MySQL Replication Update
MySQL 5.5 (GA) & MySQL 5.6.2 (Dev. Milestone)

Lars Thalmann
Development Director
MySQL Replication, Backup & Connectors

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MySQL Releases

- **MySQL 5.1** - Generally Available, November 2008
- **MySQL 5.5** - Generally Available, December 2010
- **MySQL 5.6.2** - Development Milestone Release, April 2011
What is MySQL Replication?
MySQL Replication

Asynchronous replication for maximum performance
MySQL Replication Architecture
Statement-based replication

MySQL Server

Application

 Parse/optimise/execute

 InnoDB

 NDB

 Binlog

Rows

Storage engine interface

Storage Engines

Replication

Statements flushed at commit (DML+DDL)

Application

MySQL Server

Application

I/O thread

SQL thread

Relay Binlog

InnoDB

NDB

Binlog

Storage Engines
MySQL Replication Architecture
MySQL 5.1: Row-based replication
MySQL 5.5 (GA)
MySQL Replication users wanted

High Availability Enhancements
● Be sure that slave has received the updates from master
● Tune replication for maximum performance or safeness
● Get a crashed slave to automatically recover the relay log
● Immediately detect if replication is not working

Flexibility Enhancements
● Filter events from particular servers
● Flush logs independently
● Correctly convert data when master/slave use different data types

This is included in MySQL 5.5
MySQL 5.5 Replication Features

1. **Semisynchronous replication**
   Improved resilience by having master wait for slave to persist events.

2. **Slave fsync tuning & Automatic relay log recovery**
   Tune fsyncs so corruption is less likely on slave crashes.
   Let the slave recover from corrupted relay logs.

3. **Replication Heartbeat**
   Have a more precise failure detection mechanism.
   Avoid spurious relay log rotation when the master is idle.

4. **Per server replication filtering**
   Instruct slave to discard events from a master with a specific server id

5. **Precise Slave Type Conversions**
   Use different types on master and slave
   Get automatic type promotion and demotion when using RBR

6. **Individual Log Flushing**
   Selectively flush server logs when using 'FLUSH LOGS'
1. Semisynchronous Replication

Originally developed by Mark Callaghan and Wei Li, Google Modularized, tested, and bug fixed by Zhenxing He, MySQL

Available as two separate loadable components for the master and the slave
Slave acknowledge relay logging each transaction
1. Semisynchronous Replication

![Diagram of MySQL Semi-synchronous Replication]

- Write to binary log
- Write to relay log
- Write to binary log
- Begin
- Commit

- T - transaction
- t - time

- Applier - SQL thread
- Distribution - Dump threads
- Execution - Session Thread
- Collector - IO Thread

MySQL Semi-synchronous Replication
2. Slave fsync tuning

Three new variables: \texttt{sync\_relay\_log\_info}, \texttt{sync\_master\_info}, \texttt{sync\_relay\_log} for fsync of replication meta data and log.

\texttt{sync\_relay\_log\_info}
Synchronize relay-log.info file to disk after that many transactions

\texttt{sync\_master\_info}
Slave synchronize master info after that many events.

\texttt{sync\_relay\_log}
Slave synchronizes the relay after this many events.
2. Automatic Relay Log Recovery

relay_log_recovery = 1
On restart, slave discards all unprocessed relay logs (and retrieves them from master).
This can be used after a slave crash to ensure that potentially corrupted relay logs are not processed.
The default value is 0 (disabled).
Automatic checking of connection status
No more relay log rotates when the master is idle
Detection of master/slave disconnect configurable in millisecs

CHANGE MASTER SET master_heartbeat_period= val;
SHOW STATUS like 'slave_heartbeat period'
SHOW STATUS like 'slave_received_heartbeats'
4. Per server replication filtering

If server A is removed from the circle, server B can be set to terminate A's events in the new circle

Server B> CHANGE MASTER TO MASTER_HOST=D ... IGNORE_SERVER_IDS=(A)
5. Precise Slave Type Conversions

• Example, MySQL 5.5 row-based
  SLAVE_TYPE_CONVERSIONS = 'ALL_LOSSY':
    master> CREATE TABLE foo (a INT);
    slave> CREATE TABLE foo (a TINYINT);
    master> INSERT INTO foo VALUES (1);
    slave> <<<success>>>

Example, MySQL 5.5 row-based
  SLAVE_TYPE_CONVERSIONS = '':
    master> CREATE TABLE foo (a INT);
    slave> CREATE TABLE foo (a TINYINT);
    master> INSERT INTO foo VALUES (1);
    slave> <<<error>>>
6. Individual log flushing

Flush of individual logs:

```
FLUSH <log_type> LOGS;
```

Examples:
```
FLUSH ERROR LOGS, RELAY LOGS;
FLUSH BINARY LOGS, ENGINE LOGS, SLOW LOGS;
```

Log types supported:

- **SLOW** - close & reopen the slow query log file.
- **ERROR** - close & reopen the error log file.
- **BINARY** - close & reopen the binary log files.
- **ENGINE** - close & reopen any flushable logs for installed storage engines
- **GENERAL** - close & reopen the general query log file
- **RELAY** - close & reopen the relay log files
MySQL 5.6.2 (Development Milestone)
MySQL 5.6.2 Development Milestone Replication Features

1. Crash-safe slave – replication info tables
2. Crash-safe master – binary log recovery
3. Replication event checksums
4. Time delayed replication
5. Optimized row-based logging
6. Informational log events
7. Remote backup of binary logs
8. Server UUIDs – Replication topology detection
1. Crash-safe slave - Slave Info Tables

- Protection against slave crashes
  - Automatic recovery
  - Engine agnostic
- Possibility to do SELECT of slave information
  - Possibility to code multi-source replication in pure SQL
- Automatic conversion between files and tables on startup
1. Crash-safe slave - Slave Info Tables

- System tables:
  - slave_master_info (master.info)
  - slave_relay_log_info (relay-log.info)

- Positional info transactionally stored with the data in tables
2. Crash-safe master

• Server can cope with binary log corruption in the event of a crash

• On restart
  – The active binary log is scanned and any log corruption is detected
  – Invalid portion of the binary log file is discarded and the file is trimmed
3. Replication Events Checksums

1. Create checksum in session thread
2. Check in dump thread
3. Check when reading from network
4. Create before writing to Relay Log (if there is none)
5. Check when reading Relay Log
3. Replication Events Checksums

- Algorithm: CRC32. CRC appended at end of event:

<table>
<thead>
<tr>
<th>Common Header</th>
<th>Sub Header</th>
<th>Payload</th>
<th>CRC</th>
</tr>
</thead>
</table>

- New configuration options:
  - `--binlog-checksum = NONE,CRC32` (default: NONE)
  - `--master-verify-checksum=0,1` (default: 0)
  - `--slave-sql-verify-checksum=0,1` (default: 1)
4. Time-Delayed Replication

- Make replication slave lag behind the master
  - Protects against user mistakes
  - Test how lagging affects replication
- Slave waits a given number of seconds before applying the changes
  - Delays configured per slave
  - Implemented in the SQL thread layer
5. Row-based optimized logging

• Server dynamically choose which columns to log for DELETE, UPDATE and INSERT row events:
  – **Minimal** – Primary key for BI and changed columns for AI
  – **Noblob** – No blobs columns when not needed
  – **Full** – All columns always
5. Row-based optimized logging

- **Update t1**: 
  - SET c1=2, c2='b' WHERE c1=1
  - BI

- **Delete from t1**: 
  - WHERE c1=1
  - BI

- **Insert into t1(c1,c2)**
  - VALUES (1, 'a')

  - BI

- **Update t1**: 
  - SET c1=2, c2='b' WHERE c1=1
  - BI

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  - BI

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  - VALUES (1, 'a')

  - BI
6. Informational Log Events

• Logs the query that originated the subsequent rows changes
• Shows up in mysqlbinlog and SHOW SLAVE STATUS output
• New option:
  --binlog-rows-query-log-events= ON|OFF
• New server variable:
  --binlog_rows_query_log_events= ON|OFF
7. Remote Binary Log Backup

- `mysqlbinlog` can now retrieve and dump a remote MySQL binary log
- No need for remote login to retrieve master's binary logs, e.g. to setup a slave (no need for SSH access to MySQL host machine)
8. Server UUIDs

• Servers generate their own UUIDs and include them in the replication setup handshake protocol
• The UUIDs are exposed to the end user, enabling automatic tools, such as MySQL Enterprise Monitor, able to easily and reliably:
  • Replication topology auto-discovery
  • Topology reconfiguration auto-discovery, e.g. during fail-overs
labs.mysql.com
Multi-Threaded Slave

• Increased slave performance
• Workload applied in parallel:
  • Changes to each database are applied and committed independently
  • Automatic (serialized) recovery at restart
• Download from labs.mysql.com
Progress and Planning
Progress: Priority 1

1. Options for writing full or partial row images in RBR
   Optimize for performance, disk size, or functionality

2. Replication-level checksums
   Detect transmission or disk corruptions

3. Transactional replication information
   Automatically recover from a slave crash

4. Informational events
   Original statement for RBR, User and IP of statement executor, engine-dependent information

5. Time-delayed replication
   Protect against user mistakes

6. Server UUIDs
   Unique server ids making it easier to analyze replication topologies

7. Remote backup of binary logs using mysqlbinlog tool
   Retrieve the binary log from master

8. Enhancements to Oracle Golden Gate Replication
   Use Golden Gate to replicate MySQL to/from Oracle DBMS and other systems
Progress: Priority 1

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7. **Remote backup of binary logs using `mysqlbinlog` tool** *MySQL 5.6*
   Retrieve the binary log from master

8. **Enhancements to Oracle Golden Gate Replication** *Golden Gate works with MySQL*
   Use Golden Gate to replicate MySQL to/from Oracle DBMS and other systems
9. Multi-threaded slave for better performance labs.mysql.com
   Faster slave since different threads apply different databases

10. Performance schema for replication state
    Possible to use queries instead of SHOW commands to read the state

11. Preallocated binlog files
    Improved performance by not having to append to files

12. Group commit for the binary log (and some other scalability enhancements)
    Improved performance by commit multiple transactions in one go

13. Modular replication
    Use different replication modules to replicate to/from a MySQL server

14. Scriptable replication
    Write your own plugin (e.g. replication filtering on data or statement type,
    extraction of data, pre-heating of caches)

15. High resolution replication delay measurement
    IO and SQL delay separately measured in milliseconds

16. Universal Transaction ID (a.k.a. Global Transaction ID, Transactional Replication)
    Identifiers enabling easy master failover
Other Developments
MySQL Workbench Utilities

- Easy-to-use command line solutions for administration and maintenance
  - Part of MySQL Workbench 5.2.31
  - Written in Python
  - Easily to extend using the supplied library

- How to get it
  - Download MySQL Workbench
    http://www.mysql.com/downloads/workbench/
  - Get the source
    https://launchpad/net/mysql-utilities
MySQL Enterprise Backup 3.5

- History and Progress tables
- Fully aligned with MySQL server development testing
- Easier installation out of box for all supported platforms
  (No Perl installation required)
- Optimized and reorganized internal code rewritten in C/C++
  (mysqlbackup)
- Fewer processes (No MySQL client process required)
- Improved error reporting
Tips

• MySQL High Availability
  Bell, Kindahl & Thalmann
  O'Reilly Media, July 2010

• MySQL Support
  www.mysql.com/contact

• Book Signing, 12 Apr 3:50pm, O'Reilly booth in Expo hall
• MySQL Replication BOF, 13 Apr 6:00pm

Lars Thalmann
Development Director, MySQL Replication, Backup & Connectors
lars.thalmann@oracle.com
www.larsthalmann.com
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