MySQL 5.7 Performance: Scalability & Benchmarks

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Are you Dimitri?.. ;-)

- Yes, it's me :-)
- Hello from Paris! ;-)
- Passionated by Systems and Databases Performance
- Previous 15 years @Sun Benchmark Center
- Started working on MySQL Performance since v3.23
- But during all that time just for “fun” only ;-)
- Since 2011 “officially” @MySQL Performance full time now
- http://dimitrik.free.fr/blog / @dimitrik_fr

Agenda

- Overview of MySQL Performance
- Performance improvements in MySQL 5.7 & Benchmark results
- Pending issues..
- Q & A

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Why MySQL Performance ?...

Why benchmarking MySQL?..

- Any solution may look “good enough”...

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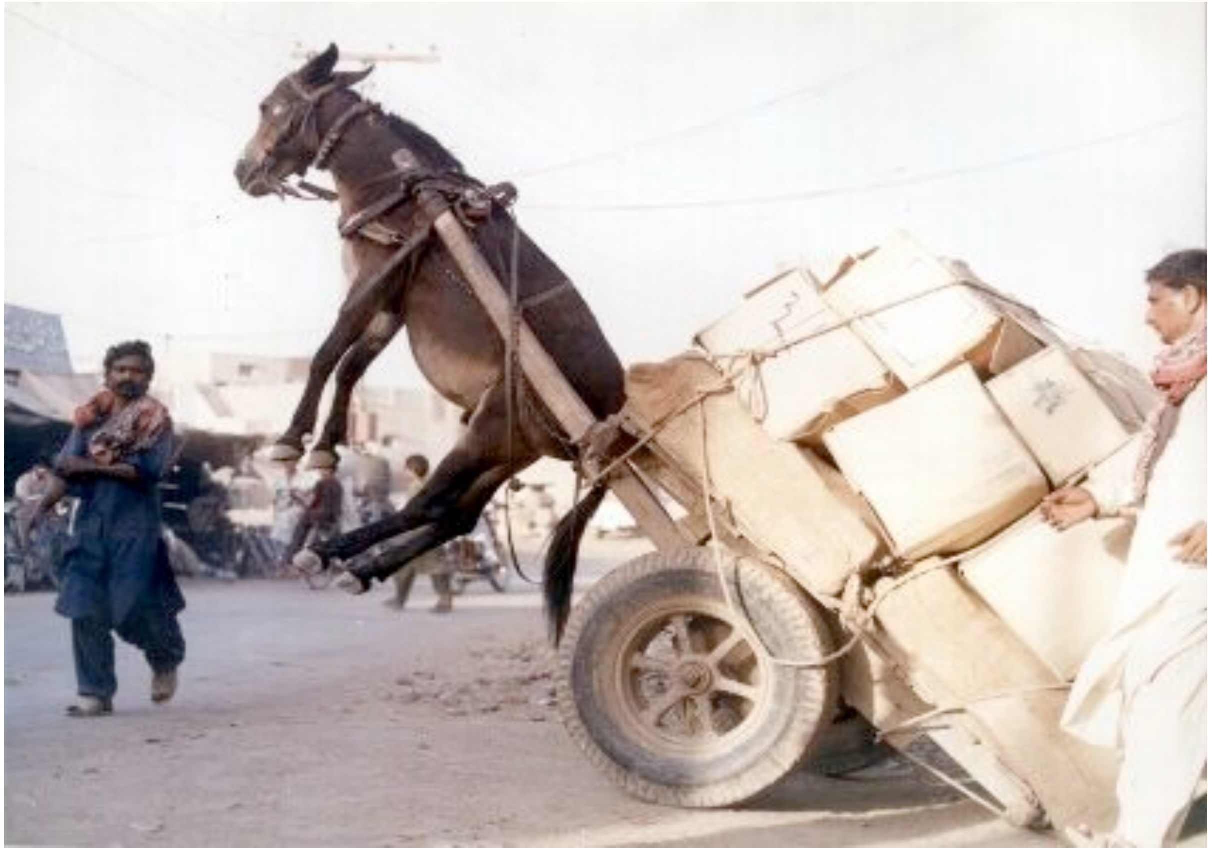
Why benchmarking MySQL?..

- Until it did not reach its limit..



Why benchmarking MySQL?..

- And even improved solution may not resist to increasing load..

Why benchmarking MySQL?..

- And reach a similar limit..

Why benchmarking MySQL?..

- A good benchmark testing may help you to understand ahead the resistance of your solution to incoming potential problems ;-)

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Why benchmarking MySQL?..

- But keep it in mind:
  - Even a very powerful solution but leaved in wrong hands may still be easily broken!... :-)

The Main MySQL Performance Tuning
#1 Best Practice is... ???..

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USE YOUR BRAIN !!!... ;-)

The Main MySQL Performance Tuning #1 Best Practice is... ???..

USE YOUR BRAIN !!!... ;-)

THE MAIN SLIDE! ;-))

Think “Database Performance” from the beginning!

malloc() !!!
I/O & FS !!

- Server:
  - Having faster CPU is still better! 32 cores is good enough ;-)
  - OS is important! - Linux, Solaris, etc.. (and Windows too!)
  - Right **malloc**() lib!! (Linux: jemalloc, Solaris: libumem)
- Storage:
  - Don't use slow disks! (except if this is a test validation goal :-))
  - Flash helps when access is random! (reads are the most costly)
  - FS is important! - ZFS, UFS, QFS, VxFS, EXT3, EXT4, XFS, etc..
  - O_DIRECT or not O_DIRECT, AIO or not AIO, and be aware of bugs! ;-)
  - **Do some generic I/O tests first !!** (Sysbench, IObench, iozone, etc.)
- Don't forget network !! :-) (faster is better, 10Gbit is great!)

Test Workload

- Before to jump into something complex...
  - Be sure first you're comfortable with “basic” operations!
  - Single table? Many tables?
  - Short queries? Long queries?
- Remember: any complex load in fact is just a mix of simple operations..
  - So, try to split problems..
  - Start from as simple as possible..
  - And then increase complexity progressively..
- NB : **any** test case is important !!!
  - Consider the case rather reject it with “I’m sure you’re doing something wrong..” ;-))

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“Generic” Test Workloads @MySQL

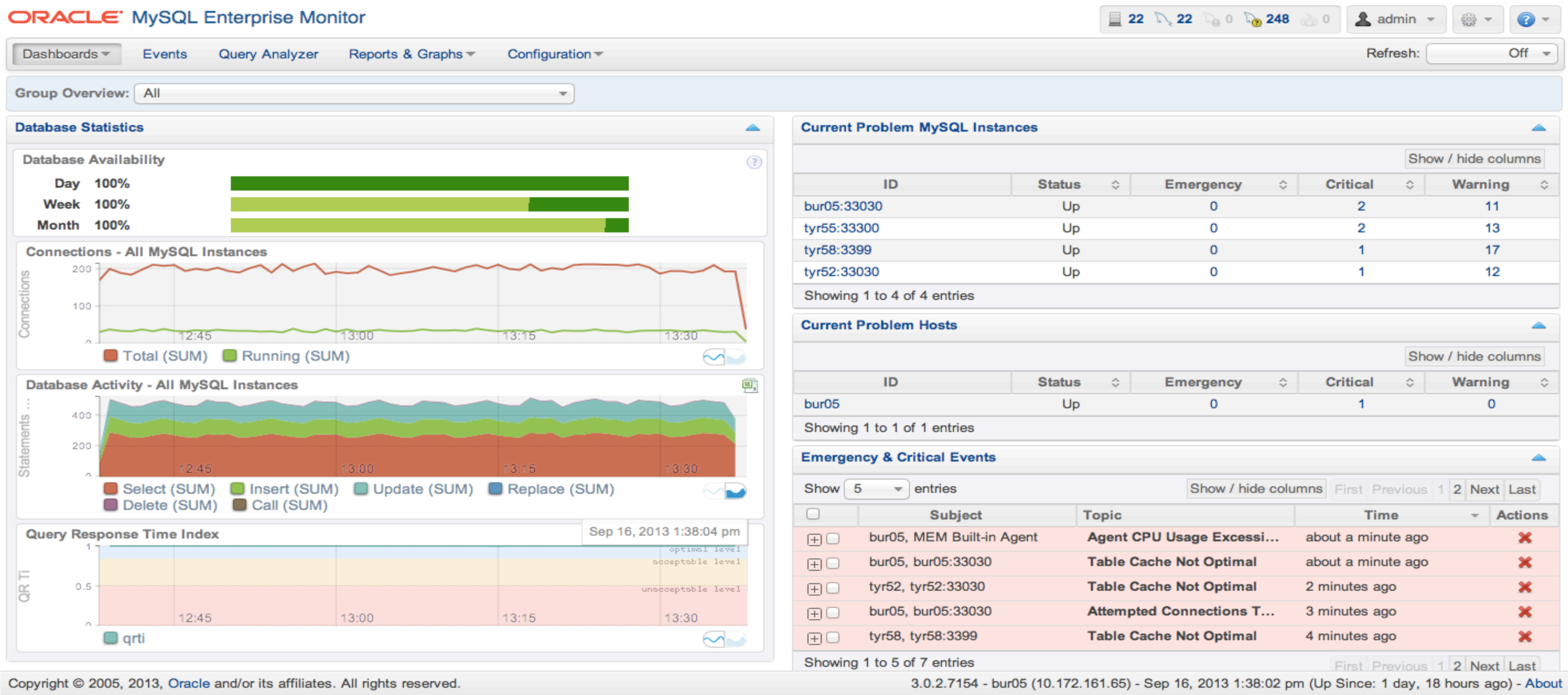
- Sysbench
  - OLTP, RO/RW, 1-table, since v0.5 N-table(s), lots load options, deadlocks
- DBT2 / TPCC-like
  - OLTP, RW, very complex, growing db, no options, deadlocks
  - In fact using mostly only 2 tables! (thanks Performance Schema ;-))
- dbSTRESS
  - OLTP, RO/RW, several tables, one most hot, configurable, no deadlocks
- LinkBench (Facebook)
  - OLTP, RW, very intensive, IO-hungry..
- DBT3
  - DWH, RO, complex heavy query, loved by Optimizer Team ;-)

Monitoring is THE MUST !

even don’t start to test anything without monitoring.. ;-)

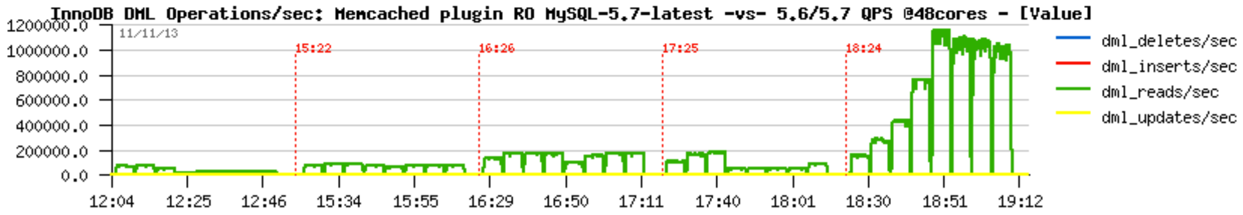
MySQL Enterprise Monitor

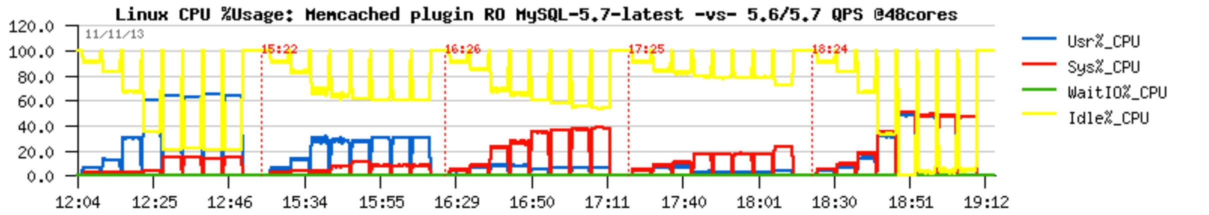
- Fantastic tool!
  - Did you already try it?.. Did you see it live?..



Other Monitoring Tools

- Cacti, Zabbix, Nagios, Etc.....
- dim_STAT
  - well, I'm using this one, sorry ;-)
  - all graphs within presentation were made with it
  - details are in the end of presentation..



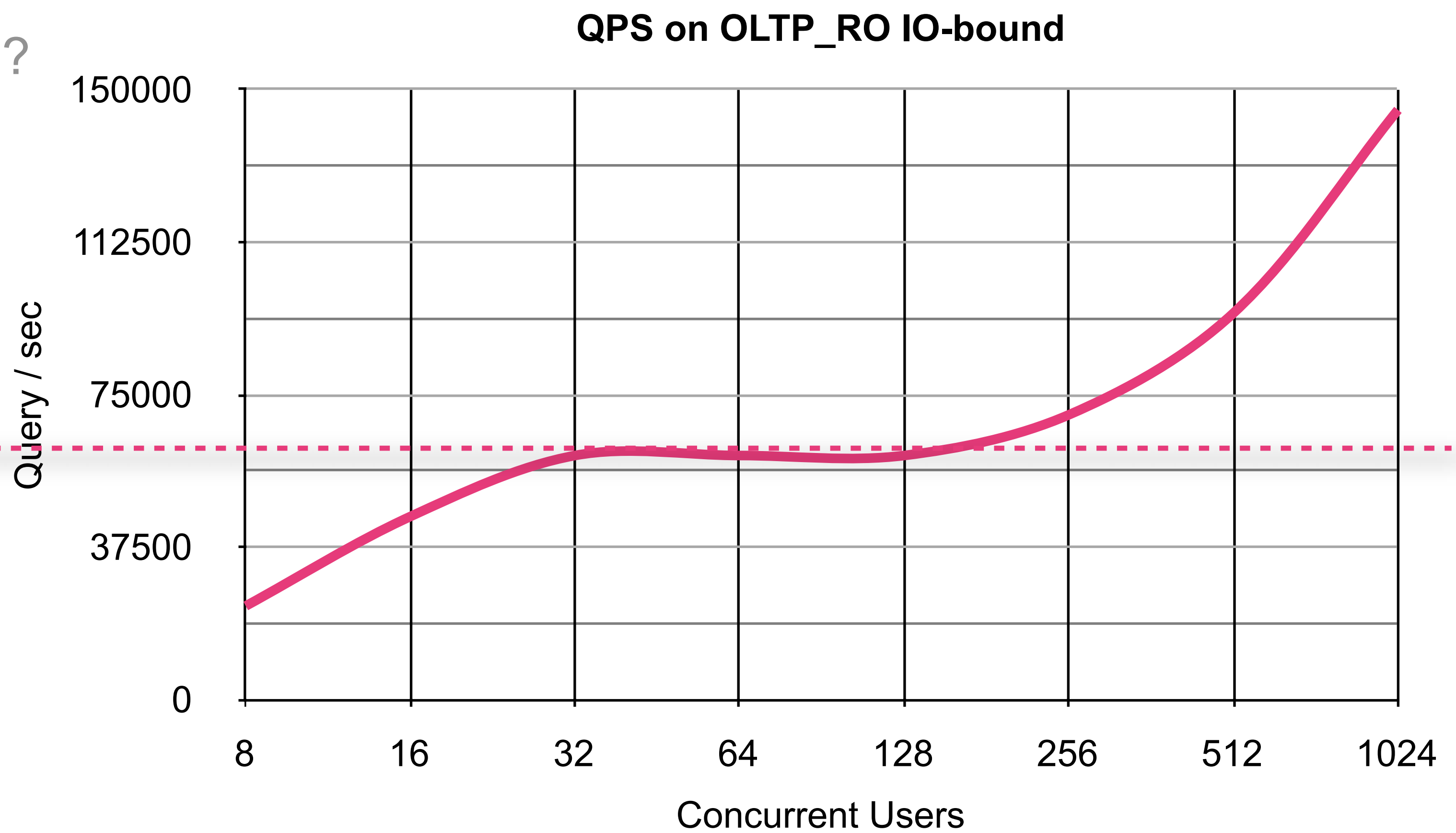


Be sure you can trust your Benchmark results ;-)

- Know your HW platform **limits**
- Understand what your **Workload** is doing
- Keep in mind MySQL Server **internals**
- There is **NO** “Silver Bullet” !!!
  - Think about the #1 MySQL Performance Best Practice ;-))

Let’s analyze the following benchmark result..

- Test : fully random IO-bound OLTP_RO
  - Storage limit : 60K reads/sec max
  - 150K QPS ??
  - WTF?.. ;-)



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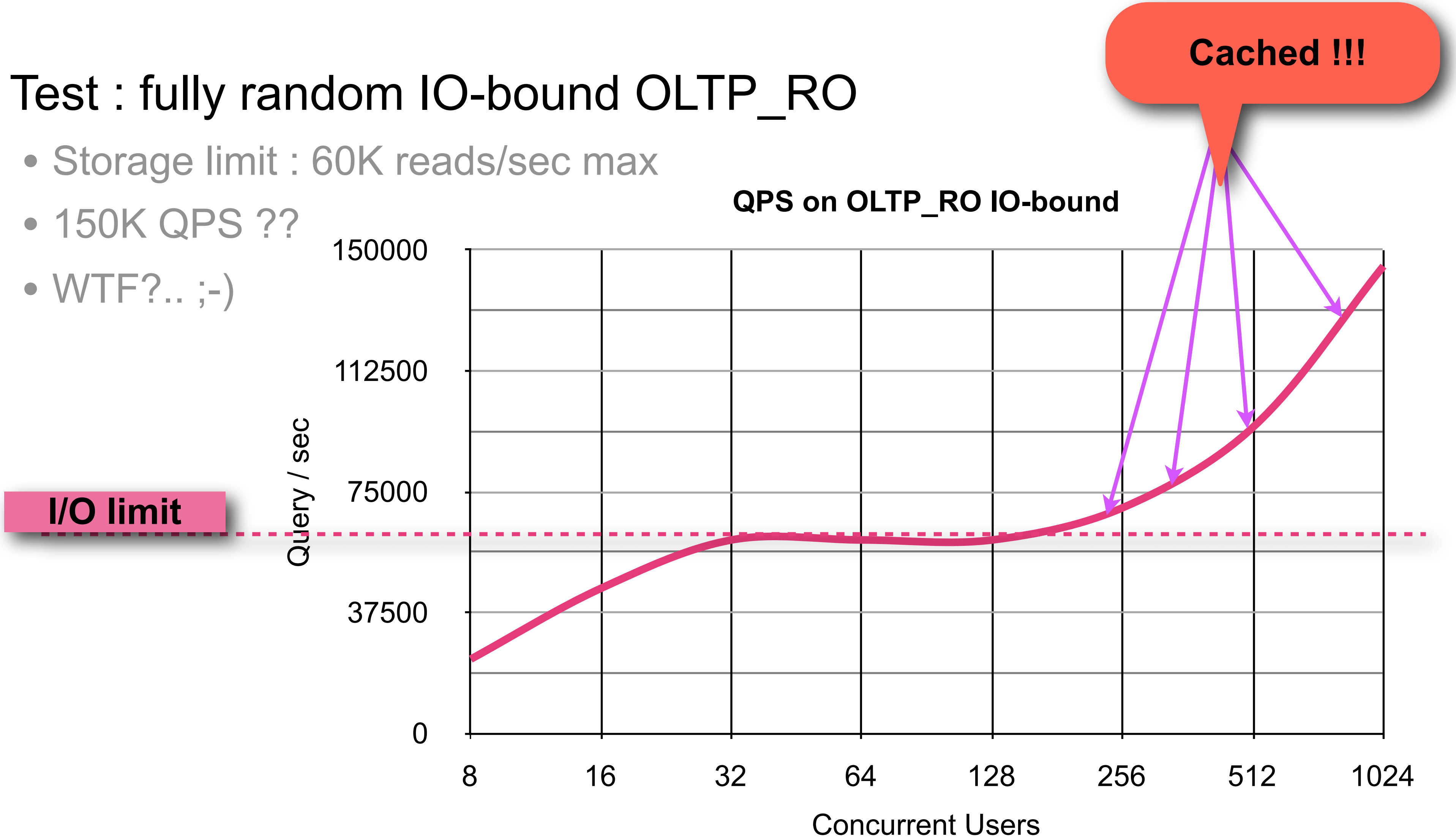
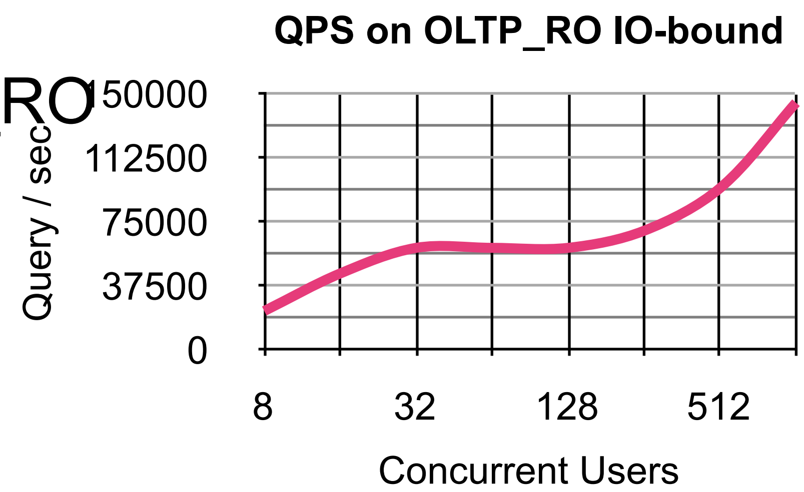


Let's analyze the following benchmark result..

- Test : fully random IO-bound OLTP_RO
  - Storage limit : 60K reads/sec max
  - 150K QPS ??
  - WTF?.. ;-)
- The issue:
  - the random ID for a row acces is not that random as expected..
  - and with a higher workload the probability to get the same "random" row ID on the same time and by different threads only increasing..
  - workaround : for some of the tests started to use as many Sysbench processes as user threads (1 connection = 1 sysbench process)..



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Analyzing Workloads: RO -vs- RW

- Read-Only (RO) :
  - Nothing more simple when comparing DB Engines, HW configs, etc..
  - RO In-Memory : data set fit in memory / BP / cache
  - RO IO-bound : data set out-passing a given memory / BP / cache
- Read+Write (RW) :
  - I/O is **ALWAYS** present ! - storage performance matters a lot !
  - may be considered as always IO-bound ;-)
  - RW In-Memory : same as RO, data set fit in memory, but :
    - small data set => small writes
    - big dataset => big writes ;-)
  - RW IO-bound : data set out-passing a memory
    - means there will be (a lot of?) reads !
    - don't forget that I/O random reads = I/O killer !

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Read-Only Scalability @MySQL / InnoDB

- Depends on a workload..
  - sometimes the limit is only within your memcpy() rate ;-)
- But really started to scale only since MySQL 5.7
  - due improved TRX list management, MDL, THR_lock, etc..
  - scaling up to 48 CPU cores for sure, reported on more cores too..
  - Note : code path is growing with new features! (small HW may regress)
- IO-bound :
  - could be limited by storage (if you’re not using a fast flash)
  - or by internal contentions (InnoDB file_sys mutex)
- Limitations
  - there are still some limitations “by design” (block lock, file_sys, etc..)
  - all in TODO to be fixed, but some are needing a deep redesign

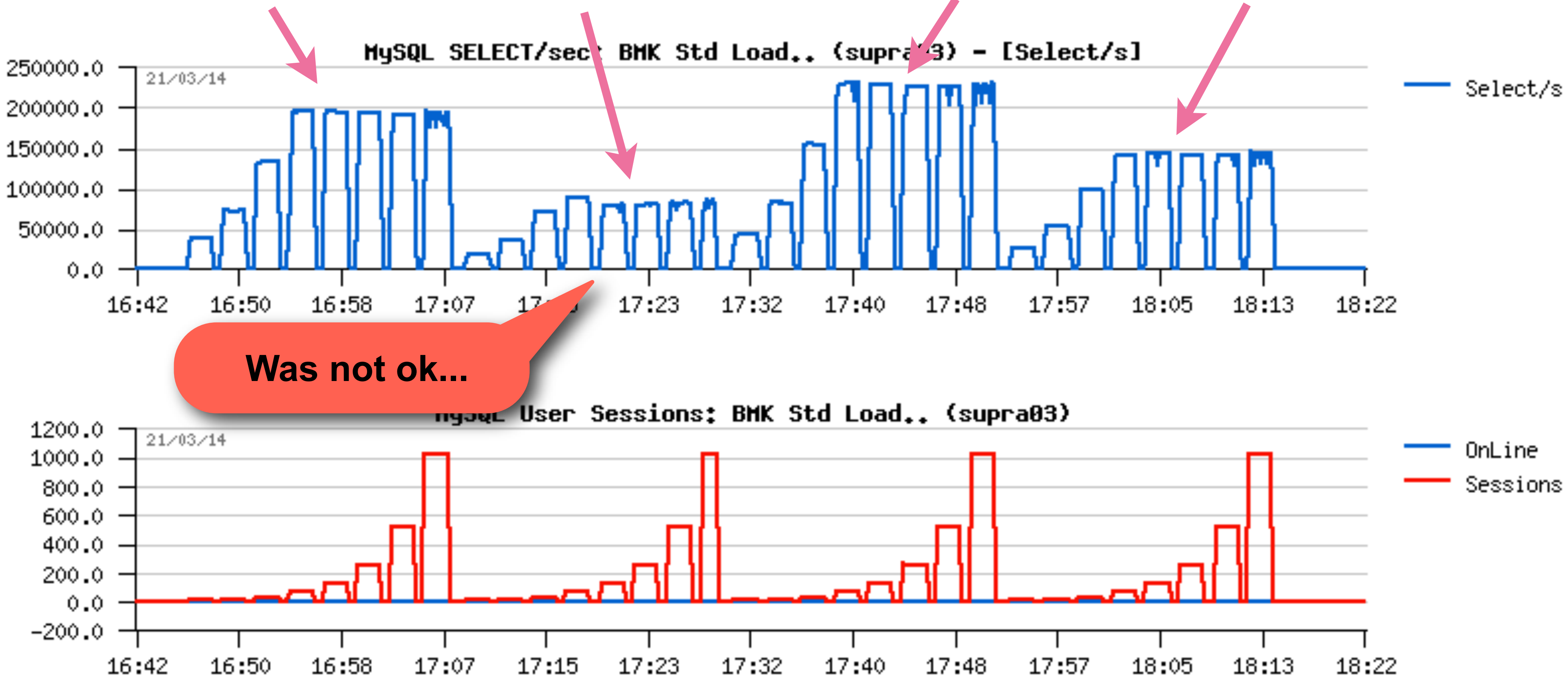
RO related starter configuration settings

- my.conf :

```
join_buffer_size=32K
sort_buffer_size=32K

table_open_cache = 8000
table_open_cache_instances = 16
query_cache_type = 0

innodb_buffer_pool_size= 64000M (2/3 RAM ?)
innodb_buffer_pool_instances=32
innodb_thread_concurrency = 0 / 32 / 64
innodb_spin_wait_delay= 6 / 48 / 96

innodb_stats_persistent = 1
innodb_adaptive_hash_index= 0 / 1
innodb_monitor_enable = '%'
```

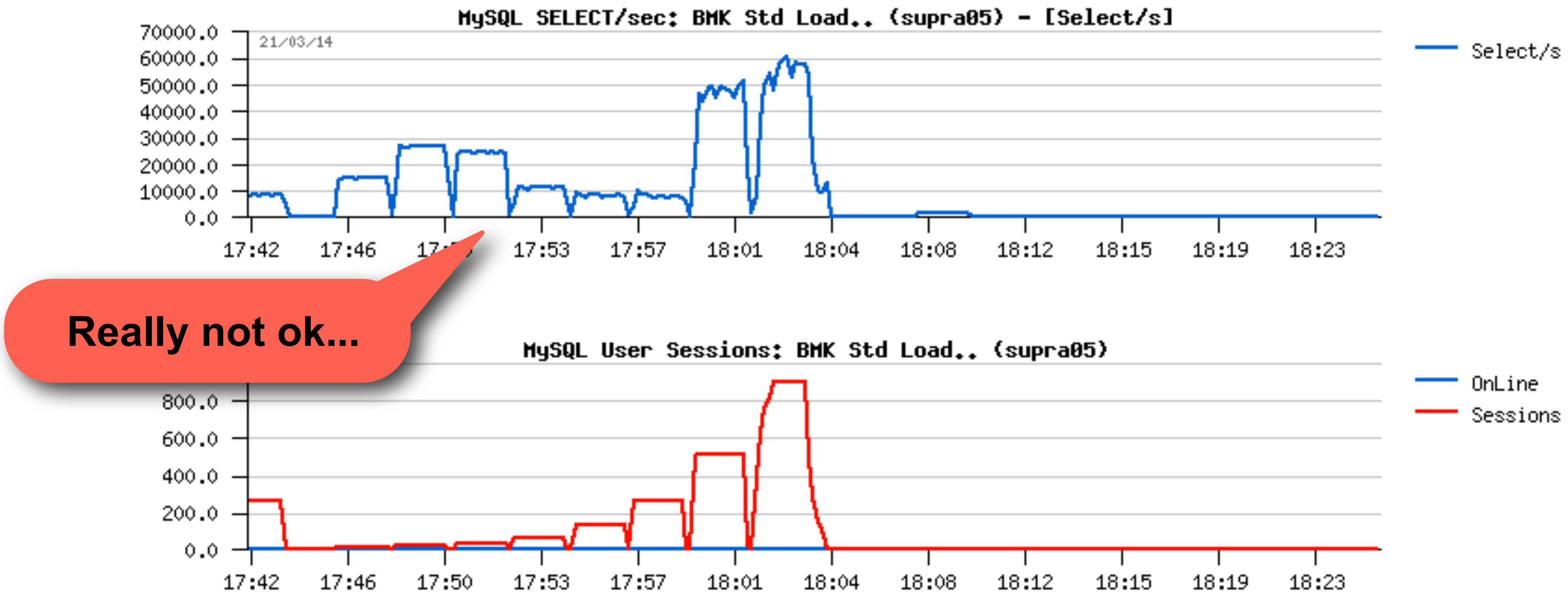
Sysbench OLTP_RO Workloads @MySQL 5.7

- Simple ranges, Distinct ranges, SUM ranges, Ordered ranges



Story #1 : mysterious kernel contention

- Sysbench RO Distinct Selects
  - 40cores-HT server



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Story #1 : mysterious kernel contention (2)

- Sysbench RO Distinct Selects
  - 40cores-HT server
- Profiler:

```
80.52%  [kernel]      [k] _spin_lock
 7.36%  [kernel]      [k] native_write_msr_safe
 2.08%  [kernel]      [k] smp_invalidate_interrupt
 0.82%  [kernel]      [k] find_next_bit
 0.76%  [kernel]      [k] flush_tlb_others_ipi
 0.69%  [kernel]      [k] __bitmap_empty
 0.53%  [kernel]      [k] native_flush_tlb
...
```

Really not ok...

Story #1 : mysterious kernel contention (3)

- Sysbench RO Distinct Selects
  - 40cores-HT server
- Profiler:

```
 80.52%  [kernel]                [k] _spin_lock
  7.36%  [kernel]                [k] native_write_msr_safe
  2.08%  [kernel]                [k] smp_invalidate_interru
  0.82%  [kernel]                [k] find_next_bit
  0.76%  [kernel]
  0.69%  [kernel]
  0.53%  [kernel]
...
```

```
 73.13%   mysqld  [kernel.kallsyms]                    [k] _spin_lock
          |
          --- _spin_lock
             |
             |--99.96%-- flush_tlb_others_ipi
             |          native_flush_tlb_others
             |          flush_tlb_mm
             |          zap_page_range
             |          sys_madvise
             |          system_call_fastpath
             |          madvise
             |          |
             |          |--2.73%-- 0x7f03db1e1818
...
```

But who is the killer ?...

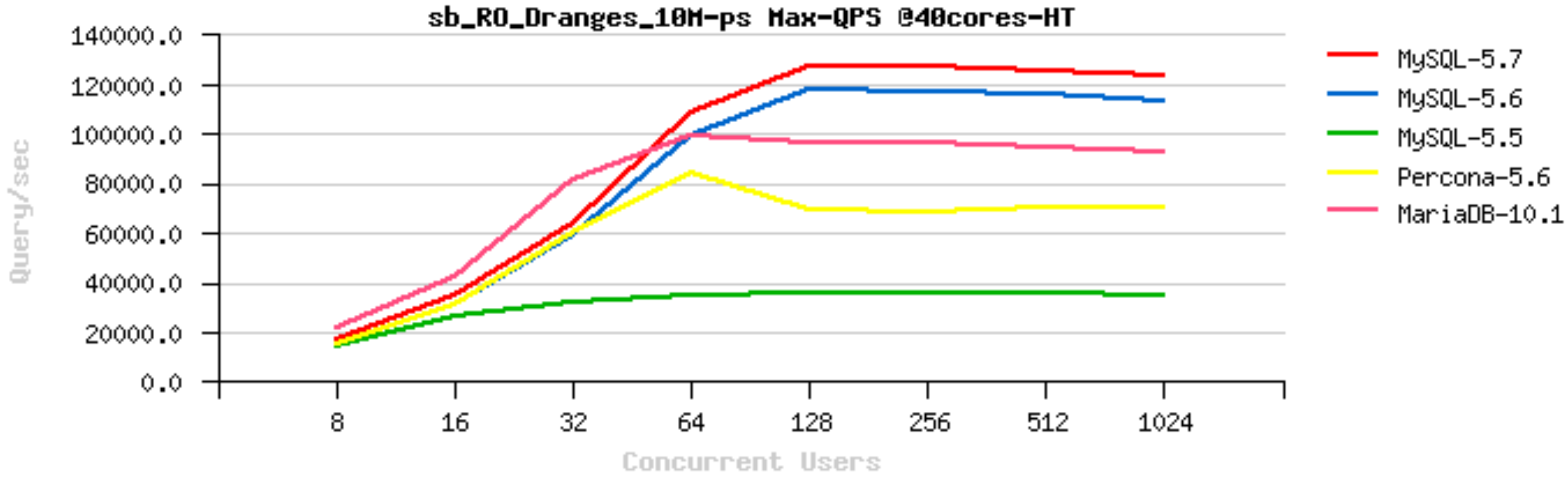
Story #1 : mysterious kernel contention (4)

- Sysbench RO Distinct Selects
  - 40cores-HT server
- And the killer is... - **jemalloc** !!! ;-)
  - Distinct Selects workload is extremely hot on malloc (HEAP)
    - in fact any SELECT involving HEAP temp tables will be in the same case..
    - ex: small results via group by, order by, etc..
  - jemalloc has a smart memory free stuff...
  - trigger OS via madvise()..
  - disabling this jemalloc feature resolving the problem ;-)

```
LD_PRELOAD=/apps/lib/libjemalloc.so  ; export LD_PRELOAD
MALLOC_CONF=lg_dirty_mult:-1         ; export MALLOC_CONF
```

OLTP_RO Distinct Selects with “fixed” jemalloc

- Max QPS @40cores-HT :

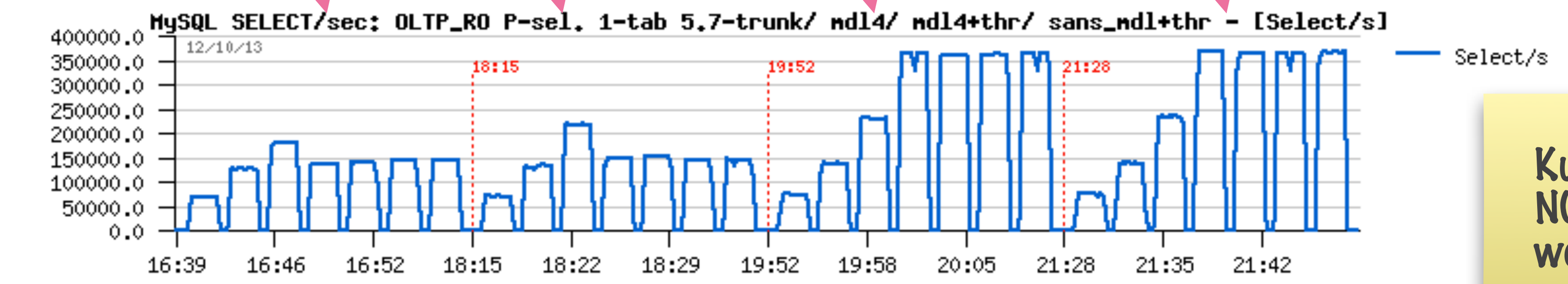


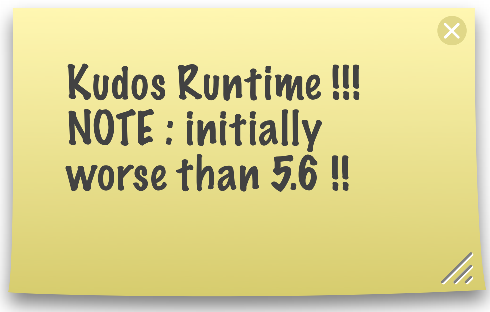
Story #2 : contentions around a hot table

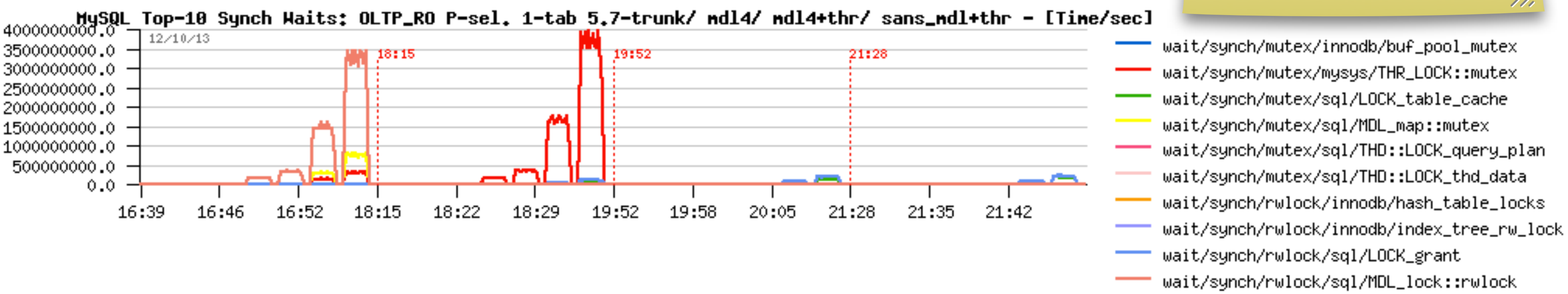
- Once again a game of contentions :
  - improved TRX list ==> more hot MDL..
  - more hot MDL ==> regression on all single-table workloads..
  - improved MDL ==> more hot THR_lock..
  - more hot THR_lock ==> regression on all single-table workloads..
  - improved THR_lock ==> “next-level” locks become visible now!
  - expectation for today : once the next level lock are fixed, there should be no one new unexpected contention for a while ;-)

Story #2 : contentions around a hot table (2)

- Making-off @OLTP_RO Point-Selects, single-table :
  - original | MDL-fix | MDL&THR_lock fix | original w/out MDL&THR_lock

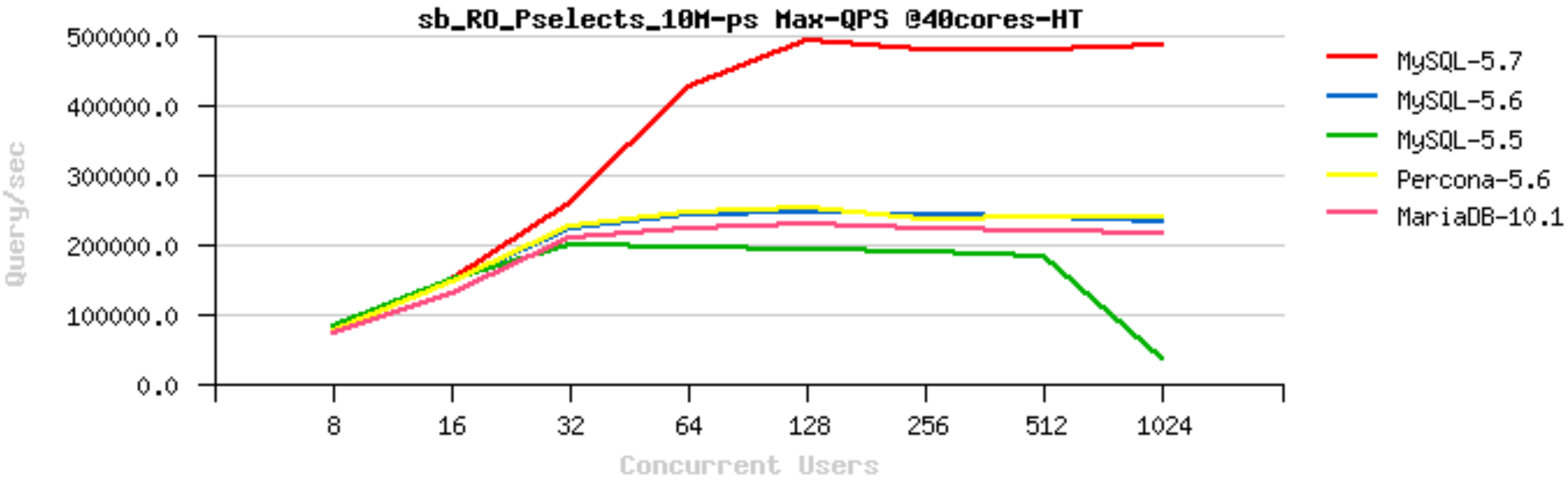






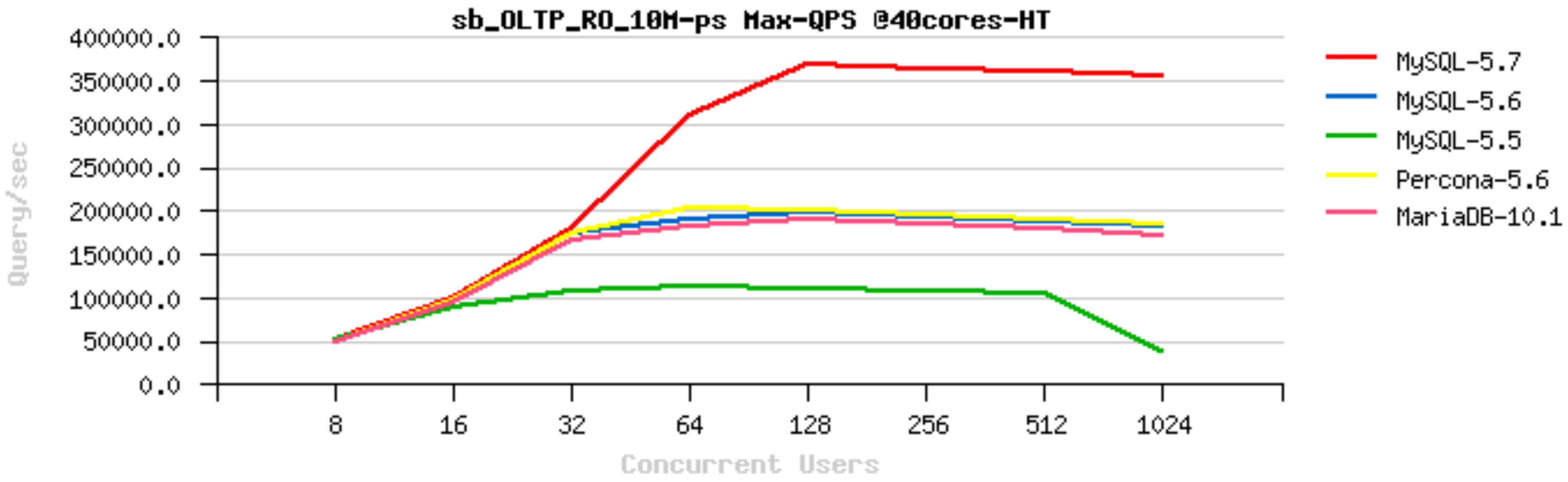
Sysbench OLTP_RO Point-Selects single-table

- Max QPS @40cores-HT :



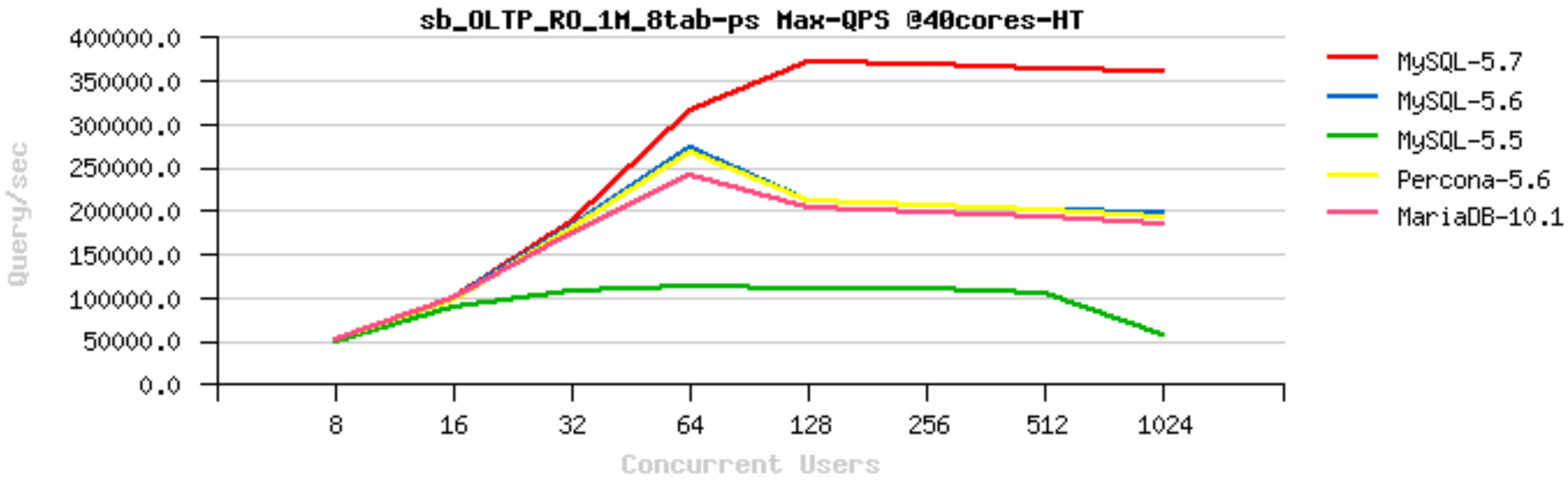
Sysbench OLTP_RO Single-table

- Max QPS @40cores-HT :



RO In-Memory @MySQL 5.7

• Sysbench OLTP_RO 8-tables, 40cores-HT :



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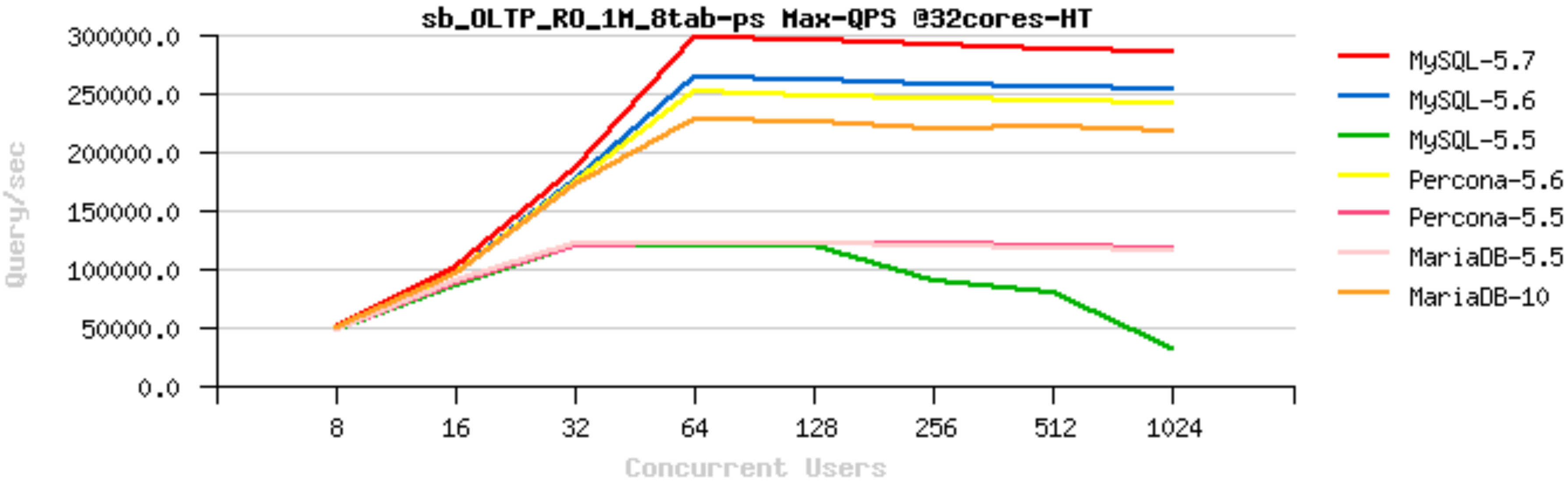
RO In-Memory @MySQL 5.7

- Sysbench OLTP_RO 8-tables, 32cores-HT :



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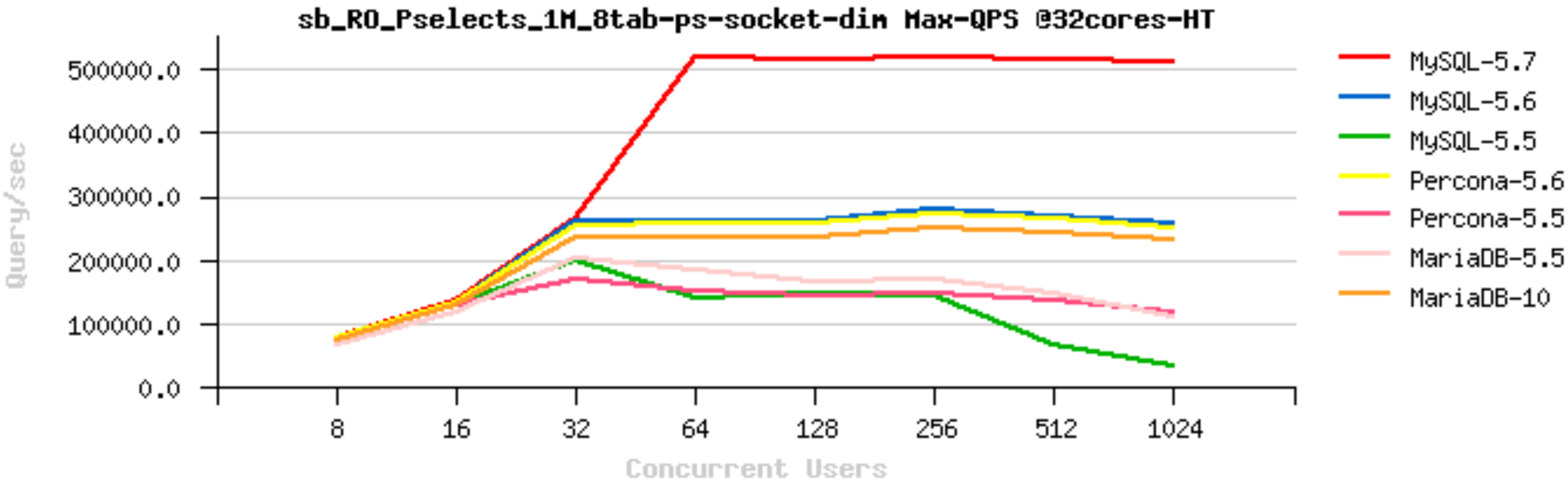
RO In-Memory @MySQL 5.7

- **500K QPS** Sysbench Point-Selects 8-tab, 32cores-HT :



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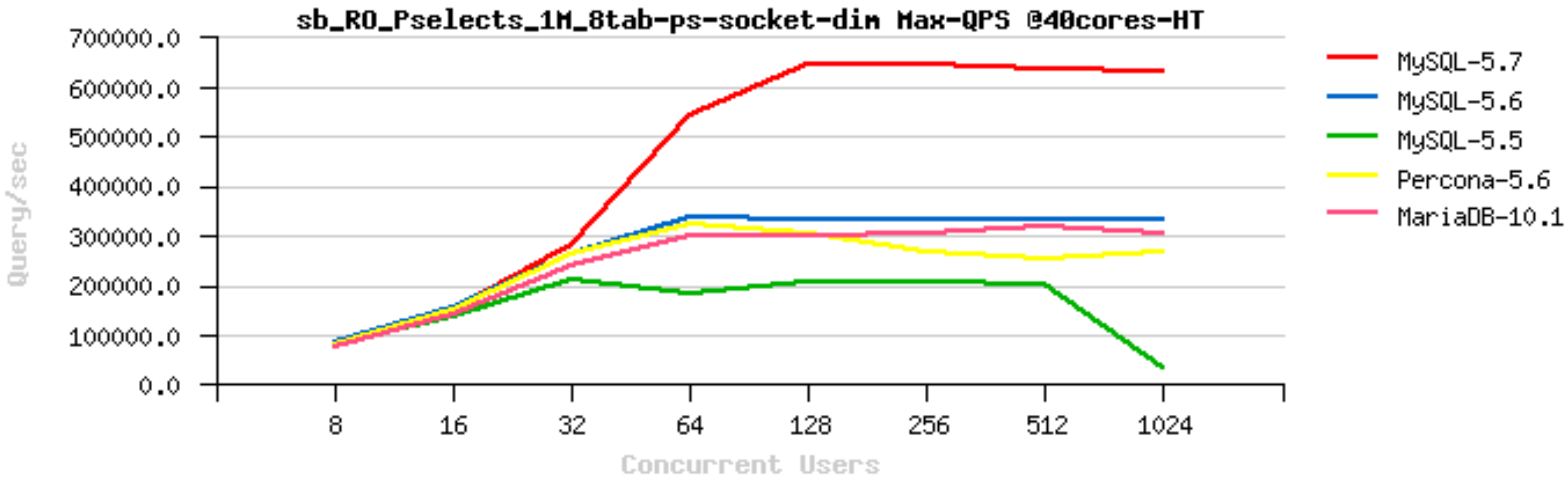
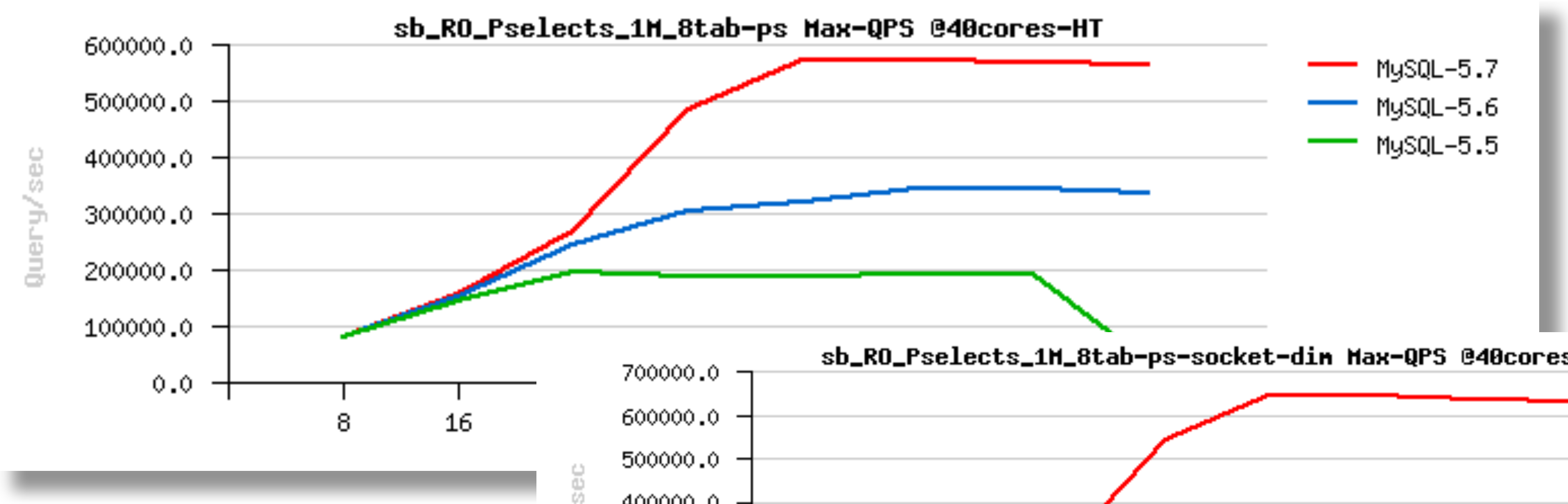
RO In-Memory @MySQL 5.7

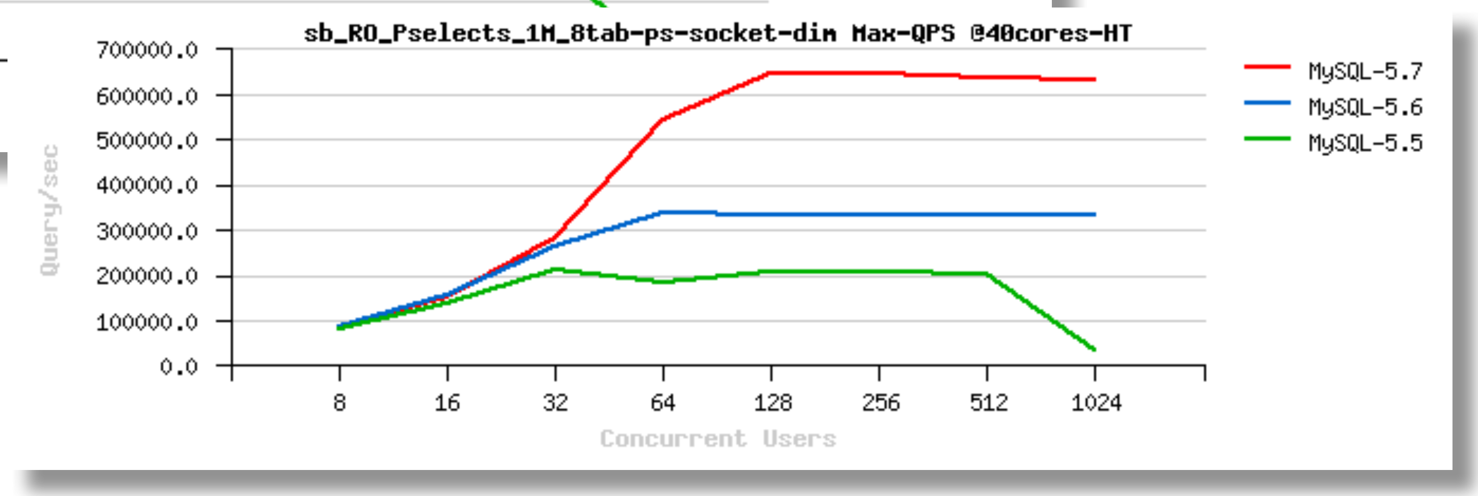
- **645K QPS** Sysbench Point-Selects 8-tab, 40cores-HT :



Few words about RO scalability

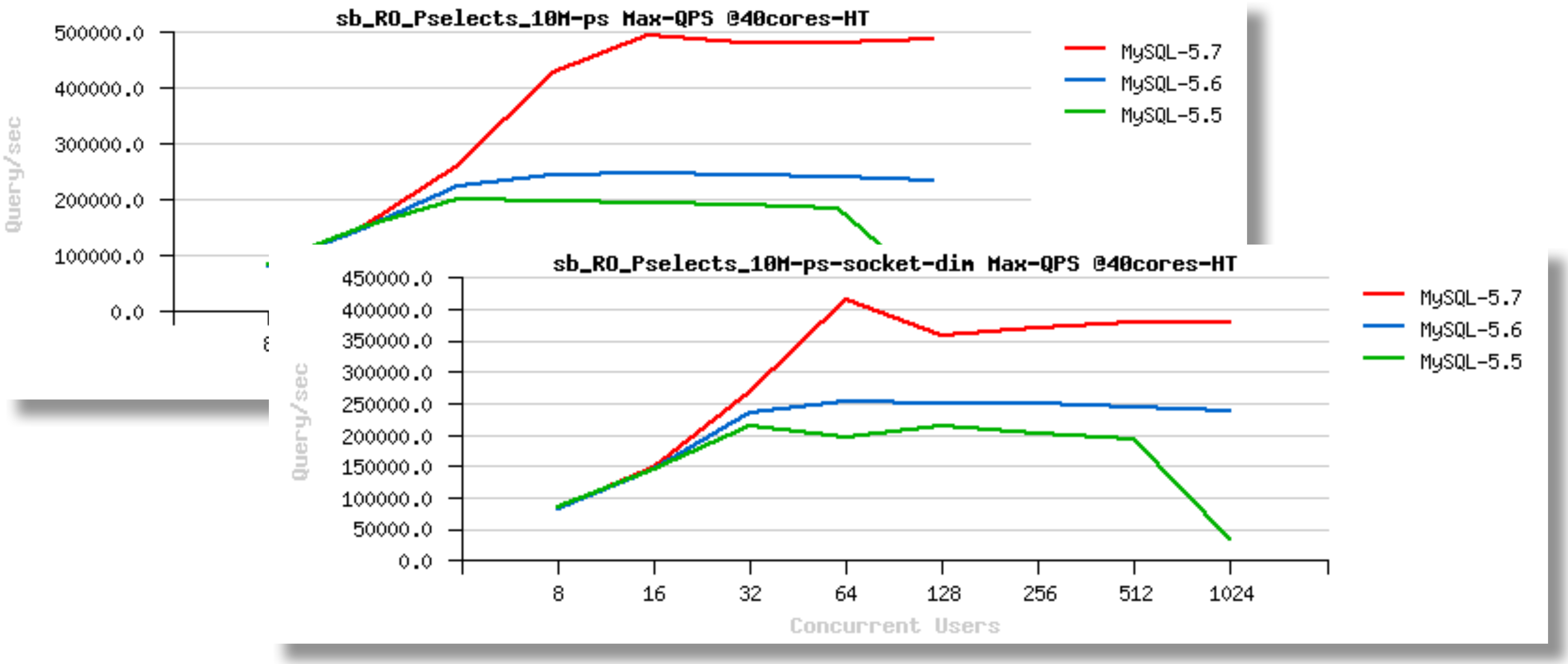
- OLTP_RO Point-selects **8**-tables, the same 40cores host
  - IP socket & sysbench 0.4.13 -vs- UNIX socket & sysbench 0.4.8 :





Few words about RO scalability (bis)

- OLTP_RO Point-selects **1**-table, the same 40cores host
  - IP socket & sysbench 0.4.13 -vs- UNIX socket & sysbench 0.4.8 :



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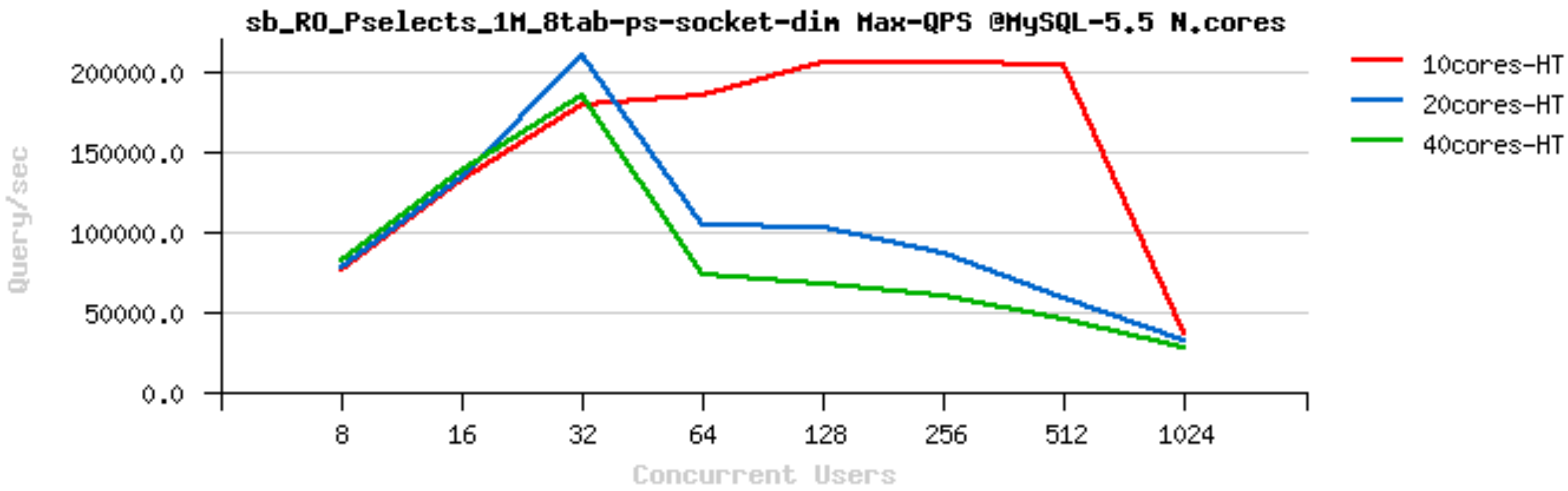
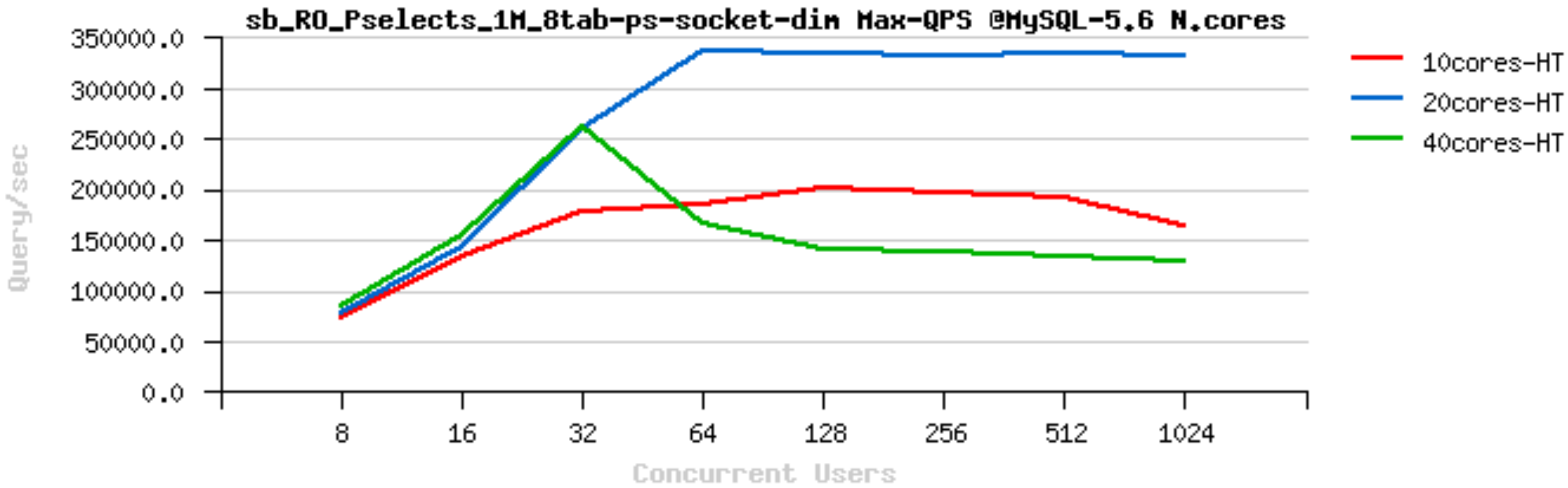
Few words about RO scalability (2)

- OLTP_RO Point-selects 8-tables
  - MySQL 5.5 : Max QPS is @10cores...



Few words about RO scalability (3)

- OLTP_RO Point-selects 8-tables
  - MySQL 5.6 : Max QPS is @20cores..



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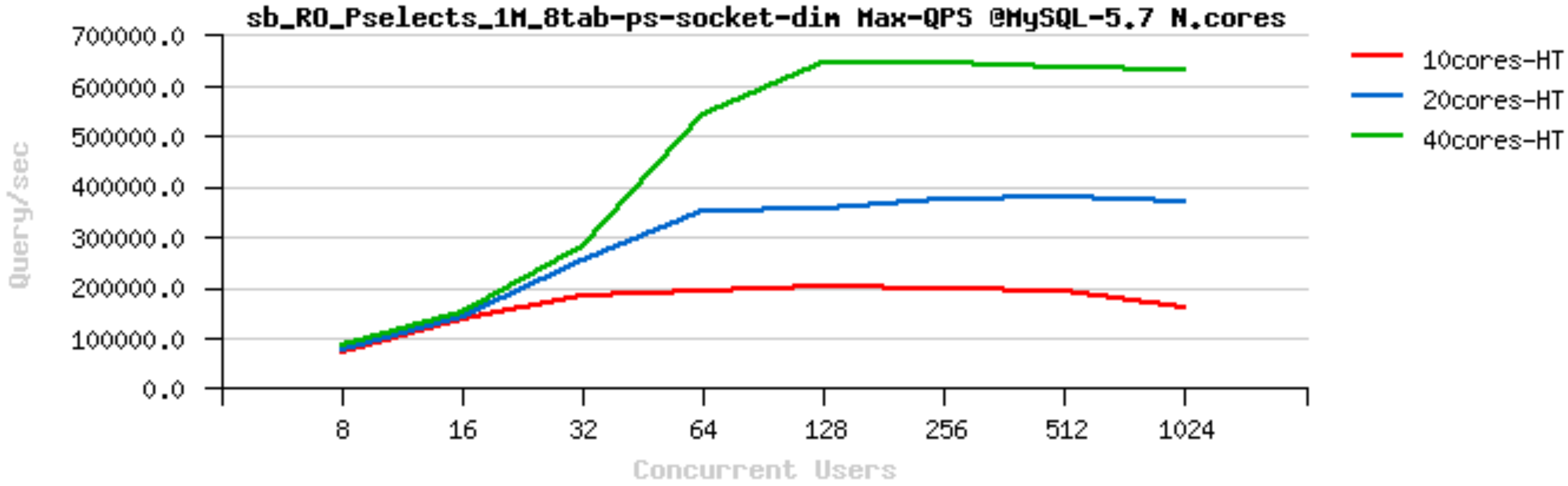
Few words about RO scalability (4)

- OLTP_RO Point-selects 8-tables
  - MySQL 5.7 : Max QPS is @40cores (finally! ;-))



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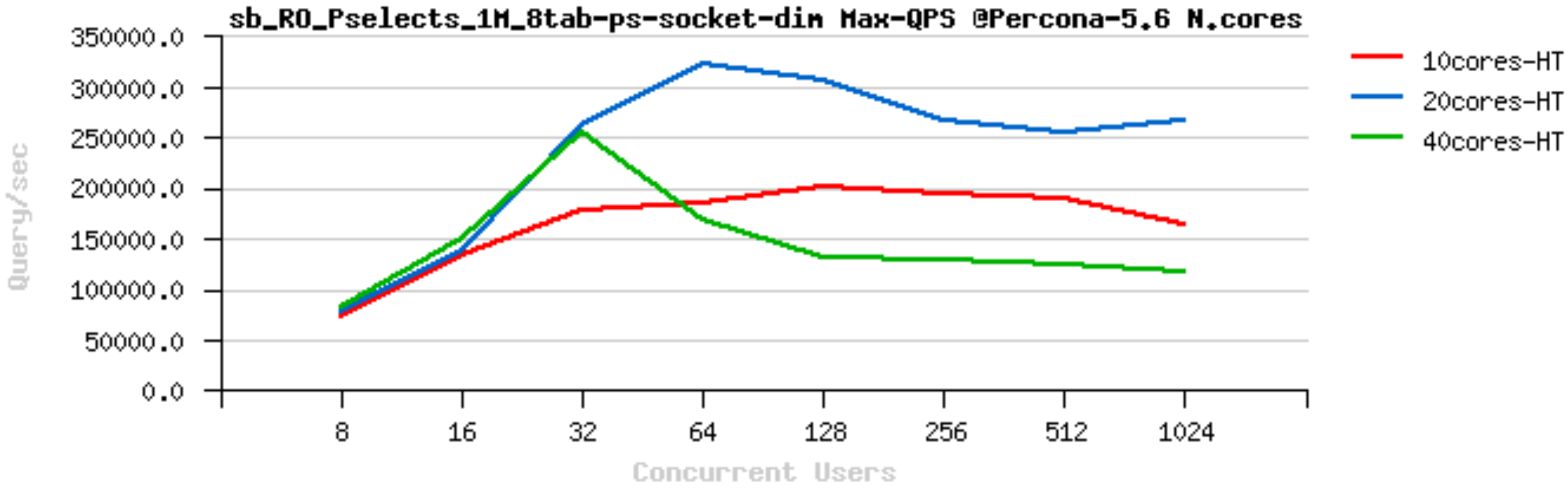
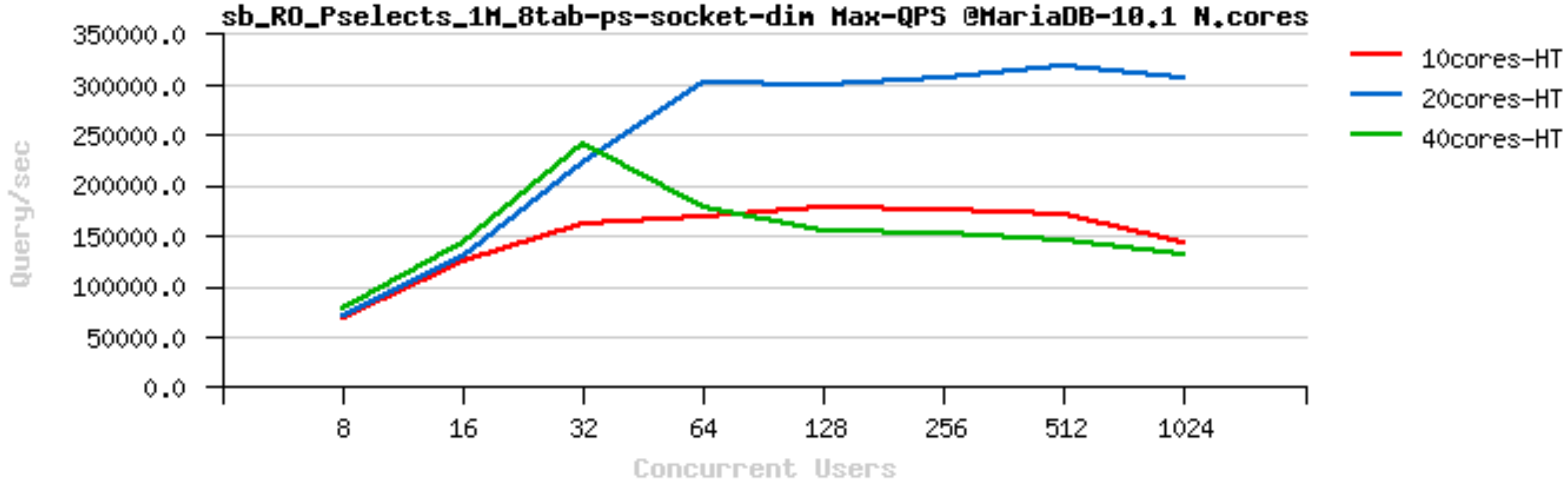
Few words about RO scalability (5)

- OLTP_RO Point-selects 8-tables
  - Percona Server 5.6 : Max QPS is @20cores..



Few words about RO scalability (6)

- OLTP_RO Point-selects 8-tables
  - MariaDB 10.1 : Max QPS is @20cores..



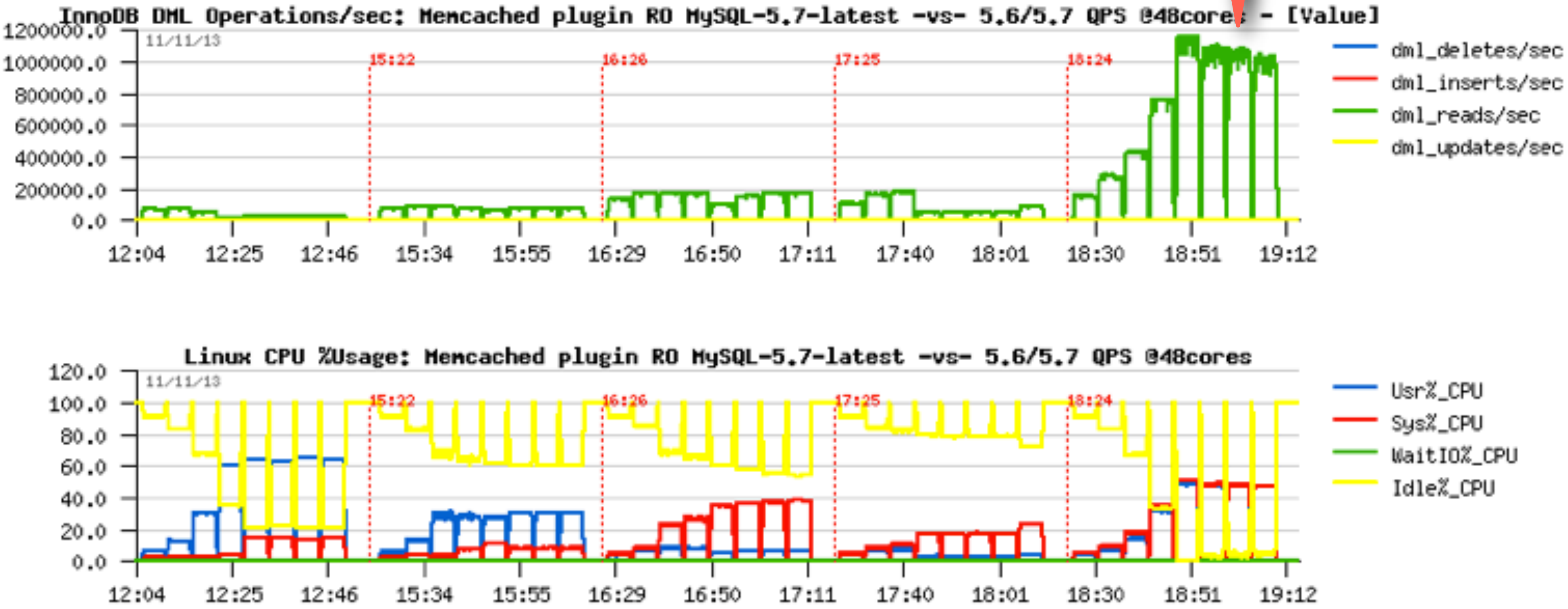
InnoDB Memcached

- MySQL 5.6 :
  - initially introduced
  - QPS : not too much better than SQL..
- MySQL 5.7 :
  - improved TRX list code opened many doors ;-)
  - Facebook => tech talk + test case
  - InnoDB => 1M QPS ;-)
    - 32cores-HT : **900K** QPS
    - 40cores-HT : **1000K** QPS
    - 48cores-HT : **1100K** QPS

InnoDB Memcached @MySQL 5.7

- **Over 1M (!) QPS** on 48cores-HT :

That's it ;-)



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Story #3 : Connect/sec performance

- A true TeamWork :
  - starting with a bug report about PFS overhead on user connect..
  - analyze of PFS issue is pointing also on some hot contentions around connect / disconnect..
  - PFS instrumentation is improved then by ServerGen Team
  - while Runtime Team comes back with yet more ideas for “connect” code
  - the result : x2 times better Connect/sec performance than before! ;-)
- NOTE :
  - the Connect performance was already greatly improved in 5.6 and 5.7
  - this was the next step in Connect speed-up ;-)
- Why Connect/sec performance is important?
  - for many web sites it will be one of the main show-stoppers

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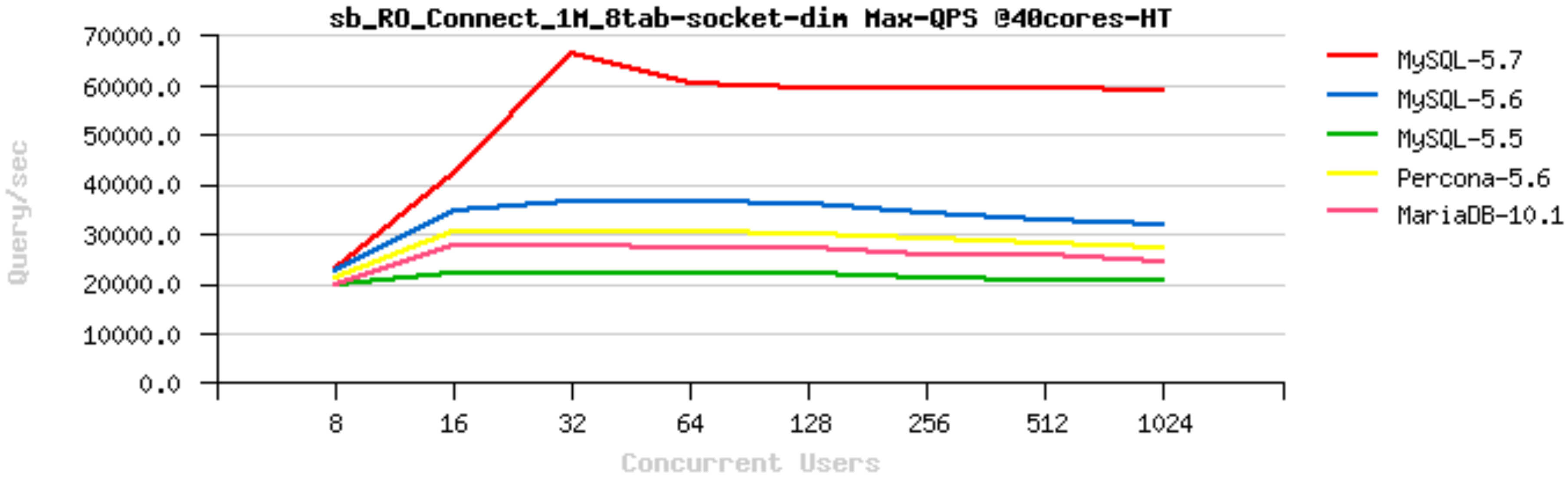
OLTP_RO Connect Performance

- 40cores-HT 2.3Ghz : **65K** Connect/sec
  - 1 single point-select per Connect/Disconnect
  - localhost
  - the result is yet more higher on a **faster** CPU



Story #4 : strange scalability issue @dbSTRESS

- Preface:
  - we already observed in the past some strange scalability problems
  - most are gone since “G5 patch” (CPU false caching)
  - but on dbSTRESS the problem remained..
  - lack of needed instrumentation & profiling kept investigation on stand-by
  - finally took some time to analyze it more in detail now ;-)
- Schema:
  - State [1K] <= History [200M] <= Object [10M] => Section[100] =>Zone [10]
  - SEL1 : for Object #id SELECT Object => Section =>Zone
  - SEL2 : for Object #id SELECT all History => State

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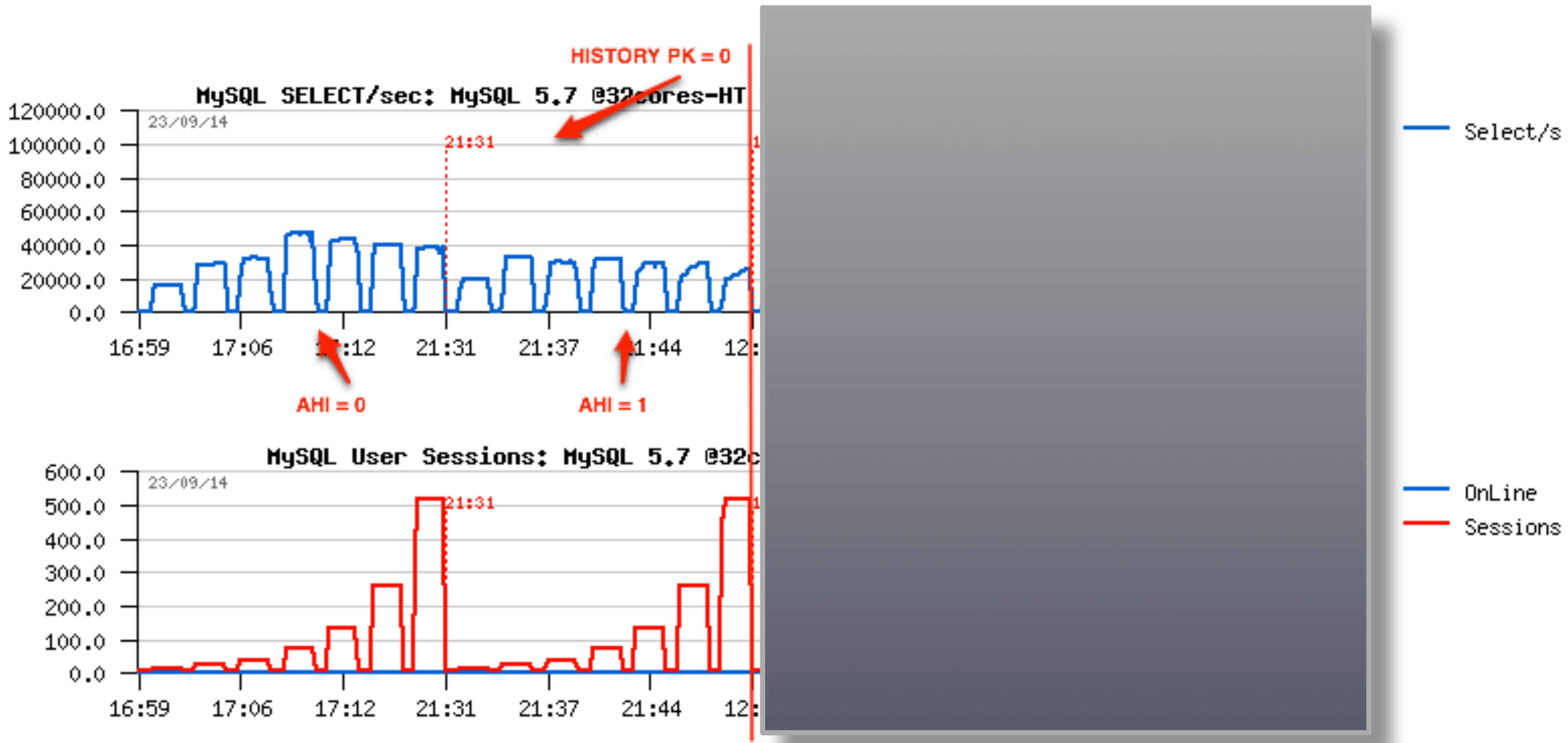
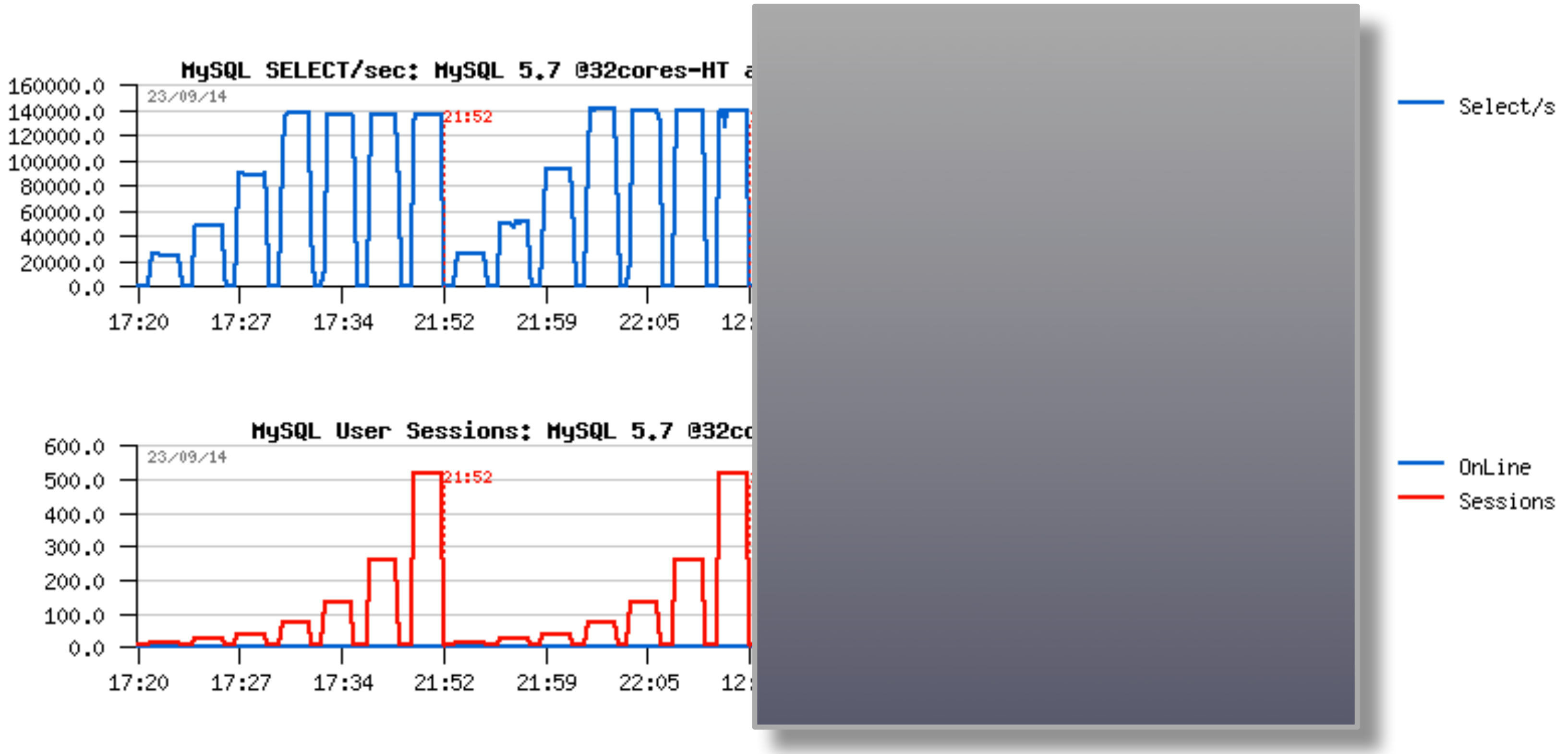
Story #4 : strange scalability issue @dbSTRESS (2)

- 32cores-HT, MySQL 5.7
  - test : dbSTRESS-RO, AHI = off / on



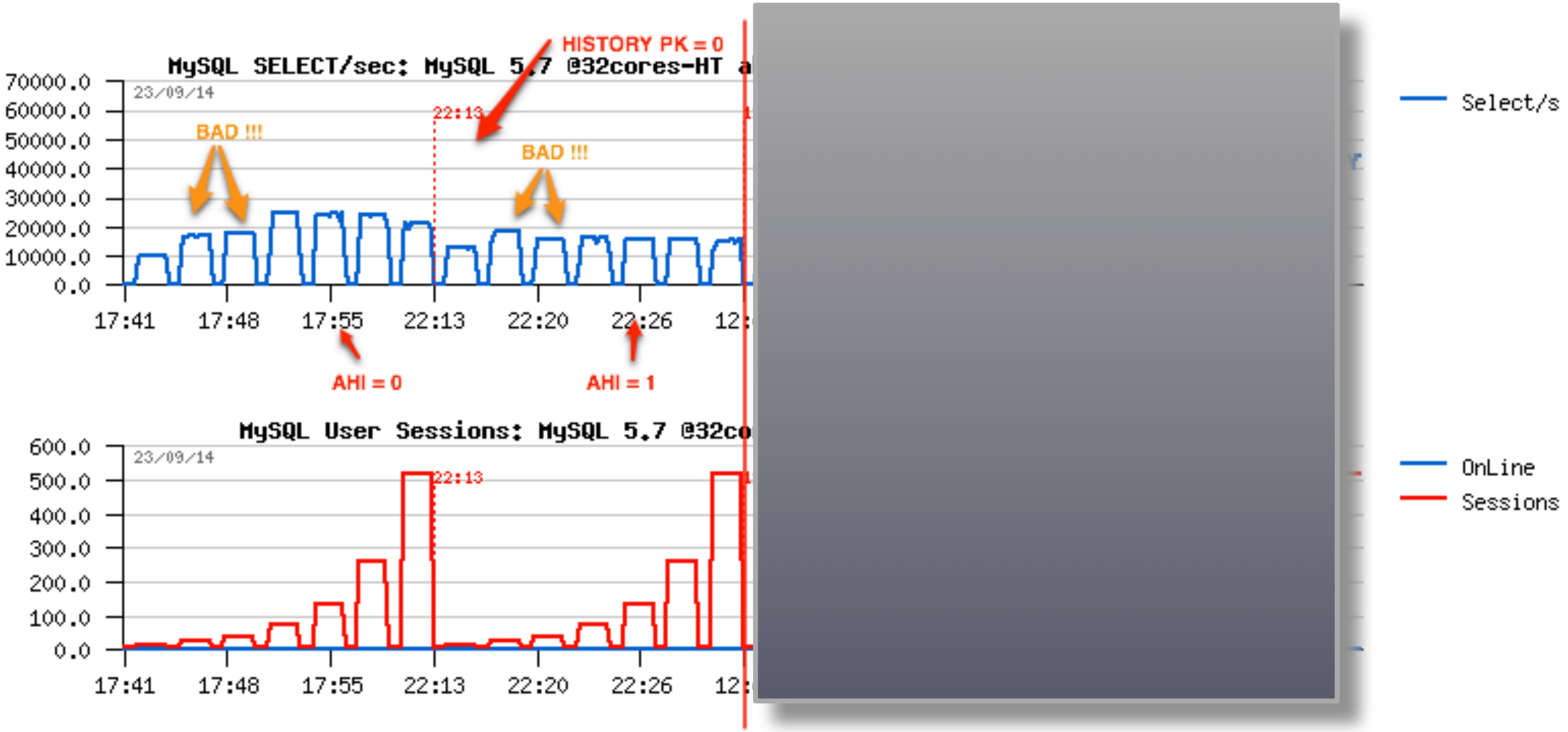
Story #4 : strange scalability issue @dbSTRESS (3)

- 32cores-HT, MySQL 5.7
  - test : dbSTRESS-SEL1, AHI = off / on



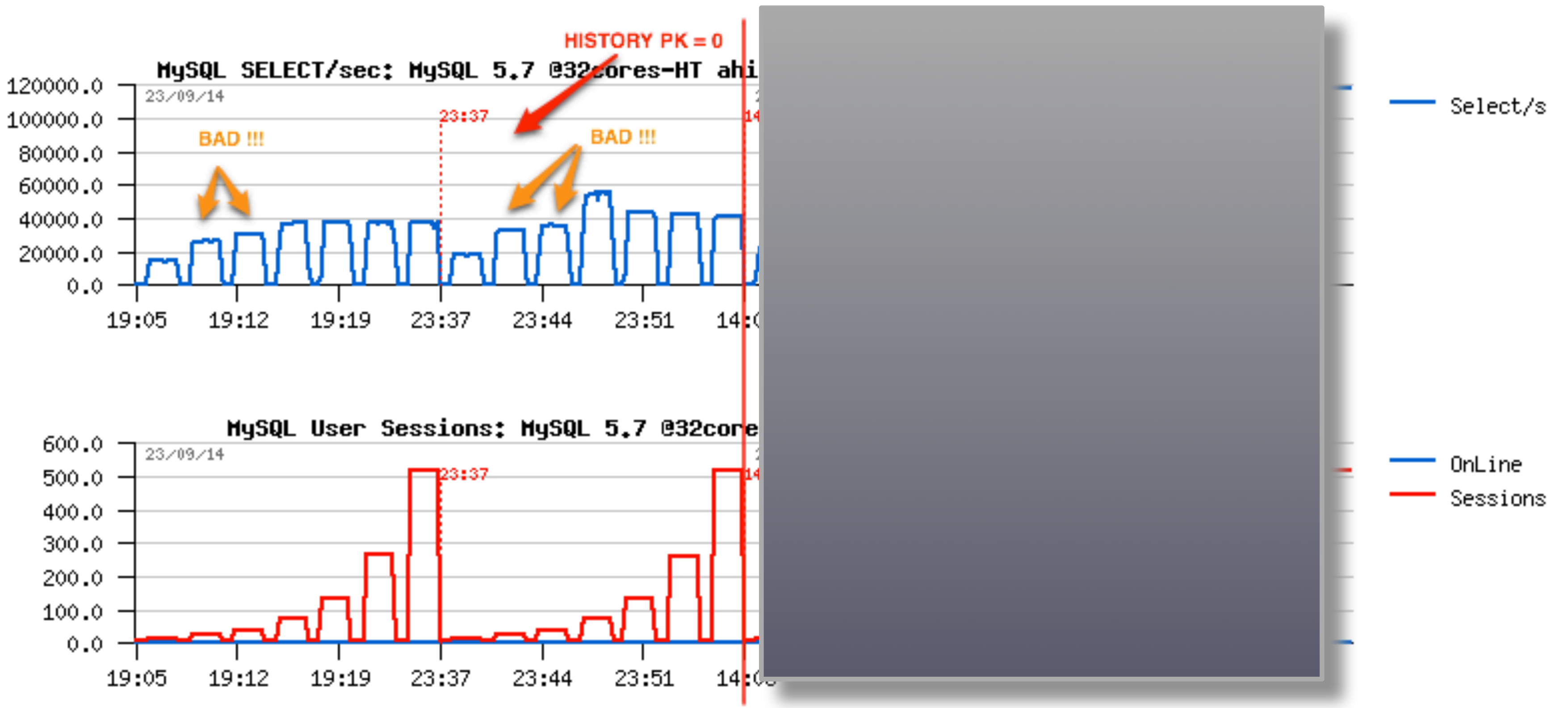
Story #4 : strange scalability issue @dbSTRESS (4)

- 32cores-HT, MySQL 5.7
  - test : dbSTRESS-SEL2, AHI = off / on



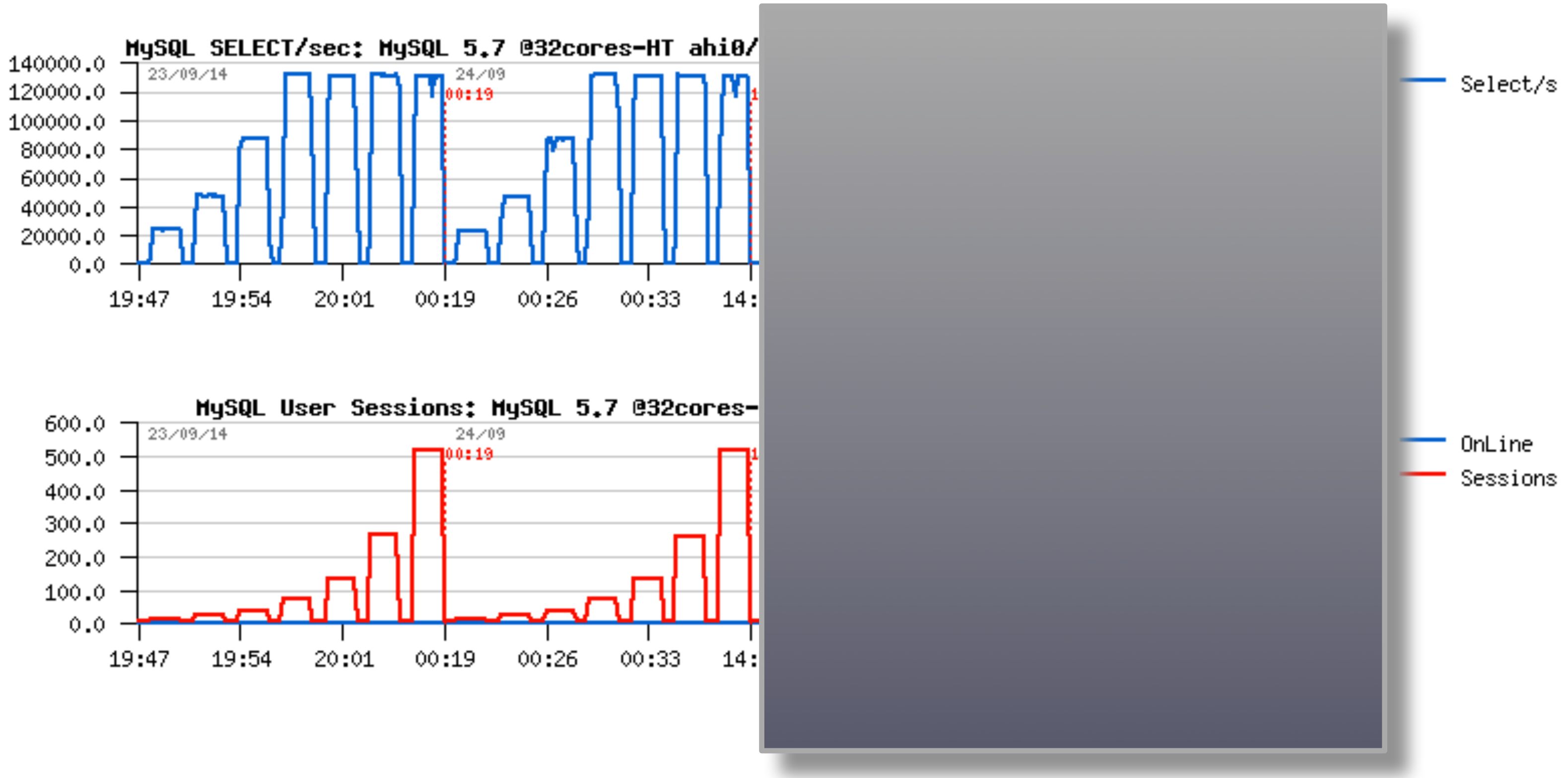
Story #4 : strange scalability issue @dbSTRESS (5)

- 32cores-HT, MySQL 5.7
  - test : dbSTRESS-H1, AHI = off / on



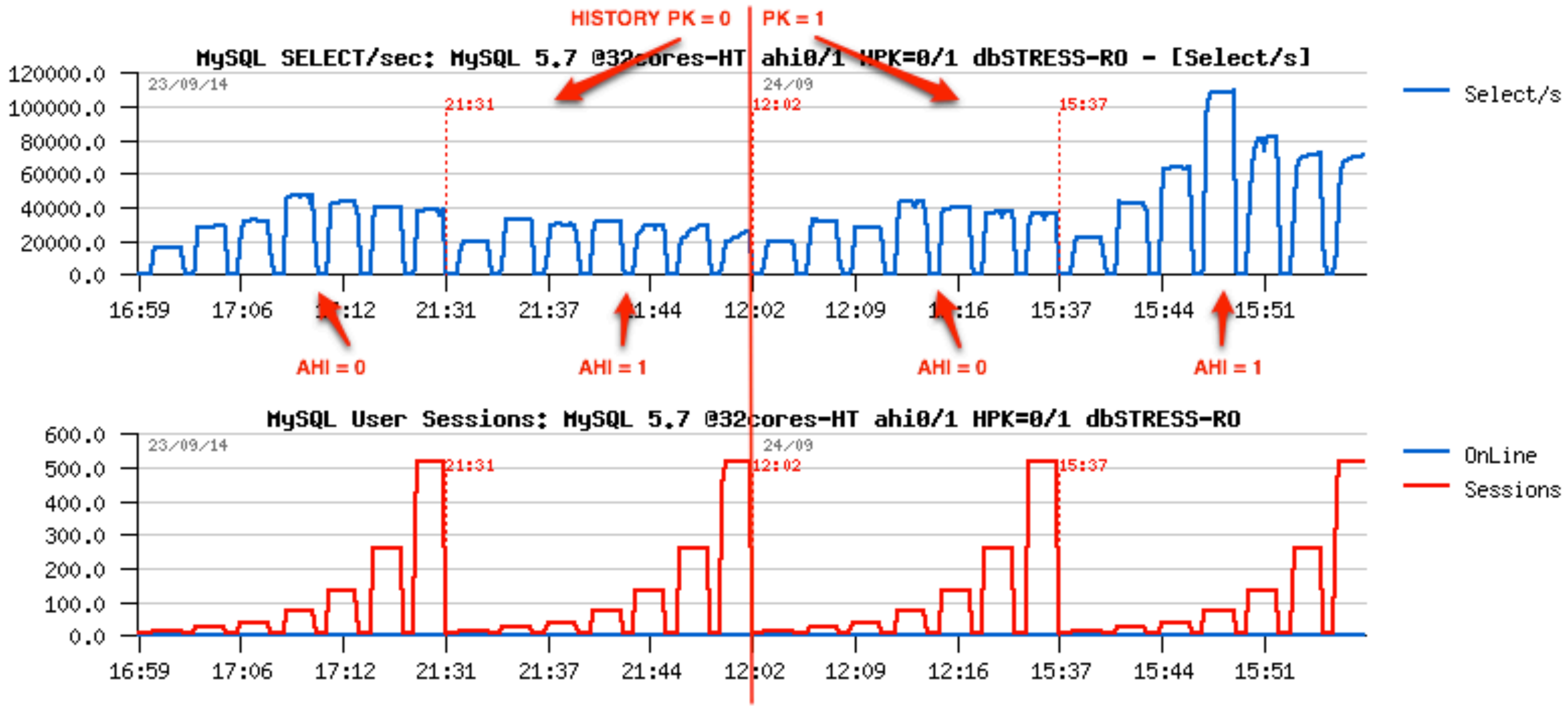
Story #4 : strange scalability issue @dbSTRESS (6)

- 32cores-HT, MySQL 5.7
  - test : dbSTRESS-H1_hord, AHI = off / on



Story #4 : strange scalability issue @dbSTRESS (2/2)

- 32cores-HT, MySQL 5.7
  - test : dbSTRESS-RO, AHI = off / on



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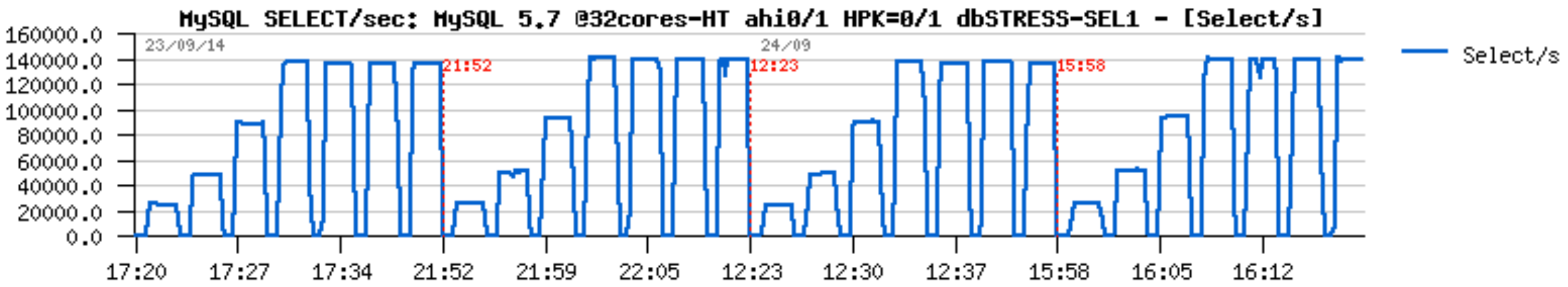
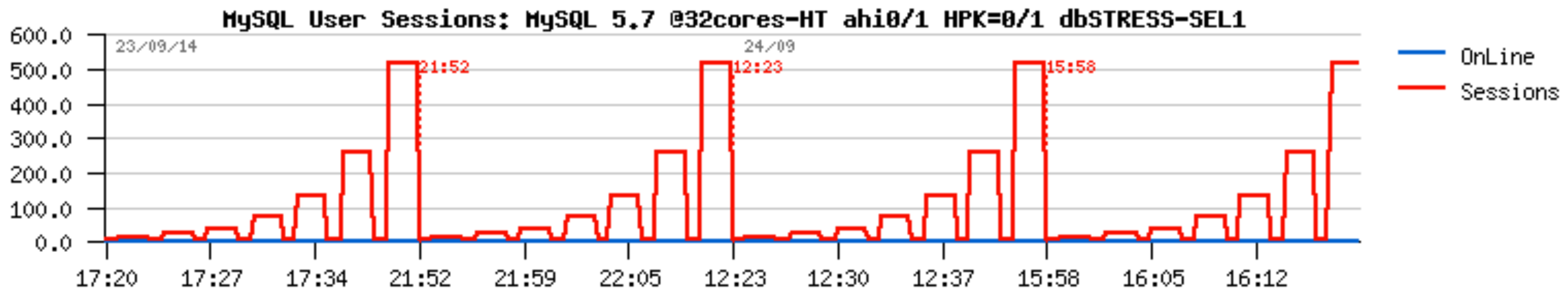
Story #4 : strange scalability issue @dbSTRESS (3/2)

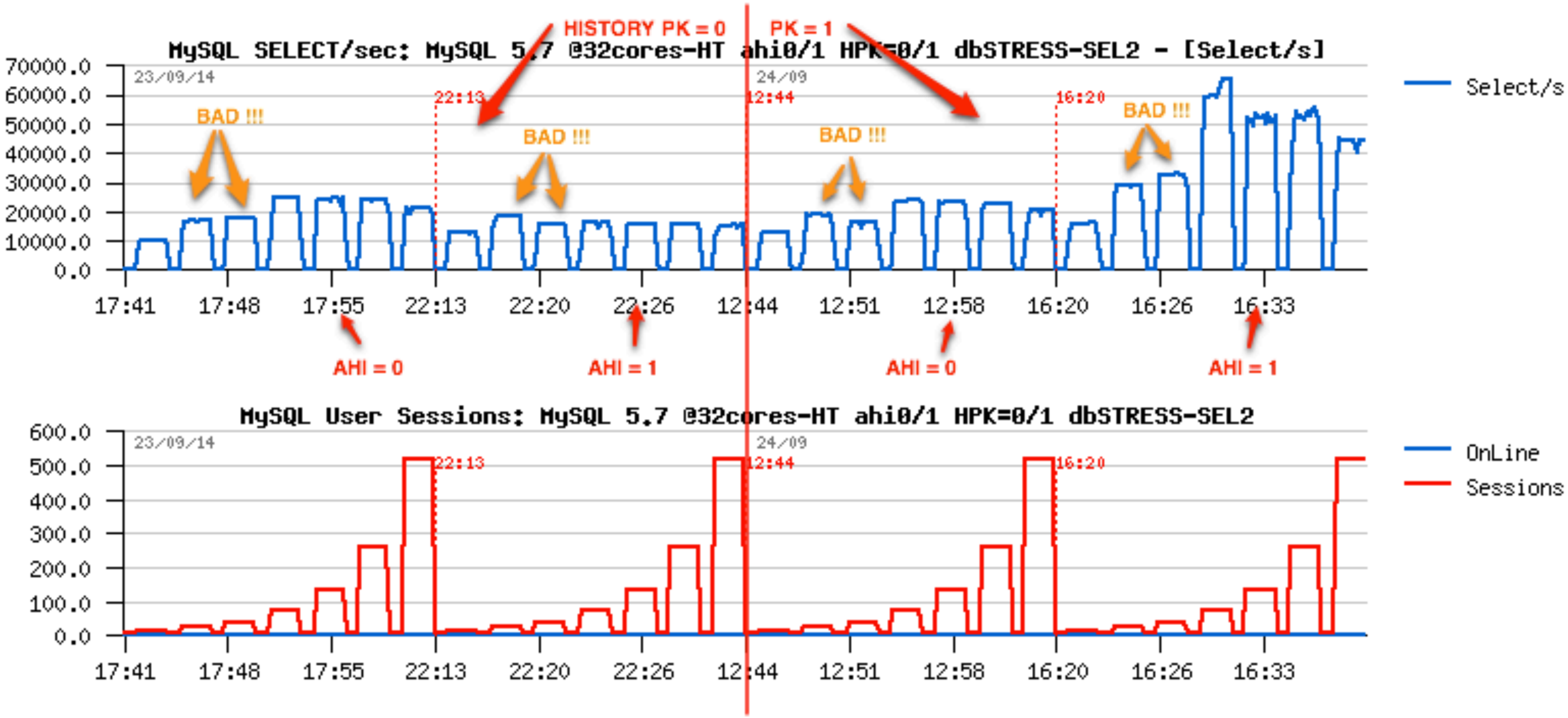
- 32cores-HT, MySQL 5.7
  - test : dbSTRESS-SEL1, AHI = off / on





Story #4 : strange scalability issue @dbSTRESS (4/2)

- 32cores-HT, MySQL 5.7
  - test : dbSTRESS-SEL2, AHI = off / on



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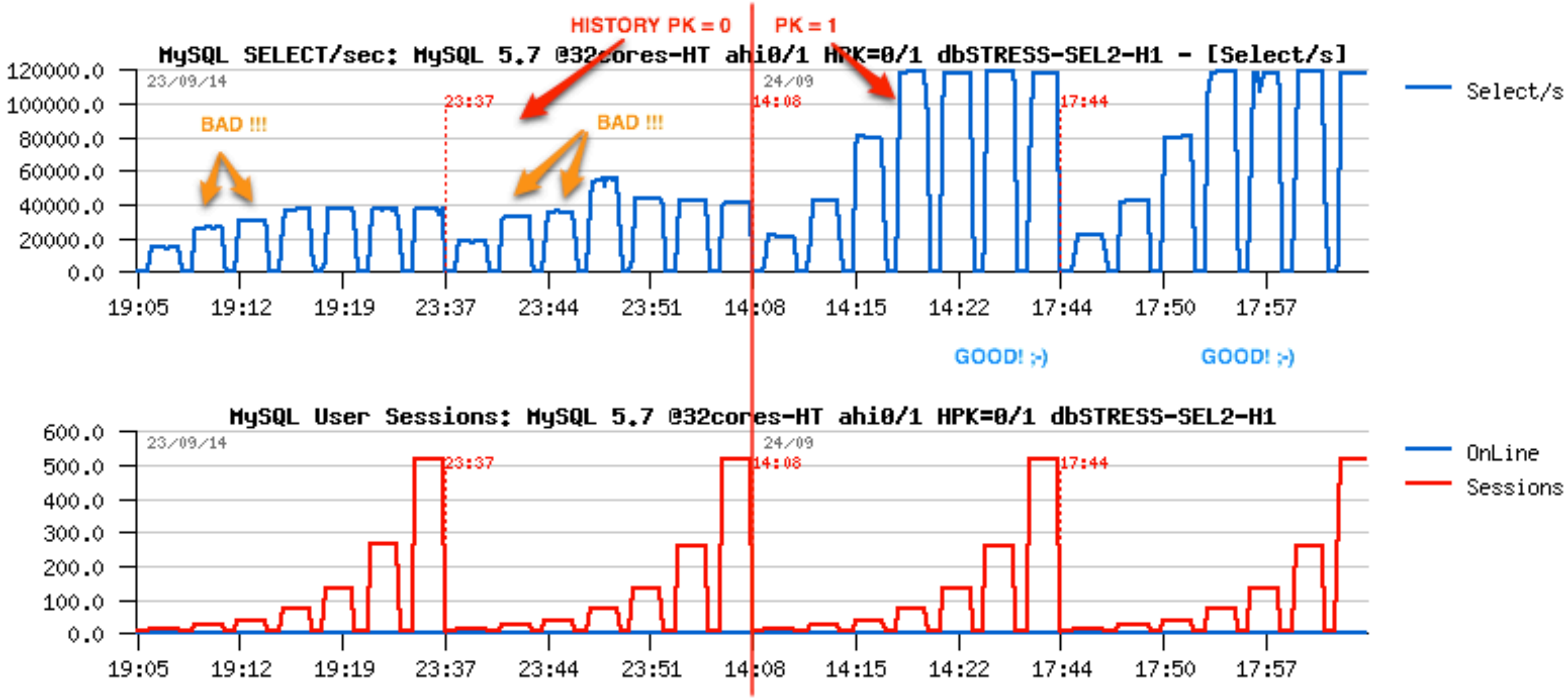
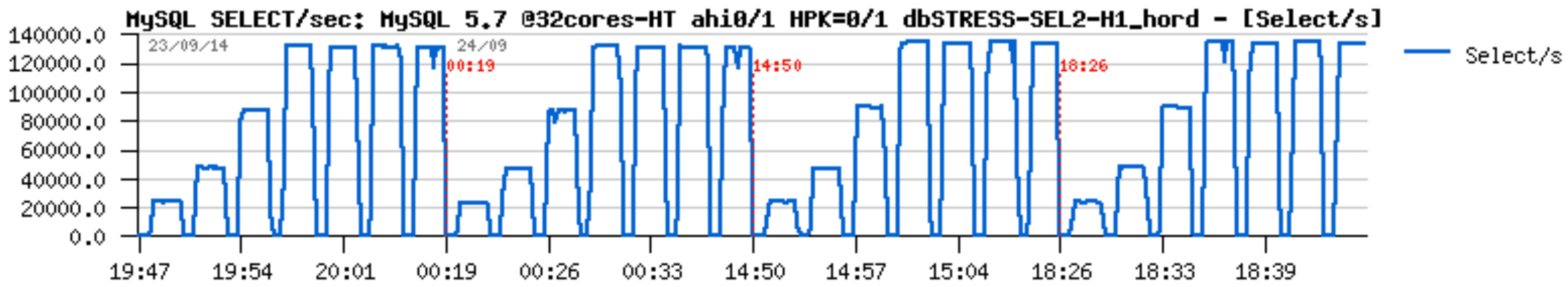
Story #4 : strange scalability issue @dbSTRESS (5/2)

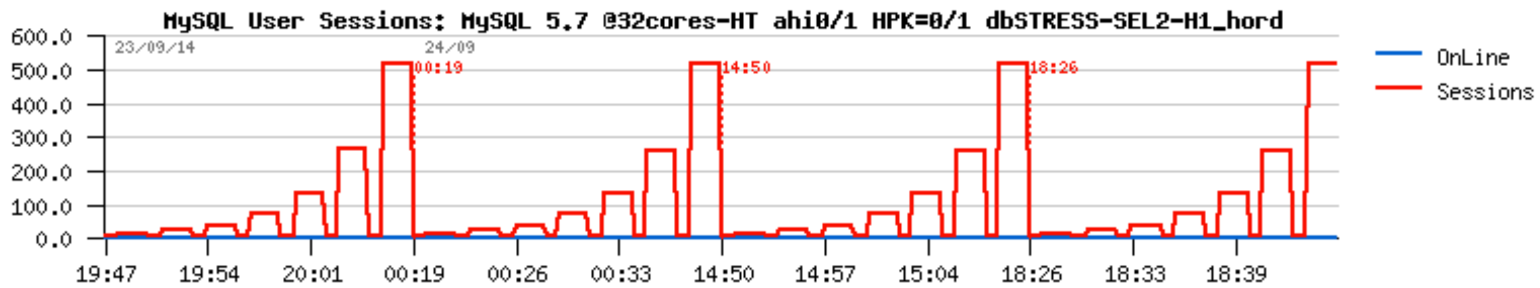
- 32cores-HT, MySQL 5.7
  - test : dbSTRESS-H1, AHI = off / on



Story #4 : strange scalability issue @dbSTRESS (6/2)

- 32cores-HT, MySQL 5.7
  - test : dbSTRESS-H1_hord, AHI = off / on





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Story #4 : strange scalability issue @dbSTRESS (7)

- 32cores-HT, MySQL 5.7
  - test case workload dbSTRESS-SEL2 <== the main show-stopper..
  - amazing to see the x3 time performance difference between PK access and secondary index..
  - what do you see in your own workloads and productions systems?
  - the fix is in TODO, but not for tomorrow..
  - NOTE : pfs_* names in profiler are not always related to PFS ;-)

```
24925.00 19.5% pfs_end_rwlock_rdwait_v1              mysqld-575-withPFS-03-Sep
11686.00  9.2% pfs_unlock_rwlock_v1                  mysqld-575-withPFS-03-Sep
 8554.00  6.7% pfs_start_rwlock_wait_v1              mysqld-575-withPFS-03-Sep
 4503.00  3.5% btr_cur_search_to_nth_level(dict_inde mysqld-575-withPFS-03-Sep
 4413.00  3.5% rec_get_offsets_func(unsigned char co mysqld-575-withPFS-03-Sep
 3536.00  2.8% buf_page_get_gen(page_id_t const&, pa mysqld-575-withPFS-03-Sep
 3056.00  2.4% pfs_rw_lock_s_unlock_func(rw_lock_t*) mysqld-575-withPFS-03-Sep
  ...
```

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Read+Write Workloads Scalability @MySQL

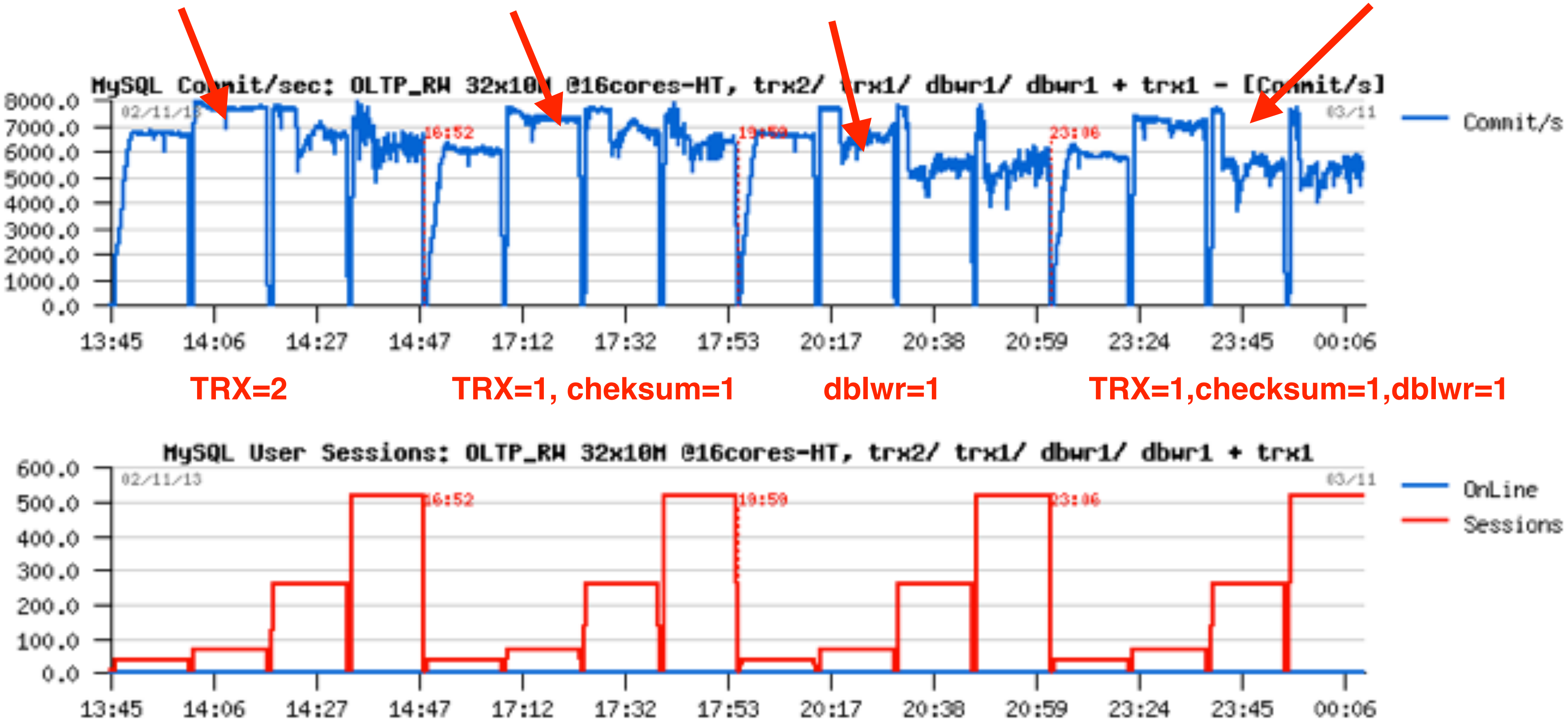
- Huge progress is already here!
- However, not yet as good as Read-Only..
  - Performance continues to increase with more CPU cores
  - But on move from 16 to 32cores-HT you may gain only 50% better
  - Better performance on a faster storage as well
  - But cannot yet use a full power of fast flash for today..
  - Work in progress ;-)
  - Internal contentions & Design limitations are the main issues here..

Read+Write Performance @MySQL / InnoDB

- Transactional processing
  - your CPU-bound transactional processing defines your Max possible TPS
  - with a bigger volume / more IO / etc. => Max TPS will not increase ;-)
- Data Safety
  - binlog : overhead + bottleneck (be sure you have binlog group commit)
  - InnoDB checksums : overhead (reasonable since crc32 is used)
  - innodb_flush_log_at_trx_commit = 1 : overhead + bottleneck
  - InnoDB double write buffer : **KILLER** ! overhead + huge bottleneck..
    - need a fix / re-design / etc. in urgency ;-)
    - Fusion-io atomic writes is one of (**true** support in MySQL 5.7)
    - Using EXT4 with data journal is another one
    - but a true re-design is still preferable ;-)

Impact of “safety” options..

- OLTP_RW 32x10M-tables @Percona-5.6
  - trx=2 | trx=1 + chksum=1 | dblwr=1 | trx=1 + chksum=1 + dblwr=1



RW related starter configuration settings

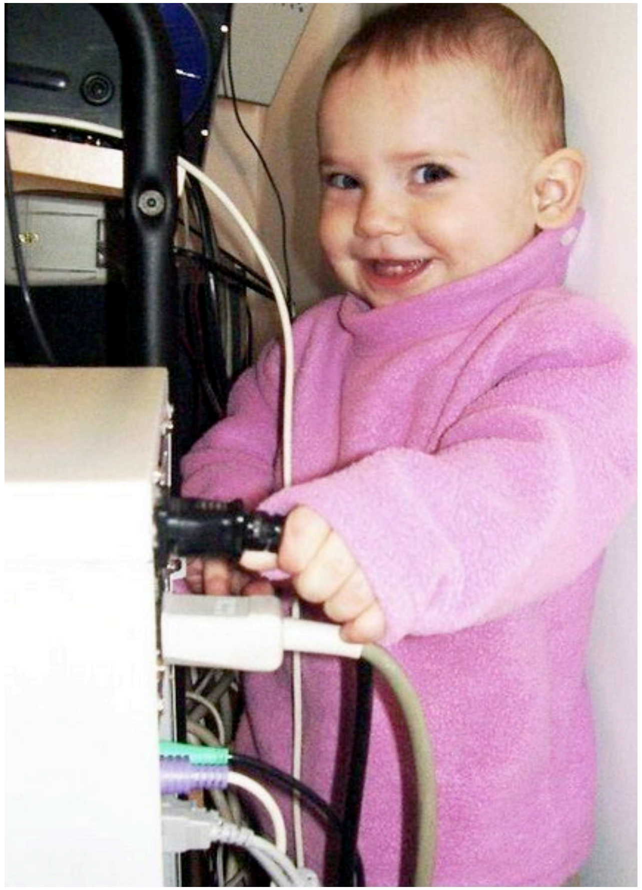
- my.conf :

```
innodb_file_per_table
innodb_log_file_size=1024M
innodb_log_files_in_group=3 / 12 / ...
innodb_checksum_algorithm= none / crc32
innodb_doublewrite= 0 / 1
innodb_flush_log_at_trx_commit= 2 / 1
innodb_flush_method=O_DIRECT
innodb_use_native_aio=1
innodb_adaptive_hash_index=0

innodb_adaptive_flushing = 1
innodb_flush_neighbors = 0
innodb_read_io_threads = 16
innodb_write_io_threads = 16
innodb_io_capacity=15000
innodb_max_dirty_pages_pct=90
innodb_max_dirty_pages_pct_lwm=10
innodb_lru_scan_depth=4000
innodb_page_cleaners=4

innodb_purge_threads=4
innodb_max_purge_lag_delay=30000000
innodb_max_purge_lag=1000000

binlog ??
```



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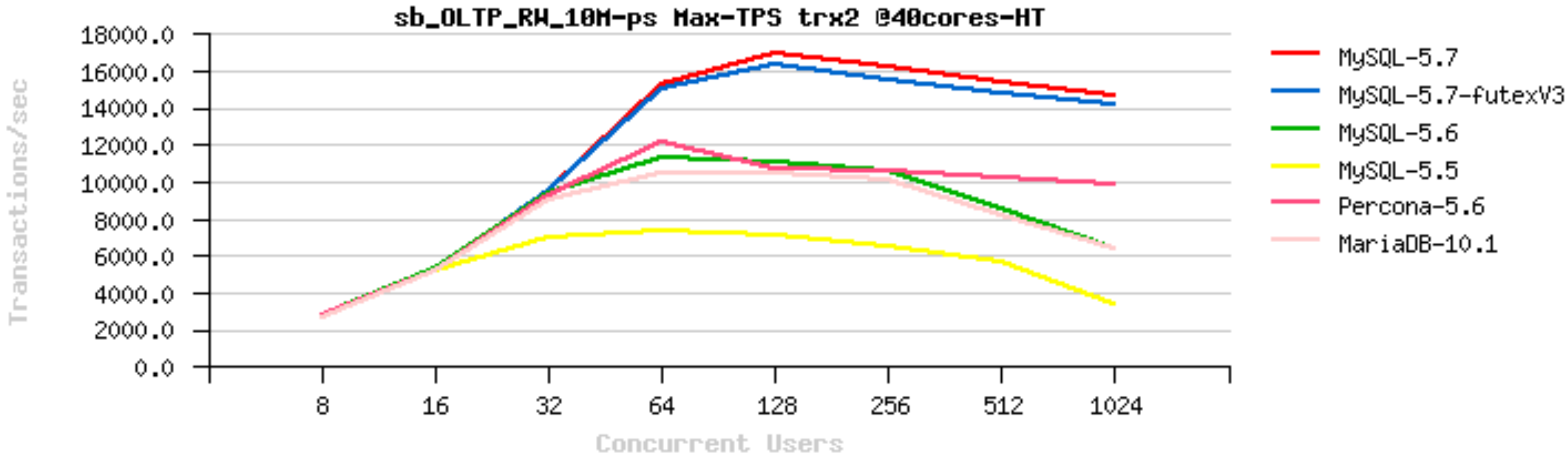
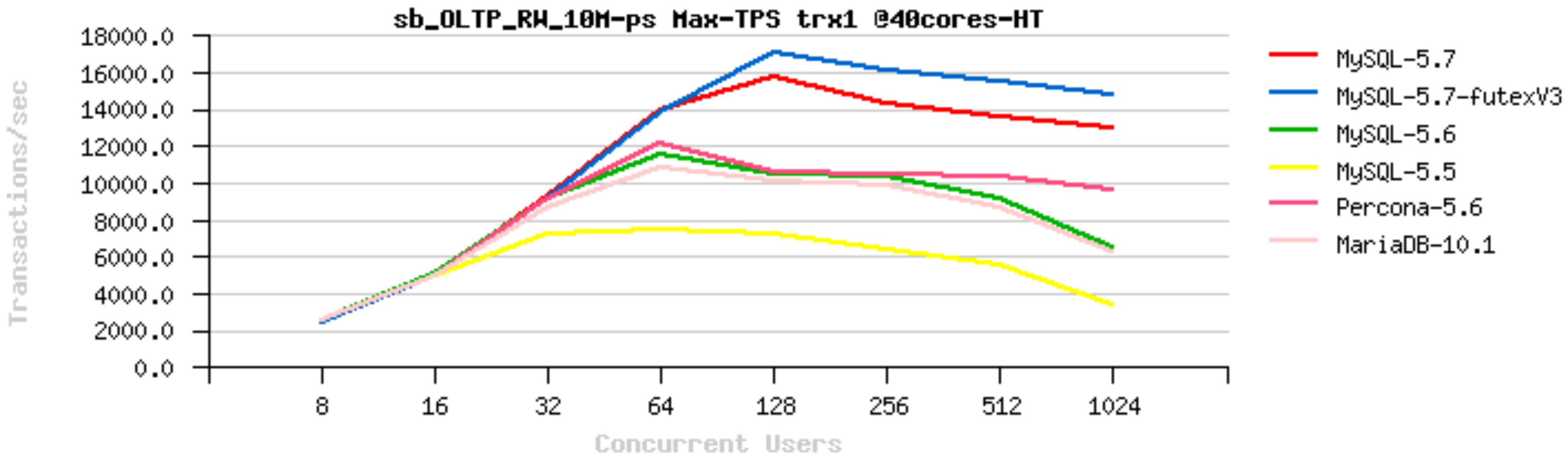
Sysbench OLTP_RW In-Memory

- Sysbench OLTP_RW **1-table** TRX2 @40cores-HT :
  - TRX2 : innodb_flush_log_at_trx_commit = 2



Sysbench OLTP_RW In-Memory

- Sysbench OLTP_RW **1-table** TRX1 @40cores-HT :
  - TRX1 : innodb_flush_log_at_trx_commit = 1



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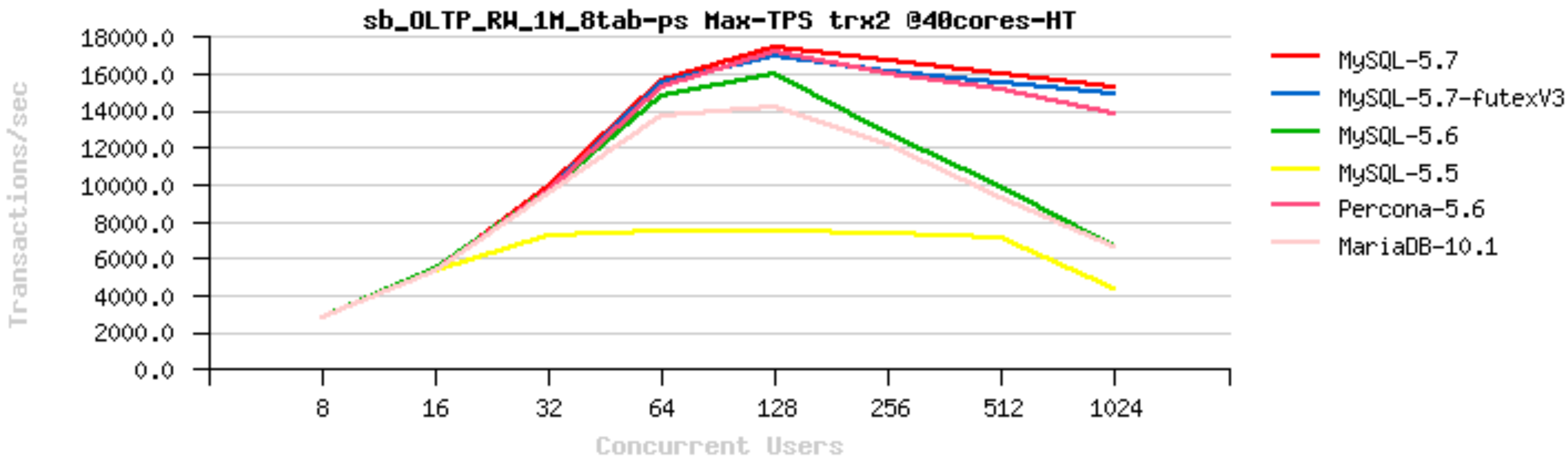
Sysbench OLTP_RW In-Memory

- Sysbench OLTP_RW **8-tables** TRX2 @40cores-HT :
  - TRX2 : innodb_flush_log_at_trx_commit = 2



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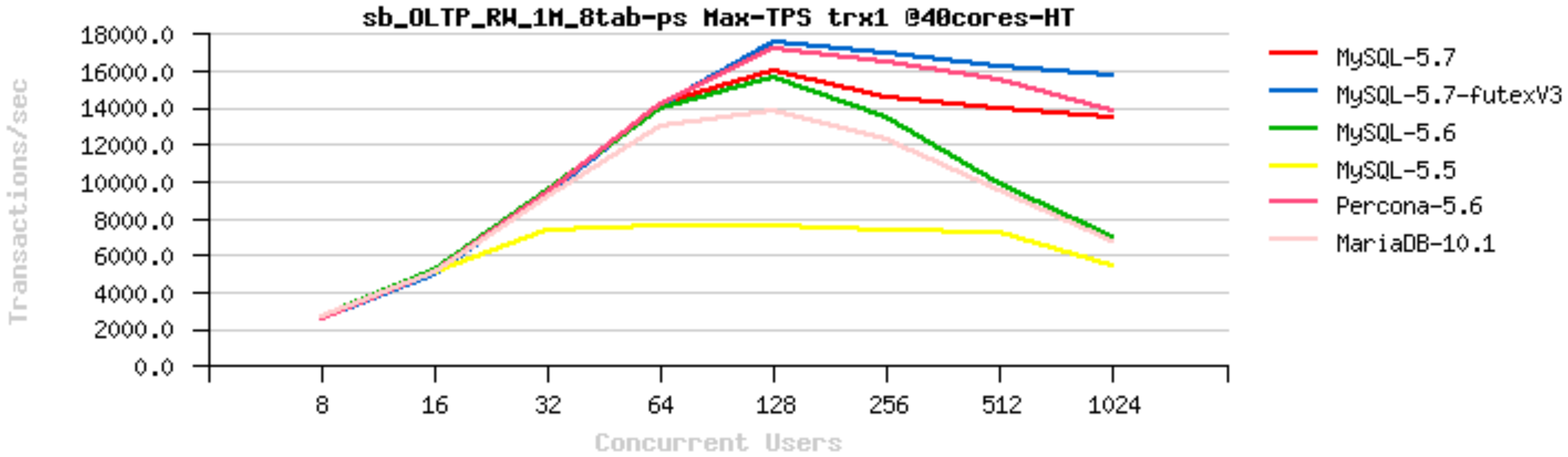
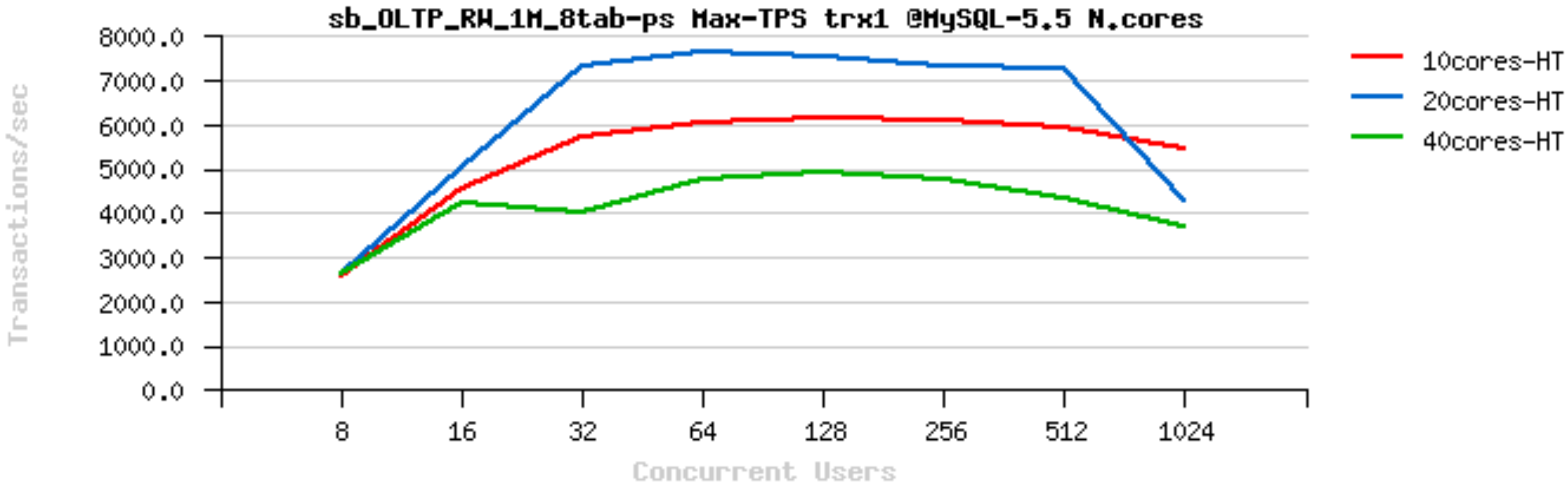
Sysbench OLTP_RW In-Memory

- Sysbench OLTP_RW **8-tables** TRX1 @40cores-HT :
  - TRX1 : innodb_flush_log_at_trx_commit = 1



Sysbench OLTP_RW In-Memory

- Sysbench OLTP_RW 8-tables TRX1 @40cores-HT :
  - MySQL 5.5 : Max TPS @20cores



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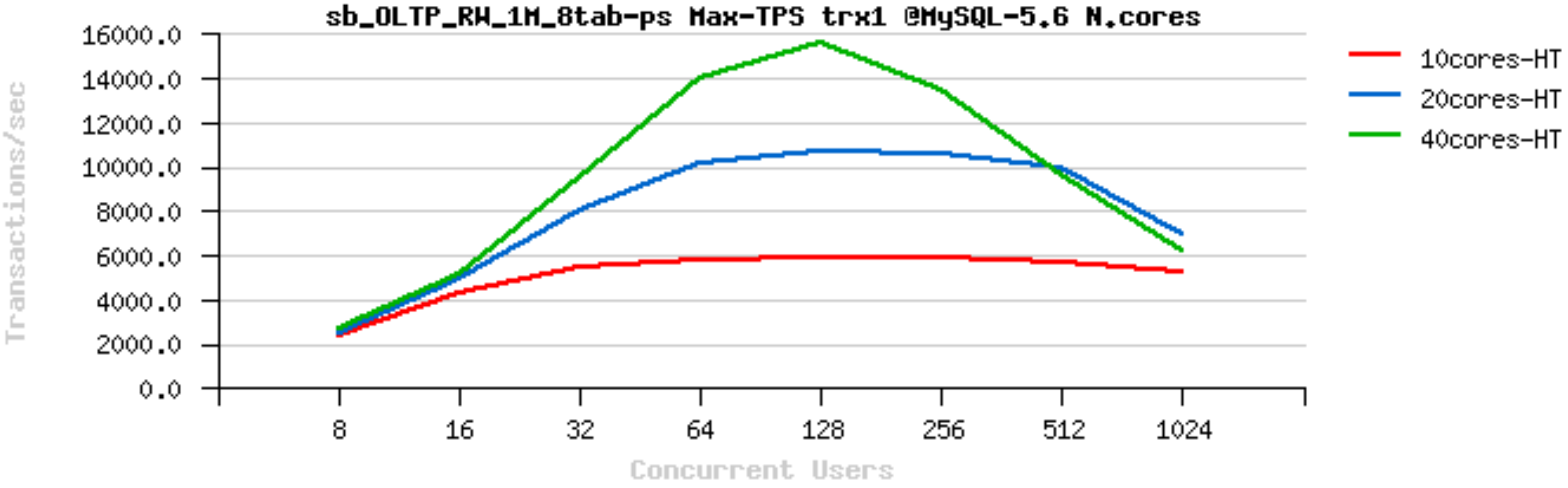
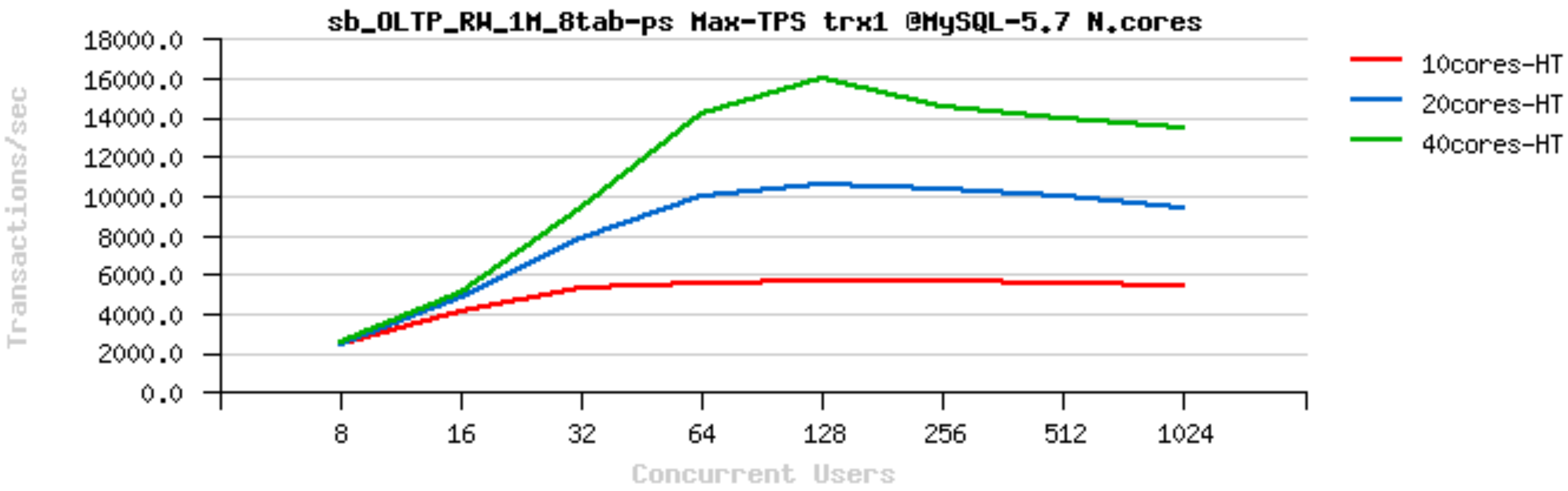
Sysbench OLTP_RW In-Memory

- Sysbench OLTP_RW 8-tables TRX1 @40cores-HT :
  - MySQL 5.6 : Max TPS @40cores



Sysbench OLTP_RW In-Memory

- Sysbench OLTP_RW 8-tables TRX1 @40cores-HT :
  - MySQL 5.7 : Max TPS @40cores



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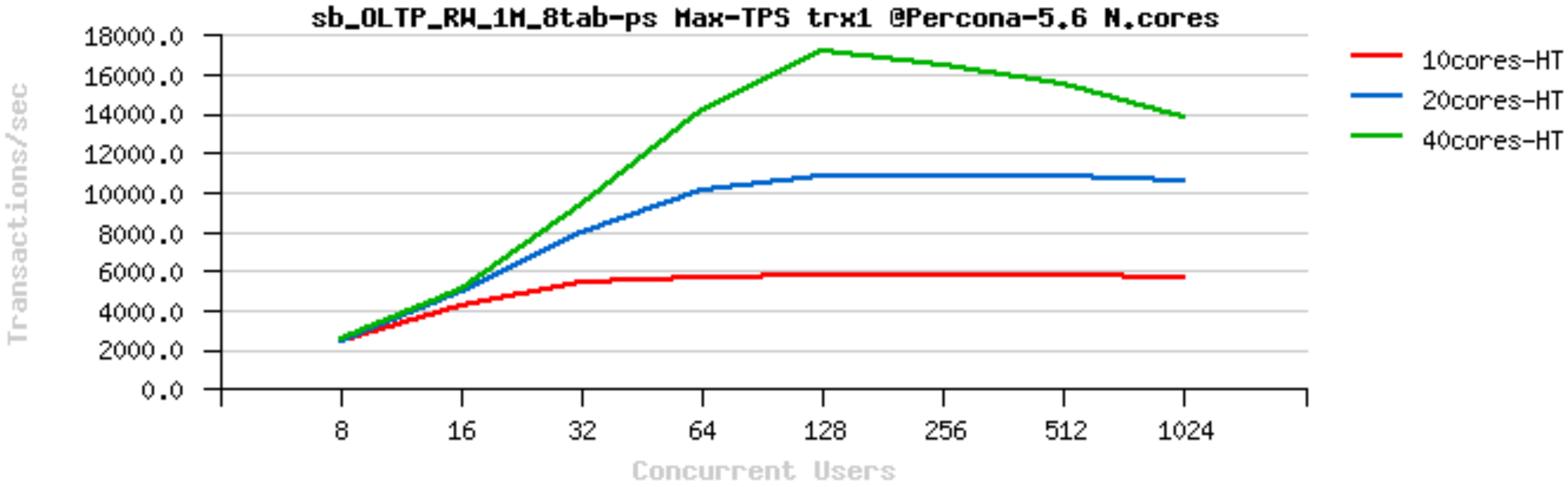
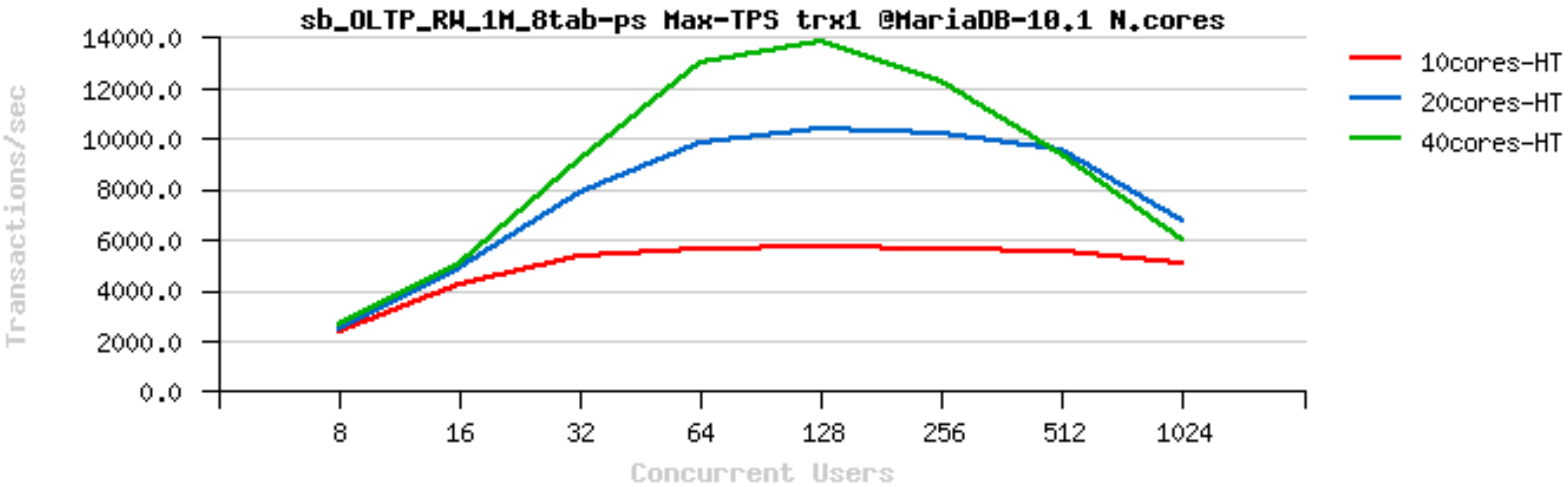
Sysbench OLTP_RW In-Memory

- Sysbench OLTP_RW 8-tables TRX1 @40cores-HT :
  - Percona Server 5.6 : Max TPS @40cores



Sysbench OLTP_RW In-Memory

- Sysbench OLTP_RW 8-tables TRX1 @40cores-HT :
  - MariaDB 10.1 : Max TPS @40cores



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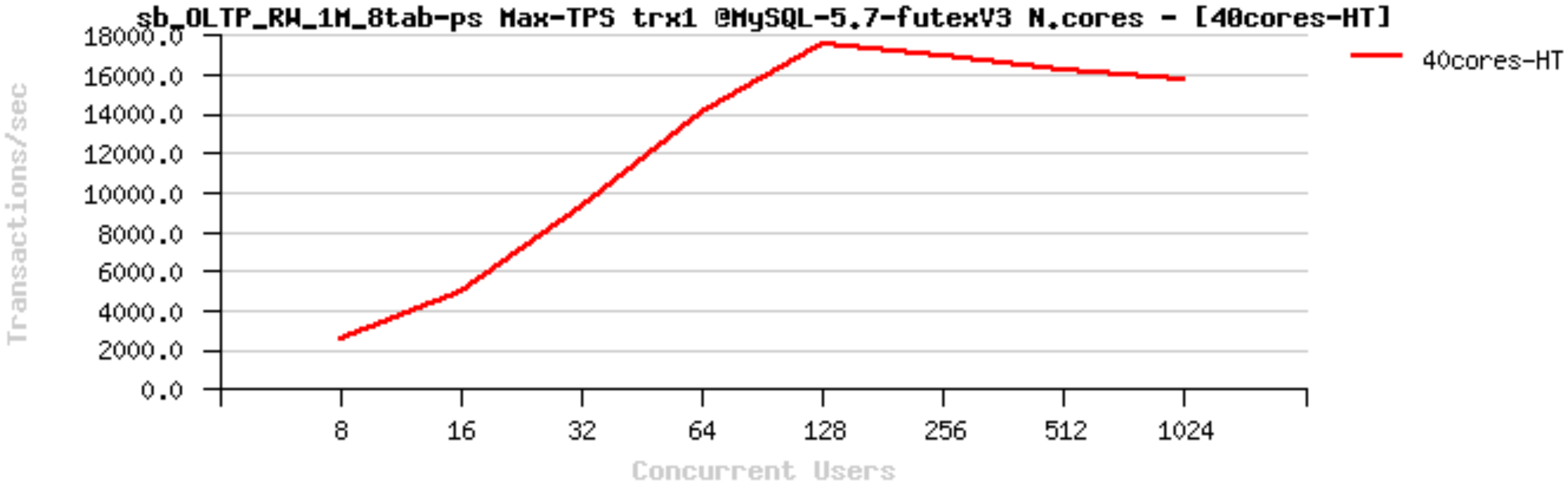
Sysbench OLTP_RW In-Memory

- Sysbench OLTP_RW 8-tables TRX1 @40cores-HT :
  - MySQL 5.7-dev3 : Max TPS @40cores



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Sysbench OLTP_RW In-Memory

- Max TPS configs :

```
mysql> select max(tps), t_engine, t_ccr, spin_delay, trx_commit
          from Bench where t_name = 'sb_OLTP_RW_1M_8tab-ps'
           and t_tag= '575_DMR-RW' and t_cpu like '40cores%'
         group by 2,3,4,5 order by 1 desc  limit 10;

+----------+-------------------+-------+------------+------------+
| max(tps) | t_engine          | t_ccr | spin_delay | trx_commit |
+----------+-------------------+-------+------------+------------+
|    17617 | mysql576_futex_V3 |    64 |         96 |          1 |
|    17497 | mysql576_futex_V3 |     0 |         96 |          1 |
|    17438 | mysql575          |    64 |         96 |          2 |
|    17307 | mysql575          |     0 |         96 |          2 |
|    17231 | percona5620       |    64 |         96 |          1 |
|    17197 | percona5620       |     0 |         96 |          1 |
|    17168 | percona5620       |     0 |         96 |          2 |
|    17113 | percona5620       |    64 |         96 |          2 |
|    16963 | mysql576_futex_V3 |    64 |         96 |          2 |
|    16780 | mysql576_futex_V3 |     0 |         96 |          2 |
+----------+-------------------+-------+------------+------------+
10 rows in set (0.03 sec)

mysql>
```

RW IO-bound

- Still data In-Memory, but much bigger volume :
  - more pages to flush for the **same** TPS rate
- Data bigger or much bigger than Memory / cache / BP :
  - the amount of free pages becomes short very quickly..
  - and instead of mostly IO writes only you’re starting to have IO reads too
  - these reads usually mostly random reads
  - if your storage is slow - reads will simply kill your TPS ;-)
  - if your storage can follow - once you’re hitting fil_sys mutex you’re done
  - as well LRU flushing may become very heavy..
- NOTE:
  - using **AIO + O_DIRECT** seems to be the most optimal for RW IO-bound
  - but always check yourself ;-)

RW IO-bound "In-Memory"

- Impact of the database size
  - with a growing db size the TPS rate may be only the same or worse ;-)
  - and required Flushing rate may only increase..
- ex.: DBT2 workload :
  - 64 users, db volume: 50W, 100W, 250W, 500W

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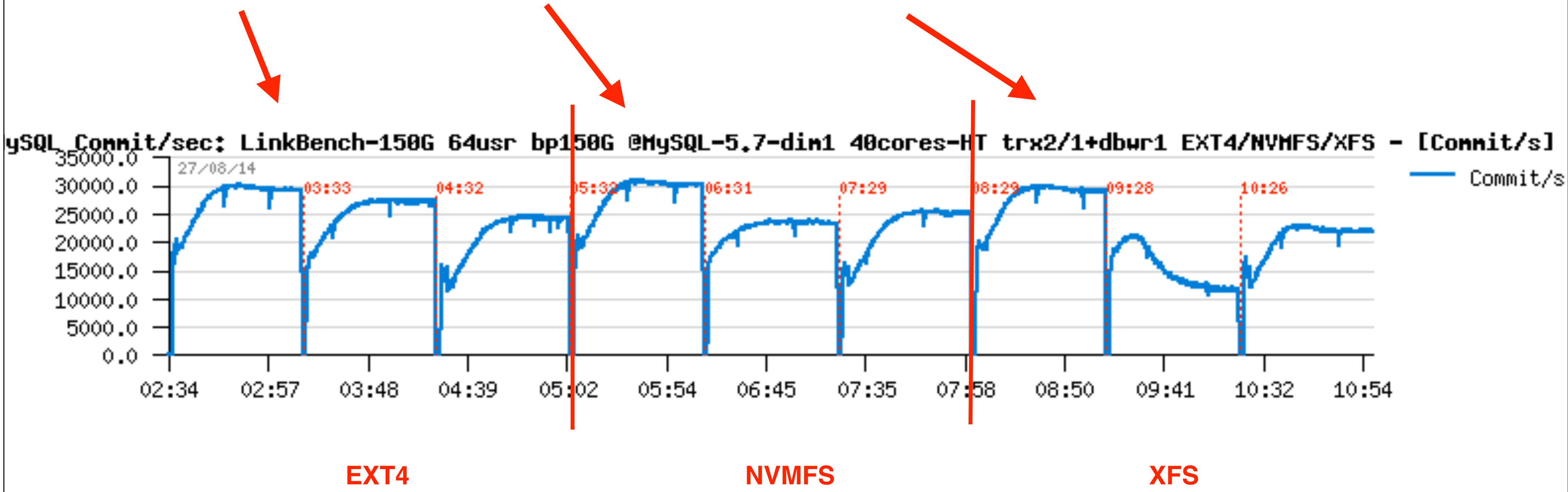
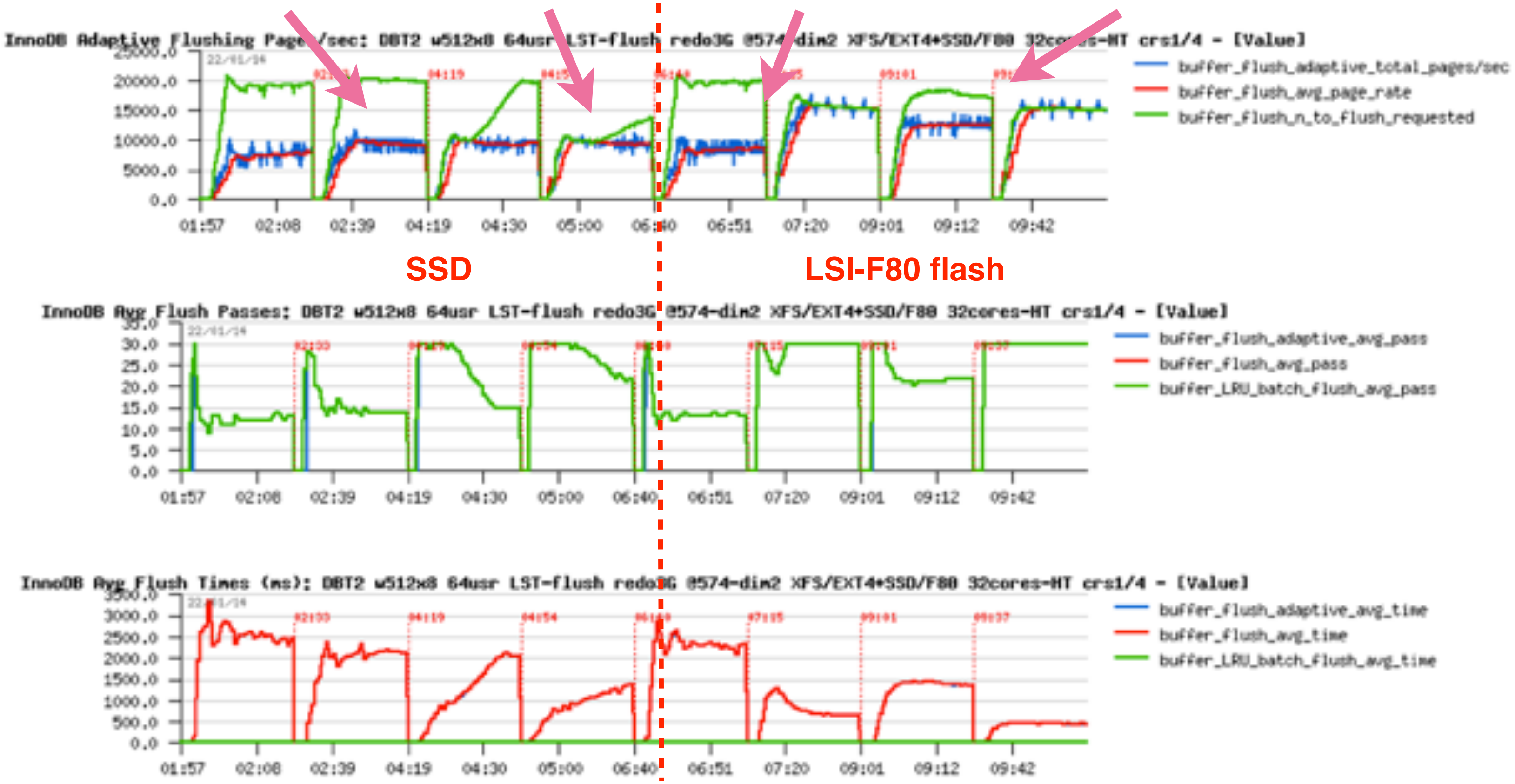
RW IO-Bound : Test your Filesystem before to deploy

- LinkBench 150G
  - safety options on 64usr, Fusion-io
  - EXT4 -vs- NVMFS -vs- XFS



RW IO-Bound : Consider a fast storage

- InnoDB Flushing in MySQL 5.7 & storage:
  - DBT2 512Wx8, 64usr, each test first with 1 then with 4 cleaners
  - XFS@SSD | EXT4@SSD | XFS@LSI-F80 | EXT4@LSI-F80



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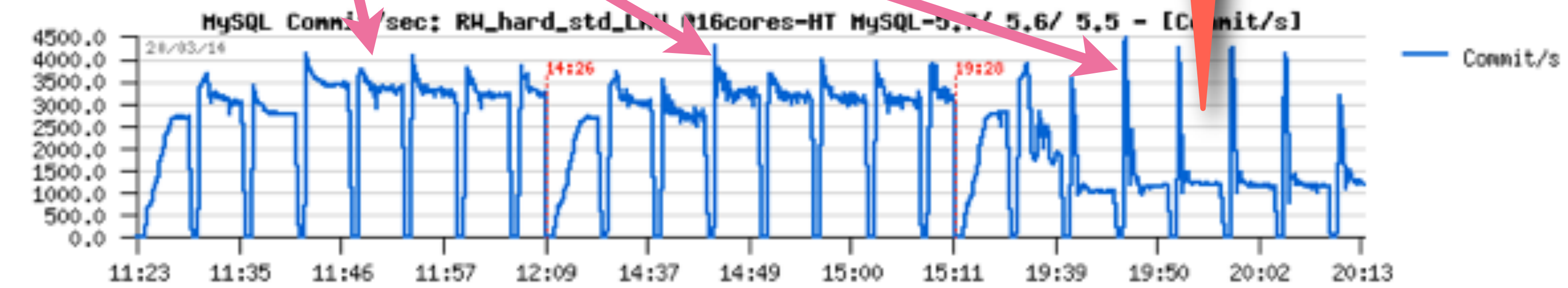
RW IO-bound "Out-of-Memory"

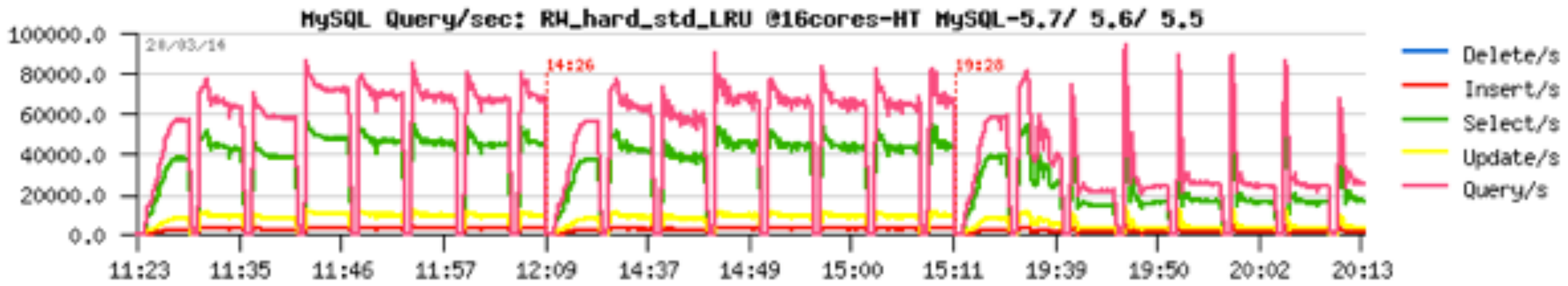
- The "entry" limit here is storage performance
  - as you'll have a lot of IO reads..
- Once storage is no more an issue :
  - you may hit internal contentions (ex. InnoDB file_sys mutex)
  - or other engine design limitations..
  - sometimes a more optimal config settings may help..
  - but sometimes not ;-)

RW LRU-bound : 5.5 is out of the game..

- Sysbench OLTP_RW 10M x32-tables
  - Users: 8, 16, 32 .. 1024
  - MySQL : 5.7 / 5.6 / 5.5

Please, upgrade me to 5.6 !!!

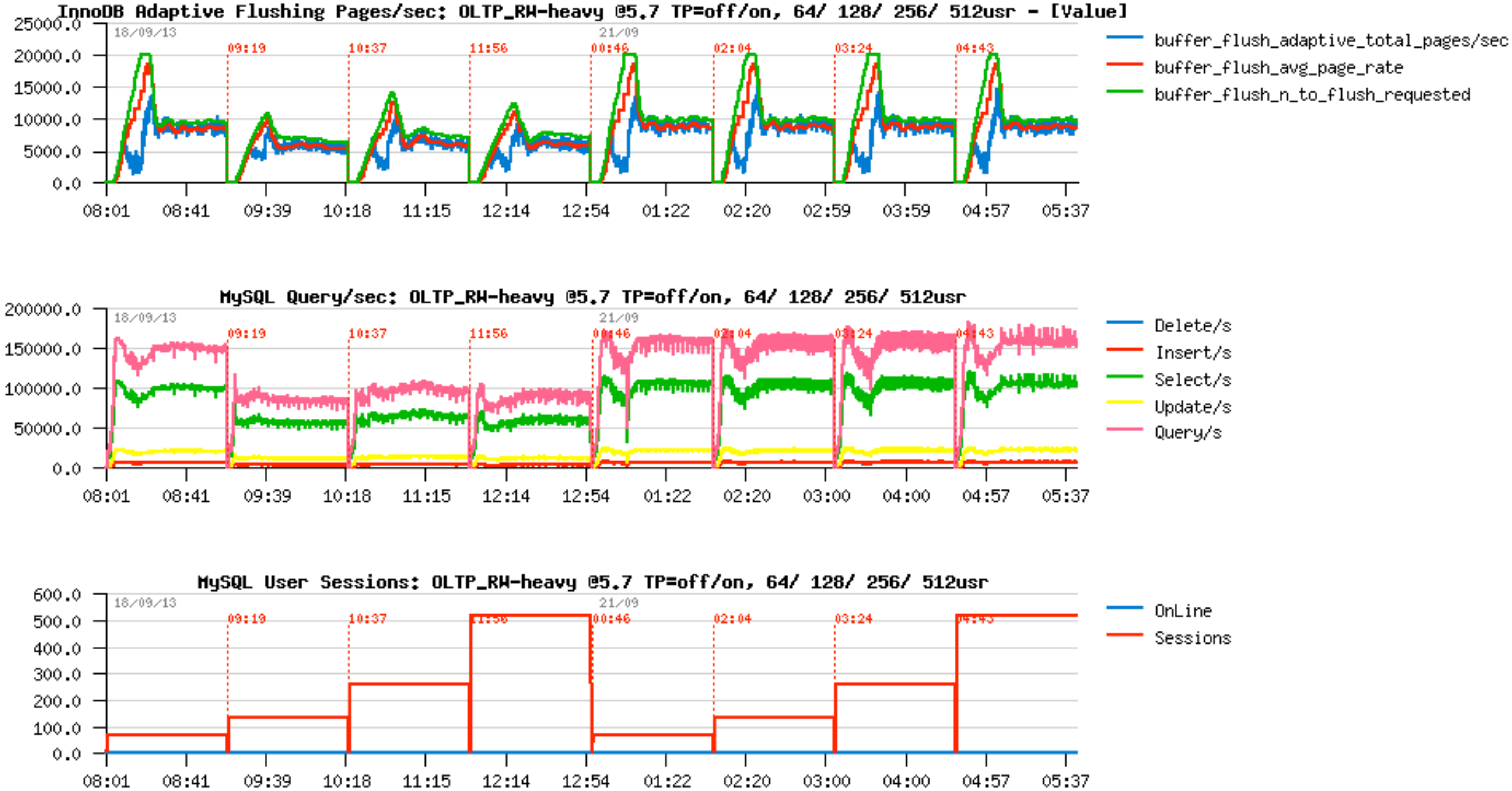




High Concurrency Tuning

- If bottleneck is due a concurrent access on the same data (due application design) – ask your dev team to re-design ;-)
- If bottleneck is due MySQL/InnoDB internal contentions, then:
  - If you cannot avoid it, then at least don't let them grow ;-)
  - tune InnoDB spin wait delay to improve your Max QPS (dynamic)
  - innodb_thread_concurrency=N to avoid QPS drop on usr++ (dynamic)
  - CPU taskset / prcset (Linux / Solaris, both dynamic)
  - Thread Pool
  - NOTE:
    - things with contentions may radically change since 5.7, so stay tuned ;-)
    - InnoDB thread concurrency feature was **improved** in 5.6 and 5.7
    - the best working in 5.7, and using innodb_thread_concurrency=64 by default now makes sense..

Thread Pool in old MySQL 5.7 @Heavy OLTP_RW



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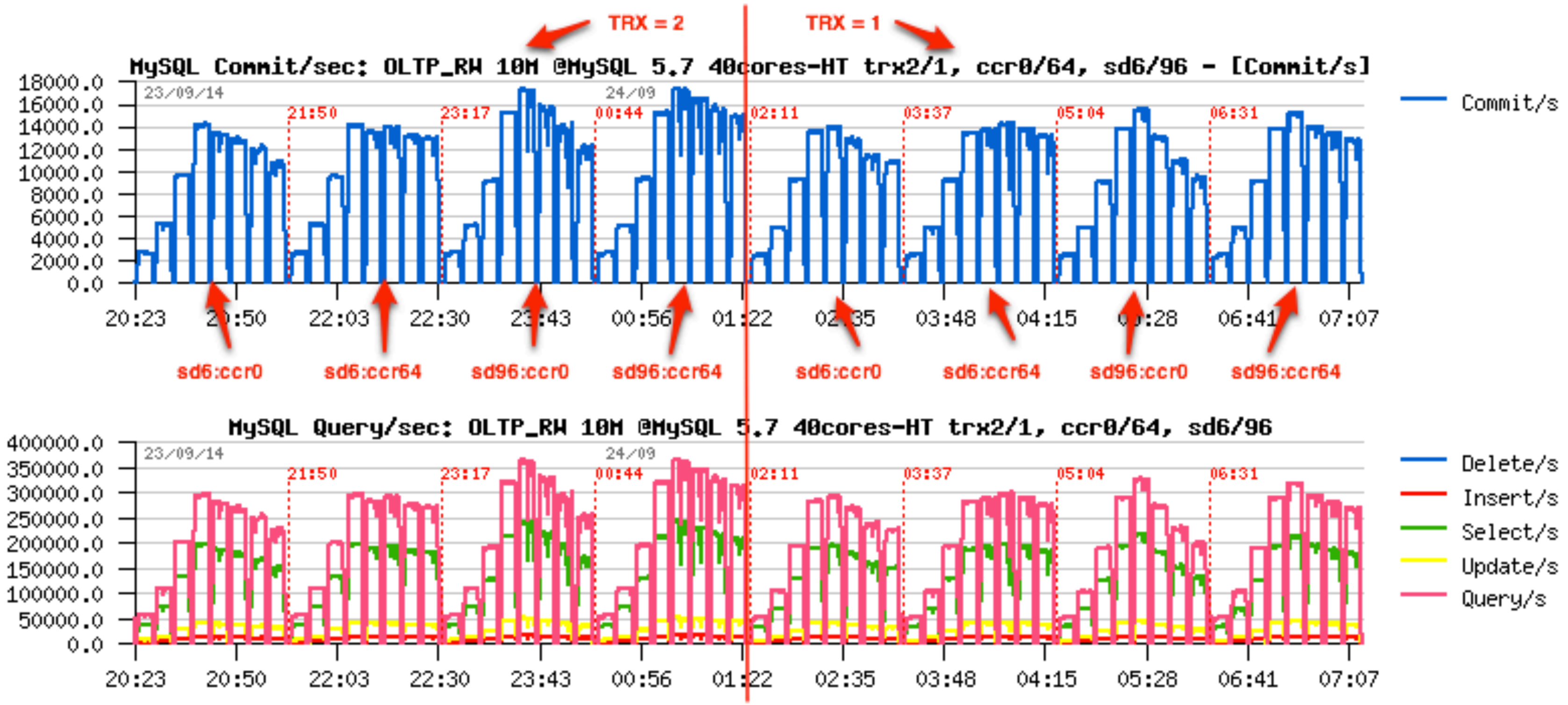
Concurrency tuning on OLTP_RW @MySQL 5.7

- OLTP_RW 10M @MySQL 5.7 40cores-HT :
  - load conditions: TRX = 2 -vs- TRX = 1
  - cooking receipt : concurrency (ccr) & spin wait delay (sd)



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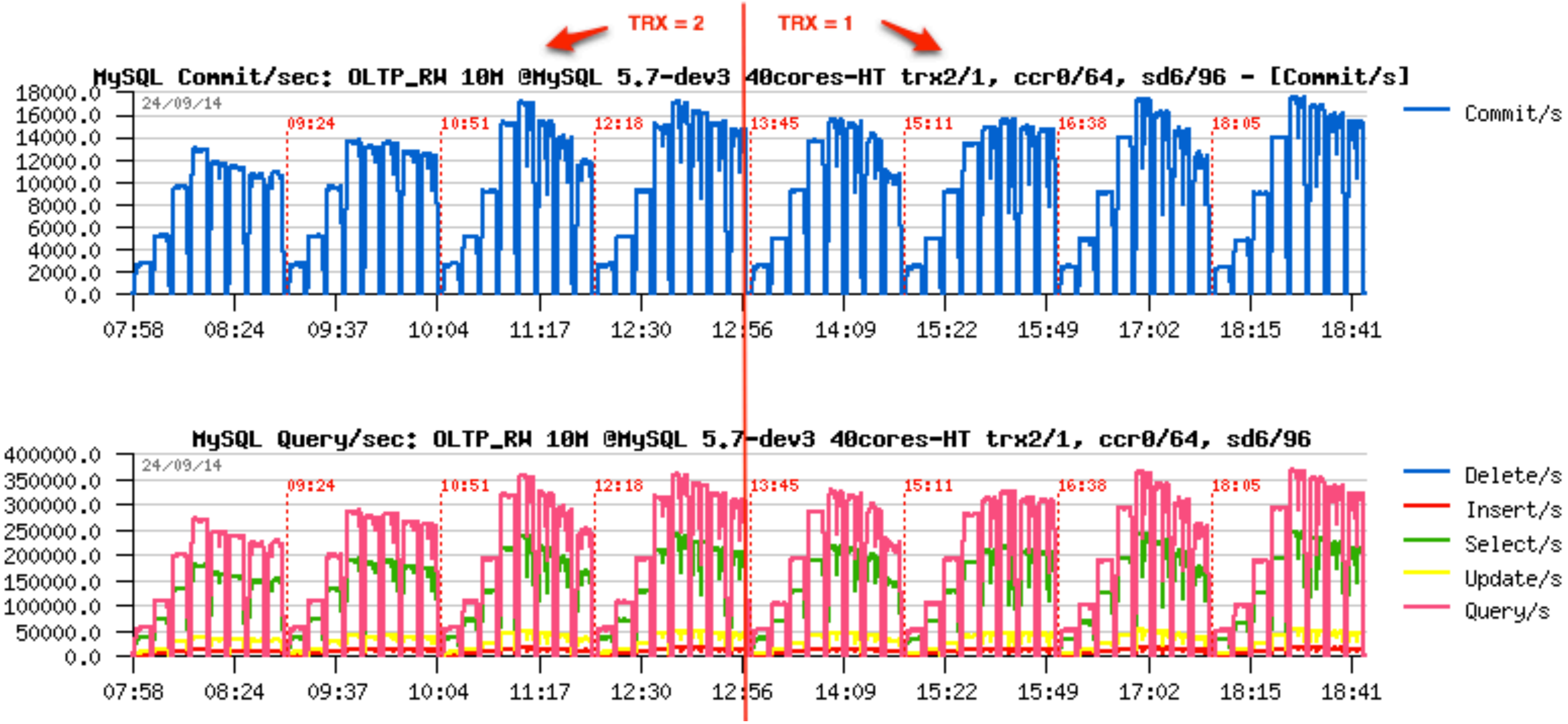
Concurrency tuning on OLTP_RW @MySQL 5.7-dev3

- OLTP_RW 10M @MySQL 5.7-dev3 40cores-HT :
  - load conditions: TRX = 2 -vs- TRX = 1
  - cooking receipt : concurrency (ccr) & spin wait delay (sd)



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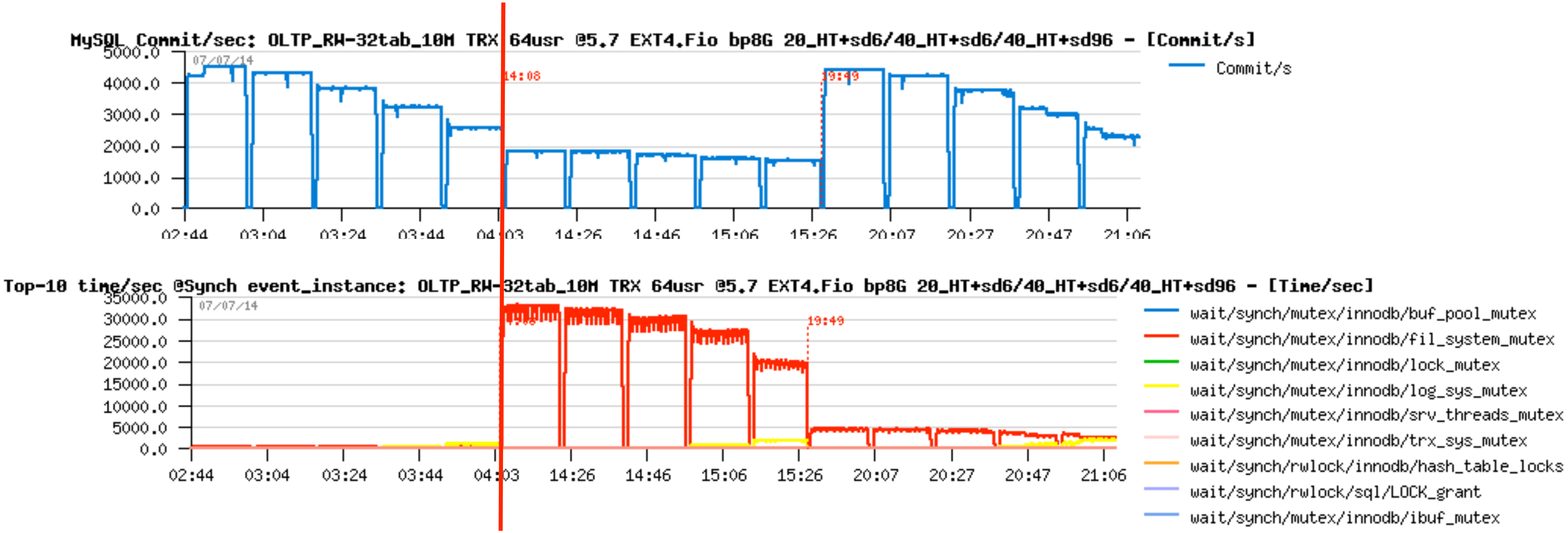
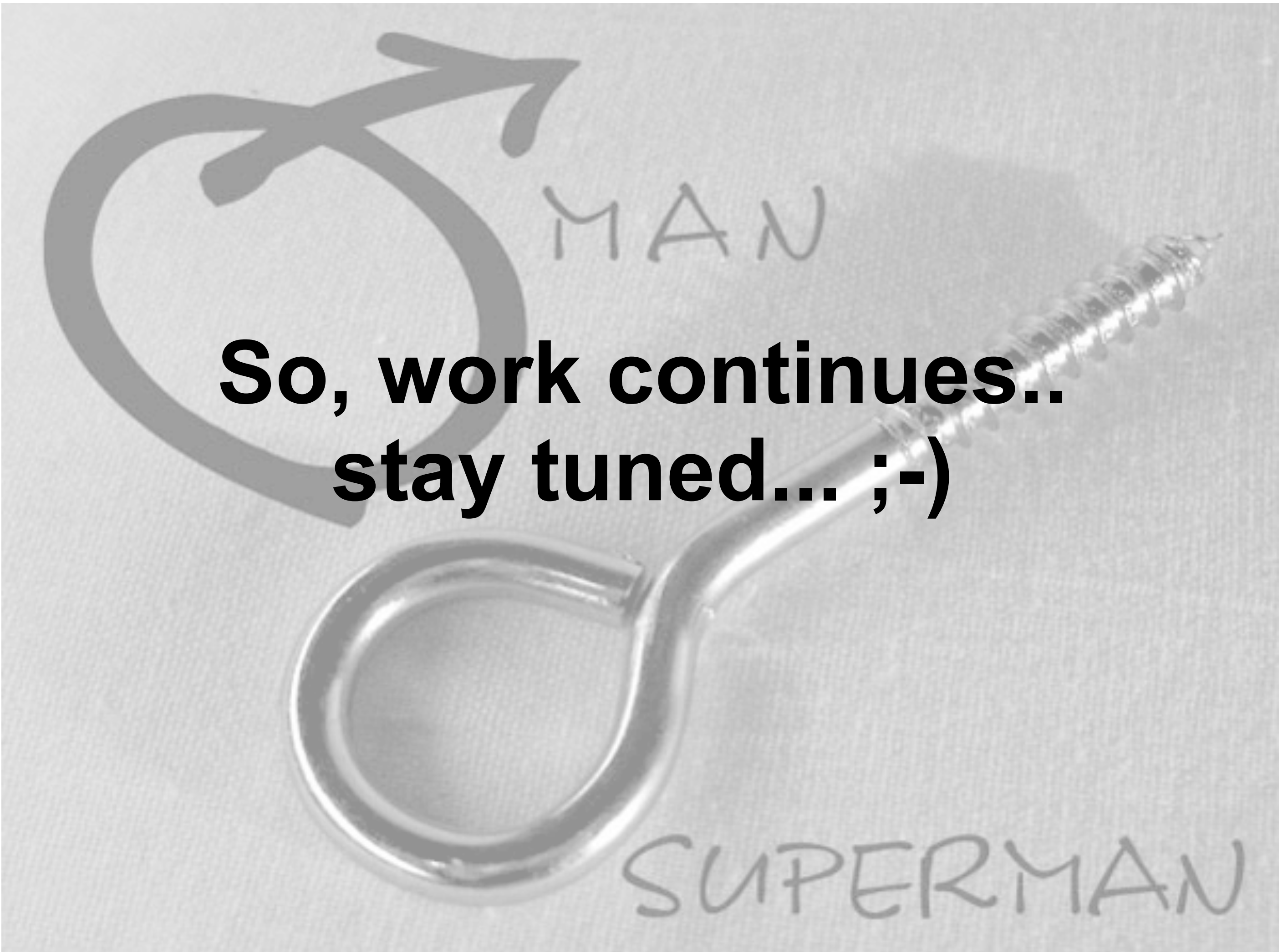
Impact of “Write” queries on MySQL Performance

- IO Bound “out-of-memory”
  - 64usr, growing R/W ratio, near x2 times TPS drop at the end..
  - 20cores | 40cores | 40cores & spin delay = 96





So, work continues..
stay tuned... ;-)

Few words about dim_STAT (if you're asking ;-))

- All graphs are built with dim_STAT (http://dimitrik.free.fr)
  - All System load stats (CPU, I/O, Network, RAM, Processes,...)
  - Manly for Solaris & Linux, but any other UNIX too :-)
  - Add-Ons for Oracle, MySQL, PostgreSQL, Java, etc.
  - MySQL Add-Ons:
    - mysqlSTAT : all available data from "show status"
    - mysqlLOAD : compact data, multi-host monitoring oriented
    - mysqlWAITS : top wait events from Performance SCHEMA
    - InnodbSTAT : most important data from "show innodb status"
    - innodbMUTEX : monitoring InnoDB mutex waits
    - innodbMETRICS : all counters from the METRICS table
  - And any other you want to add! :-)

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THANK YOU !!!

- All details about presented materials you may find on:
  - http://dimitrik.free.fr - dim_STAT, dbSTRESS, Benchmark Reports, etc.
  - http://dimitrik.free.fr/blog - Articles about MySQL Performance, etc.