Troubleshooting Best Practices

Monitoring the Production Database Without Killing Performance

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Introduction: Between Desire and Reality
Desire

• When disaster happens we need
Desire

• When disaster happens we need
  • As many information as possible
Desire

- When disaster happens we need
  - As many information as possible
  - For this exact case
When disaster happens we need
  • As many information as possible
  • For this exact case
  • Any slow down is not acceptable!
Reality

• Almost any monitoring is not free
Almost any monitoring is not free

Think about
- Memory
- Disk space
- CPU
- All of them

Reality
Testing: Internal Tools

• Everything is ON:
  
general-log
innodb-monitor-enable=all
innodb-print-all-deadlocks=1
innodb-status-file=1
innodb-status-output=1
slow-query-log
performance-schema=1
userstat=1
thread-statistics=1
Testing: Internal Tools

- **OFF:**
  
  - general-log=0
  - innodb-monitor-disable=all
  - innodb-print-all-deadlocks=0
  - innodb-status-file=0
  - innodb-status-output=0
  - slow-query-log=0
  - performance-schema=0
  - userstat=0
  - thread-statistics=0
Testing: Performance Schema

- Instruments: "counters"
  - Locks
  - Temporary tables
  - Time spent
  - ...

Instruments and Consumers

You can turn any of them ON or OFF
Testing: Performance Schema

- Instruments: "counters"
- Consumers
  - Tables contain data
  - In memory
  - You can tune their size
Testing: Performance Schema

• Instruments: ”counters”
• Consumers
• Instruments and Consumers
  • You can turn any of them ON or OFF
Testing: Internal Tools

- Percona-Server-5.7.17-13
- Standard OLTP SysBench test:

```bash
for i in 'echo 1 2 4 8 16 32 64 72 128 144 256 512 1024'
  do
    echo $i
    LD_PRELOAD=/data/sveta/5.7.17/lib/mysql/libjemalloc.so /data/sveta/sbkk/bin/sysbench
    --test=/data/sveta/sysbench/sysbench/tests/db/oltp_prepared.lua --db-driver=mysql
    --oltp-tables-count=8 --oltp-table-size=10000000 --mysql-table-engine=$engine
    --mysql-user=msandbox --mysql-password=msandbox --mysql-socket=/tmp/mysql_sandbox5717.sock
    --num-threads=$i --max-requests=0 --mysql-db=$db --max-time=300 --percentile=0
    run >> $engine-oltp-prepared-$suffix.log
  done
```
Monitoring is OFF

![Graph showing Trx/s vs Threads with a line labeled Everything is OFF]

Trx/s

Threads

0 1 2 4 8 16 32 36 64 72 128 144 256 512 1024

40000 30000 20000 10000 0

PERCONA
Monitoring is ON

![Graph showing Trx/s vs Threads with two lines, one for 'Everything is OFF' and one for 'Everything is ON'.](Image)

- **Trx/s** vs **Threads**

- **Graph Legend**:
  - Green: Everything is OFF
  - Red: Everything is ON

- **Axes**:
  - Y-axis: Trx/s (transactions per second)
  - X-axis: Threads (number of threads)

- **Graph Description**:
  - The green line (Everything is OFF) shows a steady increase in Trx/s as the number of threads increases, reaching a peak and then stabilizing.
  - The red line (Everything is ON) remains relatively flat with a slight increase as the number of threads increases, indicating a more efficient or optimized performance compared to the 'Everything is OFF' scenario.

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**Note**: The graph data and analysis are based on the image provided and do not include any extraneous information not visible in the image.
Only Performance Schema

![Graph showing Trx/s vs Threads with different performance settings.]

- Green line: Everything is OFF
- Red line: Everything is ON
- Orange line: P_S ON, other OFF
Performance Schema: defaults, MDL and Memory

![Graph showing the performance schema with threads ranging from 1 to 1024 and transaction per second (Trx/s) on the y-axis. The graph compares the performance with 'Everything is OFF,' 'Everything is ON,' 'P_S is ON, all instruments,' and 'P_S is ON, only defaults, Memory and MDL.'
Why Monitoring is Expensive?
Log Files Require Disk Space

- General or binary log can use all free space
Log Files Require Disk Space

• General or binary log can use all free space
  • Imagine write load 40GB/hour?
Log Files Require Disk Space

• General or binary log can use all free space
  • Imagine write load 40GB/hour?

• Rotate policy
Memory

• Performance Schema
  • Requires pre-allocated memory
Memory

- Performance Schema
  - Requires pre-allocated memory
  - Memory allocated
    - 5.7: After first use
    - 5.6: At server startup
    - Never gets free
Memory

• Performance Schema
  • Requires pre-allocated memory
  • Memory allocated
    ■ 5.7: After first use
    ■ 5.6: At server startup
    ■ Never gets free

• Size of history tables is limited
Memory

• Performance Schema
• Information Schema
  • Some queries require too much memory

MySQL bug #72322
Fixed in 5.5.44, 5.6.25, 5.7.8, 8.0
Memory

- Performance Schema
- Information Schema
  - Some queries require too much memory
  - MySQL 8.0 re-designed tables
    - No temporary tables for each query
    - Index support

MySQL 8.0.0 Release Notes
Memory

- Performance Schema
- Information Schema
  - Some queries require too much memory
  - MySQL 8.0 re-designed tables
  - Upgrade!
CPU Usage

• Performance Schema
  • Fires code instruction each time when examined function called
CPU Usage

• Performance Schema
  • Fires code instruction each time when examined function called
  • Number of calls doubled
CPU Usage

• Performance Schema
  • Fires code instruction each time when examined function called
  • Number of calls doubled

• Binary log
  • `sync_binlog` fires `fsync` calls
Network

- ProxySQL and other proxy
  - Additional layer
Internal Locks

- SHOW SLAVE STATUS
  - 5.6: SHOW SLAVE STATUS NONBLOCKING
    - Only Percona Server!

MySQL WL #6402 in 5.7
Internal Locks

• SHOW SLAVE STATUS
• SHOW [GLOBAL] STATUS
  • Performance slows when called in parallel

MySQL Bug #42930

- Fixed in 5.7.0
- Upgrade!
Internal Locks

• SHOW SLAVE STATUS
• SHOW [GLOBAL] STATUS
• Information Schema
Internal Locks

• SHOW SLAVE STATUS
• SHOW [GLOBAL] STATUS
• Information Schema
• Binary log
Applications with Graphical User Interface

- Use same instruments
  - STATUS Variables
  - MySQL and operating system log files
  - Performance Schema
Applications with Graphical User Interface

- Use same instruments
  - STATUS Variables
  - MySQL and operating system log files
  - Performance Schema

- Have same limitations
How to Find "Golden Ratio"?
You Cannot Turn All Log Files OFF!

Welcome to the MySQL monitor. Commands end with ; or \g.  
Your MySQL connection id is 1  
Server version: 5.6.24-72.2 Percona Server (GPL), Release 72.2, Revision 8d0f85b  
Copyright (c) 2009-2015 Percona LLC and/or its affiliates  
Copyright (c) 2000, 2015, Oracle and/or its affiliates. All rights reserved.  
Oracle is a registered trademark of Oracle Corporation and/or its affiliates. Other names may be trademarks of their respective owners.  
Type 'help;' or '\h' for help. Type '\c' to clear the current input statement.  
mysql> select user, host from user;  
ERROR 2013 (HY000): Lost connection to MySQL server during query
Start with Necessary Minimum

• MySQL error log
Start with Necessary Minimum

- MySQL error log
- Log files of operating system
Turn ON by Demand

- General, slow query log files
Turn ON by Demand

- General, slow query log files
- InnoDB Monitors
Turn ON by Demand

- General, slow query log files
- InnoDB Monitors
- Consumers in Performance Schema
  - Performance Schema already ON
Turn ON by Demand

- General, slow query log files
- InnoDB Monitors
- Consumers in Performance Schema
  - Performance Schema already ON
- Data collection with help of pt-stalk
Turn ON by Demand
Dynamically

• General query/Audit log
Dynamically

- General query/Audit log
- Slow query log
Dynamically

- General query/Audit log
- Slow query log
- InnoDB Monitors
Dynamically

- General query/Audit log
- Slow query log
- InnoDB Monitors
- Performance Schema
  - Instruments
  - Consumers
Restart Required

• Error log
Restart Required

- Error log
- Binary log
Restart Required

- Error log
- Binary log
- Performance Schema
Task Dependent

• Optimization
Queries Optimization: Built-Ins

- Tables in P_S: statements and stages

```sql
mysql> SELECT THREAD_ID TID, SUBSTR(SQL_TEXT, 1, 50) SQL_TEXT, ROWS_SENT RS,
    -> ROWS_EXAMINED RE, CREATED_TMP_TABLES, NO_INDEX_USED, NO_GOOD_INDEX_USED
    -> FROM performance_schema.events_statements_history
    -> WHERE NO_INDEX_USED=1 OR NO_GOOD_INDEX_USED=1\G
```

```
*************** 1. row ***************
    TID: 10124
    SQL_TEXT: select emp_no, first_name, last_name from employee
    RS: 97750
    RE: 397774
    CREATED_TMP_TABLES: 0
    NO_INDEX_USED: 1
    NO_GOOD_INDEX_USED: 0
...```
Queries Optimization: Built-Ins

- Tables in P_S: statements and stages
- Slow query log

```sql
SET timestamp=1493438095;
SELECT data FROM usertable WHERE YCSB_KEY = 'user100040185076507112';
```
Query Optimization: Graphical

- Query Analytics in PMM

```
SELECT sbtest1
```

<table>
<thead>
<tr>
<th>Metrics</th>
<th>Rate/Sec</th>
<th>Sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Query Count</td>
<td>195.32 (per sec)</td>
<td>703.16 k 25.36% of total</td>
</tr>
<tr>
<td>Query Time</td>
<td>2.17 load (0.02%)</td>
<td>7818.34 sec 0.02% of total</td>
</tr>
<tr>
<td>Lock Time</td>
<td>&lt;0.01 (avg load)</td>
<td>34.75 sec &lt;0.01% of total 0.00</td>
</tr>
<tr>
<td>Rows Sent</td>
<td>164.71 (per sec)</td>
<td>592.94 k 1.15% of total</td>
</tr>
</tbody>
</table>

**Selected query class: 691.43 k Queries (192.06 QPS, 0.02%, 2.15 Load) | Total: 2.73 m Queries (757.56 QPS, 100.00%, 11.51 k Load)**

© Last seen 2 minutes ago
Query Optimization: Graphical

- Query Analytics in PMM
- Advice for SQL in Solarwinds
- Query Analyzer (QUAN) in MEM
- Queries in VividCortex
- Others
Application Optimization

• InnoDB Monitors
Application Optimization

- InnoDB Monitors
- Performance Schema
Application Optimization

- InnoDB Monitors
- Performance Schema
- Data collection on demand
  - Manually
    - SHOW
    - SELECT ... FROM INFORMATION_SCHEMA
- pt-stalk
Application Optimization

- InnoDB Monitors
- Performance Schema
- Data collection on demand
  - Manually
    - `SHOW`
    - `SELECT ... FROM INFORMATION_SCHEMA`
- pt-stalk
- Graphical
- OpenSource: PMM
- Commercial
Task Dependent

• Optimization
  • Queries
  • Application

• Locks
Locks

• P_S MDL tables
Locks

• P_S MDL tables
• InnoDB Monitors
Locks

- P_S MDL tables
- InnoDB Monitors
- innodb_print_all_deadlocks
Task Dependent

• Optimization
  • Queries
  • Application

• Locks
• Crashes
Crashes

- Core dumps
Crashes

- Core dumps
- General query log
Crashes

• Core dumps
• General query log
• Audit log
Crashes

- Core dumps
- General query log
- Audit log
- Binary log
  - Only commands, changing data
  - SELECT can cause crash too
  - Crash can happen before command is written!
Task Dependent

- Optimization
  - Queries
  - Application
- Locks
- Crashes
- Unexpected behavior
Unexpected Behavior

- General query log
Unexpected Behavior

- General query log
- Binary log
  - Only for written data
Always ON

- MySQL error log
- Operating system log files
Turn ON on Demand

- P_S
- InnoDB Monitors
- General, slow, binary log
External Tools

- Percona Toolkit
- PMM
- MySQL Enterprise Monitor
- Interactive Demo for SolarWinds
- VividCortex
- MONYOG
Thank You!

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https://github.com/svetasmirnova