How to Upgrade Like a Boss to MySQL 8.0

Upgrading successfully to latest version

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Oct 2019
Who Am I? @ask_dba

Born to Sail, Forced to Work
• Open Source Database Evangelist
• Global Database Operations Expert
• Cloud Infrastructure Architect AWS
• Inspiring Technical and Strategic Leader
• Creative Team Builder
• Speaker, Mentor, and Coach
About Percona

Solutions for your success with MySQL, PostgreSQL, and MongoDB
Support, Managed Services, Consulting, Software, and Tools
Our Software is 100% Open Source
Support Broad Ecosystem – MySQL, MariaDB, Amazon RDS, MongoDB, PostgreSQL
In Business over 10 years
More than 3000 customers, including top Internet companies and enterprises
Most Recent Percona Software Updates
Sep 2019

- Percona Server for MySQL 8.0.16-7
- Percona Server for MongoDB 4.2.0.1
- Percona XtraDB Cluster 5.7.25-31.39
- Percona XtraBackup 8.0.7
- Percona Monitoring and Management 2.0.1
- Percona Toolkit 3.1.0
- Percona Kubernetes Operators!
Why Even Upgrade?

Feature rich and secure version is always a right choice
Because MySQL 8 is Good 😊

- SQL DML
  - Window Functions, Recursive/Non-Recursive CTEs, Derived Tables,…
- SQL DDL
  - Instant ADD/RENAME Column,…
- INDEXES
  - Invisible/Descending/Functional Indexes,…
- FUNCTIONS
  - Regexp_%, UUID,…
- JSON
  - JSON_%, Sorting, In-place
Because MySQL 8 is Better 😊

- GIS
  - Spatial Reference Systems, ST functions, Geography Support
- Character Sets and Collations
  - UTF-8, Unicode 9.0, ...
- Information Schema
  - Views over Data Dictionary, New Views, ...
- Performance Schema
  - Indexes, Error handling, Data Locks, Latency histograms
- Show
  - Hidden columns, Index information
Because MySQL 8 is Great 😊

- Optimizer
  - Histograms, Hints,
- InnoDB
  - Redo Log, Encryption, ...
- Data Dictionary and Upgrade
  - Transactional DD, Meta Data in InnoDB, Auto Upgrade
- Replication / Group Replication
  - Binlog Encryption, Atomic DDL Recovery / Savepoints, Switchovers, Auto-rejoin
- Security, Shell, Router and many more features.
Fast Adoption to MySQL 8.X

MySQL 8.0: Fast Adoption

April 2018 (8.0 GA)

- MySQL 5.7: 66%
- MySQL 5.6: 25%
- MySQL 5.5: 4%

August 2019

- MySQL 8.0: 26%
- MySQL 5.7: 47%
- MySQL 5.6: 24%

Ref: PLEAMS19 MySQL State of the Dolphin Geir Høydalsvik Keynote © 2019 Percona
Pros of Upgrading to New Version

• Rich features (Business specific needs)
• Technical advantages (QPS, Throughput, Administration)
• Avoid multiple version upgrades
• Bug fixes
• Security and Compliance
• Community and Vendor support
Cons of Upgrading to New Version

- Risks of hitting unknown issues
- Different behavior and results
- Slower throughput due to
  - `sql_mode`, Optimizer, Charset, etc
- Amount of time and material needed for upgrade project
- Downtime that is scheduled to happen
- Downgrade from MySQL 8.0 to MySQL 5.7 is not supported.
How We Always Upgraded?

The good old-fashioned way, maybe
Traditionally pre-V8

- Major versions only (Ascending Order)
  - 5.1 → 5.5
  - 5.5 → 5.6
  - 5.6 → 5.7
    - Set innodb_fast_shutdown=0
    - Stop existing MySQL server
    - Change binaries to new version
    - Adjust config (my.cnf) to new version
    - Start MySQL server
    - Run mysql_upgrade (Time Consuming)
    - Restart MySQL Server (Additional Downtime)
MySQL 8.0 Upgrade Process

Testing
- Slow Query Log
- pt-upgrade
- MySQL Shell

Technique
- Side by Side
- In-place

Cutover
- Failover to new topology
- Migrate over time
Before You Even Start Testing

- Review release notes
- Changes in defaults
- Features of new version
- Removed syntax
- Deprecated functions (GIS)
- Data restrictions
- New keywords
- Changed behavior
Testing Phase

Setup a new testing environment
  • Setup slaves as replication
    • Keep it for a month on no-access server
    • Try read testing batch testing
    • Verify schema / connectivity compatibility
    • Use ProxySQL (mirroring, traffic routing)
    • Inspect slow query log

Build independent cluster
  • Query testing
    • Capture slow queries and digest (pt-query-digest)
    • pt-upgrade
  • Application testing
    • Verify results
Run `pt-upgrade` to Compare Queries

What does it achieve?
- Identify:
  - Query execution time
  - Query row counts
  - Query checksum

How does it achieve?
- Writer Handle – Master Write
- Reader Handler (Read Only)
- Master Reader Handle
- Reporting Reader Handle
Steps to Verify via pt-upgrade (High Level)

1. Setup two slaves with same hardware one of them MySQL 8
2. Capture queries \( (\text{long\_query\_time}=0) \) for 24 hours
3. Detach slaves and run pt-query-digest \( (\text{pt\-query\-digest \ --output=slowlog \ --sample=10 \ --no-report} > \text{slow.log}) \)
4. Run pt-upgrade with \( (\text{--max-examples}=1) \)
5. Repeat (after with warm buffer pool)
6. Review and analyze results
Steps to Verify via pt-upgrade RO (Detailed)

1. $ pt-query-digest --sample 25 --no-report --output slowlog <slow_log_file> > slow_log_25_samples.log

2. $pt-upgrade h=Test1 h=Test2 --max-examples=1 slow_log_25_samples.log 1> pt-upgrade_results.out 2> pt-upgrade_results.err
Steps to Verify via pt-upgrade RW (Detailed)

1. $ pt-query-digest --sample 25 --no-report --output slowlog <slow_log_file> > slow_log_25_samples.log
2. $ pt-upgrade h=Test1 h=Test2 --no-read-only --max-examples=1 slow_log_25_samples.log 1> pt-upgrade_results.out 2> pt-upgrade_results.err
Summary pt-upgrade Testing

- Capture queries for 1-2 hours during peak traffic from the master with `long_query_time=0, log_slow_rate_limit=1`.

- Prepare a file for pt-upgrade testing with 50 samples of each query.
  - Use `pt-query-digest` to prepare samples.

- Stop replication on both servers at the same position.
  - The replication will remain stopped for the duration of pt-upgrade testing.

- Run `pt-upgrade read_only` test with --save-results option.
  - The first test to warm up the buffer pool.
  - The second test to capture actual results.
MySQL Shell in a Nutshell

Nice things about MySQL Shell
The new MySQL Shell

- DBA friendly
  - Color mode
  - Auto Complete
  - Highlighted Syntax
  - History, pager/less
  - Multiple output formats

- Development friendly
  - SQL
  - JavaScript
  - Batch
  - Document Store
  - InnoDB Cluster Admin
How Can MySQL Shell help? *(upgrade_checker)*

- **Built-in function** `util.checkForServerUpgrade()`

  The MySQL server at localhost:33060, version 5.7.26-29 - Percona Server (GPL), Release 29, Revision 11ad961, will now be checked for compatibility issues for upgrade to MySQL 8.0.16…

  1) Usage of old temporal type
     - No issues found
  2) Usage of db objects with names conflicting with reserved keywords in 8.0
     - No issues found
  3) Usage of utf8mb3 charset
     - No issues found
  4) Table names in the mysql schema conflicting with new tables in 8.0
     - No issues found
  5) Foreign key constraint names longer than 64 characters
     - No issues found
  ...

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MySQL Shell Can Do Even More (**mydba**)

```
mysqlsh --py root@localhost

import sys
sys.path.append('/home/fred/workspace/mysql-shell-mydba')
import mydba

MySQL localhost:33060+ ssl Py > mydba.getProcedures('airline')
Total: 0
MySQL localhost:33060+ ssl Py > mydba.getFragmentedTables()

+--------------------------------+------------+---------+------------+------------+------------+-------------------+
| Table                          | Engine     | # Rows  | Data Size  | Idx Size   | Total Size  | Data Free         |
+--------------------------------+------------+---------+------------+------------+------------+-------------------+
| information_schema.COLUMNS     | InnoDB     | None    | 0.00G      | 0.00G      | 0.00G      | 8.00MB (100%)     |
| information_schema.EVENTS      | InnoDB     | None    | 0.00G      | 0.00G      | 0.00G      | 8.00MB (100%)     |
| information_schema.OPTIMIZER_TRACE | InnoDB    | None    | 0.00G      | 0.00G      | 0.00G      | 8.00MB (100%)     |
+--------------------------------+------------+---------+------------+------------+------------+-------------------+

https://github.com/lefred/mysql-shell-mydba
MySQL Shell Can Do Even More (**innotop**)  

```python
mysqlsh --py root@localhost

import sys
sys.path.append('/home/fred/workspace/mysql-shell-innotop')
import innotop

innotop.session_processlist.run()
```

https://github.com/lefred/mysql-shell-innotop

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Upgrade Checker Identifies

- Reserved Data Dictionary table names (catalogs)
- Old Style Decimals, Varchar, Time/Datetime/Timestamp
  - CHECK TABLE {table_name} FOR UPGRADE
  - Mysqlcheck
  - Check-upgrade in 5.7
    - Use REPAIR TABLE & Dump/Restore
- Partitioned tables using non-native partitioning was deprecated in 5.7 removed in 8.0
  - Switch to native partitioning or not
Upgrade Checker Does NOT Identify

- Removed syntax
- Deprecated functions (GIS)
- Data restrictions
- New keywords
- Changed behavior
- Change in defaults
MySQL Upgrade 5.7 to 8.0 (In-place)

- 5.7 to 8.0
  - Stop existing MySQL server
  - Change binaries to new version
  - Adjust config (my.cnf) to new version
  - Start MySQL server
    - Automatic upgrade
    - New mysqld options
      - --upgrade=AUTO (default)
      - --upgrade=NONE (errors if anything needs upgrade)
      - --upgrade=MINIMAL (to avoid DDL on some system tables)
      - --upgrade=FORCE
  - Eliminates issues with metadata using transactional data dictionary
MySQL Upgrade 5.7 to 8.0 (Replication & Rolling Upgrade)

- 5.7 to 8.0
  - Stop existing MySQL Slave server
  - Change binaries to new version
  - Adjust config (my.cnf) to new version
  - Start MySQL server
    - Automatic upgrade
    - New mysqld options
      - --upgrade=AUTO (default)
      - --upgrade=NONE (errors if anything needs upgrade)
      - --upgrade=MINIMAL (to avoid DDL on some system tables)
      - --upgrade=FORCE
  - Eliminates issues with metadata using transactional data dictionary
  - Repeat above for minimum of 2 slaves and promote one as master
MySQL 8.0 Upgrade

```
MySQL localhost:33060+ ssl SQL > show global variables like "innodb_fast_shutdown";
+----------------------|-------+
| Variable_name         | Value |
+----------------------|-------+
| innodb_fast_shutdown  | 1     |
+----------------------|-------+
1 row in set (0.0037 sec)

MySQL localhost:33060+ ssl SQL > set global innodb_fast_shutdown=0;
Query OK, 0 rows affected (0.0007 sec)

MySQL localhost:33060+ ssl SQL > show global variables like "innodb_fast_shutdown";
+----------------------|-------+
| Variable_name         | Value |
+----------------------|-------+
| innodb_fast_shutdown  | 0     |
+----------------------|-------+
1 row in set (0.0054 sec)
```
# MySQL 8.0 Packages

<table>
<thead>
<tr>
<th>Package</th>
<th>Contains</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>percona-server-server</code></td>
<td>The server itself (the <code>mysqld</code> binary)</td>
</tr>
<tr>
<td><code>percona-server-debuginfo</code></td>
<td>Debug symbols for the server</td>
</tr>
<tr>
<td><code>percona-server-client</code></td>
<td>The command line client</td>
</tr>
<tr>
<td><code>percona-server-devel</code></td>
<td>The header files needed to compile software using the client library.</td>
</tr>
<tr>
<td><code>percona-server-shared</code></td>
<td>The client shared library.</td>
</tr>
<tr>
<td><code>percona-server-shared-compat</code></td>
<td>Shared libraries for software compiled against old versions of the client library. The following libraries are included in this package: <code>libmysqlclient.so.12</code>, <code>libmysqlclient.so.14</code>, <code>libmysqlclient.so.15</code>, <code>libmysqlclient.so.16</code>, and <code>libmysqlclient.so.18</code>.</td>
</tr>
<tr>
<td><code>percona-server-test</code></td>
<td>package includes the test suite for <em>Percona Server for MySQL</em>.</td>
</tr>
</tbody>
</table>
Percona Server for MySQL 8.0

yum Installation - Repo

Install the Percona repository

You can install Percona yum repository by running the following command as a root user or with sudo:

$ sudo yum install https://repo.percona.com/yum/percona-release-latest.noarch.rpm

You should see some output such as the following:

Preparing...                          ########################################### [100%]
1:percona-release                    ########################################### [100%]

Enable the repository:

$ sudo percona-release setup ps80

Install the packages

You can now install Percona Server for MySQL by running:

$ sudo yum install percona-server-server
Percona Server for MySQL 8.0

**yum** Installation - Yum

Installed:

* percona-server-server.x86_64 0:8.0.15-6.1.el7

Dependency Installed:

percona-server-client.x86_64 0:8.0.15-6.1.el7
percona-server-shared-compat.x86_64 0:8.0.15-6.1.el7
percona-server-shared.x86_64 0:8.0.15-6.1.el7

Complete!
Percona Server for MySQL 8.0

**yum** Installation - Connectivity

MySQL localhost:33060+ ssl SQL > \ls
MySQL Shell version 8.0.16

Session type:       X
Connection Id:     16
Default schema:    
Current schema:    
Current user:      root@localhost
SSL:               Cipher in use: ECDHE-RSA-AES128-GCM-SHA256 TLSv1.2
Using delimiter:   ;
Server version:    8.0.15-6 Percona Server (GPL), Release 6, Revision 63abd08
Protocol version:  X protocol
Client library:    8.0.16
Connection:        localhost via TCP/IP
TCP port:          33060
Server charset:    utf8mb4
Schema charset:    utf8mb4
Client charset:    utf8mb4
Conn. charset:     utf8mb4
Uptime:            2 min 26.0000 sec
Percona Server for MySQL 8.0
yum Installation - Errorlog

2019-06-18T14:11:42.790252Z 0 [System] [MY-010116] [Server] /usr/lib64/mysqlld (mysqld 8.0.15-6) starting as process 29198
2019-06-18T14:11:47.731582Z 0 [ERROR] [MY-013180] [Server] Function 'mysqlx' already exists.
2019-06-18T14:11:47.731590Z 0 [Warning] [MY-010736] [Server] Couldn't load plugin named 'mysqlx' with soname 'mysqlx.so'.
2019-06-18T14:11:47.738319Z 0 [Warning] [MY-013129] [Server] A message intended for a client cannot be sent there as no client-session is attached. Therefore, we're sending the information to the error-log instead: MY-001287 - 'validate password plugin' is deprecated and will be removed in a future release. Please use validate_password component instead.
2019-06-18T14:11:49.700555Z 0 [Warning] [MY-010068] [Server] CA certificate ca.pem is self signed.
2019-06-18T14:11:49.709724Z 0 [ERROR] [MY-013129] [Server] A message intended for a client cannot be sent there as no client-session is attached. Therefore, we're sending the information to the error-log instead: MY-001146 - Table 'mysql.component' doesn't exist.
2019-06-18T14:11:49.709743Z 0 [Warning] [MY-013129] [Server] A message intended for a client cannot be sent there as no client-session is attached. Therefore, we're sending the information to the error-log instead: MY-003543 - The mysql.component table is missing or has an incorrect definition.
2019-06-18T14:11:49.719544Z 0 [Warning] [MY-010929] [Server] Storage engine 'MyISAM' does not support system tables. [mysql.user].
2019-06-18T14:11:49.719552Z 0 [Warning] [MY-010929] [Server] Storage engine 'MyISAM' does not support system tables. [mysql.db].
2019-06-18T14:11:49.719561Z 0 [Warning] [MY-010929] [Server] Storage engine 'MyISAM' does not support system tables. [mysql.tables_priv].
2019-06-18T14:11:49.719568Z 0 [Warning] [MY-010929] [Server] Storage engine 'MyISAM' does not support system tables. [mysql.columns_priv].
2019-06-18T14:11:49.719576Z 0 [Warning] [MY-010929] [Server] Storage engine 'MyISAM' does not support system tables. [mysql.procs_priv].
2019-06-18T14:11:49.719873Z 0 [Warning] [MY-010929] [Server] Storage engine 'MyISAM' does not support system tables. [mysql.proxies_priv].
2019-06-18T14:11:49.720019Z [ERROR] [MY-013143] [Server] Column count of mysql.user is wrong. Expected 51, found 45. The table is probably corrupted.
2019-06-18T14:11:49.720107Z [Warning] [MY-010966] [Server] ACL table mysql.role_edges missing. Some operations may fail.
2019-06-18T14:11:49.720125Z [Warning] [MY-010966] [Server] ACL table mysql.default_roles missing. Some operations may fail.
2019-06-18T14:11:49.720135Z [Warning] [MY-010966] [Server] ACL table mysql.global_grants missing. Some operations may fail.
2019-06-18T14:11:49.720143Z [Warning] [MY-010966] [Server] ACL table mysql.password_history missing. Some operations may fail.
2019-06-18T14:11:49.721700Z [ERROR] [MY-010965] [Server] Missing system table mysql.global_grants; please run mysql_upgrade to create it.
2019-06-18T14:11:49.727806Z [Warning] [MY-010727] [Server] System table 'func' is expected to be transactional.
2019-06-18T14:11:49.729690Z [Warning] [MY-010405] [RepI] Info table is not ready to be used. Table 'mysql slave_master_info' cannot be opened.
2019-06-18T14:11:49.7296962Z [ERROR] [MY-010422] [RepI] Error in checking mysql slave_master_info repository info type of TABLE.
2019-06-18T14:11:49.729716Z [ERROR] [MY-010426] [RepI] Slave: Failed to initialize the master info structure for channel "", its record may still be present in 'mysql slave_master_info' table, consider deleting it.
2019-06-18T14:11:49.729735Z [ERROR] [MY-010529] [RepI] Failed to create or recover replication info repositories.
Run mysql_upgrade (8.0.15-6)

[root@localhost ~]# screen -r download_airline

Checking server version.
Running queries to upgrade MySQL server.
Upgrading system table data.
Checking system database.

mysql.default_roles OK
mysql.engine_cost OK
...

Found outdated sys schema version 1.5.1.
Upgrading the sys schema.
Checking databases.

airline.ontime OK
sys.sys_config OK

Upgrade process completed successfully.
Checking if update is needed.
Best Practices

- Upgrade slaves first
- Beware of optimizer changes
- Watch default values
- Pay attention to reserve words
- Inspect character sets, file types
- Prepare tooling, backups and monitoring in advance
- Plan your rollback scenarios
Latest News on MySQL 8.0.X

Minor versions aren’t minor anymore
MySQL 8.0.16

• 8.0.0 to 8.0.5 Several Bugs Fixed
• 8.0.11 Deprecates uft8mb3
• 8.0.12 Improves performance_schema defaults
• 8.0.13 Major deprecations InnoDB, Partitioning
• 8.0.14 Dual passwords, Lateral Derived Tables, Parallel Read of Index, GR Consistency Levels
• 8.0.15 Bugs Fixed
  • InnoDB: After a checkpoint operation persisted modifications to data dictionary metadata, there was potential for new metadata changes to be lost under certain circumstances. (Bug #29120297)
  • Group Replication was unable to function in the 8.0.14 release of MySQL Server if IPv6 support was disabled at the operating system level, even if the replication group did not use any IPv6 addresses. The issue is fixed by this release of MySQL Server, 8.0.15. (Bug #29249542, Bug #94004)
  • If MySQL was running on the host system and within Docker, it was not possible to update or remove MySQL on the host system. (Bug #28244773, Bug #91405)
• 8.0.16 Account-management capabilities, deprecation of mysql_upgrade, Check Constraints, GR Auto Re-Join
• 8.0.17 Clone Plugin, JSON Array Indexes and Schema
• 8.0.18 Hash Join, Explain Analyze
Percona Server for MySQL 8.0.16-7

- Faster and more consistently run queries
- Enhanced security with binary log (binlog) encryption and data-at-rest encryption
- MyRocks, TokuDB Storage Engines
- InnoDB Full-Text Search Improvements
- Extra Hash/Digest Functions
- Improved diagnostics with instrumentation and troubleshooting features
Join in: Percona Community

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- Join in with our community forums percona.com/forums
- Contribute to our open source projects

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Description
In this hands-on tutorial, you’ll learn how to leverage the unique features of Amazon Aurora to build faster, more scalable database applications optimized for the cloud. We discuss architectural best practices and features designed to help you develop applications faster and reach the widest possible audience, including Aurora Serverless, read replica auto scaling, cross-region replicas, backtracking, fast database cloning, and Performance Insights. You’ll understand how to best take advantage of the Aurora platform’s capabilities to effectively accelerate application development.
We’re Hiring!

Percona’s open source database experts are true superheroes, improving database performance for customers across the globe.

Our staff live in nearly 30 different countries around the world, and most work remotely from home.

Discover what it means to have a Percona career with the smartest people in the database performance industries, solving the most challenging problems our customers come across.
References and Links

- Automatic Upgrade and New Error Logging in MySQL 8.0
- MySQL Shell - A DevOps-engineer day with MySQL’s development and administration tool
- Upgrading to MySQL 8.0? Here is what you need to know…
- Changes in MySQL 8.0
- The complete list of new features in MySQL 8.0
- Reducing Risk When Upgrading MySQL
- Changes in MySQL 8.0
- MySQL 8.0.16: mysql_upgrade is going away
Credits

- @lefred for answering my numerous questions
- My team at Percona helping review this presentation
Thank You