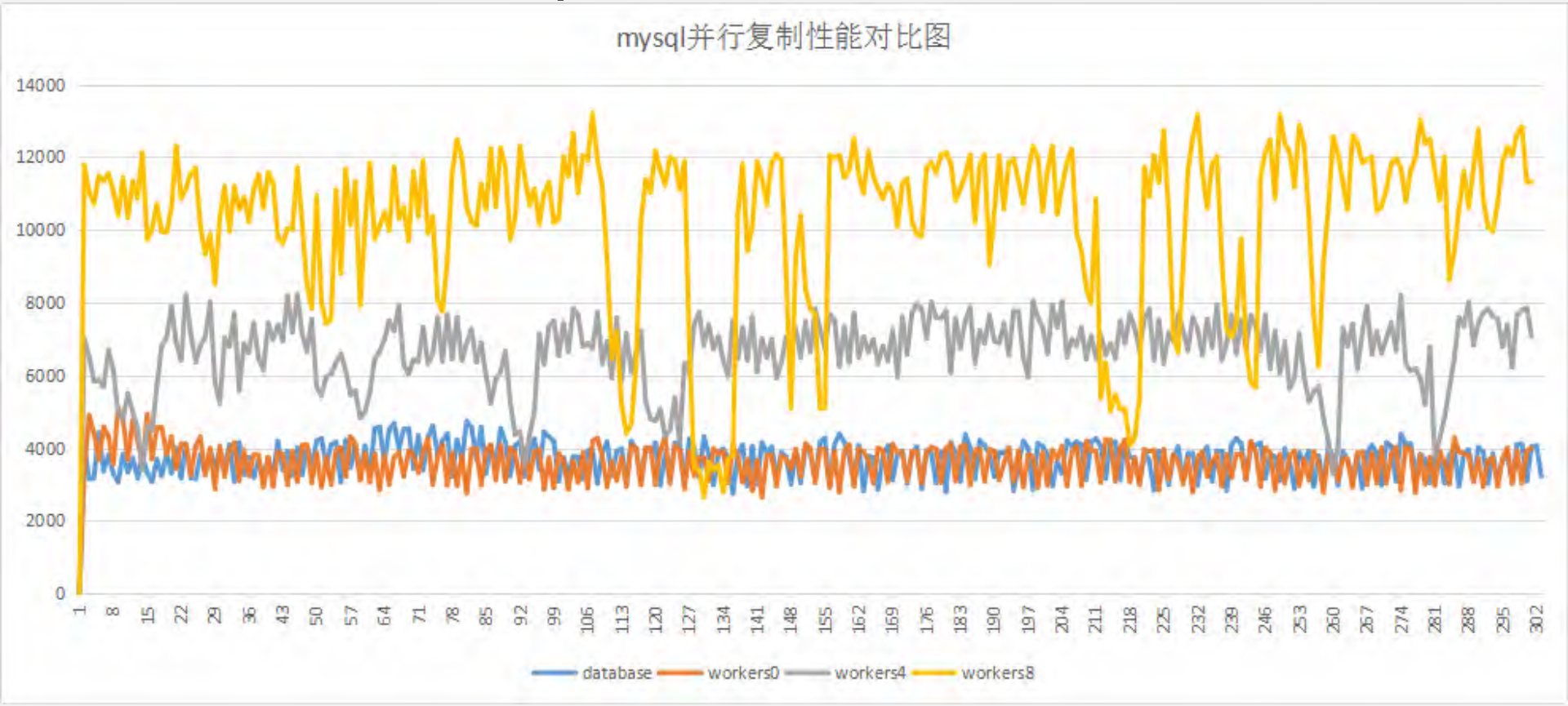
图片源自《Multi-Threaded Replication in MySQL 5.6 and MySQL 5.7》by Stéphane Combaudon

multi-threaded replication



图片源自《Whats New in MySQL 5.7》by Geir Høydalsvik & Simon Mudd

multi-threaded replication



图片源自https://my.oschina.net/anthonyyau/blog/663137

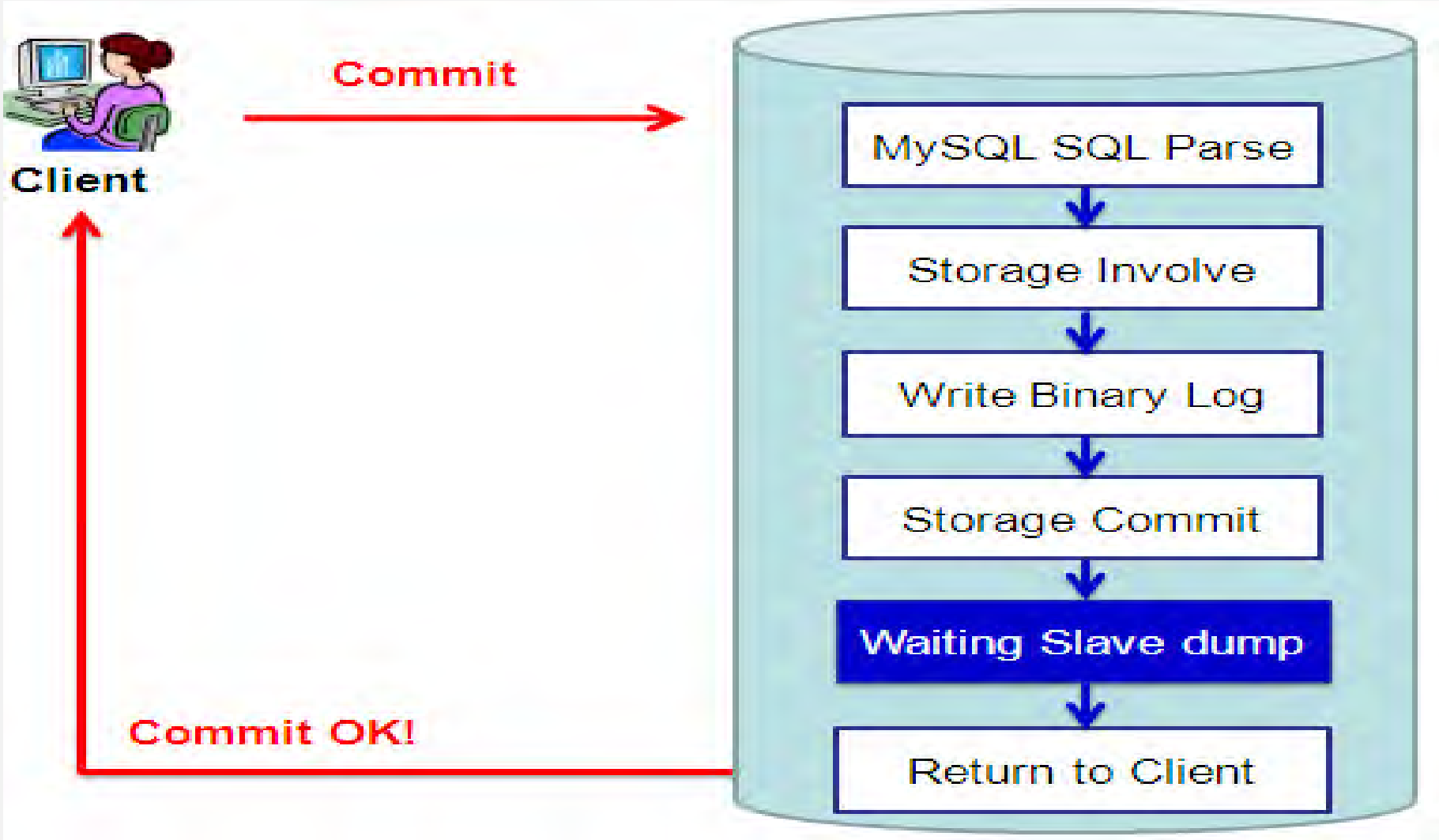
3、lossless semi-sync replication/无损半同步复制

- 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。

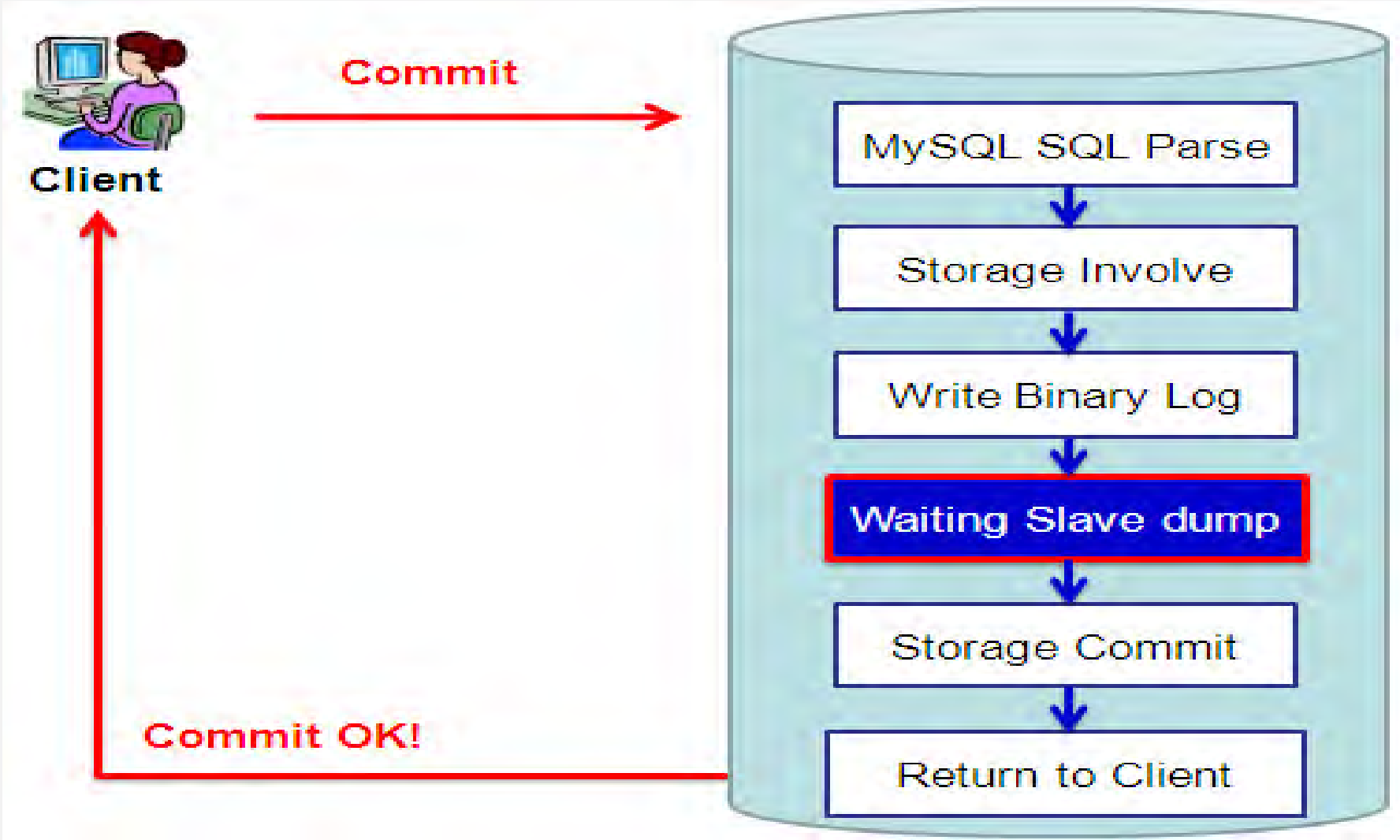
4、group replication/组复制

- 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，表必须有主键，且基于RBR。

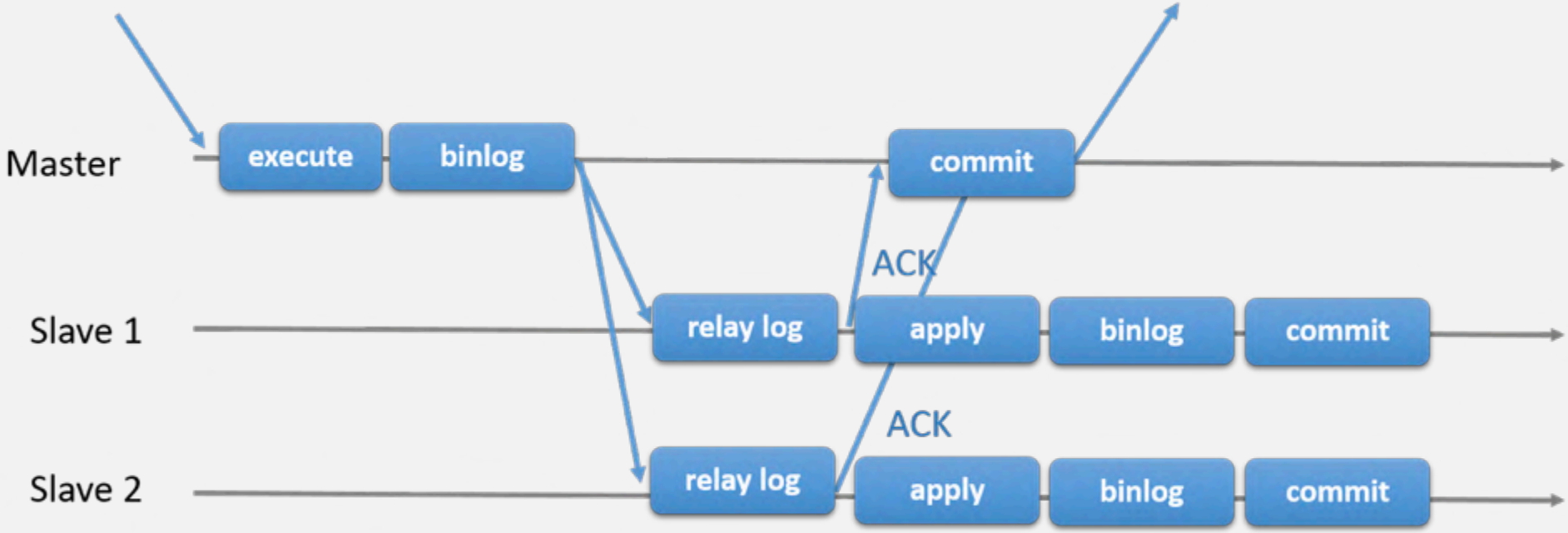
semi-sync replication



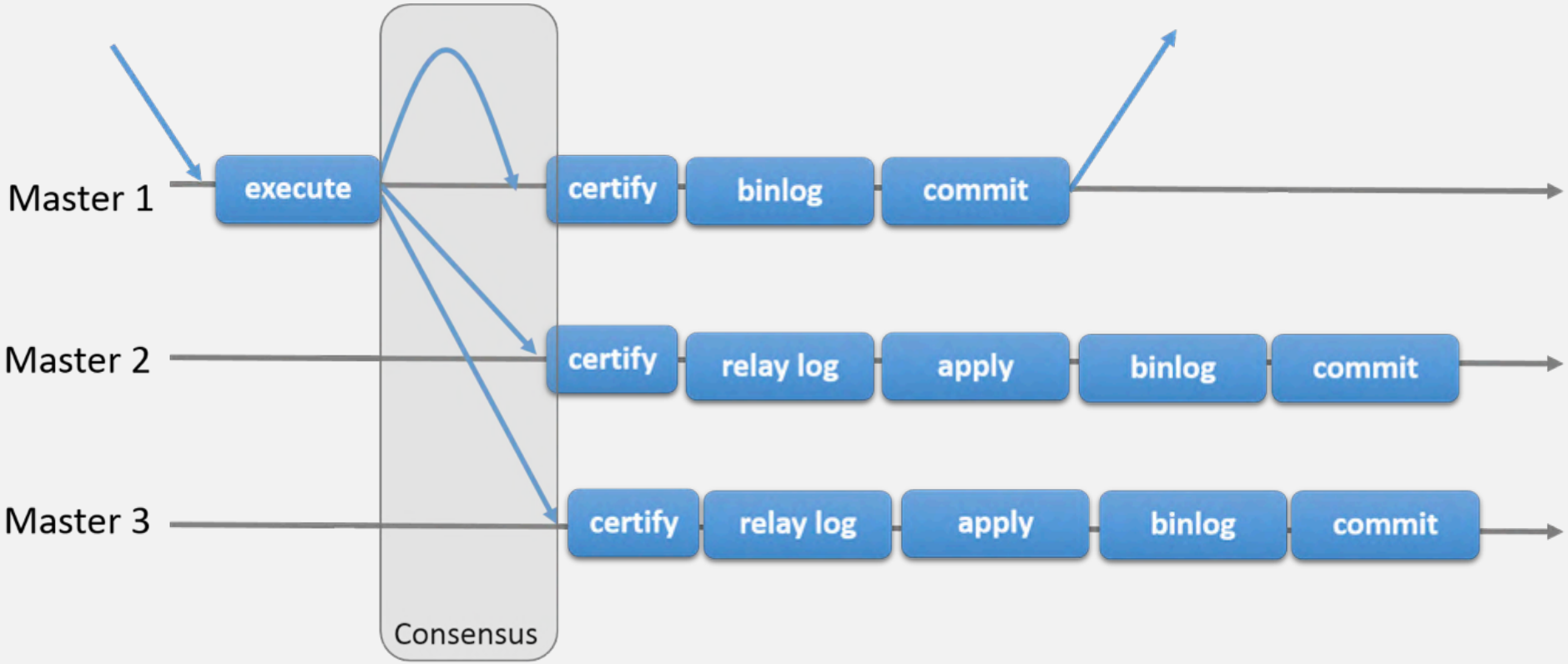
lossless semi-sync replication



增强semi-sync replication（ack异步且独立线程处理）



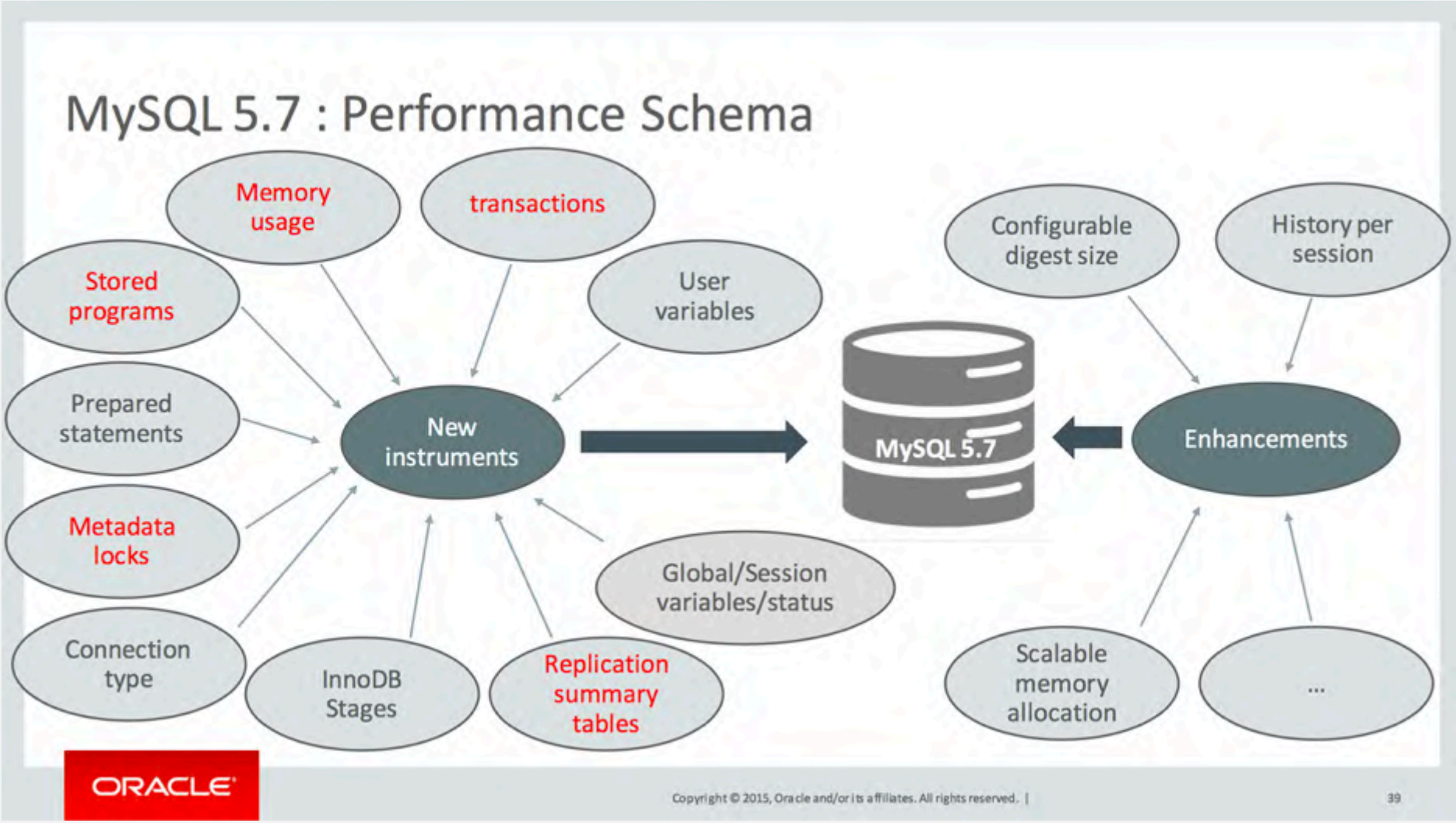
group replication



p_s、sys增强

p_s、sys增强

APMCon



sys schema中， schema、table相关统计视图

```
yejr@imysql.com[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               |
+-------------------------------------+
```

table对象DML统计

```
mysql> select table_schema,table_name,rows_fetched,rows_inserted,
 rows_updated,rows_deleted,io_read_requests,io_read,io_write_requests,
 io_write from schema_table_statistics order by rows_inserted desc limit 2\G
*************************** 1. row ***************************
     table_schema: test
       table_name: t1
     rows_fetched: 1187841
    rows_inserted: 102400
     rows_updated: 0
     rows_deleted: 0
 io_read_requests: 278
          io_read: 95.62 KiB
io_write_requests: 849
         io_write: 12.30 MiB
*************************** 2. row ***************************
     table_schema: yejr
       table_name: tt2
     rows_fetched: 512003
    rows_inserted: 102400
     rows_updated: 0
     rows_deleted: 0
 io_read_requests: 26
          io_read: 2.91 KiB
io_write_requests: 839
         io_write: 12.71 MiB
```

table对象DML统计

```
mysql> select 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 = 'test' and table_name = 't1';
+--------------+---------------+--------------+--------------+-------------------+-----------+--------------------+-----------+
| rows_fetched | rows_inserted | rows_updated | rows_deleted | io_read_requests  | io_read   | io_write_requests  | io_write  |
+--------------+---------------+--------------+--------------+-------------------+-----------+--------------------+-----------+
|      1187841 |        102400 |            0 |            0 |               278 | 95.62 KiB |                849 | 12.30 MiB |
+--------------+---------------+--------------+--------------+-------------------+-----------+--------------------+-----------+
```

index对象usage统计

```
mysql> select index_name, rows_selected, rows_inserted, rows_updated, rows_deleted
       from schema_index_statistics where table_schema ='test' and table_name='t1';
+------------+---------------+---------------+--------------+--------------+
| index_name | rows_selected | rows_inserted | rows_updated | rows_deleted |
+------------+---------------+---------------+--------------+--------------+
| u1         |        163841 |             0 |            0 |            0 |
| PRIMARY    |             0 |             0 |            0 |            0 |
+------------+---------------+---------------+--------------+--------------+
```

redundant indexes

```
mysql> select * from schema_redundant_indexes limit 1\G
*************************** 1. row ***************************
               table_schema: yejr
                 table_name: t3
       redundant_index_name: u1
    redundant_index_columns: u1
redundant_index_non_unique: 1
        dominant_index_name: u1_2
     dominant_index_columns: u1,u2
 dominant_index_non_unique: 1
             subpart_exists: 0
             sql_drop_index: ALTER TABLE `yejr`.`t3` DROP INDEX `u1`
```

unused indexes

```
mysql> select * from schema_unused_indexes;
+-------------------+---------------+--------------+
| object_schema     | object_name   | index_name   |
+-------------------+---------------+--------------+
| yejr              | t1            | int_col      |
| yejr              | t1            | char_col     |
| yejr              | t2            | char_col     |
| yejr              | t3            | u1           |
| yejr              | t3            | u1_2         |
| yejr              | t3            | u3           |
| yejr              | tt2           | int_col      |
| yejr              | tt2           | char_col     |
+-------------------+---------------+--------------+
```

row lock waits

```
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
```

mdl lock waits

```
mysql> select * from schema_table_lock_waits\G
...
*************************** 2. row ***************************
               object_schema: test
                 object_name: t1
           waiting_thread_id: 628
                 waiting_pid: 595
             waiting_account: root@localhost
           waiting_lock_type: EXCLUSIVE
       waiting_lock_duration: TRANSACTION
               waiting_query: alter table t1 drop index u1
          waiting_query_secs: 29
 waiting_query_rows_affected: 0
 waiting_query_rows_examined: 0
          blocking_thread_id: 629
                blocking_pid: 596
              blocking_account: root@localhost
            blocking_lock_type: SHARED_WRITE
      blocking_lock_duration: TRANSACTION
     sql_kill_blocking_query: KILL QUERY 596
sql_kill_blocking_connection: KILL 596
```

```
mysql> show processlist;
+-----+------+-----------+------+---------+------+---------------------------------+-----------------------------+
| Id  | User | Host      | db   | Command | Time | State                           | Info                        |
+-----+------+-----------+------+---------+------+---------------------------------+-----------------------------+
| 595 | root | localhost | test | Query   |    4 | Waiting for table metadata lock | alter table t1 drop index u1 |
| 596 | root | localhost | test | Query   |    0 | starting                        | show processlist            |
+-----+------+-----------+------+---------+------+---------------------------------+-----------------------------+
```

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
```

热门SQL TOP10

```
mysql>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                                                           |
+--------------------+------------+-----------------------------------------------------------------------+
```

查看实例内存消耗

```
mysql> select *from memory_global_total;
+-----------------+
| total_allocated |
+-----------------+
| 3.49 GiB        |
+-----------------+
```

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

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

其他增强

1、EXPLAIN增强

- 查看当前活跃SESSION的SQL执行计划
  EXPLAIN FOR CONNECTION 3306
- JSON格式输出结果中，可见执行计划代价信息
- 总是启用PARTITIONS/EXTENDED选项

2、 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]} |
+----+-------------------------------------------------------------+
```

2、 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
```

2、 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  |
+----+-------------+-----------+------------+------+---------------+-----------+---------+-------+------+----------+-------+
```

2、 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
```

2、 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
```

3、SELECT中设置超时阈值

- SQL Hint
  - SELECT /*+ MAX_EXECUTION_TIME(10000) */ …
- 也可设定 max_execution_time 选项
- 可有效避免某个垃圾SQL导致雪崩
- 参考
  - MariaDB/Percona选项innodb_kill_idle_transaction

1、支持invisible index

- 无需重建索引，快速完成
- in-place设置visible/invisible
- force index也不可用
- 索引统计信息仍旧更新
- 主键不能invisible

2、descending index

- 有了倒序索引，倒序扫描效率更高了
- 也支持虚拟列（VIRTUAL、STORED）
- 只支持B+TREE，不支持HASH、FULLTEXT、SPATIAL索引
- 只支持InnoDB

- SELECT增加NOWAIT、SKIP LOCKED选项
- InnoDB memcached支持mget指令
- InnoDB表自增列最大值持久化
- 直方图（Histogram）

THANK YOU