

# Effective Testing for Live Applications

March, 29, 2018

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**PERCONA**

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- Performance Issues
- Crashes

# MySQL Troubleshooting Webinars

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- I taught to
  - Repeat problematic queries
  - Crash servers

# MySQL Troubleshooting Webinars

---

- I taught to
  - Repeat problematic queries
  - Crash servers
- **Not what you want to do in production**

# Not Acceptable

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- Updating wrong data
- Intended performance slowdowns
- Crashes

# Sandboxes

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- Slower machines
- Smaller disks
- Blocking backups

# Concurrency

---

- Hard to imitate
- Load testing tools are not perfect

# Sometimes You Have to Test on Production



# Safety First

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- Data must stay consistent
- No intended crashes
- Tests should not make performance worse

# We will Discuss

---

- Wrong data
  - SELECT
  - UPDATE/INSERT/DELETE
  - DDL

# We will Discuss

---

- Wrong data
- Performance
  - Slow queries
  - Locking issues
  - Hardware-related

# We will Discuss

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- Wrong data
- Performance
- Crashes

# General Workflow

---

- Measure: record what is wrong
  - Actual and expected results
  - Query execution time
  - Overall application performance

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- Implement them
  - May require maintenance window

# General Workflow

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- Measure: record what is wrong
  - Actual and expected results
  - Query execution time
  - Overall application performance
- Plan changes
- Implement them
  - May require maintenance window
- Measure again



# Challenges

---

- We need to know what causes bad behavior

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- Issue can have many potential solutions
  - You can find one only after many iterations

# Challenges

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- We need to know what causes bad behavior
- It is hard to find out
- Issue can have many potential solutions
  - You can find one only after many iterations
- You don't want to cause worse damage

# Wrong Data

# Wrong Data

SELECT Returns Nonsense

# There is No Harm in Experimenting

---

- This is just a query

# There is No Harm in Experimenting

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- This is just a query
- Does not change anything



# There is No Harm in Experimenting

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- This is just a query
- Does not change anything
- Works fast

# There is No Harm in Experimenting

---

- This is just a query
- Does not change anything
- Works fast
- No effect on others

# Just Run It

---

- Use all troubleshooting techniques you know

# Just Run It

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- Use all troubleshooting techniques you know
- Which we discussed
  - Troubleshooting Slow Queries

# Just Run It

---

- Use all troubleshooting techniques you know
- Which we discussed
  - Troubleshooting Slow Queries
- And not

# Measure

---

- Result of SELECT
- EXPLAIN output
- Desired result
- Can you use sandbox for tests?

# General Query Analyzing Checklist

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- Is data in the table?

# General Query Analyzing Checklist

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- Is data in the table?
- Does simplified query return correct result?



# General Query Analyzing Checklist

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- Is data in the table?
- Does simplified query return correct result?
- Try removing
  - ORDER BY
  - GROUP BY
  - WHERE
  - JOIN

# General Query Analyzing Checklist

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- Is data in the table?
- Does simplified query return correct result?
- Try removing
  - ORDER BY
  - GROUP BY
  - WHERE
  - JOIN
- Can you use part of data for tests?

# Reducing Query Example

---

- Data in the table

```
mysql> select a from t1;
```

```
+-----+  
| a      |  
+-----+  
| -9223372036854775808 |  
| -9223372036854775807 |  
| 9223372036854775806  |  
| 9223372036854775807  |  
+-----+  
4 rows in set (0.00 sec)
```

# Reducing Query Example

---

- Problematic query

```
mysql> select distinct ceil(a) from t1;
```

```
+-----+
```

```
| ceil(a) |
```

```
+-----+
```

```
| -9999999999999999 |
```

```
| 9999999999999999 |
```

```
+-----+
```

```
2 rows in set (0.00 sec)
```

---- Here is the problem!

# Reducing Query Example

---

- Wrong data type

```
mysql> select ceil(a) a from t1;
```

```
+-----+
| a      |
+-----+
| -9223372036854775808 |
| -9223372036854775807 |
|  9223372036854775806 |
|  9223372036854775807 |
+-----+
```

```
4 rows in set, 4 warnings (0.00 sec)
```

```
Warning (Code 1292): Truncated incorrect DECIMAL value: '-9223372036854775808'
```

```
Warning (Code 1292): Truncated incorrect DECIMAL value: '-9223372036854775807'
```

```
Warning (Code 1292): Truncated incorrect DECIMAL value: '9223372036854775806'
```

```
Warning (Code 1292): Truncated incorrect DECIMAL value: ...
```



# Reducing Query Example

---

- Solution

```
mysql> select distinct cast(ceil(a) as signed) from t1;
```

```
+-----+  
| cast(ceil(a) as signed) |  
+-----+  
|      -9223372036854775808 |  
|      -9223372036854775807 |  
|       9223372036854775806 |  
|       9223372036854775807 |  
+-----+
```

```
4 rows in set (0.00 sec)
```

# Reducing Query Example

---

- Based on [MySQL Bug #79571](#)

# Challenges

---

- Large datasets
  - Removing WHERE leads to high IO



# Challenges

---

- Large datasets
  - Removing WHERE leads to high IO
- Solutions
  - Limit data by primary key access
  - Run EXPLAIN before query
  - Adjust in parts

# Wrong Data

Wrong Data in the Database

# You Have Wrong Data in the Database

---

- Incorrect UPDATE statement

# You Have Wrong Data in the Database

---

- Incorrect UPDATE statement
- Concurrency

# You Have Wrong Data in the Database

---

- Incorrect UPDATE statement
- Concurrency
- Wrong order of master events on slave

# You Already Know Problematic Query

---

- All updates are in the binary log

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- All updates are in the binary log
- With RBR use `mysqlbinlog --verbose`
  - May help to discover logic error

# You Already Know Problematic Query

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- All updates are in the binary log
- With RBR use `mysqlbinlog --verbose`
  - May help to discover logic error
- Audit, general, application logs



# How to Deal with Tons of Updates?

---

- Quickly run through them

# How to Deal with Tons of Updates?

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- Quickly run through them
- Treat similar queries as same one
  - UPDATE foo SET bar=8 WHERE baz=9
  - UPDATE foo SET bar=9 WHERE baz=8

# How to Deal with Tons of Updates?

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- Quickly run through them
- Treat similar queries as same one
- Search for not trivial queries
  - `DELETE FROM t1, t2 USING t1, t2;`

# How to Deal with Tons of Updates?

---

- Quickly run through them
- Treat similar queries as same one
- Search for not trivial queries
  - `DELETE FROM t1, t2 USING t1, t2;`
    - Will work only for matching rows

# How to Deal with Tons of Updates?

---

- Quickly run through them
- Treat similar queries as same one
- Search for not trivial queries
- Examine logs for number of affected rows
  - Slow query log in Percona Server has it
  - `performance_schema.events_statements_*`
    - [Performance Schema for MySQL Troubleshooting](#)

# Concurrency and Conflicts

---

- Order of events

# Concurrency and Conflicts

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- Order of events
- Transaction isolation level

# Concurrency and Conflicts

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- Order of events
- Transaction isolation level
- Content of binary log



# Concurrency and Conflicts

---

- Order of events
- Transaction isolation level
- Content of binary log
- Application logic
  - Log files
  - What do you expect from it?

# Measure

---

- What was wrong
- DML queries
- What changed
- How result changed

# Test safely

---

```
update City, Country set City.Population=Country.Population+1000  
where City.CountryCode=Country.Code and Continent='Oceania' and Region='Polynesia';
```

# Test safely

---

```
update City, Country set City.Population=Country.Population+1000  
where City.CountryCode=Country.Code and Continent='Oceania' and Region='Polynesia';
```

- Convert to SELECT

```
select City.Population, Country.Population, Country.Code from City, Country  
where City.CountryCode=Country.Code and Continent='Oceania' and Region='Polynesia';
```

# Test safely

---

```
update City, Country set City.Population=Country.Population+1000
where City.CountryCode=Country.Code and Continent='Oceania' and Region='Polynesia';
```

- Convert to SELECT
- Multi-statement transaction and rollback

```
mysql> begin;
Query OK, 0 rows affected (0.00 sec)
```

```
mysql> update City, Country set City.Population=Country.Population+1000
    -> where City.CountryCode=Country.Code and Continent='Oceania' and Region='Polynesia';
Query OK, 12 rows affected (0.01 sec)
Rows matched: 12  Changed: 12  Warnings: 0
```

```
mysql> rollback;
Query OK, 0 rows affected (0.13 sec)
```



# Test safely

---

```
update City, Country set City.Population=Country.Population+1000  
where City.CountryCode=Country.Code and Continent='Oceania' and Region='Polynesia';
```

- Convert to SELECT
- Multi-statement transaction and rollback
- Experiment with slave

# Test safely

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```
update City, Country set City.Population=Country.Population+1000  
where City.CountryCode=Country.Code and Continent='Oceania' and Region='Polynesia';
```

- Convert to SELECT
- Multi-statement transaction and rollback
- Experiment with slave
- Be ready to revert changes!

# Performance Issues



# Measure

---

- Most important for Performance Issues

# Measure

---

- Most important for Performance Issues
- Application response time
  - How long web page loads?
  - How long took AJAX request?
  - How much took request to database?

# Measure

---

- Most important for Performance Issues
- Application response time
- Slow query log

# Measure

---

- Most important for Performance Issues
- Application response time
- Slow query log
- Throughout data collection
  - pt-stalk
  - Performance Schema
  - Manual

# What is Wrong with Hardware Metrics?

---

- They say nothing about state

# What is Wrong with Hardware Metrics?

---

- They say nothing about state
- High CPU
  - Is database starving?
  - Is it running many client threads?

# What is Wrong with Hardware Metrics?

---

- They say nothing about state
- High CPU
- Low CPU
  - Is database idle?
  - Did you limit concurrency?

# What is Wrong with Hardware Metrics?

---

- They say nothing about state
- High CPU
- Low CPU
- High Memory Usage
  - Too large buffers?
  - Too many temporary tables?



# What is Wrong with Hardware Metrics?

---

- They say nothing about state
- High CPU
- Low CPU
- High Memory Usage
- You got the idea 😊

# Measure in Right Time!

---

- Baseline: for normal load
  - Makes sense to understand hardware limits

# Measure in Right Time!

---

- Baseline: for normal load
- For troubleshooting: for **real** load

# Test Workflow

---

- Collect data

# Test Workflow

---

- Collect data
- Plan changes
  - Record everything you modify
  - Choose time

# Test Workflow

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- Collect data
- Plan changes
  - Record everything you modify
  - Choose time
- Make changes

# Test Workflow

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- Collect data
- Plan changes
  - Record everything you modify
  - Choose time
- Make changes
- Collect again

# Test Workflow

---

- Collect data
- Plan changes
  - Record everything you modify
  - Choose time
- Make changes
- Collect again
- Compare



# Can I get Situation Worse?

---

- Yes, you can!

# Can I get Situation Worse?

---

- Yes, you can!
- But you are already in trouble

# Can I get Situation Worse?

---

- Yes, you can!
- But you are already in trouble
- You have to do something

# Safe Way to Test

---

- Understand what you change

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- Understand what you change
- Test in session

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- Change dynamic variables

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- Understand what you change
- Test in session
- Change dynamic variables
- Store changes
  - Configuration file
  - 8.0+: SET PERSIST

# Safe Way to Test

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- Understand what you change
- Test in session
- Change dynamic variables
- Store changes
  - Configuration file
  - 8.0+: SET PERSIST
- **Always measure effect!**



# If Things Went Wrong

---

- Revert changes

# If Things Went Wrong

---

- Revert changes
- Record what caused failure

# If Things Went Wrong

---

- Revert changes
- Record what caused failure
- Easy if you changed in right time

# Changing in Less Busy Time

---

- May work
  - Follow regular workflow
  - Compare with data, collected for similar load

# Changing in Less Busy Time

---

- May work
  - Follow regular workflow
  - Compare with data, collected for similar load
- Won't work
  - Issue happens only during high activity
    - Number of active writing clients is greater than your disk and CPU can handle
    - InnoDB Buffer Pool aggressively purges old data only when it cannot do it in idle time

# Changing in Less Busy Time

---

- May work
  - Follow regular workflow
  - Compare with data, collected for similar load
- Won't work
  - Issue happens only during high activity
    - Number of active writing clients is greater than your disk and CPU can handle
    - InnoDB Buffer Pool aggressively purges old data only when it cannot do it in idle time
  - You may try to scale
    - Use case for [sandbox](#)
    - Not always work

# Upgrade Performance: Issues

---

- Application runs slower than before

# Upgrade Performance: Issues

---

- Application runs slower than before
- Reason is unknown



# Upgrade Performance: Issues

---

- Application runs slower than before
- Reason is unknown
- A lot of changes
  - Hardware
  - Operating System
  - MySQL version

# Upgrade Performance: Best Practices

---

- Record performance stats for old version
  - `pt-stalk`
  - Slow query log for few days

# Upgrade Performance: Best Practices

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- Record performance stats for old version
  - `pt-stalk`
  - Slow query log for few days
- Upgrade

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- Record performance stats for old version
  - `pt-stalk`
  - Slow query log for few days
- Upgrade
- Let it run

# Upgrade Performance: Best Practices

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- Record performance stats for old version
  - `pt-stalk`
  - Slow query log for few days
- Upgrade
- Let it run
- Measure again

# Upgrade Performance: Best Practices

---

- Record performance stats for old version
  - `pt-stalk`
  - Slow query log for few days
- Upgrade
- Let it run
- Measure again
- You will know exactly what went wrong!

# Calling Support

---

- Collect data
  - At the problematic time
  - `pt-stalk` in daemon mode

```
pt-stalk --daemonize --iterations=2 --sleep=30 --dest=/path/where/you/want/logs/stored  
--user=root --password=mysql-root-pass  
--function=status --variable=Threads_running --threshold=25
```

# Calling Support

---

- Collect data
  - At the problematic time
  - `pt-stalk` in daemon mode
- Identify how it affects your application



# Calling Support

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# Calling Support

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- Collect data
  - At the problematic time
  - `pt-stalk` in daemon mode
- Identify how it affects your application
- Read answers about changes you need to make
- Apply them incrementally
- Measure result

# Crashes

# You have to Make Changes

---

- You are in trouble already
- There is nothing to be more afraid of

# What to Change?

---

- Query

# What to Change?

---

- Query
- Scenario

# What to Change?

---

- Query
- Scenario
- Options



# What to Change?

---

- Query
- Scenario
- Options
- Hardware

# Log Files

---

- Error log

# Log Files

---

- Error log
- Core file

# Log Files

---

- Error log
- Core file
- Troubleshooting MySQL Crashes
  - Debug symbols
  - Analyze hints

# Workflow

---

- Study logs

# Workflow

---

- Study logs
- Make changes

# Workflow

---

- Study logs
- Make changes
- Repeat workload

# Workflow

---

- Study logs
- Make changes
- Repeat workload
- Do best to imitate in sandbox!



# Crash in Random Places

---

- Check if mysqld is the reason

# Crash in Random Places

---

- Check if mysqld is the reason
- Monitor OS around crash times

# Crash in Random Places

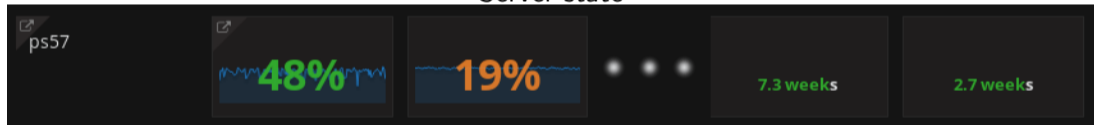
---

- Check if mysqld is the reason
- Monitor OS around crash times
- **PMM or similar tool is a must**
  - Impractical to have scheduled job

# System and Crashes

---

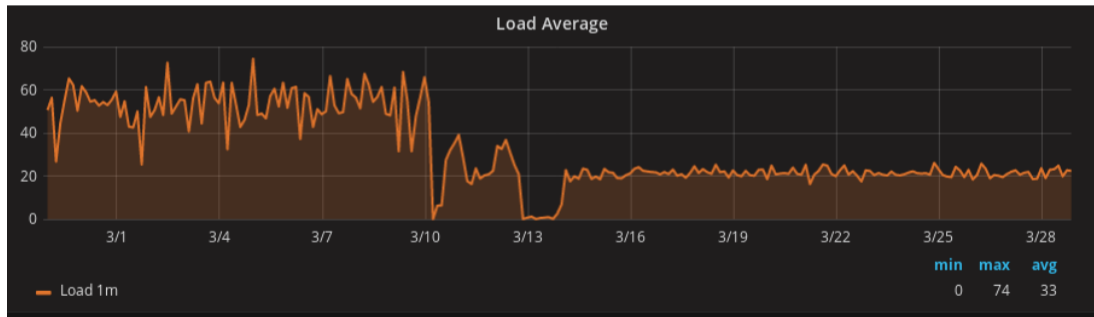
Server state



# System and Crashes

---

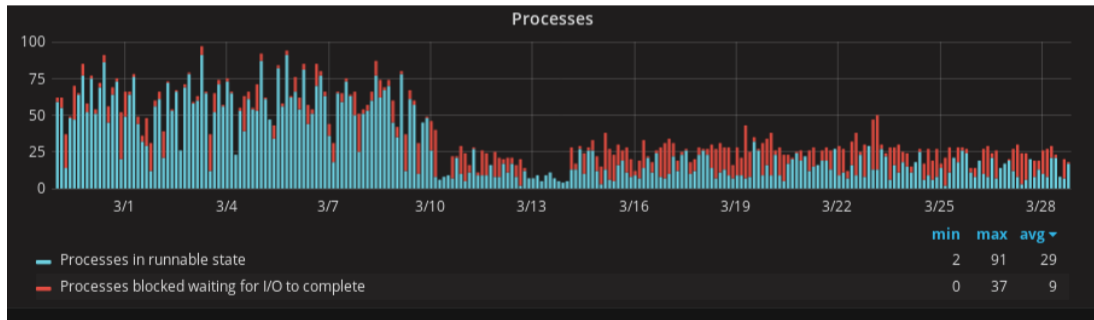
System Overview: 2.7 Weeks before



# System and Crashes

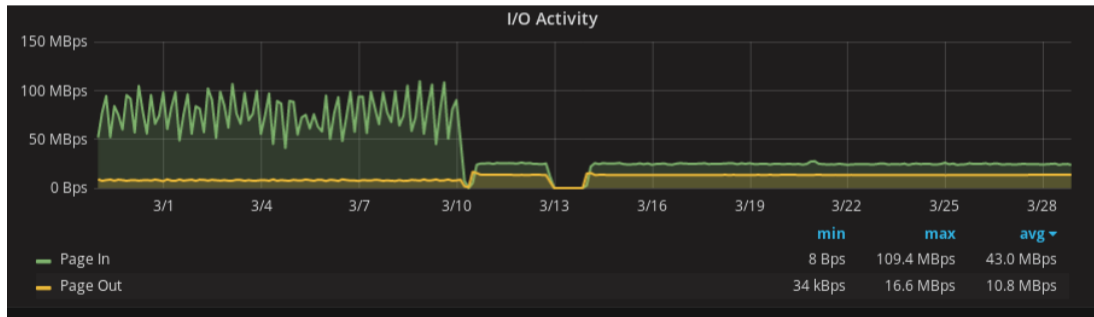
---

System Overview: 2.7 Weeks before



# System and Crashes

System Overview: 2.7 Weeks before



# Summary

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- You must monitor your system



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- You must monitor your system
- Keep historic logs, so you know what changed
  - Slow query logs
  - `pt-stalk` collections
  - PMM

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- Make changes sequentially

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- You must monitor your system
- Keep historic logs, so you know what changed
  - Slow query logs
  - `pt-stalk` collections
  - PMM
- Make changes sequentially
- Avoid to replace everything at a time

# Summary

---

- You must monitor your system
- Keep historic logs, so you know what changed
  - Slow query logs
  - `pt-stalk` collections
  - PMM
- Make changes sequentially
- Avoid to replace everything at a time
- Measure before and after the change



# More Information

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Troubleshooting Webinars at Percona

MySQL is crashing: a support engineer's point of view

[pmmdemo.percona.com/](http://pmmdemo.percona.com/)



# Thank you!

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<http://www.slideshare.net/SvetaSmirnova>

<https://twitter.com/svetsmirnova>

