Standard Replication & Galera Cluster

Codership Training

Introduction

Standard Replication & Galera Cluster

Introductions

Codership Oy

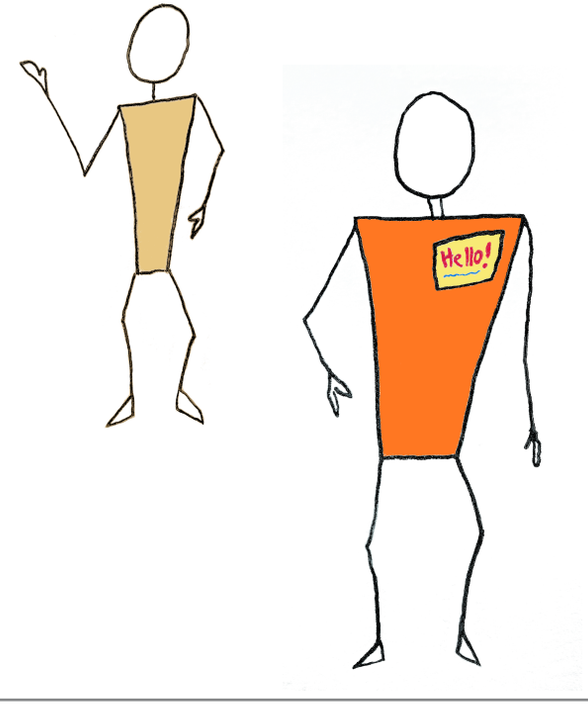
- Creators & Developers of Galera Cluster
- Employees in Multiple Countries

Galera Cluster

- Released Initially in May 2007
- Over 1.5 Million Downloads

Russell Dyer, Presenter

- KB Editor, Documentation, Instructor
  (MySQL, MariaDB)
- Writer (O'Reilly Books)



Tutorial Outline

Standard Replication

- Purpose & Advantages
- Standard Replication Layout
- Configuring Replication

Galera Cluster

- Galera Basics
- Configuring Galera
- Deploying a Cluster

Purpose & Advantages of Replication

Standard Replication & Galera Cluster

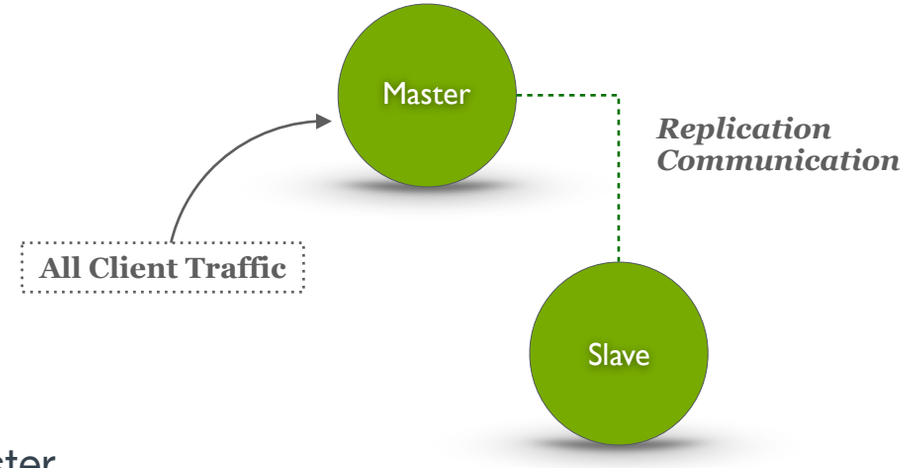
Standard Replication for Maintenance

Back-Ups

- Continuous — Never Old; Always Current
- Without Locking Tables — No Performance Drain

Upgrades & Schema Changes

- Set Slave to Read-Only
- Make Slave Master
- Redirect Traffic away from Master to Slave — New Master
- Apply Changes to Original Master
- Redirect Traffic back to Master



MySQL Replication: https://dev.mysql.com/doc/refman/en/replication.html
MariaDB Replication: https://mariadb.com/kb/en/library/high-availability-performance-tuning-mariadb-replication/

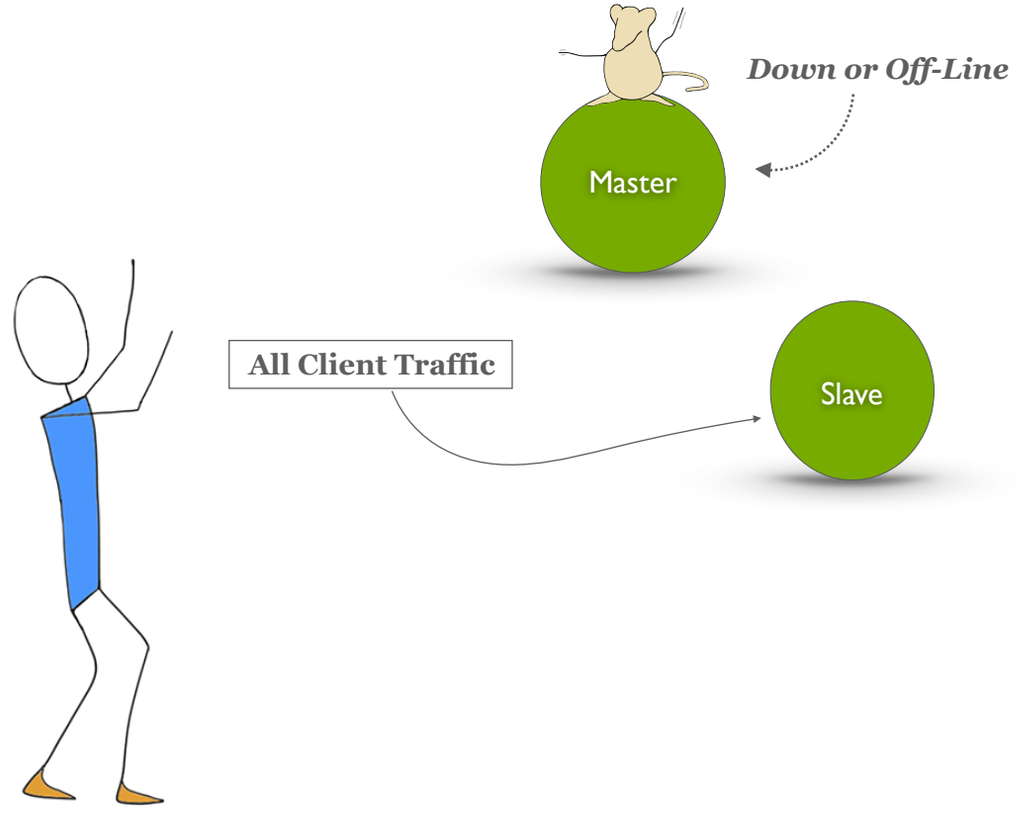
Standard Replication for High Availability

Master Fails

- Network Outage
- Physical Problems

Swappable Database Servers

- Redirect Traffic to Slave



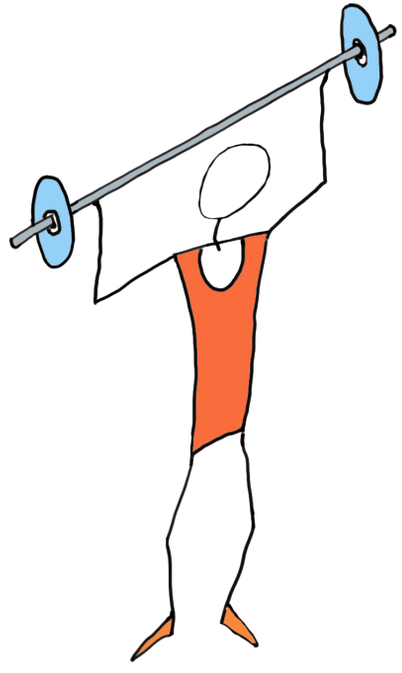
Replication for Load Balancing

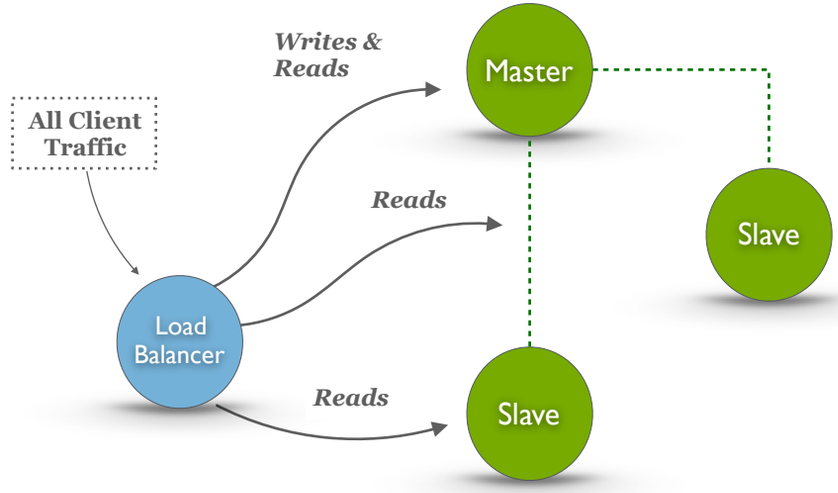
Distribute Read Traffic

- Move Slow, Heavy Queries to Slave

Redirect for Maintenance

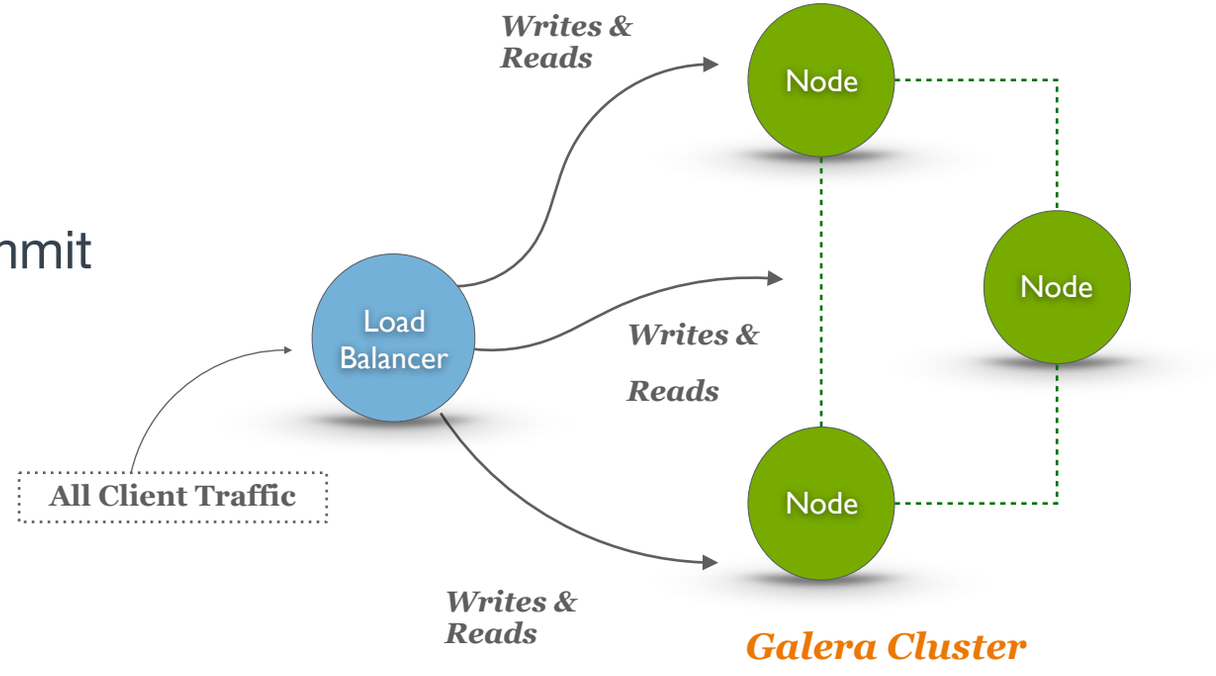
- Take Slave Off-Line to for Back-ups
- Direct away from Failed Servers
- Redirect Traffic while Upgrading





Enhanced Replication with Galera Cluster

- Multiple Masters
- Transactional Writes
  - Conflict Detection & Resolution upon Commit
- Seamlessly Remove & Add Servers
  - Nodes Isolated Easily
  - Automatic Provisioning



Galera Load Balancer: https://galeracluster.com/library/documentation/glb.html

Standard Replication Layout

Standard Replication & Galera Cluster

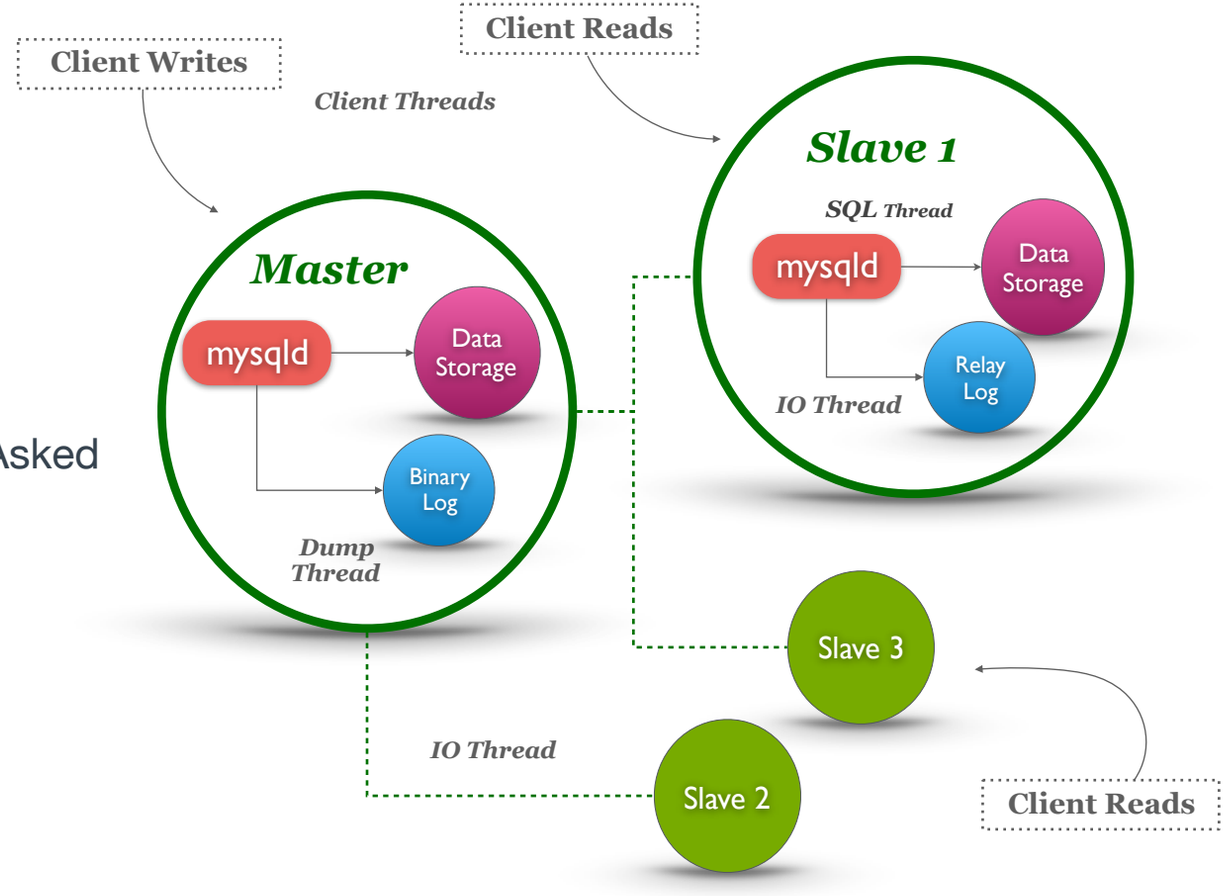
Basic Replication Elements & Process

Master

- Handles Client Writes — Possibly Also Reads
- Daemon Sends Writes to Storage Engines
- Write Queries Recorded in Binary Log
- Sends Binary Log Entries to Slave — When Asked

Slaves

- Handles Only Client Reads
- Queries Master for Binary Log Entries
- Writes to Storage Engines and Relay Log

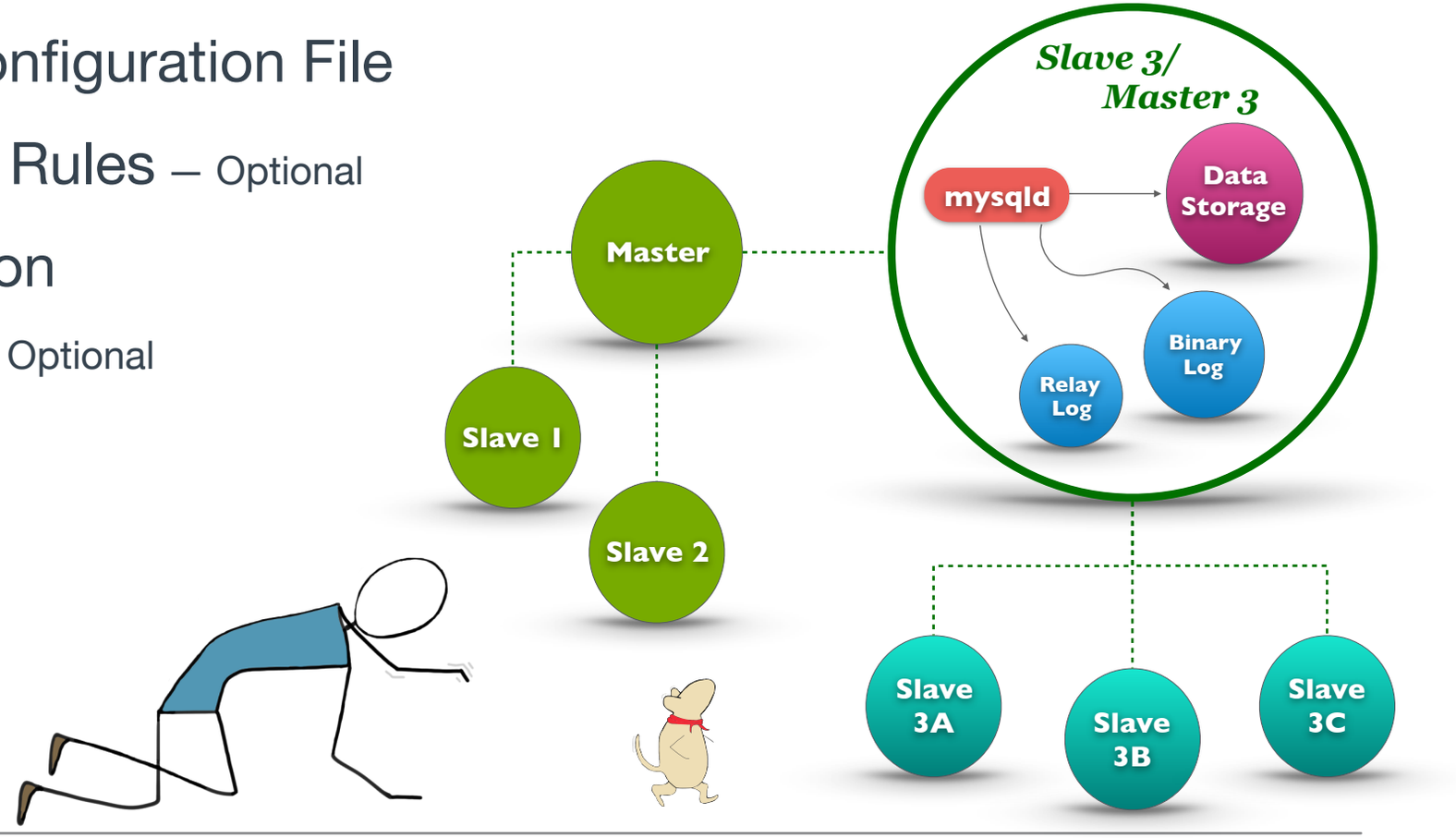


Slave Master

Set `log_slave_updates` in Configuration File

Add Replication Filtering Rules – Optional

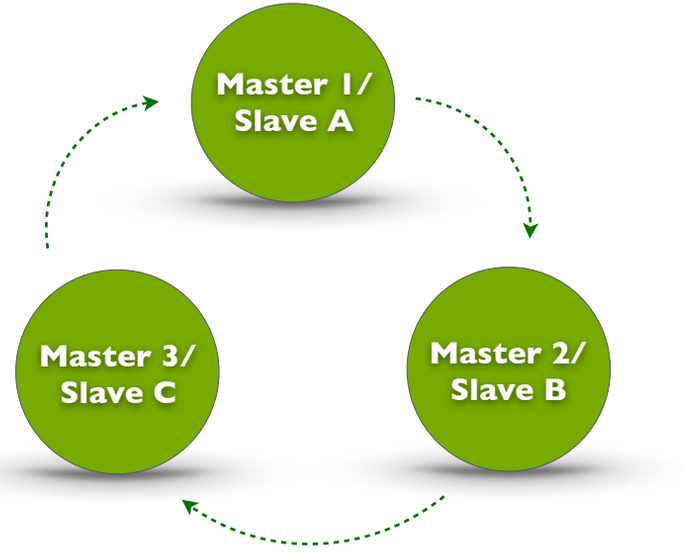
Change Storage Engine on Intermediate Slaves – Optional

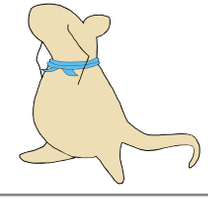


Circular Replication

- Multiple Masters for Load Balancing
  - Writes — No True Multi-Master
- Circular Replication Simulates Multi-Masters
  - Each Slave is Master to Another
  - Requires Binary Log on Each Slave
  - Set **`log_slave_updates`** Option

Circular Replication





Circular Replication: https://blogs.oracle.com/jsmyth/circular-replication-in-mysql

Asynchronous

- Master Doesn't Wait for Slaves
- IO Thread may Slow to Receive Binary Log Packets
  - Network Congestion or Disconnects
- SQL Thread may Slow in Processing Relay Log
  - Load on Slave or Network Problems

Semi-Synchronous Replication Mode

- Implemented with an optional Plug-In
- Master waits for a Slave to Acknowledge Receipt
  - Slave waits to Write to Relay Log — Not to Execute
  - Only One Slave Response Needed
- Can Affect Significantly Performance of Master

```
INSTALL PLUGIN rpl_semi_sync_master
SONAME 'semisync_master.so';

INSTALL PLUGIN rpl_semi_sync_slave
SONAME 'semisync_slave.so';
```

Executed from **`mysql`** Client

MariaDB Semi-Synchronous Replication: https://mariadb.com/kb/en/mariadb/semisynchronous-replication/
MySQL Semi-Synchronous Replication: https://dev.mysql.com/doc/internals/en/semi-sync-replication.html

Parallel Replication

Replication Process on Slaves

- Events Received from Master (IO Thread) and Queued in Relay Log
- Each Relay Log Entry is Retrieved by SQL Thread
- Each Transaction is *Applied* to Slave

Application Performed in Pool of Separate Worker Threads – Not Sequentially by SQL Thread

Parallel Replication: https://mariadb.com/kb/en/mariadb/documentation/replication/standard-replication/parallel-replication/

Configuring Standard Replication

Standard Replication & Galera Cluster

GALERA CLUSTER

Master Configuration

Enable Binary Log with `log-bin`

Set `server-id` to Unique Value

Create Replication User Account on Master

Make a Consistent Snapshot of Data on Master

```
[mysqld]
datadir=/var/lib/mysql
socket=/var/lib/mysql/mysql.sock
user=mysql
server-id = 1
log-bin
log-error=/var/log/mysqld.log
```

Excerpt from Database Configuration File

```
GRANT REPLICATION SLAVE ON *.*
TO 'replicator'@'34.211.1.12'
IDENTIFIED BY 'rover123';
```

Executed from **mysql** Client

```
mysqldump -p -u root  \
    --master-data --flush-logs \
    --all-databases > full-dump.sql
```

Executed from Command-Line

MySQL Master Configuration: https://dev.mysql.com/doc/refman/en/replication-howto-masterbaseconfig.html

Replication Threads

Master Dump Thread

- Sends Binary Log Entries to Slave

Slave IO Thread

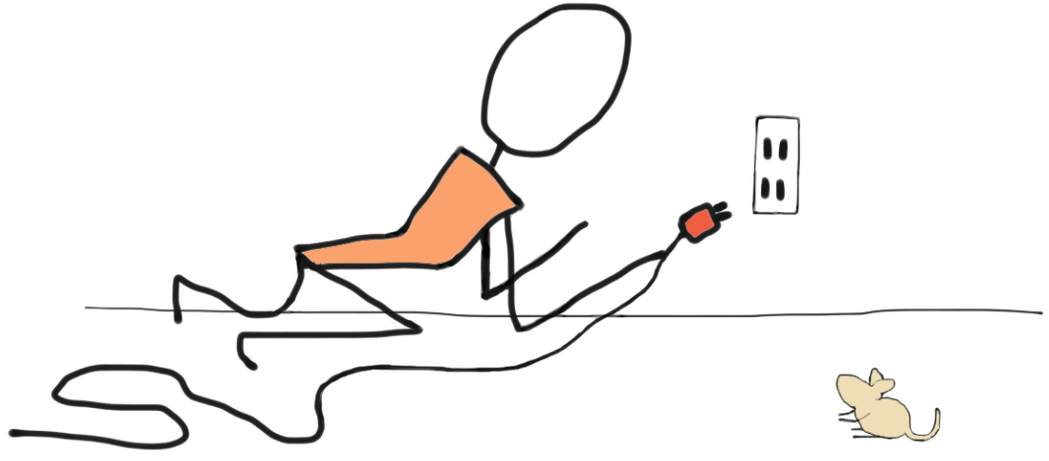
- Requests and Receives Master Binary Log Entries
- Writes Entries to its Relay Log

Slave SQL Thread

- Reads Relay Log & Executes Queries Locally
- Checks Query Result Codes Match Master

Multiple Execution Threads on Slave

- Separates Entries by Database
- Updates Applied in Parallel – Not Sequence



MySQL Replication Threads https://dev.mysql.com/doc/refman/en/replication-implementation-details.html

Replication Files

Master Binary Log Files

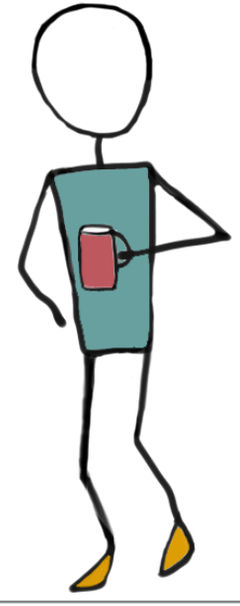
- Master Records Write to File
- Rotated when Flushed or Periodically to New Log File

Slave Relay Log File

- Log of Master Binary Log Entries
- Rotated Periodically or when Flushed

Replication Configuration Stored in **`master.info`** (Slave)

Name of Relay Log File in **`relay-log.info`** (Slave)



MySQL Binary Log: https://dev.mysql.com/doc/refman/8.0/en/binary-log.html
MariaDB Binary Log: https://mariadb.com/kb/en/library/binary-log/

Slave Configuration

Configuration File

- Set `server-id` to Unique Value
- Add `read-only` on to Prevent Writes
- Restart **`mysqld`**

Load Data from Master

Execute **`CHANGE MASTER`** Statement

Execute `START SLAVE` on Slave

```
[mysqld]
...
server-id = 2
read-only
```

Excerpt from Database Configuration File

```
mysql -p -u root < full-dump.sql
```

Executed from Command-Line

```
CHANGE MASTER TO
MASTER_HOST='172.31.31.202',
MASTER_PORT=3306,
MASTER_USER='replicator',
MASTER_PASSWORD='rover123';
```

Executed from **`mysql`** Client

```
START SLAVE;
```

Executed from **`mysql`** Client

MySQL Slave Options: https://dev.mysql.com/doc/refman/5.7/en/replication-options-slave.html
MariaDB Slave Options: https://mariadb.com/kb/en/mariadb/replication-and-binary-log-server-system-variables/
MySQL **`CHANGE MASTER TO`**: https://dev.mysql.com/doc/refman/5.5/en/change-master-to.html
MariaDB **`CHANGE MASTER TO`**: https://mariadb.com/kb/en/mariadb/change-master-to/

Configuring & Starting Replication

Monitoring Replication

Check Regularly Status on Master

Includes Current Binary Log File Name & Position

Check More Often Status of Replication on Slave

```
SHOW MASTER STATUS;
```

Executed from **mysql** Client on Master

```
SHOW SLAVE STATUS \G

Slave_IO_State:
Waiting for master to send
event
Slave_IO_Running: Yes
Slave_SQL_Running:  Yes
Last_Errno: 0
Last_Error:
Seconds_Behind_Master: 0
```

Executed from **mysql** Client on Slave

MySQL **SHOW MASTER STATUS**: https://dev.mysql.com/doc/refman/8.0/en/show-master-status.html
MariaDB **SHOW MASTER STATUS**: https://mariadb.com/kb/en/show-master-status/
MySQL **SHOW SLAVE STATUS**: https://dev.mysql.com/doc/refman/8.0/en/show-slave-status.html
MariaDB **SHOW SLAVE STATUS**: https://mariadb.com/kb/en/mariadb/show-slave-status/

Troubleshooting Replication

Check Slave Error Log for Replication Entries

- Network Disconnects
- Binary or Relay Log Event Corruption — Stops Slave SQL Thread
- Different Error Codes indicates Not Synchronized

Rebuild Slave from a Fresh Snapshot

Galera Cluster Basics

Standard Replication & Galera Cluster

Galera Cluster Features

Virtual Synchronous Replication

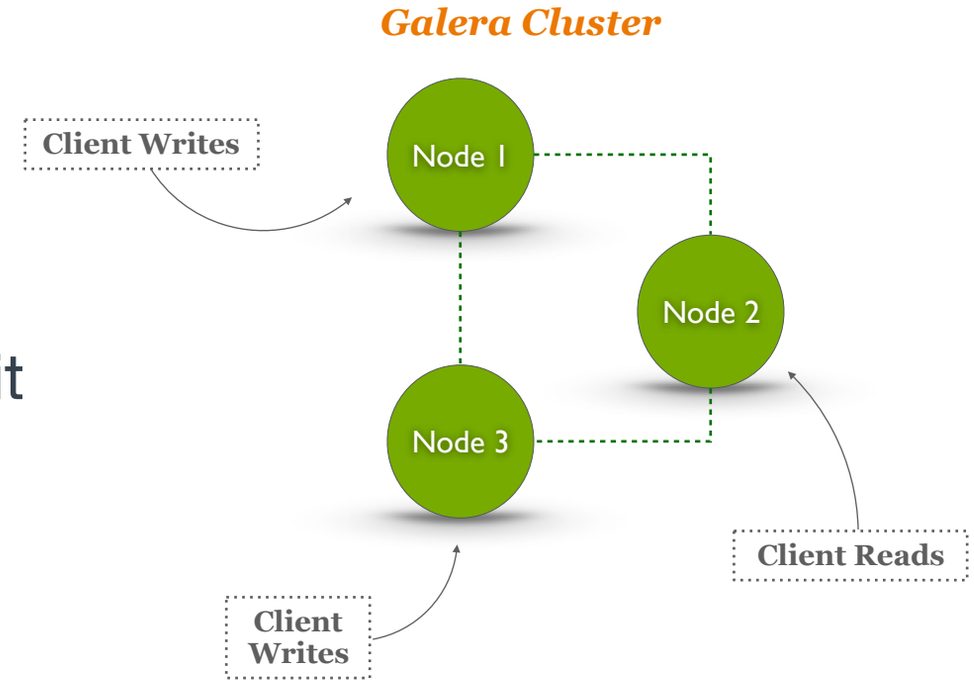
True Multi-Master Solution

Almost No Slave Lag

Conflict Detection & Resolution on Commit

Easy Maintenance

- Automatic Provisioning
- Node Isolation
- Rolling Upgrades



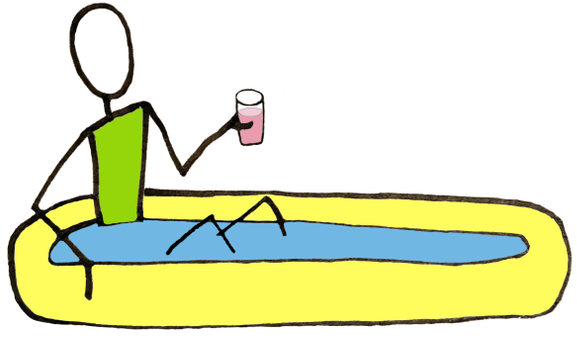
Data Centric

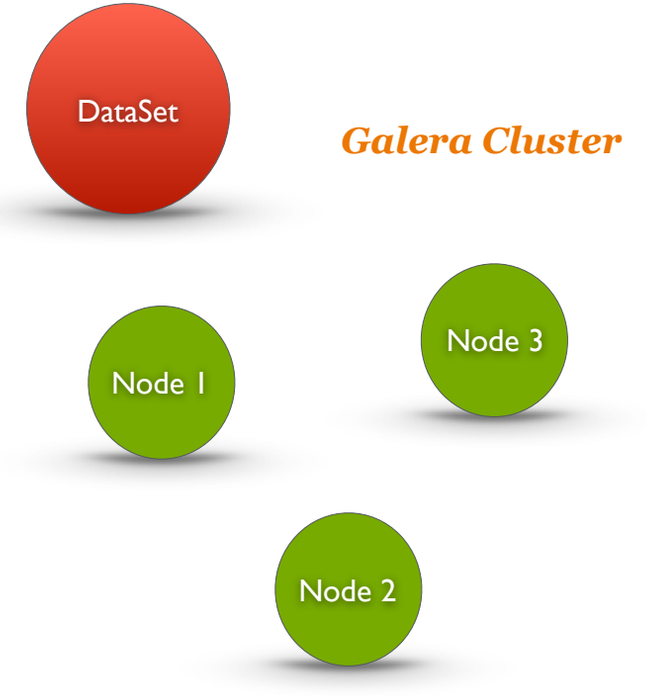
Data Doesn't Belong to a Node — Nodes Belong to Data

Data is Synchronized among Multiple Nodes

Galera Nodes are Anonymous — All are Equal

Galera Cluster is a Distributed Master





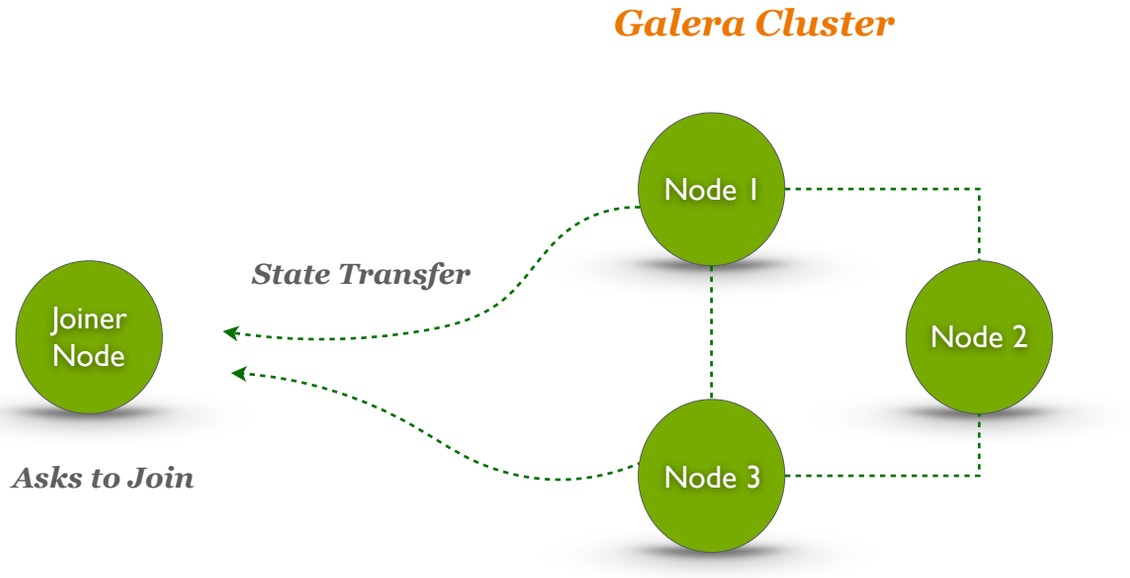
Node Provisioning Tool

State Transfers for New Nodes

- State Snapshot Transfer (SST)
- Incremental State Transfers (IST)

Methods for State Transfers

- Logical — **`mysqldump`**
- Physical — **`rsync`**



Galera Node Provisioning: https://galeracluster.com/library/documentation/node-provisioning.html
Galera State Transfers: https://galeracluster.com/library/documentation/state-transfer.html

Configuring Galera Cluster

Standard Replication & Galera Cluster

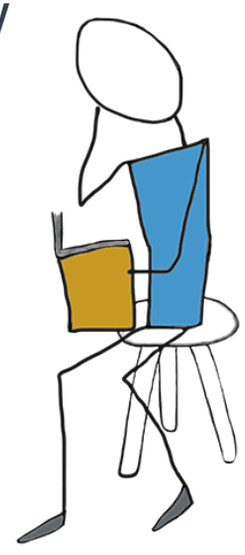
Database Configuration

Set Bind Address – Not Local Host

Set Default Storage Engine to InnoDB

Set Binary Log Format to Row

Enable Error Logging



```
[mysqld]
datadir=/var/lib/mysql
socket=/var/lib/mysql/mysql.sock
bind-address=0.0.0.0
user=mysql

default_storage_engine=InnoDB
innodb_autoinc_lock_mode=2
innodb_flush_log_at_trx_commit=0
innodb_buffer_pool_size=128M

binlog_format=ROW
log-error=/var/log/mysqld.log
```

Excerpt from MySQL Configuration File.

Galera Configuration

Identify & Enable Galera

Node Name & Address

Cluster Name & Addresses

Slave Threads

State Transfer Method

```
[mysqld]
...
wsrep_on=ON
wsrep_provider=/usr/lib64/galera-3/libgalera_smm.so

wsrep_node_name='galera-1'
wsrep_node_address="172.31.19.208"

wsrep_cluster_name='galera-training'
wsrep_cluster_address="gcomm://172.31.19.208,
                              172.31.26.197,
                              172.31.15.54"
wsrep_provider_options="gcache.size=300M;
                        gcache.page_size=300M"
wsrep_slave_threads=4
wsrep_sst_method=rsync
```

Excerpt from Database Configuration File.

Galera Configuration: https://galeracluster.com/library/training/tutorials/wsrep-configuration.html
Galera Options: https://galeracluster.com/library/documentation/mysql-wsrep-options.html

Galera Ports

MySQL Default Traffic – TCP 3306

Galera Cluster – TCP & UDP 4567

Incremental State Transfers – TCP 4444

State Snapshot Transfers – TCP 4568

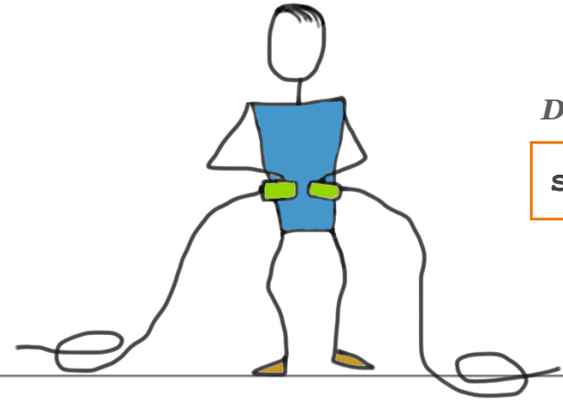
Open Ports or Disable SELinux & Firewall

Open Ports on SELinux

```
semanage port -a -t mysqld_port_t -p tcp 3306

semanage port -a -t mysqld_port_t -p tcp 4444
semanage port -a -t mysqld_port_t -p tcp 4567
semanage port -a -t mysqld_port_t -p udp 4567
semanage port -a -t mysqld_port_t -p tcp 4568

semanage permissive -a mysqld_t
```



Disables SELinux

```
setenforce 0
```

Firewall Settings: https://galeracluster.com/library/documentation/firewall-settings.html
SELinux Configuration: https://galeracluster.com/library/documentation/selinux.html
Configuring `firewalld`: https://galeracluster.com/library/documentation/firewalld.html

Deploying a Galera Cluster

Standard Replication & Galera Cluster

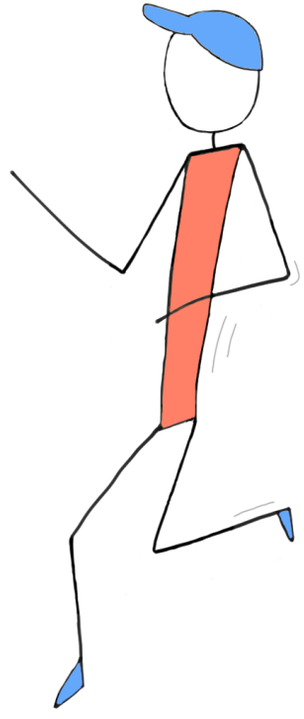
Caveats of Starting a Cluster

A Cluster is made of Multiple Nodes

— Not Stand-Alone

New Nodes Unassuming — Look for Primary Component

Tell First Node it's the Primary Component



Starting Galera Cluster: https://galeracluster.com/library/training/tutorials/starting-cluster.html

Starting Nodes

Bootstrap Database & Galera on Seed Node

- MySQL – **`mysqld_bootstrap`**
- MariaDB – **`galera_new_cluster`**

Start Database & Galera Normally on Additional Nodes

Starting MySQL Nodes

Seed Node

```
mysqld_bootstrap
```

Additional Nodes

```
systemctl start mysqld
```

Starting MariaDB Nodes

Seed Node

```
galera_new_cluster
```

Additional Nodes

```
systemctl start mariadb
```

Configuring & Starting a Galera Cluster

Conclusion

Standard Replication & Galera Cluster

Additional Resources

Codership Library (**`galeracluster.com/library`**)

- Documentation (**`/library/documentation`**)
- Knowledge Base (**`/library/kb`**)
- FAQ (**`/library/faq`**)
- Training (**`/library/training`**)
  - Videos (**`/library/training/videos`**)
  - Tutorials (**`/library/training/tutorials`**)