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MySQL Group Replication in a nutshell

MySQL InnoDB Cluster: hands-on tutorial

Percona Live Amsterdam - October 2016

Frédéric Descamps - MySQL Community Manager - Oracle

Kenny Gryp - MySQL Practice Manager - Percona

Safe Harbor Statement

The following is intended to outline our general product direction. It is intended for information purpose only, and may not be incorporated into any contract. It is not a commitment to deliver any material, code, or functionality, and should not be relied up in making purchasing decisions. The development, release and timing of any features or functionality described for Oracle's product remains at the sole discretion of Oracle.

about.me/lefred

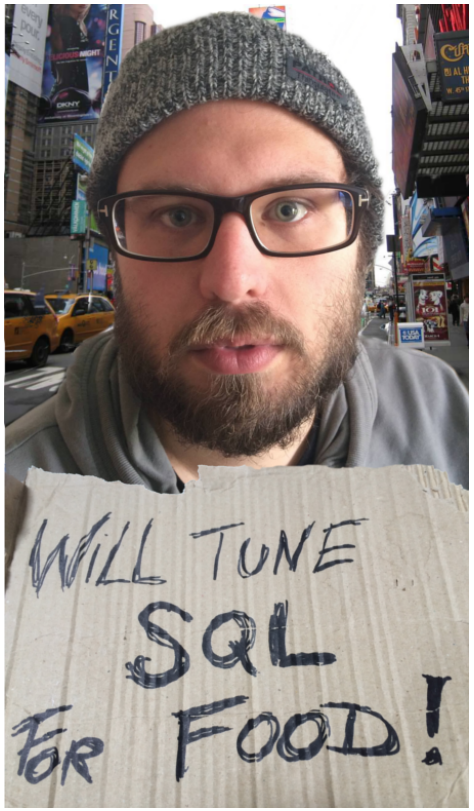
Who are we ?

Frédéric Descamps

- @lefred
- MySQL Evangelist
- Managing MySQL since 3.23
- devops believer

Kenny Gryp

- @gryp
- MySQL Practice Manager



get more at the conference

MySQL Group Replication

Other session

- MySQL Replication: Latest Developments
  - *Luìs Soares*
  - Tuesday 4 October 2016
  - 3:10pm to 4:00pm - Zürich 1

Agenda

- Prepare your workstation

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- Group Replication concepts

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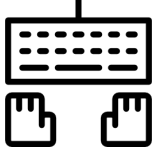
- Application interaction

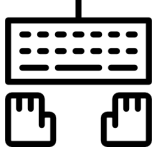
VirtualBox

Setup your workstation



Setup your workstation

- Install VirtualBox 5
- On the USB key, there is a file called `PLAM16_GR.ova`, please copy it on your laptop and doubleclick on it
- Start all virtual machines (`mysql1`, `mysql2`, `mysql3` & `mysql4`)
- Install **putty** if you are using Windows



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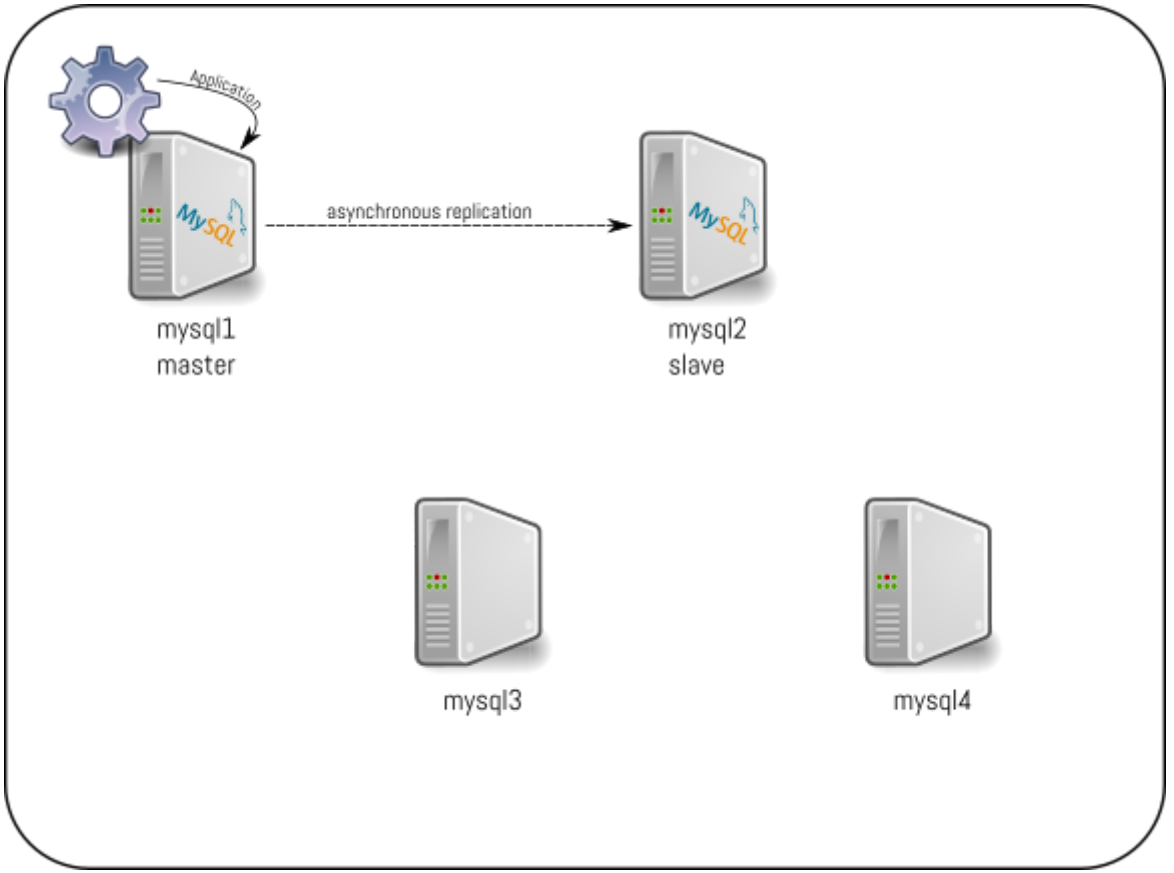
- Start all virtual machines (`mysql1`, `mysql2`, `mysql3` & `mysql4`)
- Install **putty** if you are using Windows
- Try to connect to all VM's from your terminal or putty *(root password is **X**)*:
  - `ssh -p 8821 root@127.0.0.1` to *mysql1*
  - `ssh -p 8822 root@127.0.0.1` to *mysql2*
  - `ssh -p 8823 root@127.0.0.1` to *mysql3*
  - `ssh -p 8824 root@127.0.0.1` to *mysql4*

LAB1: Current situation



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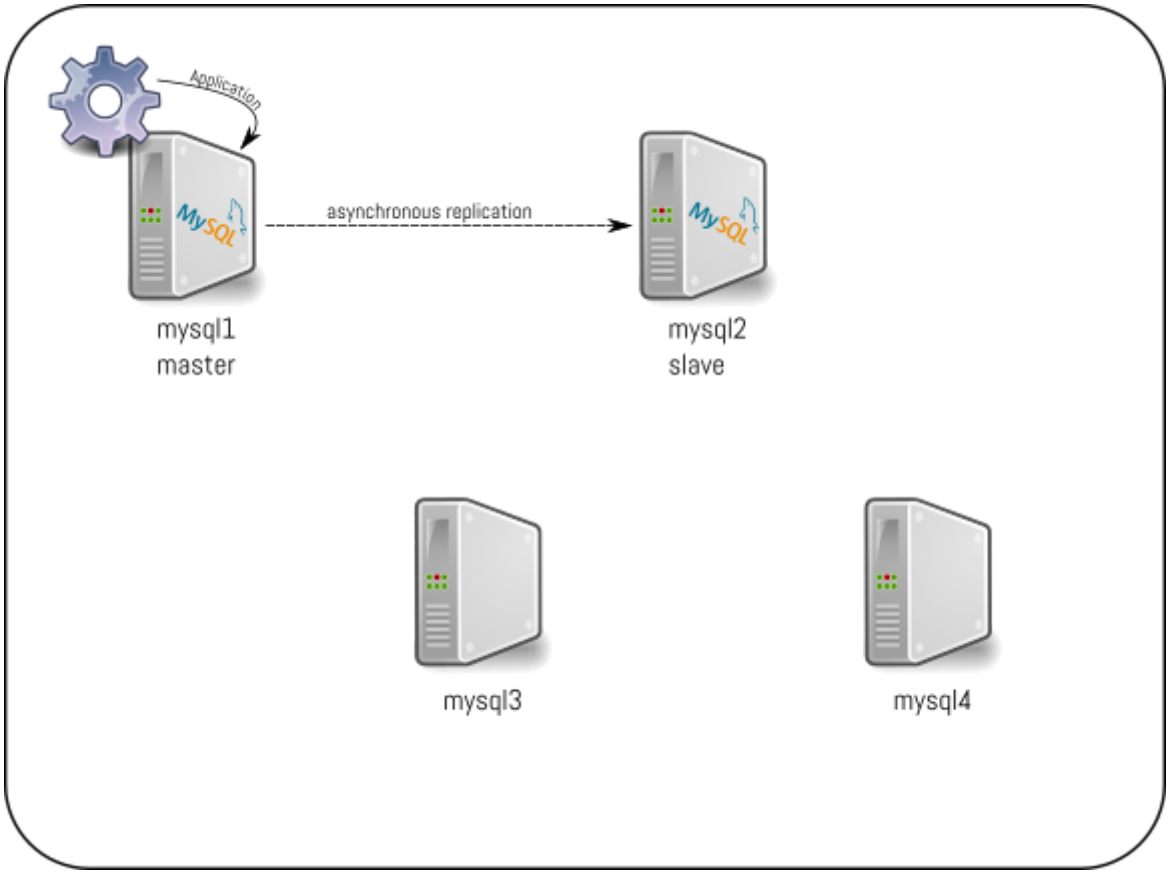

- launch `run_app.sh` on `mysql1` into a **`screen`** session
- verify that `mysql2` is a running slave

Summary

	ROLE	SSH PORT	INTERNAL IP
mysql1	master	8821	192.168.56.11
mysql2	slave	8822	192.168.56.12
mysql3	n/a	8823	192.168.56.13
mysql4	n/a	8824	192.168.56.14

the magic explained

Group Replication Concept

Group Replication : what is it ?

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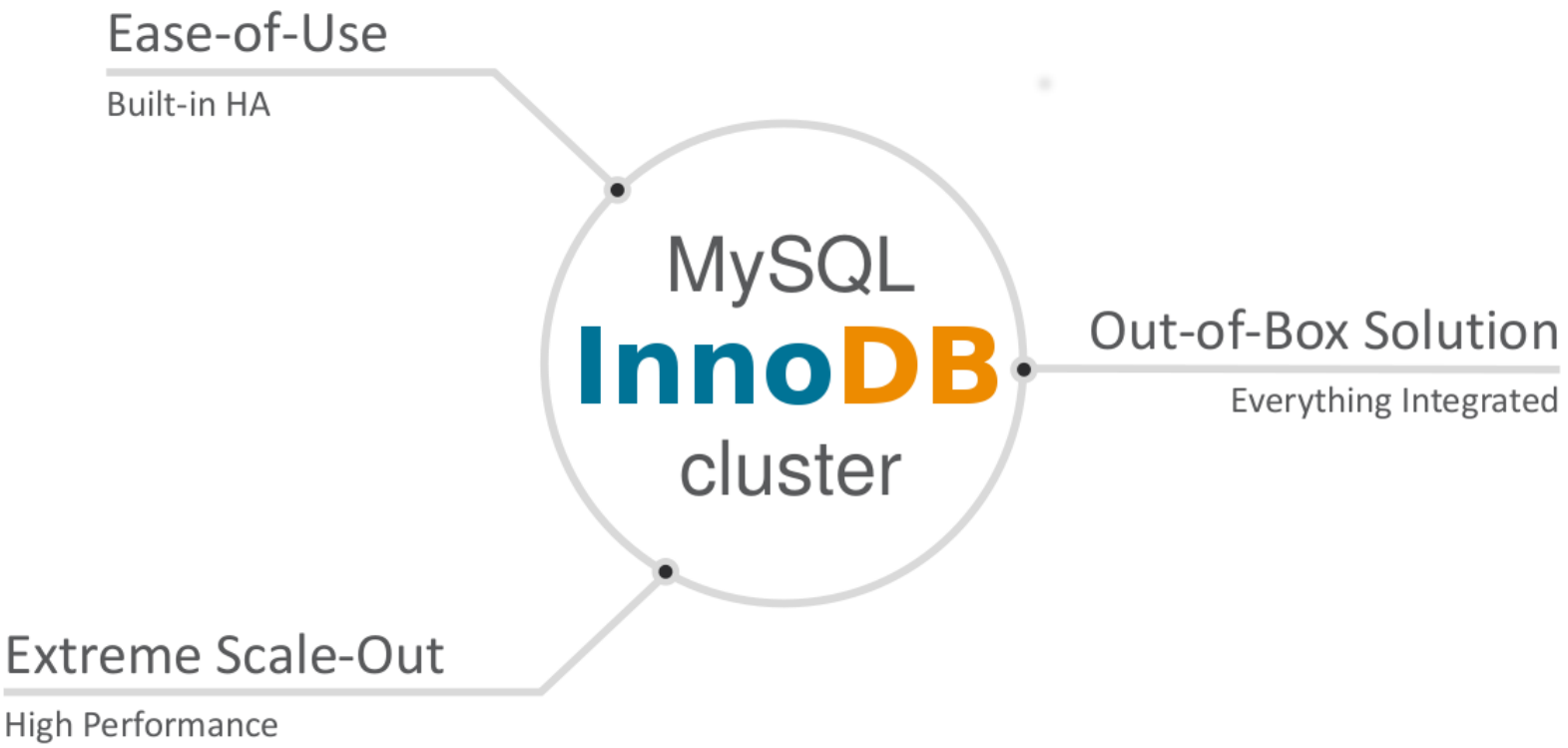

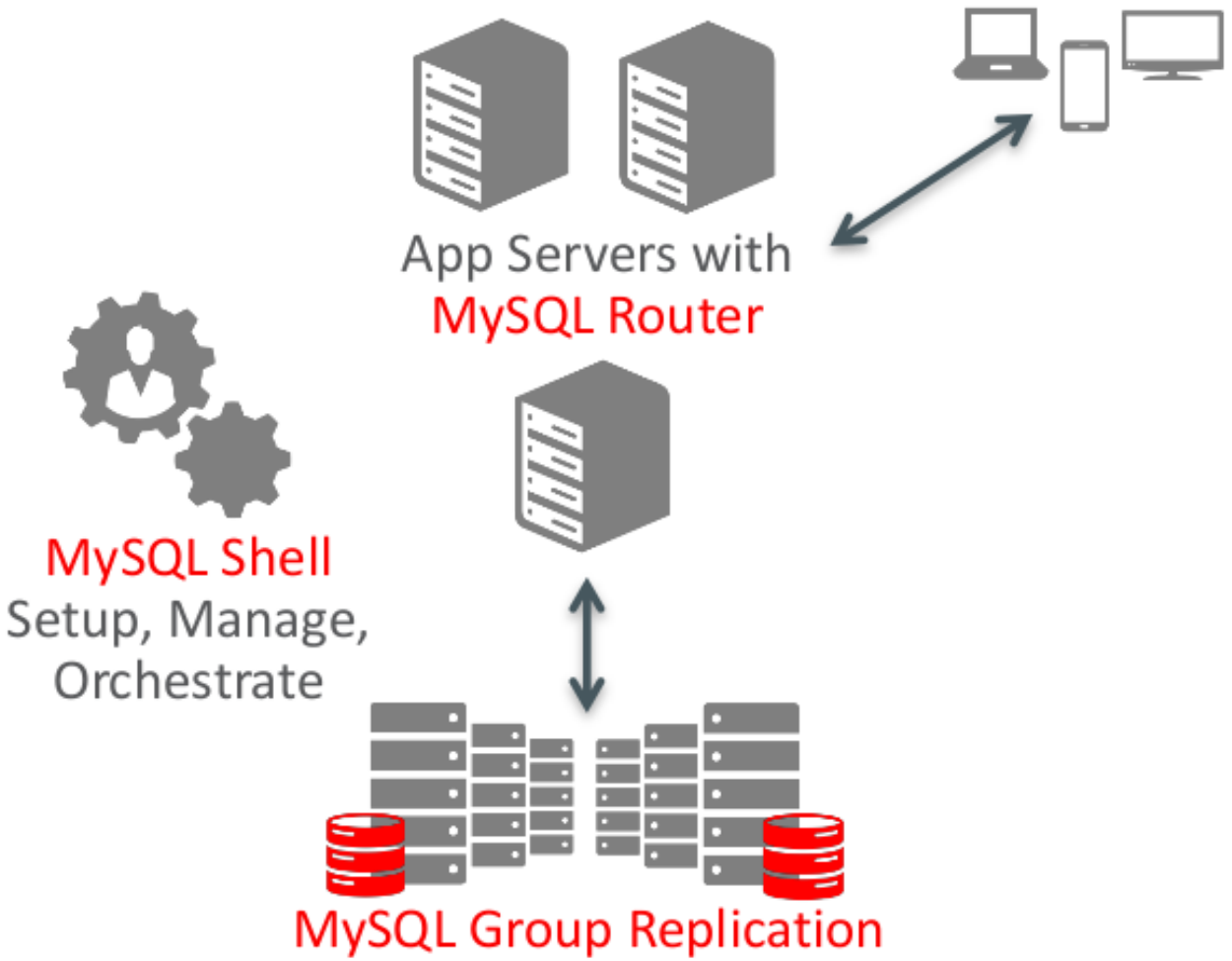

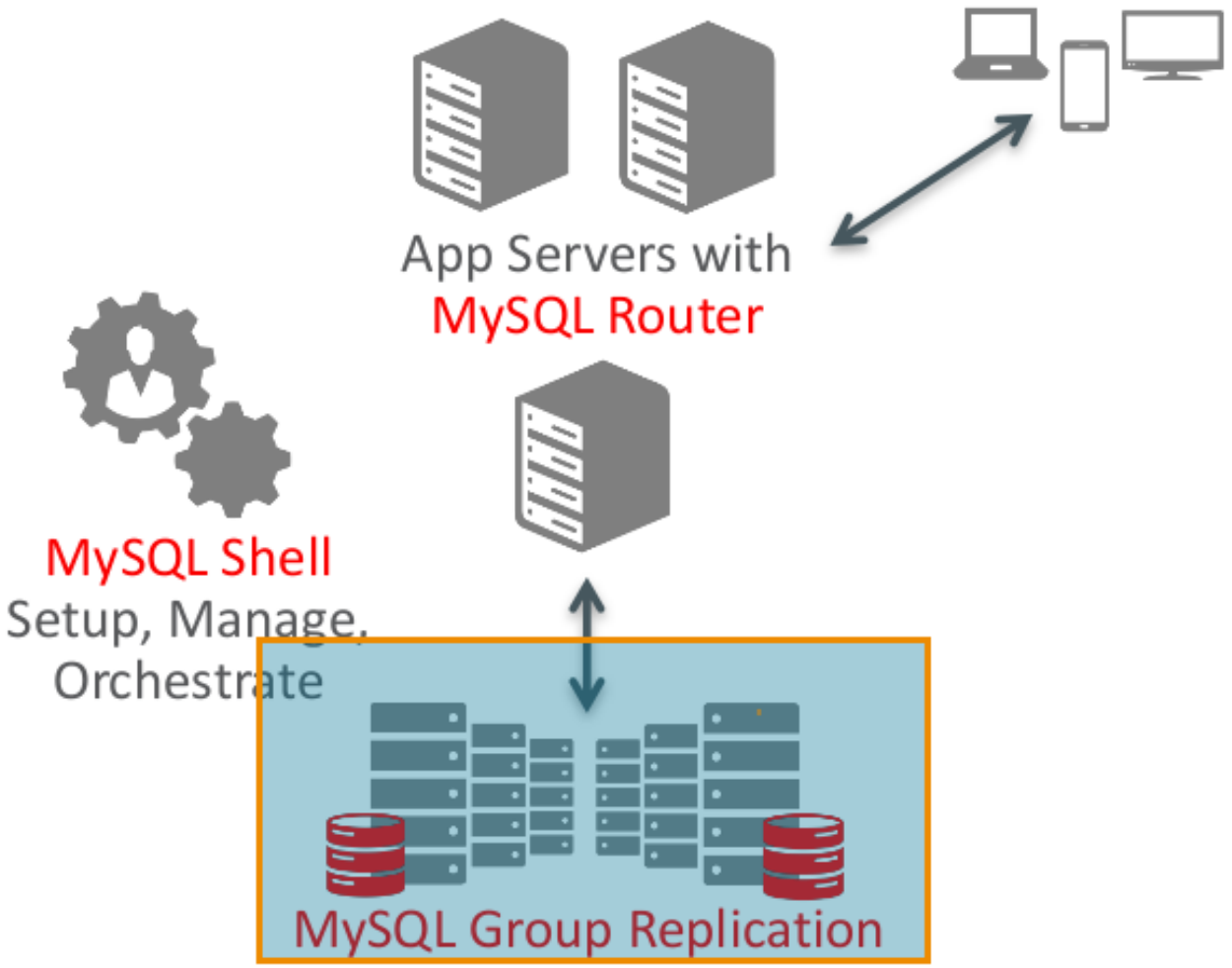

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- GR is an implementation of Replicated Database State Machine theory
  - MySQL Group Communication System (GCS) is based on Paxos Mencius
- Provides virtually synchronous replication for MySQL 5.7+
- Supported on **all MySQL platforms** !!
  - Linux, Windows, Solaris, OSX, FreeBSD

"Multi-master update anywhere replication plugin for MySQL with built-in conflict detection and resolution, automatic distributed recovery, and group membership."

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- All members consume the writeset and certify it, no need to wait for all members, ack by the majority is enough.
- If passed it is applied, if failed, transaction is rolled back on originating server and discarded at other servers.

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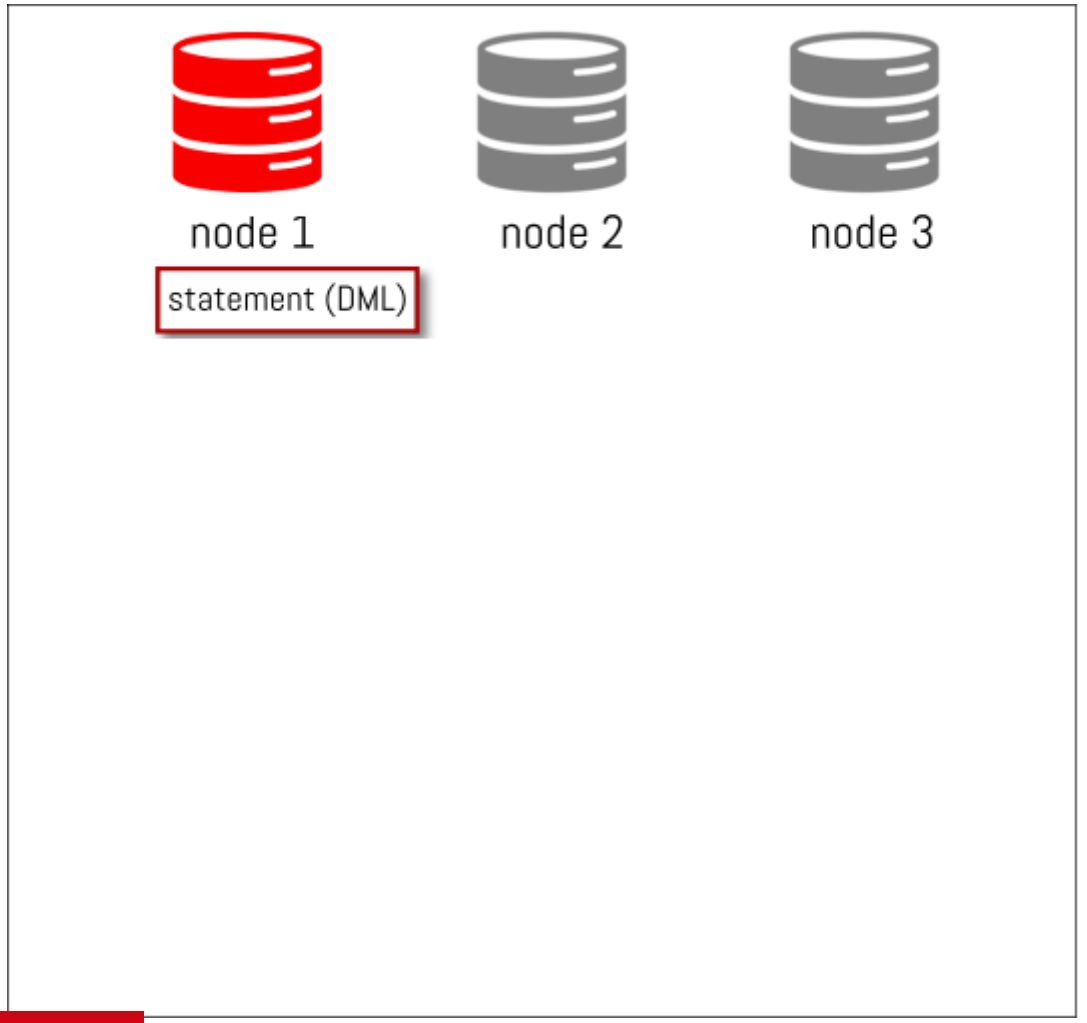
not that easy to understand... right ? Let's illustrate this...

MySQL Group Replication (autocommit)



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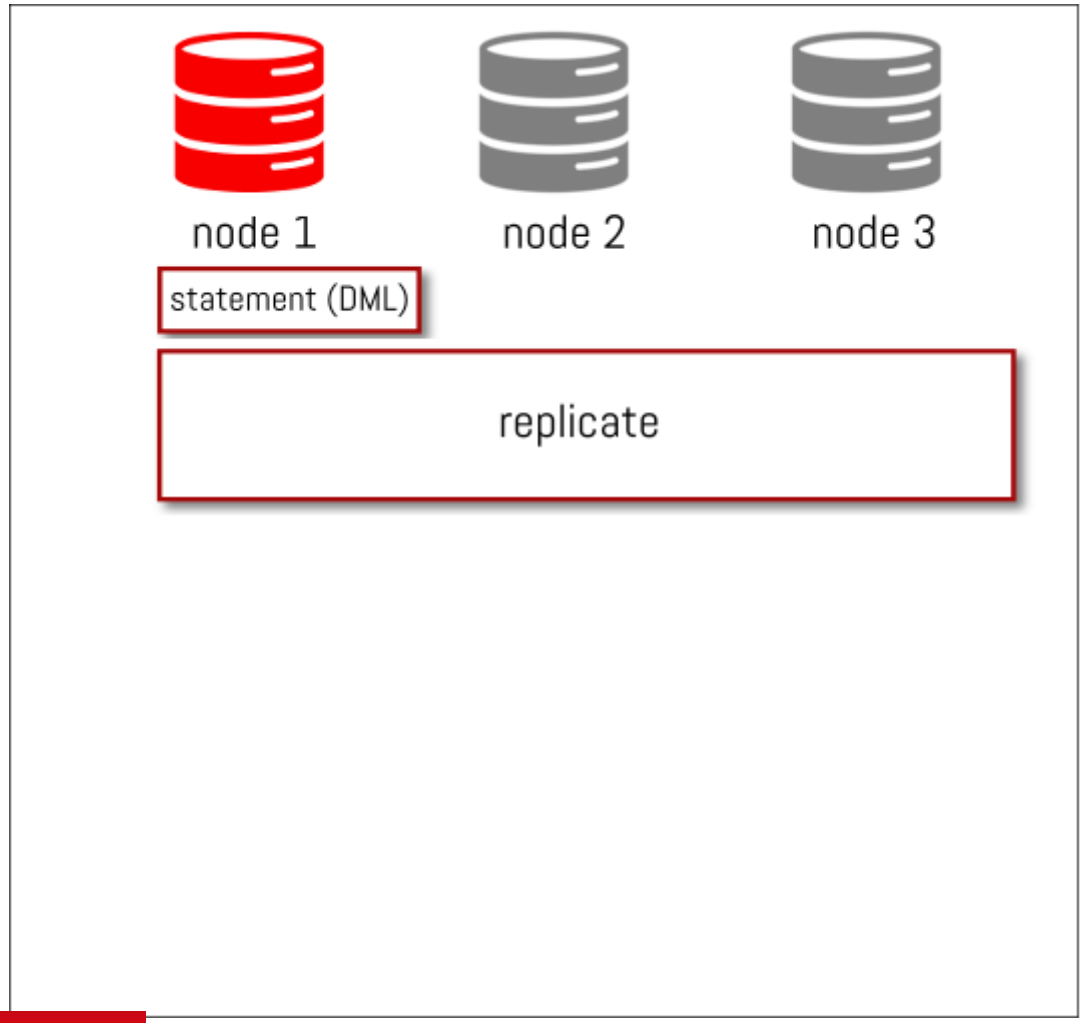

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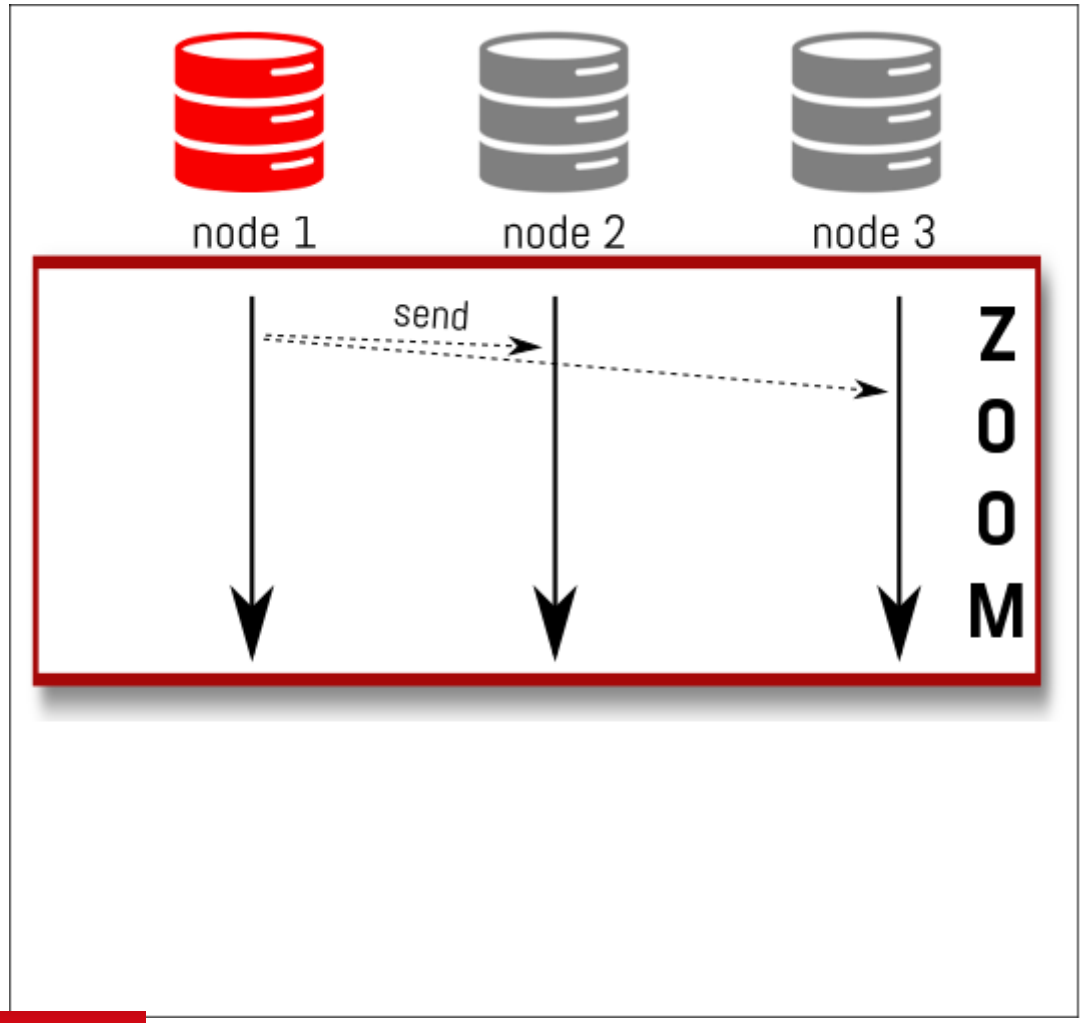

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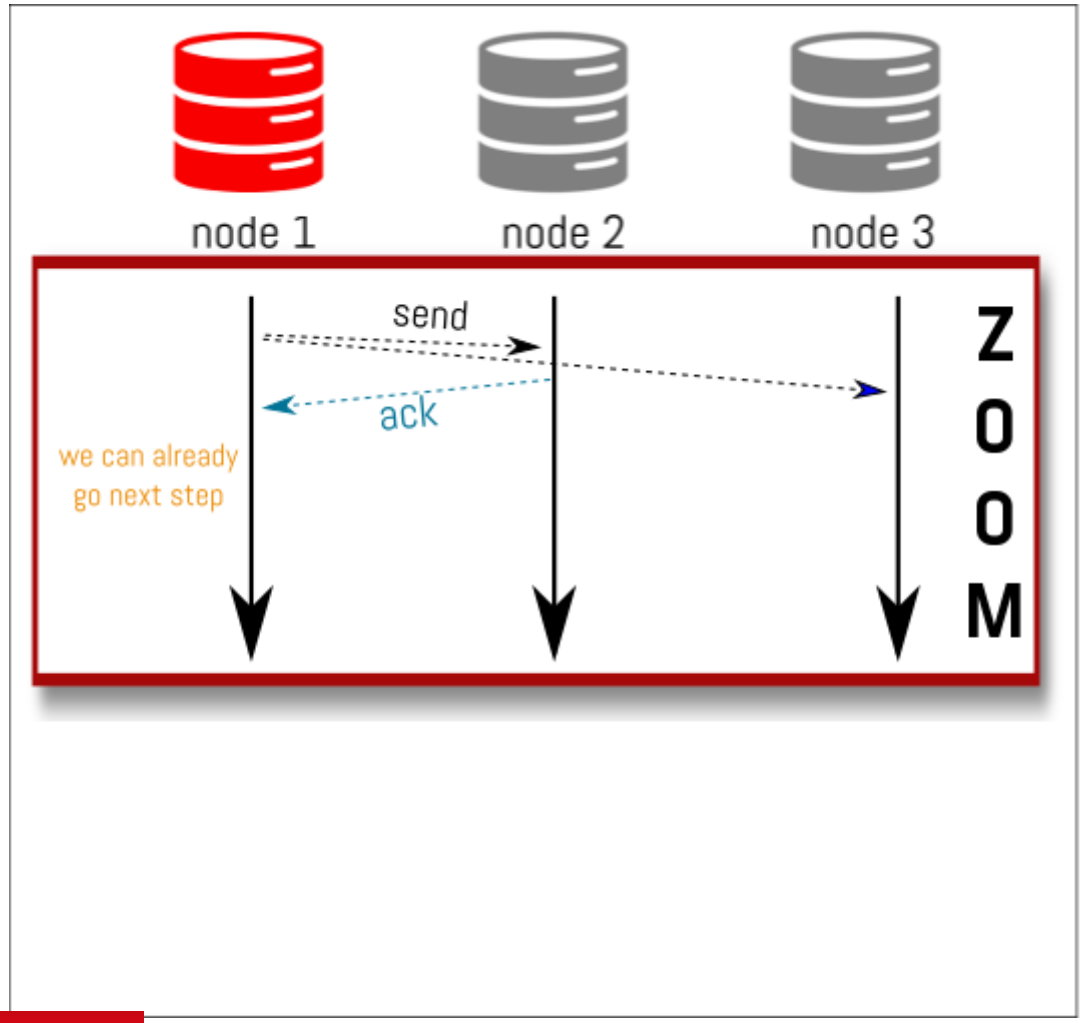

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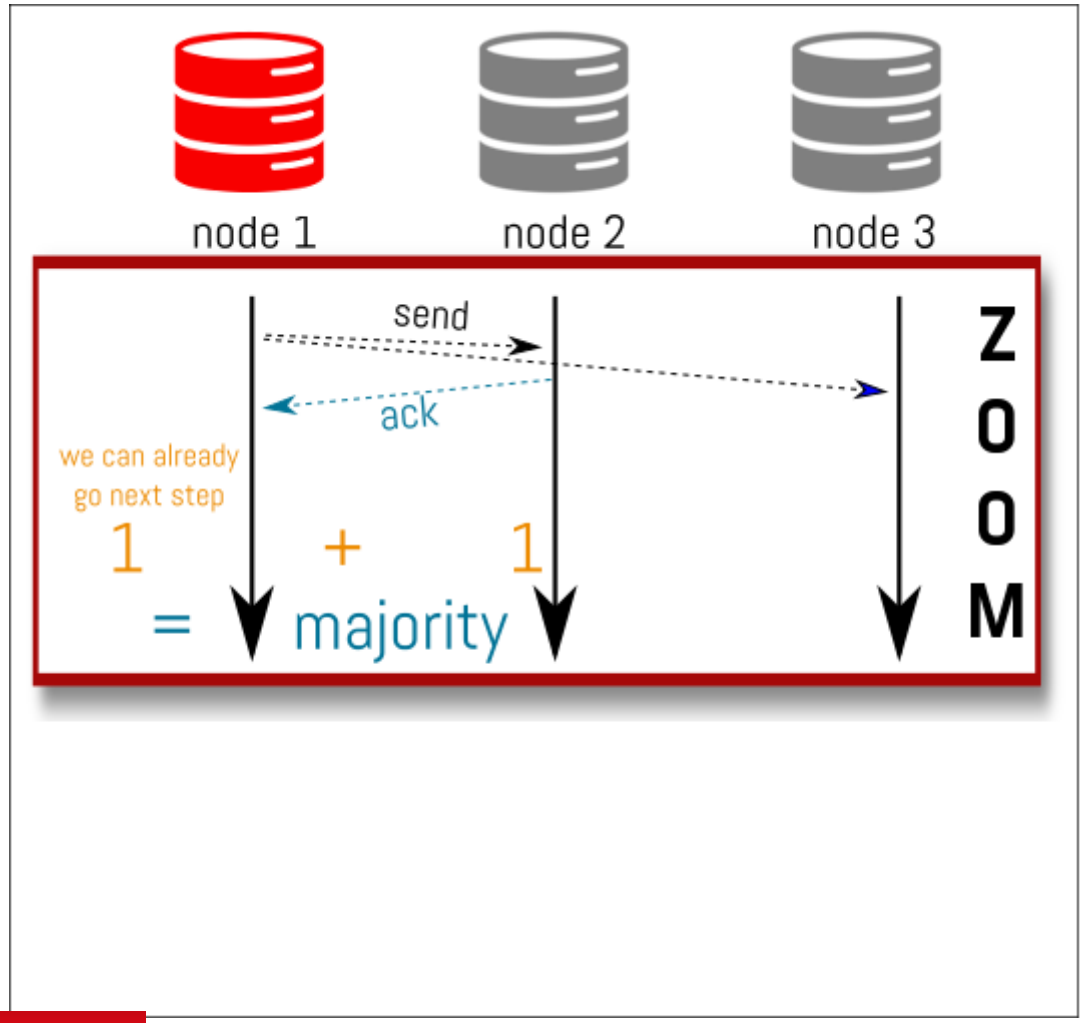

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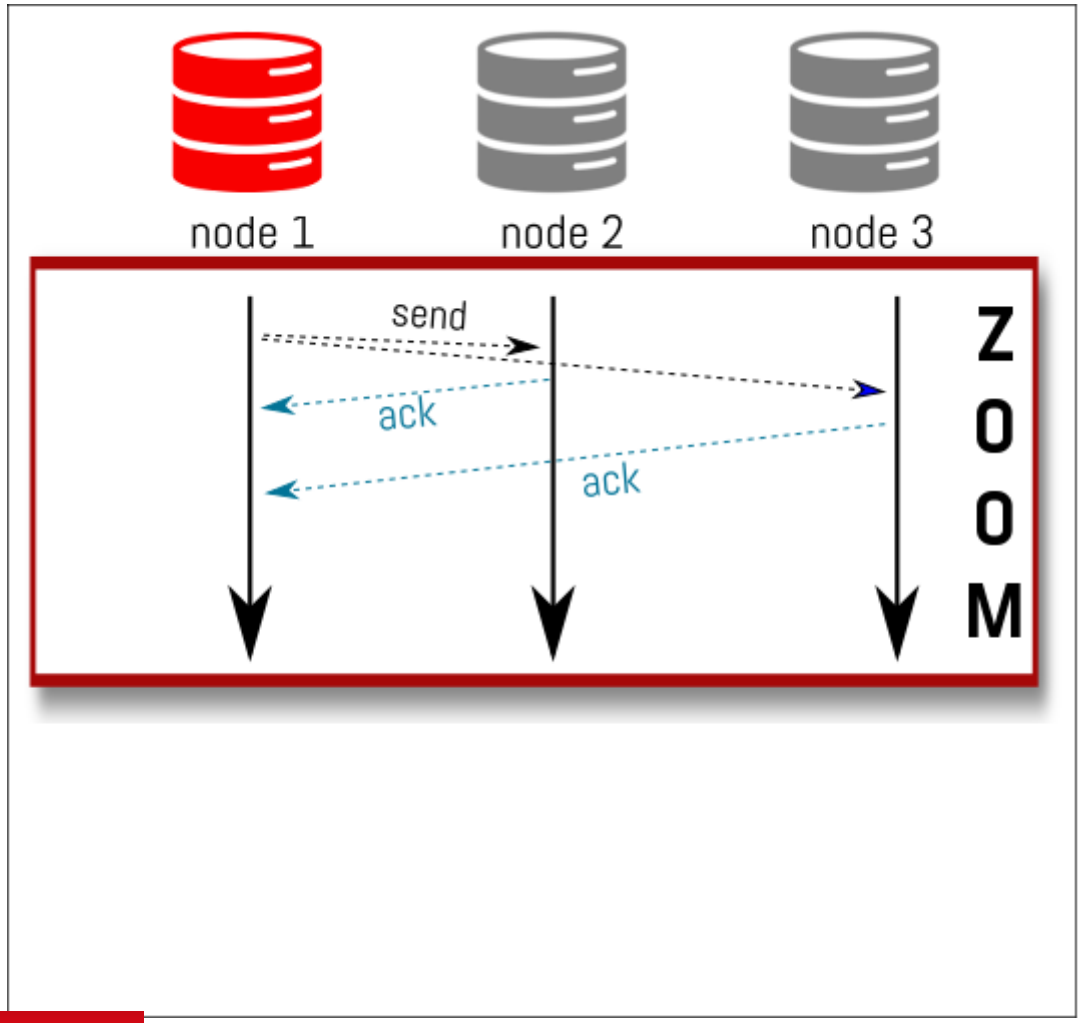

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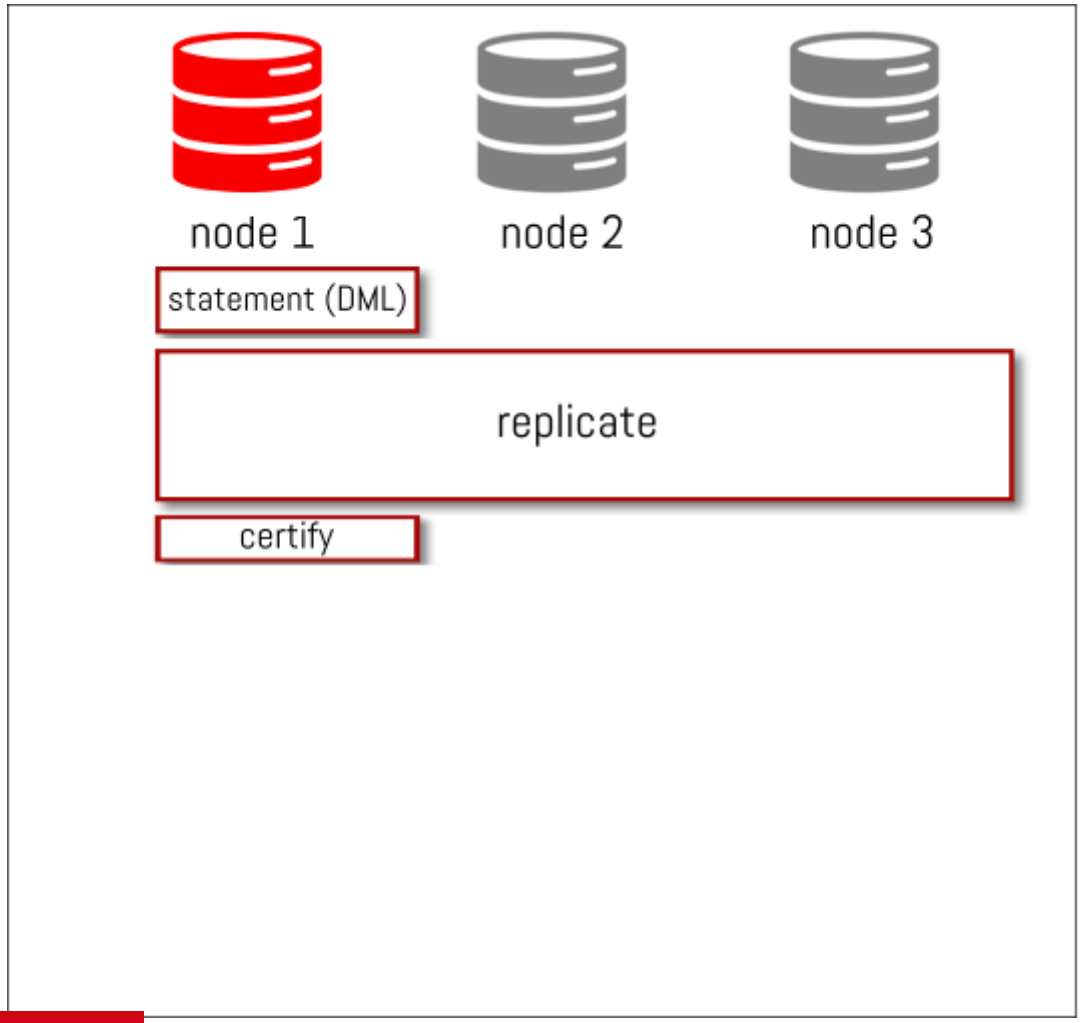

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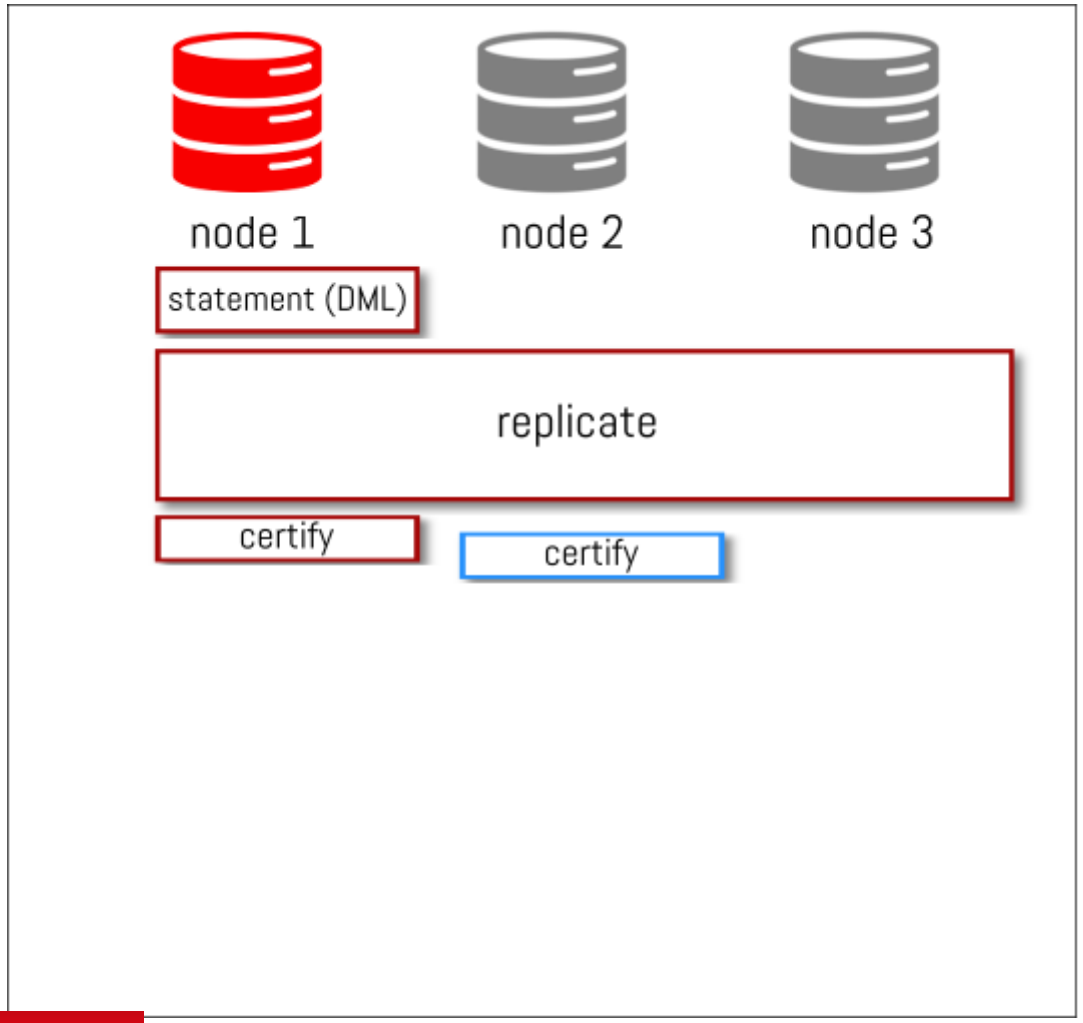

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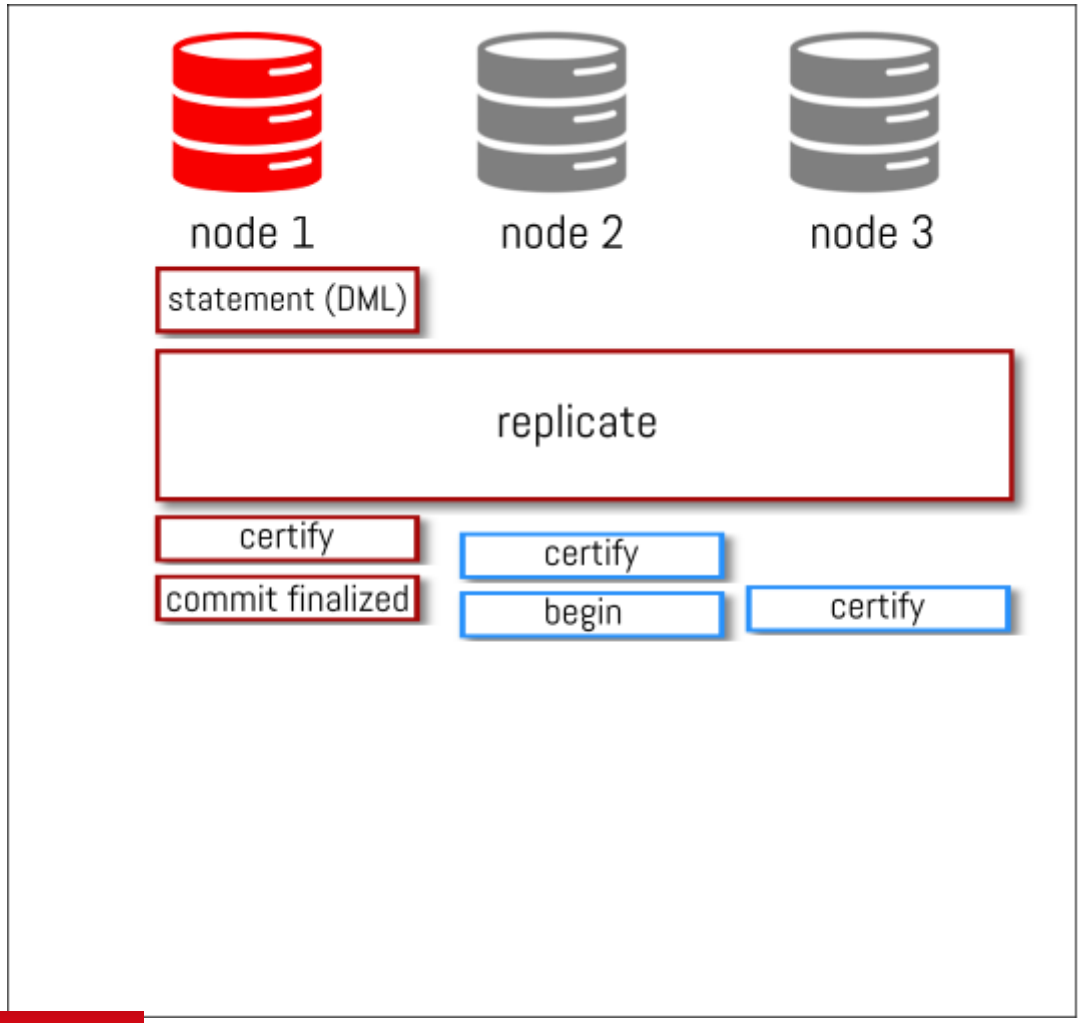

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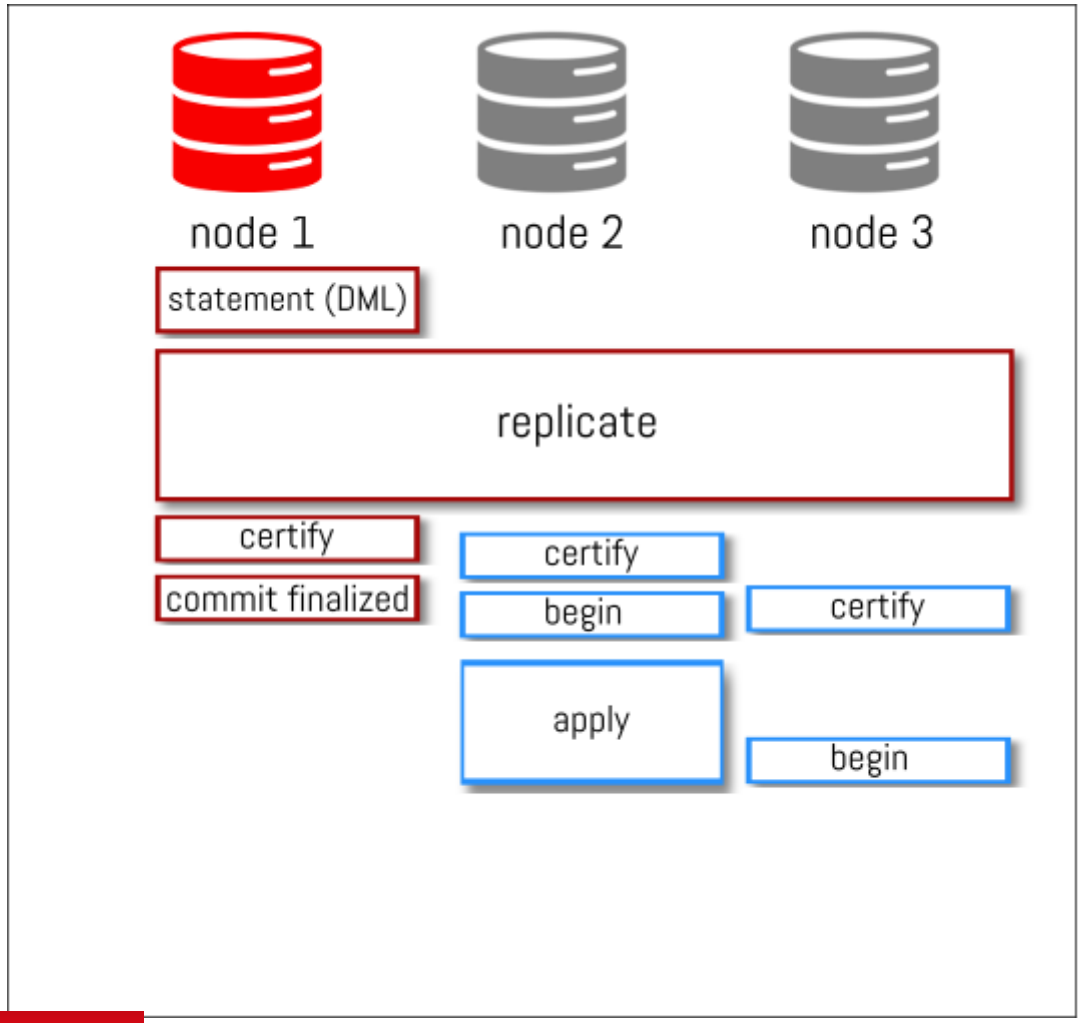

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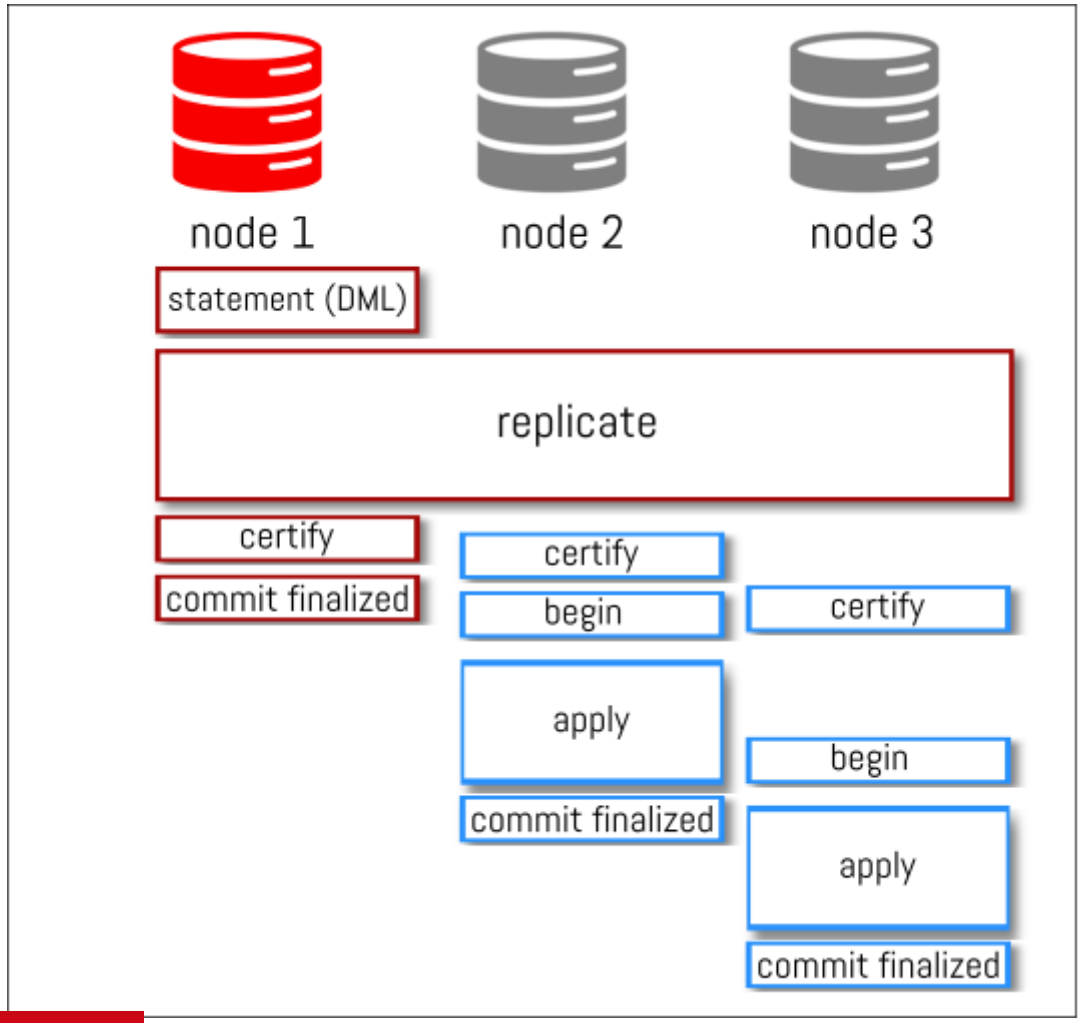
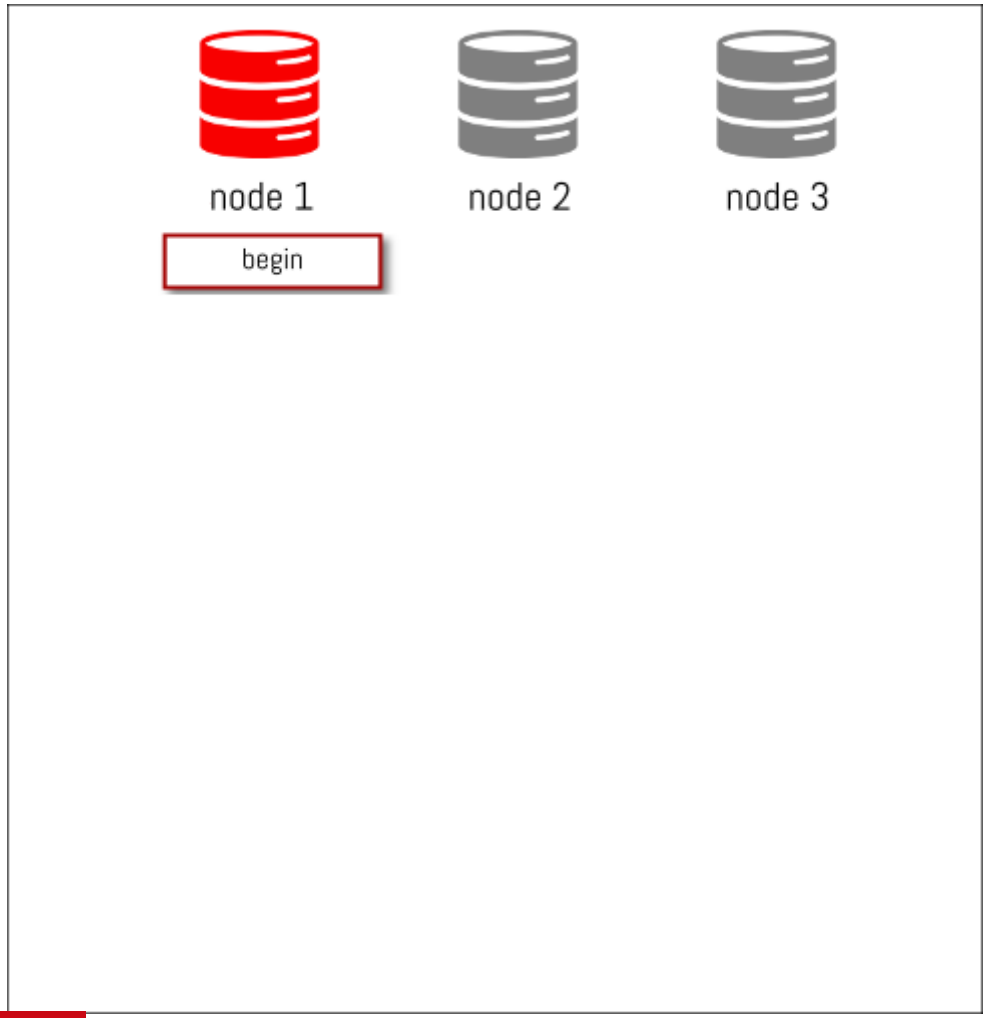


MySQL Group Replication (full transaction)



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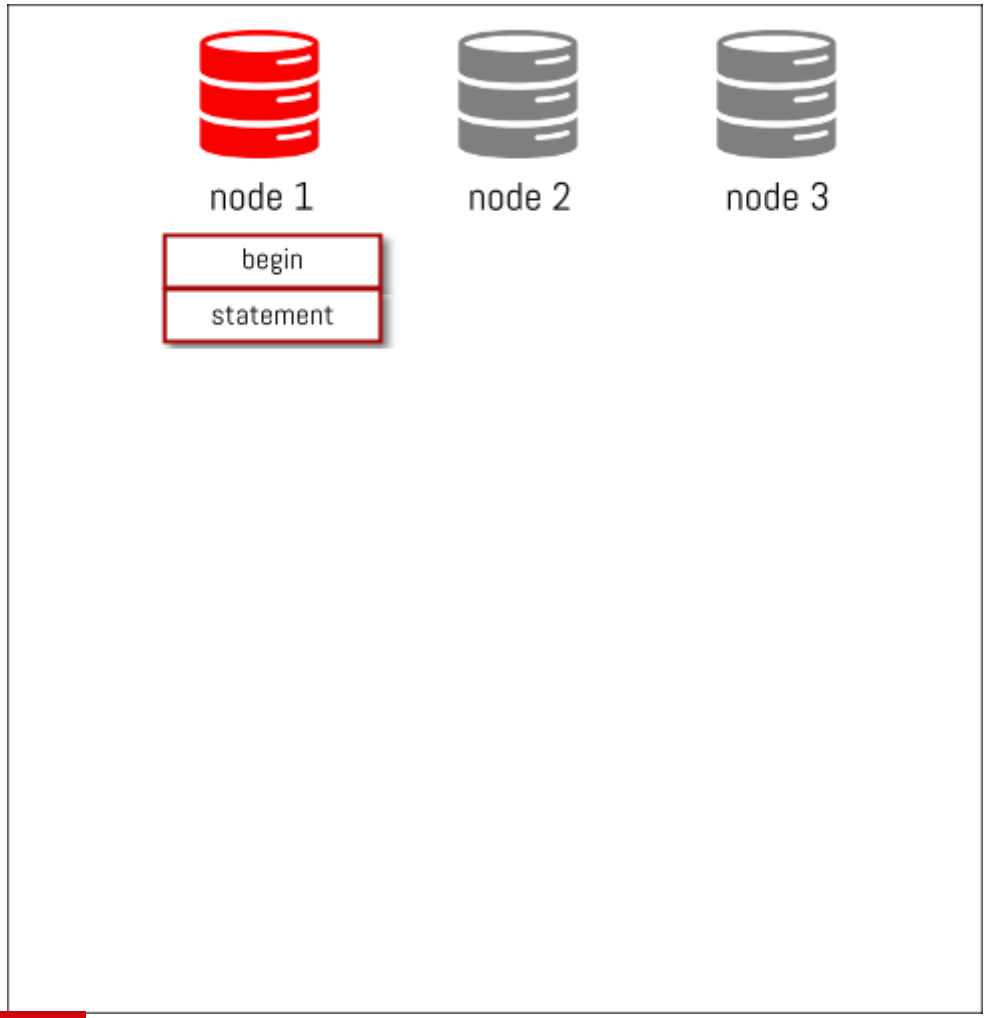

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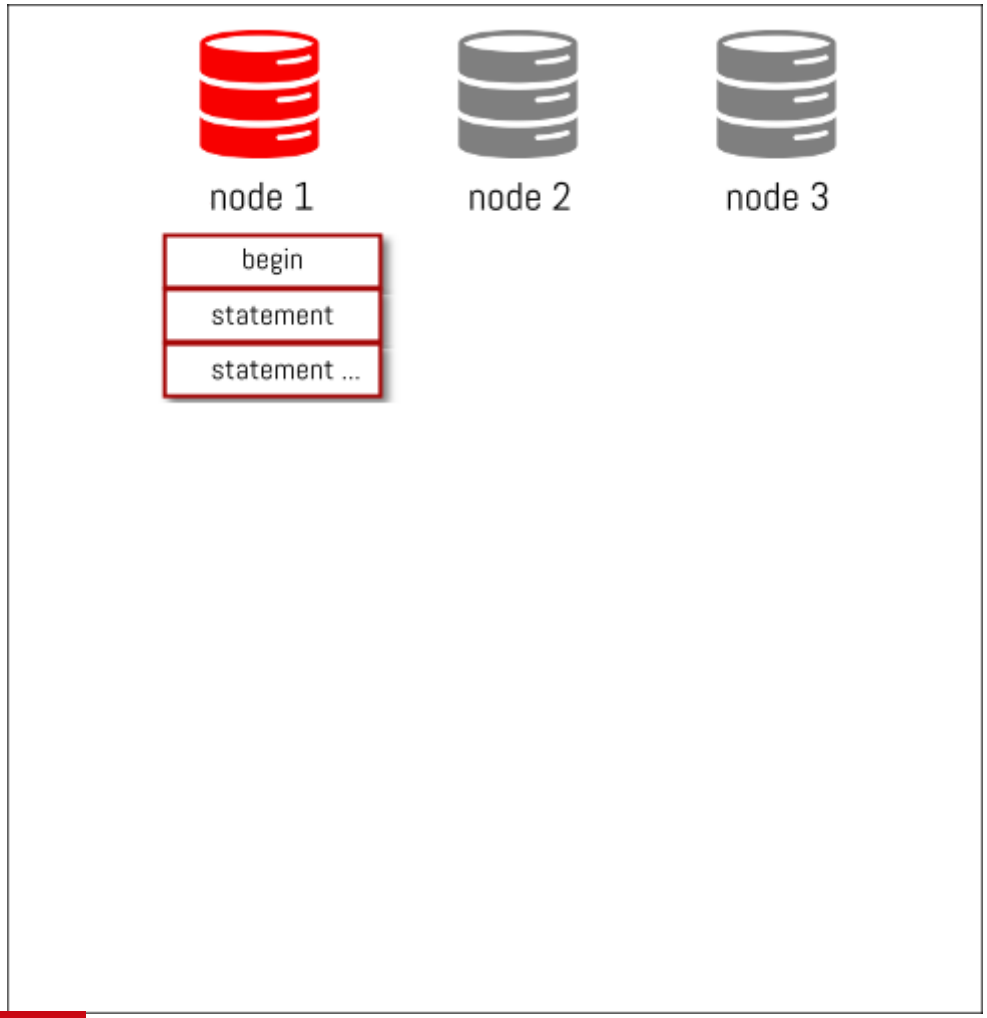

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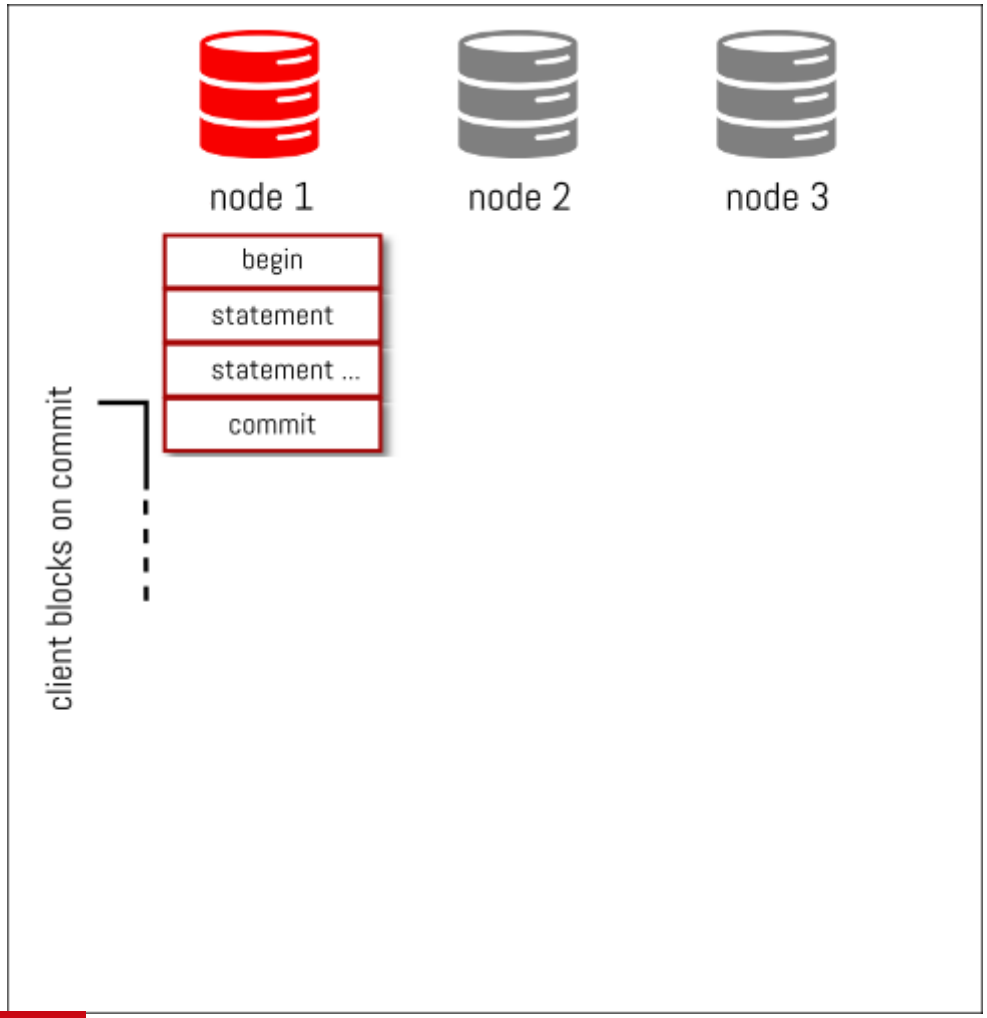

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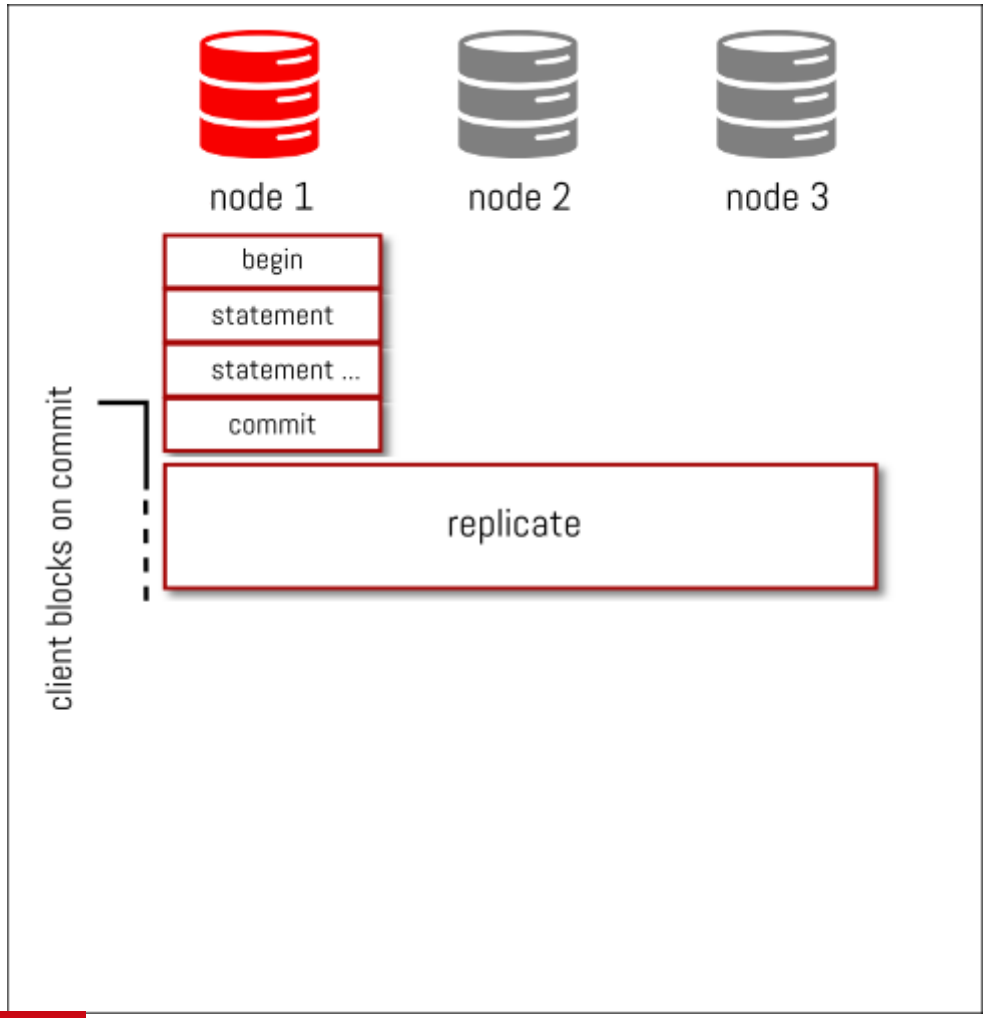

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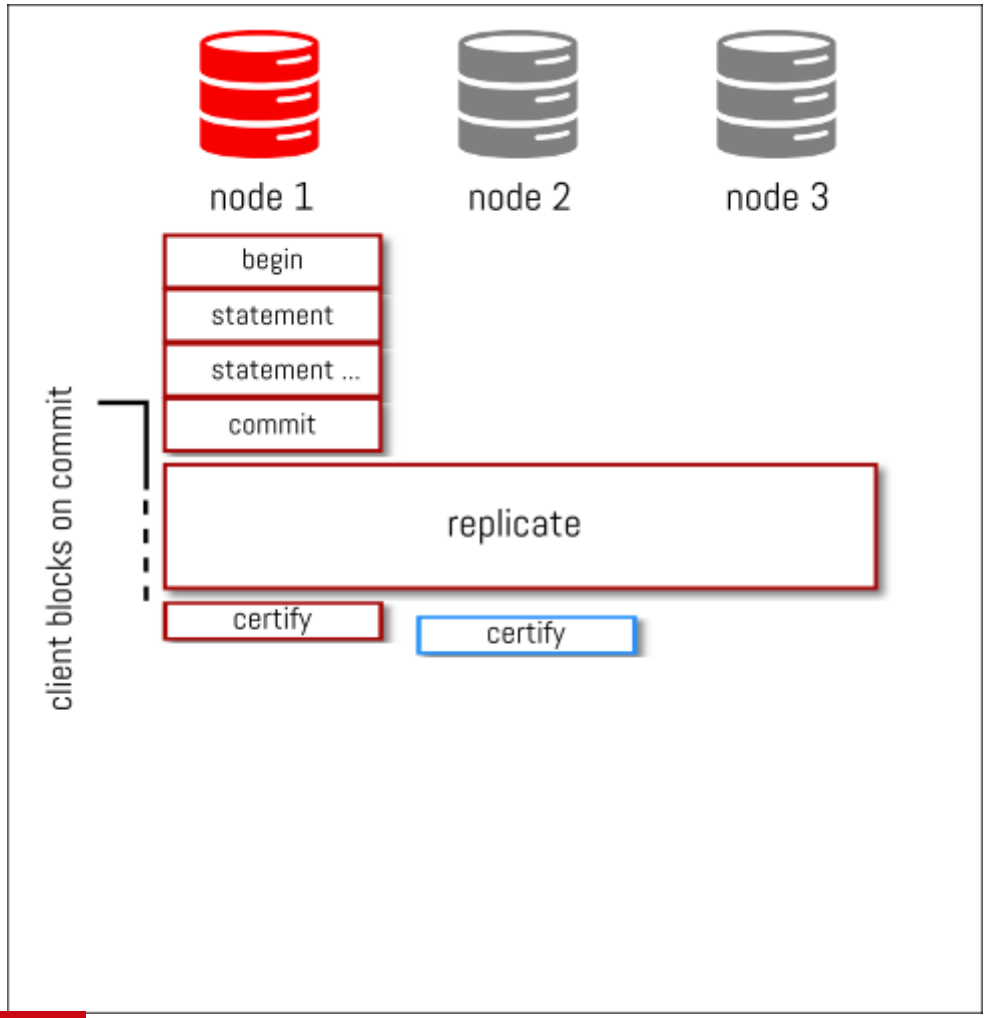

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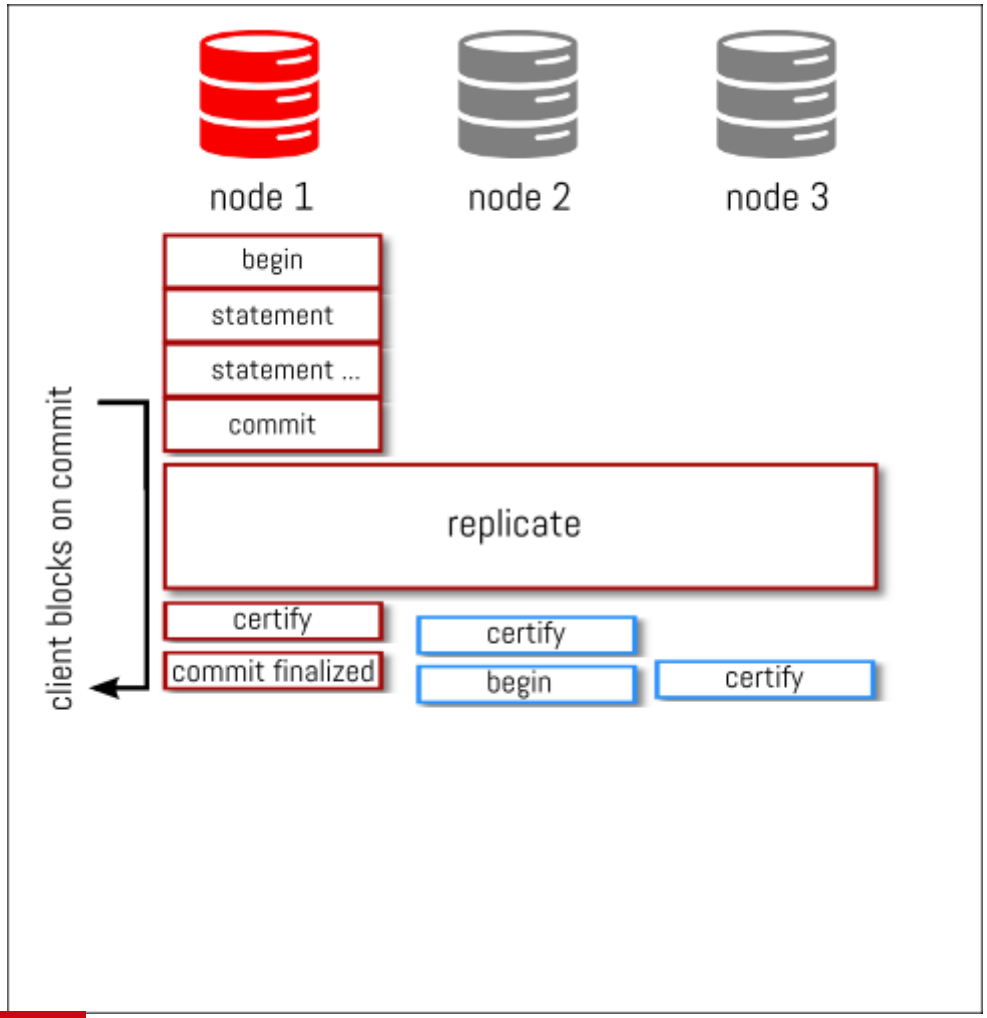

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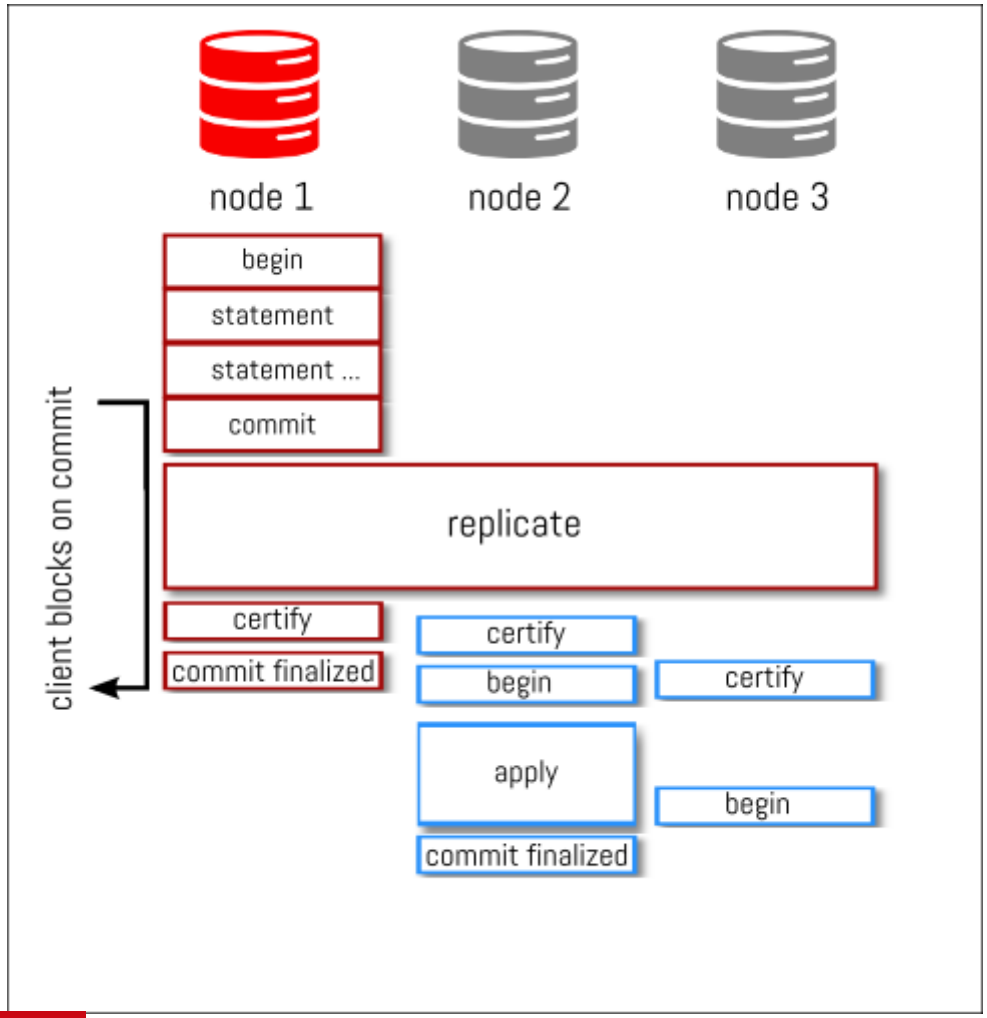

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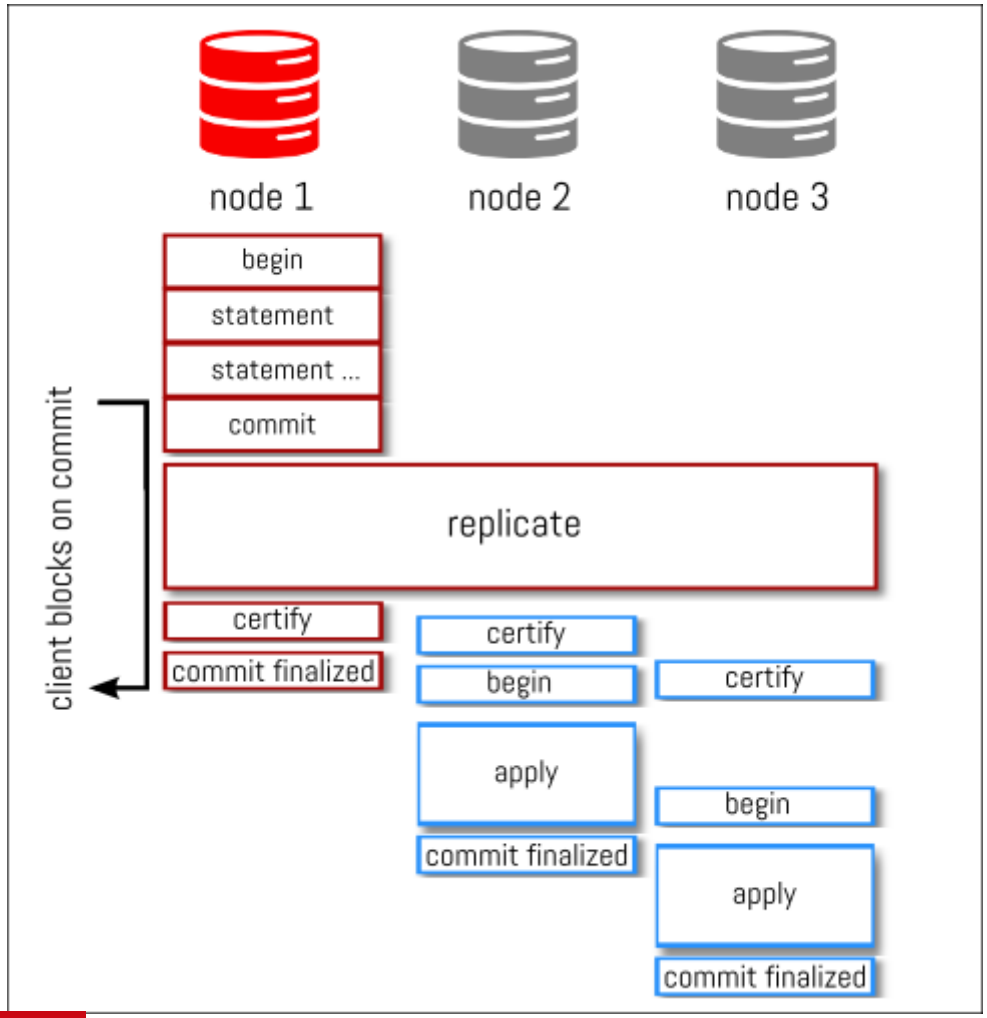

Group Replication : Total Order Delivery - GTID

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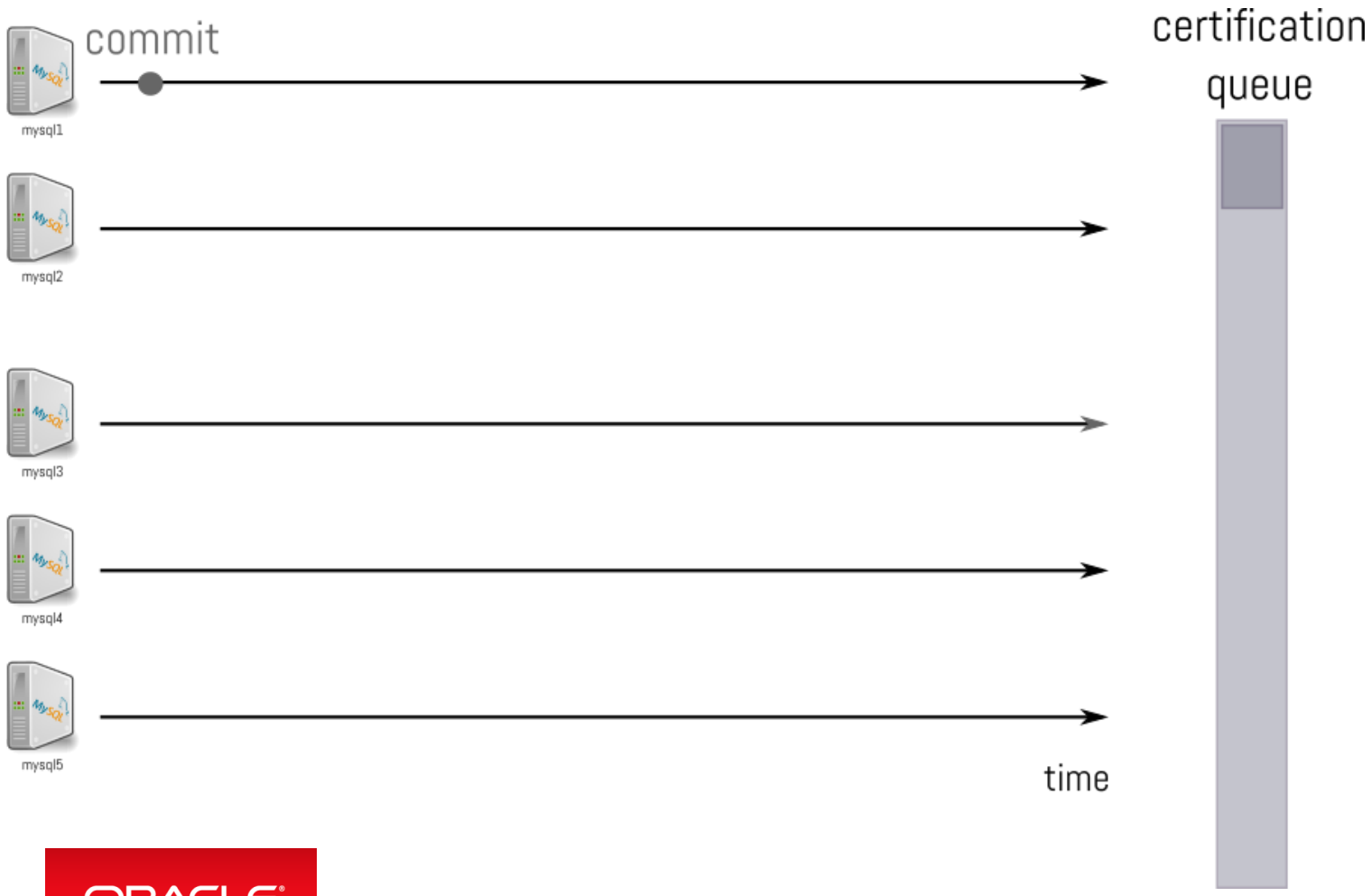

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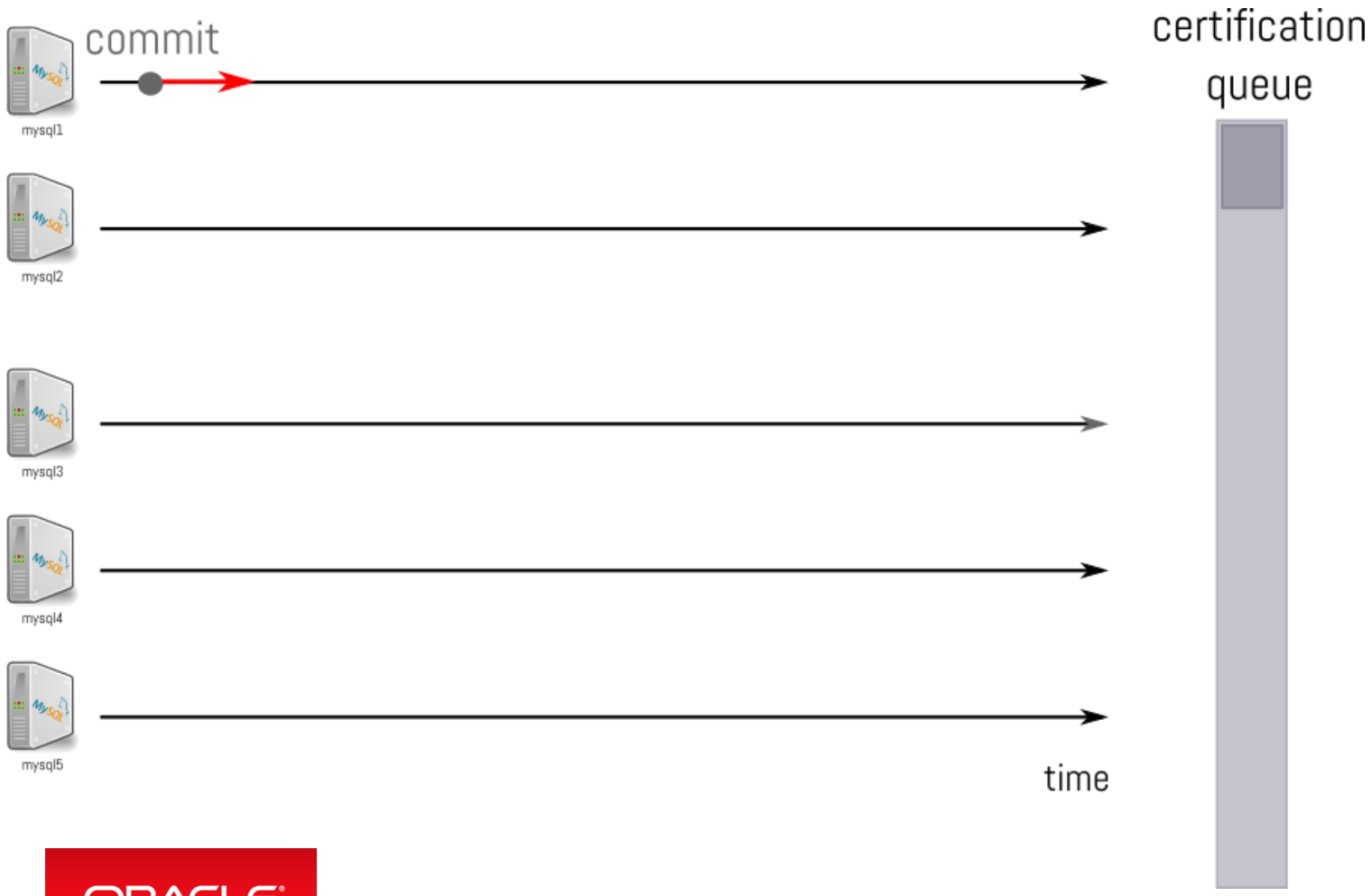

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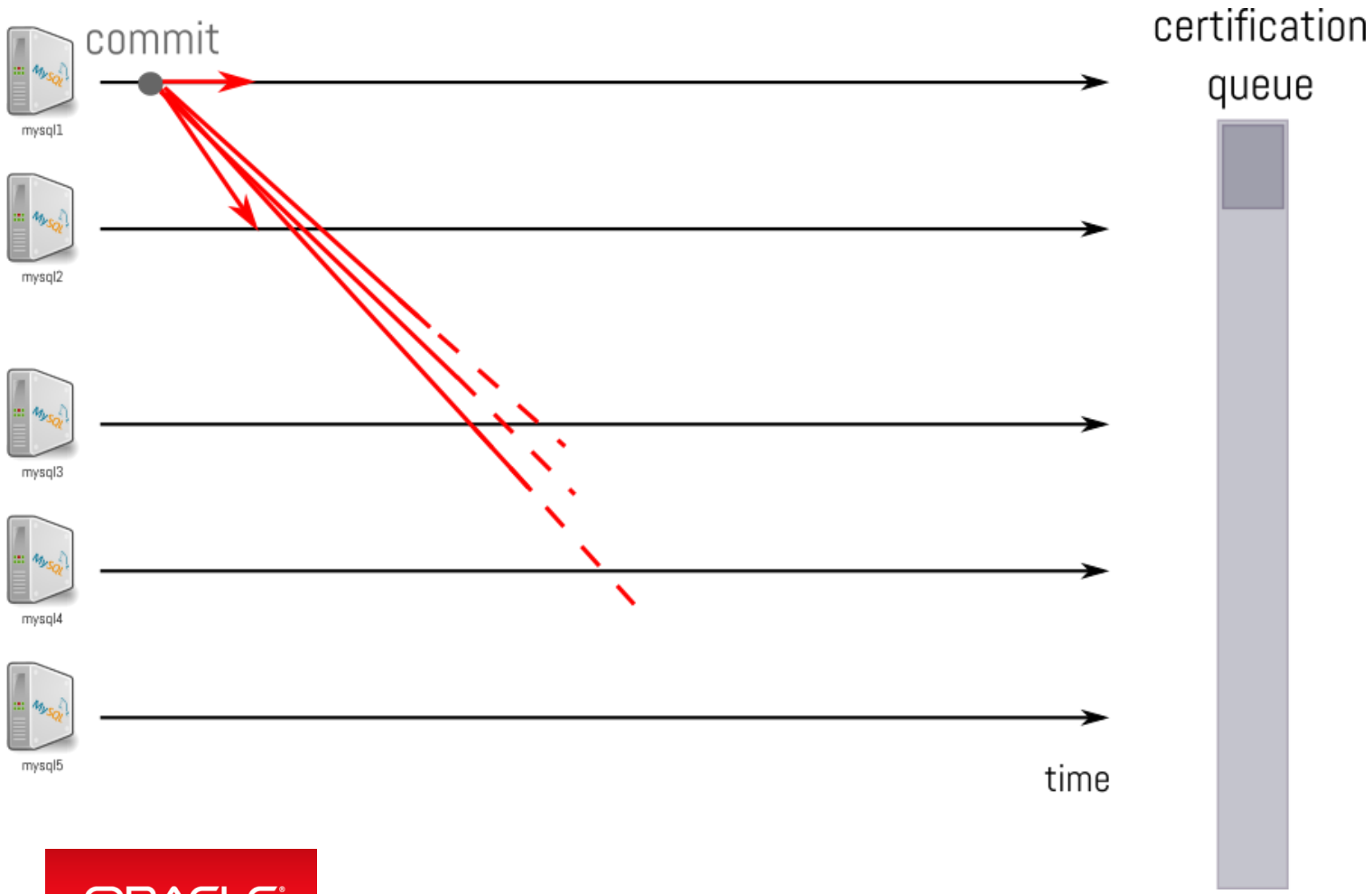

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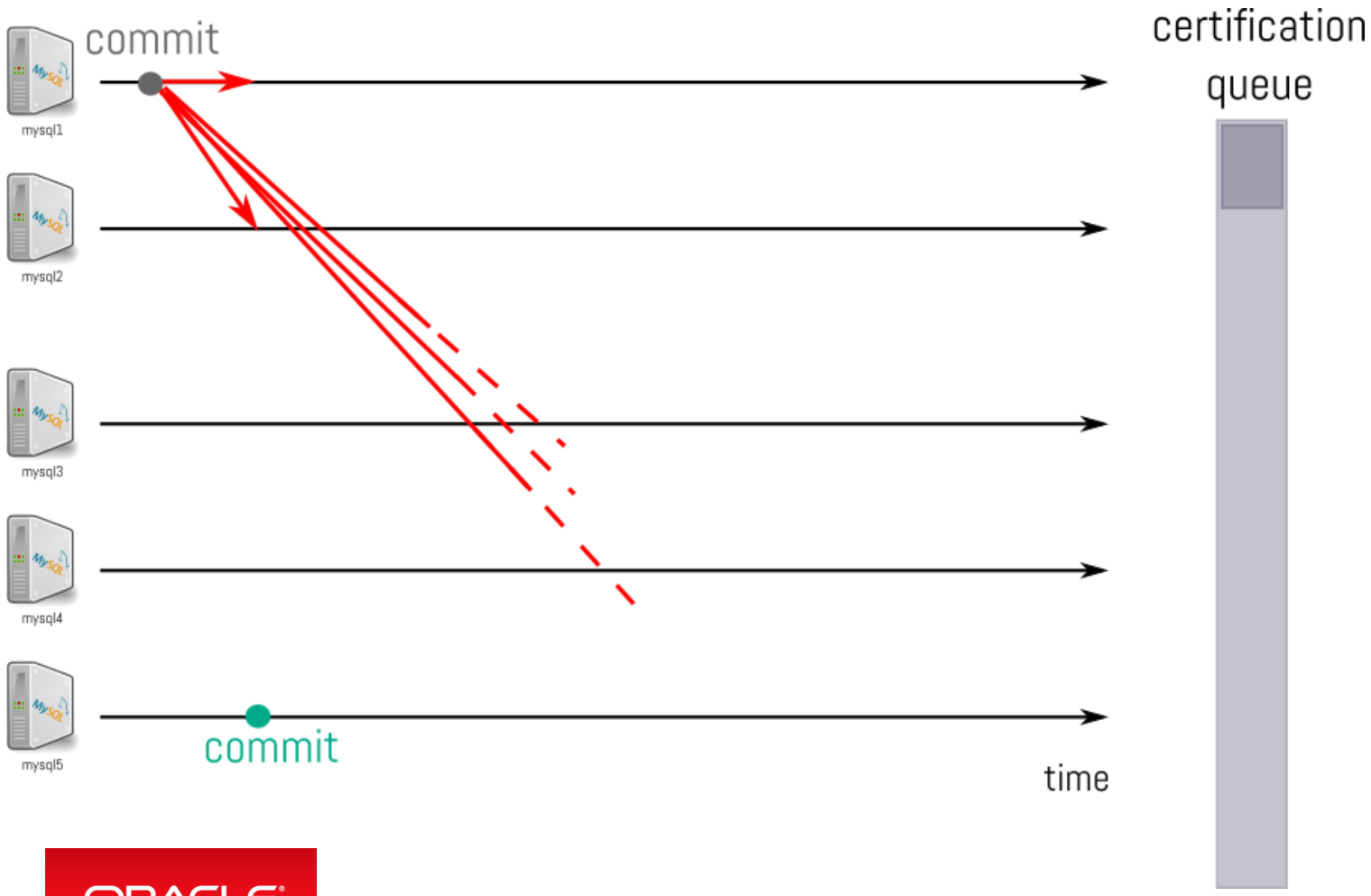

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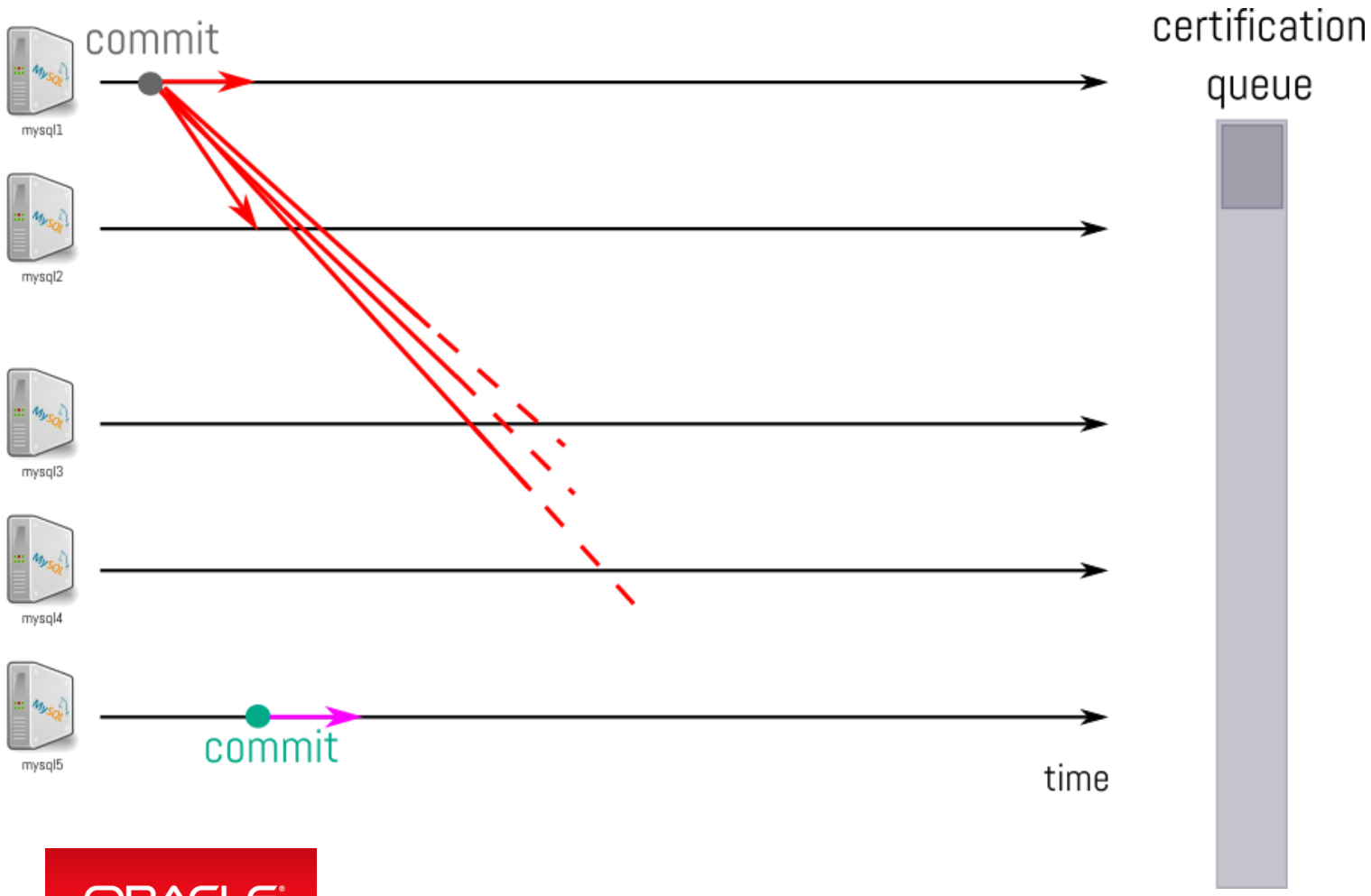

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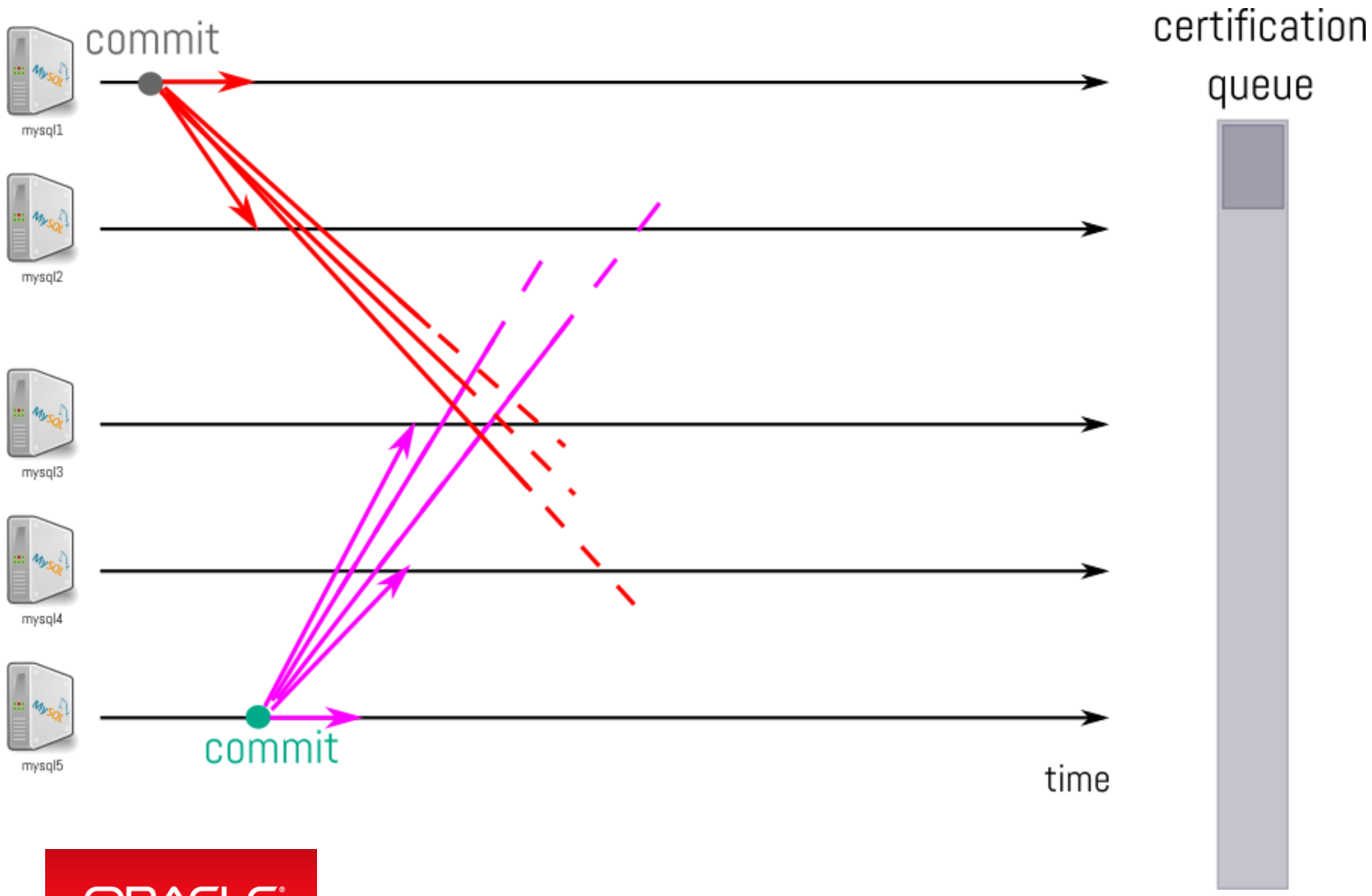

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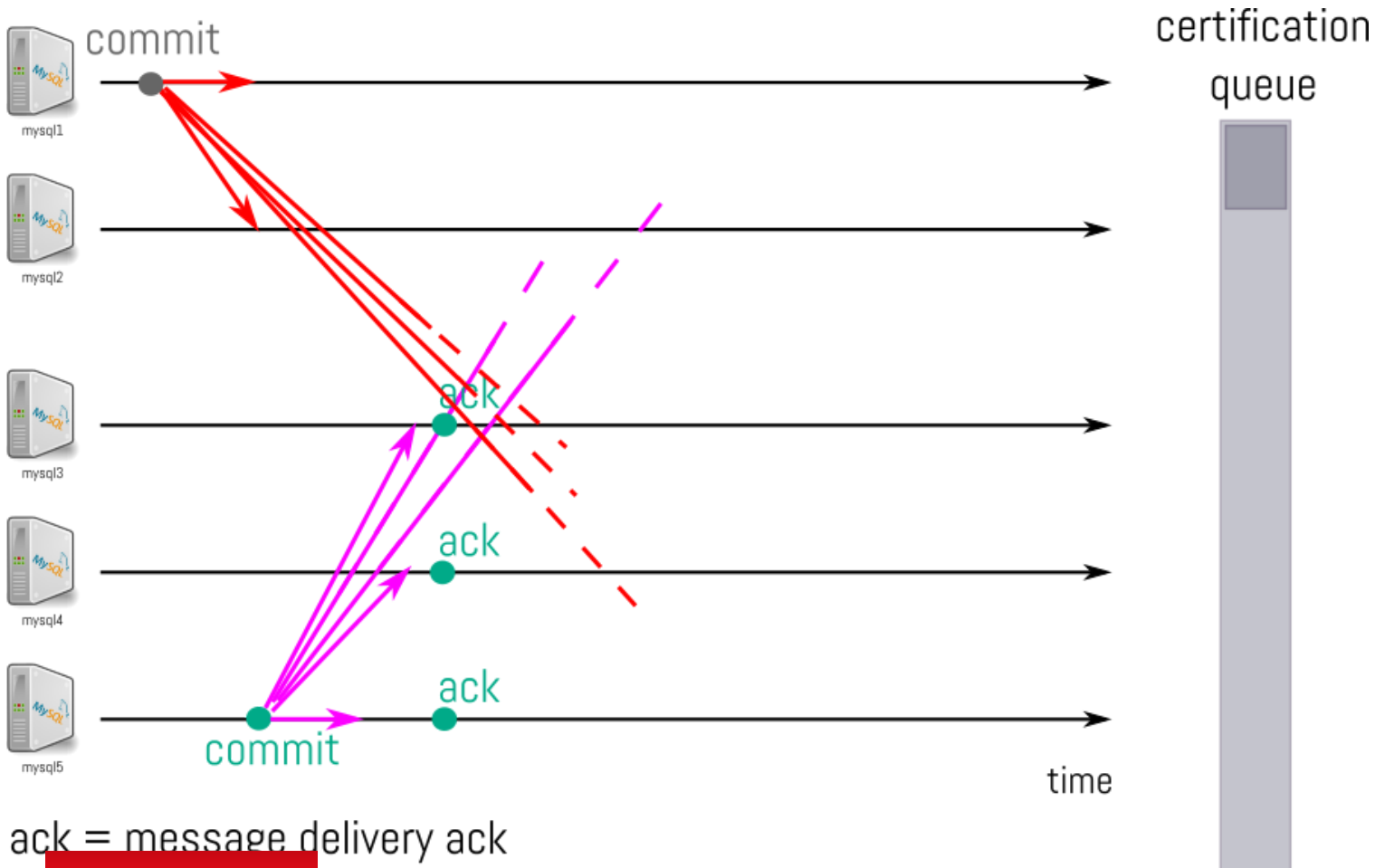

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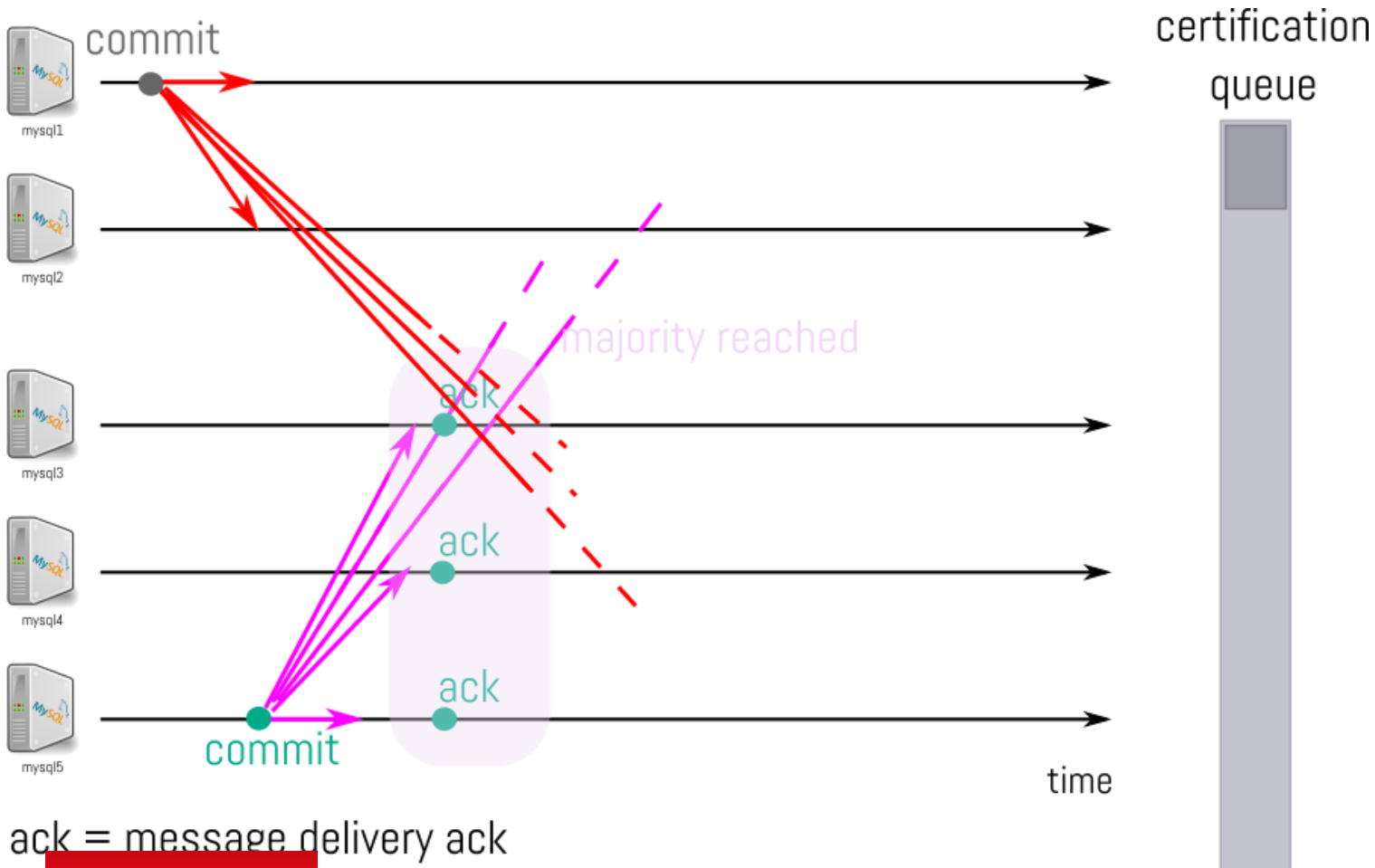

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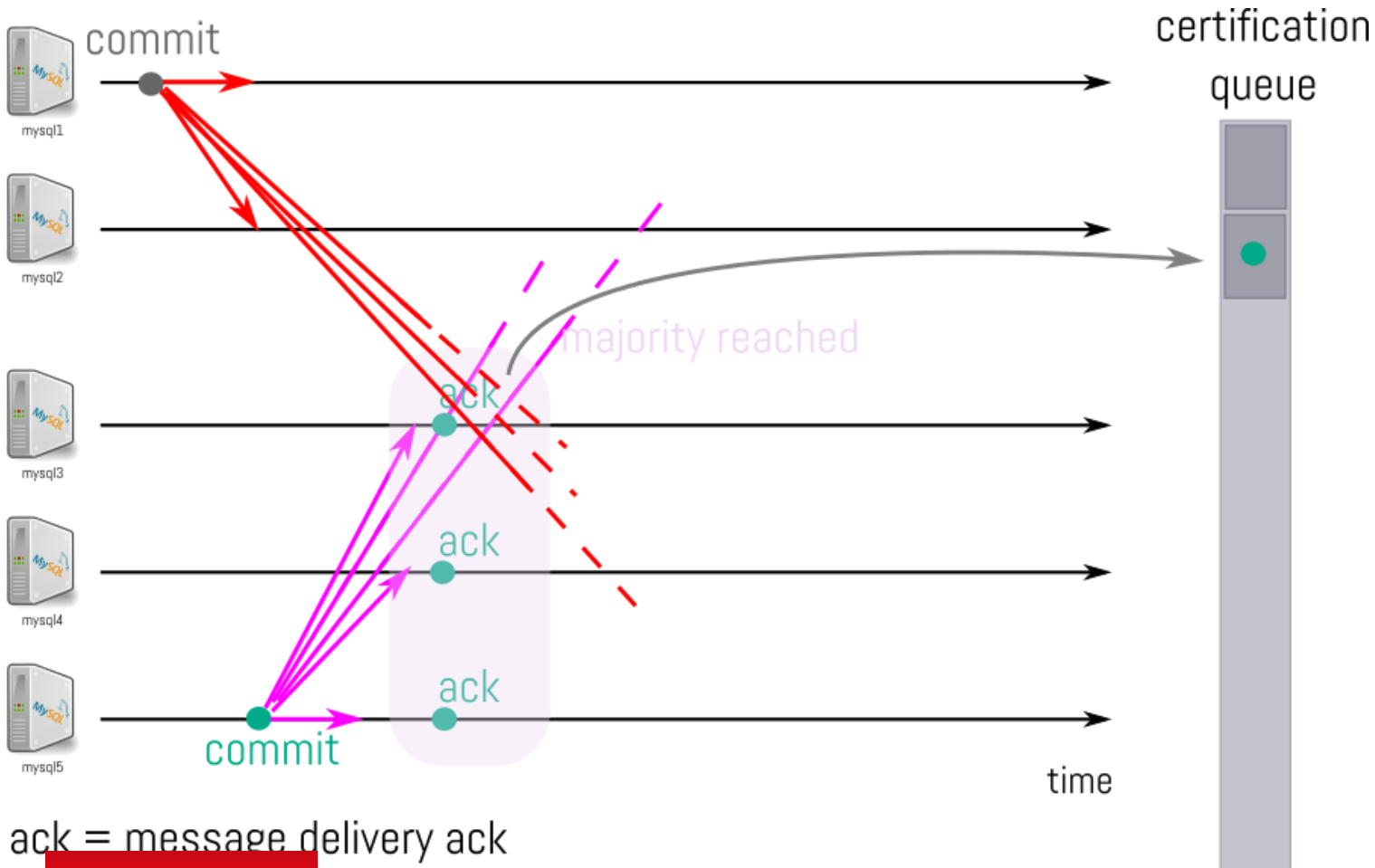

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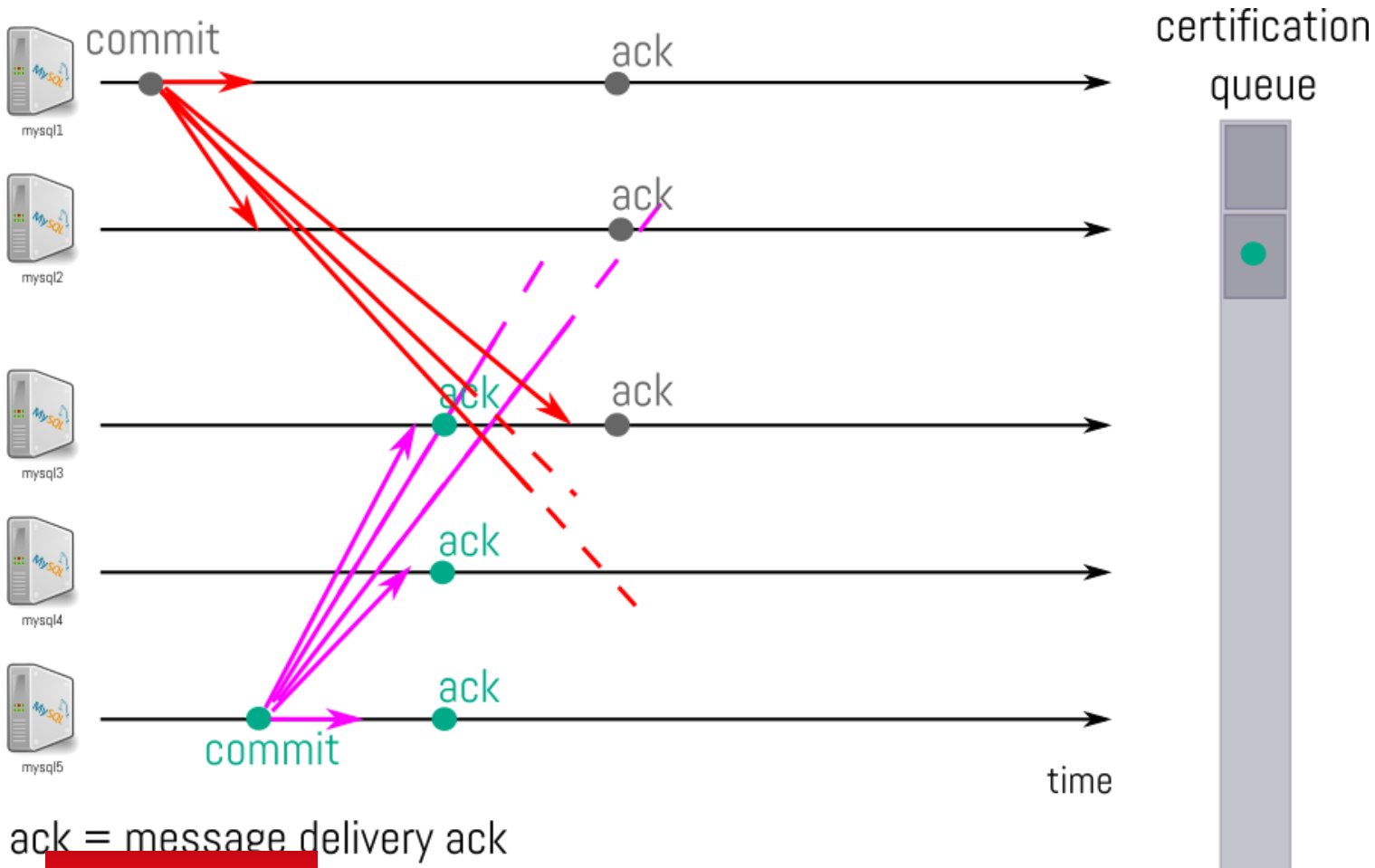

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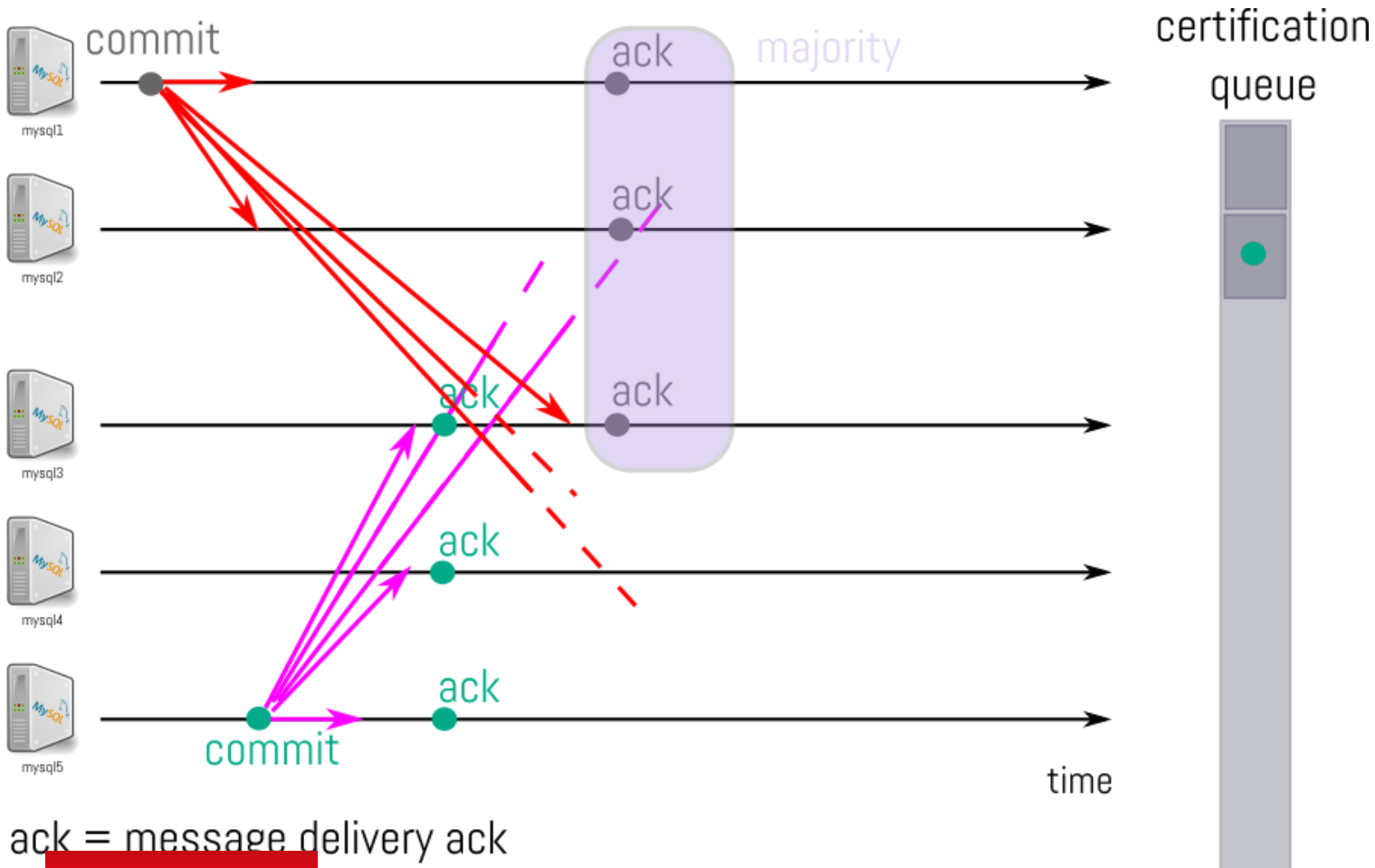

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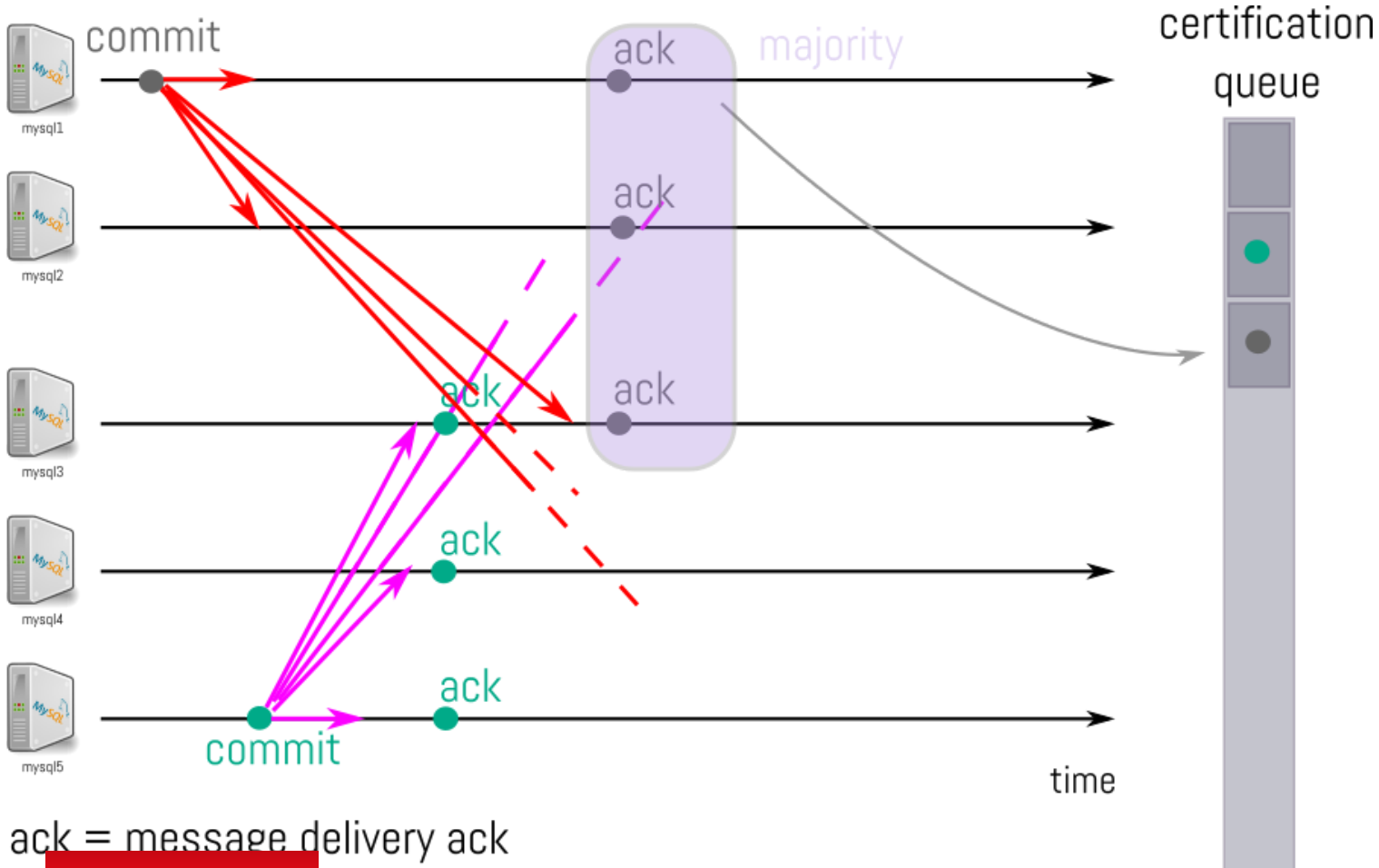

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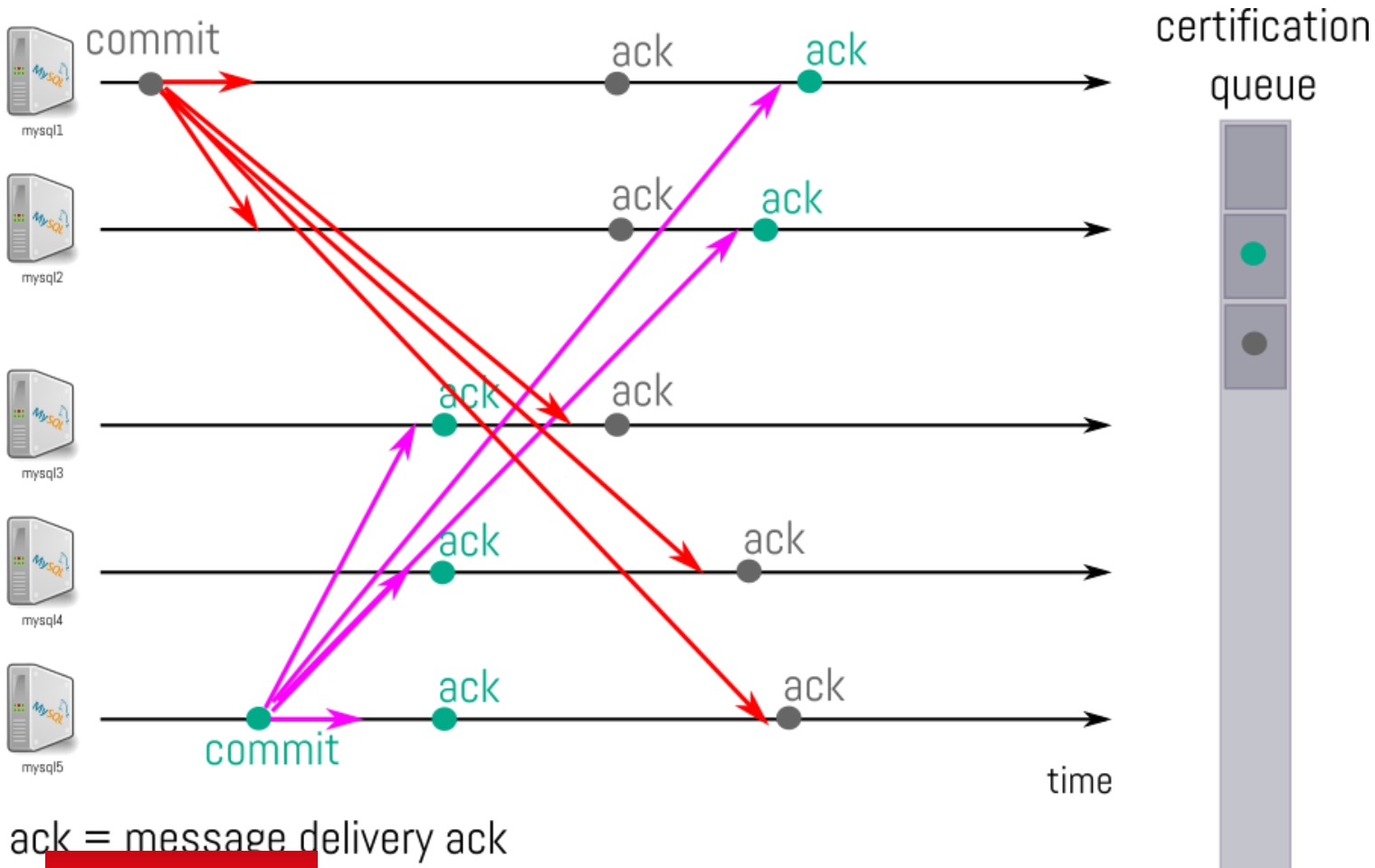

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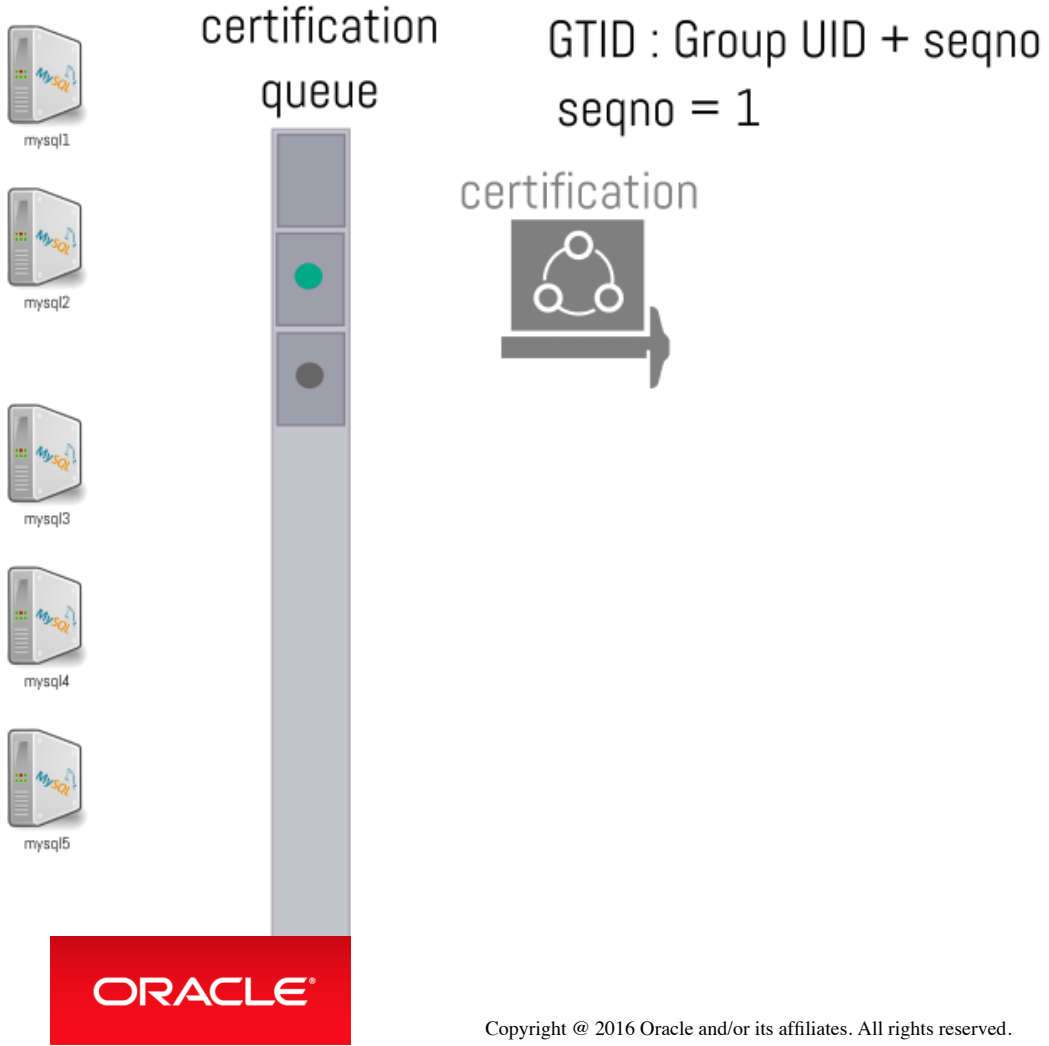

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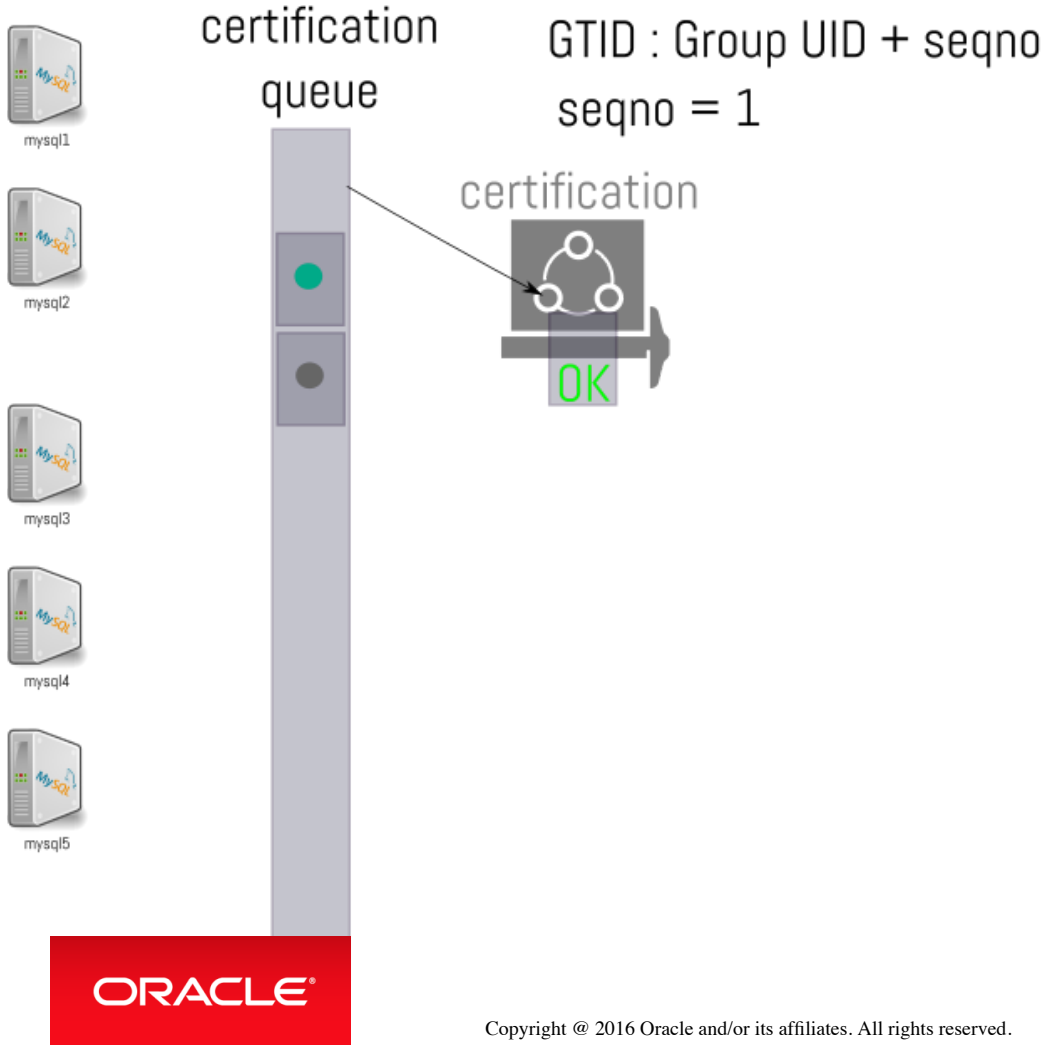

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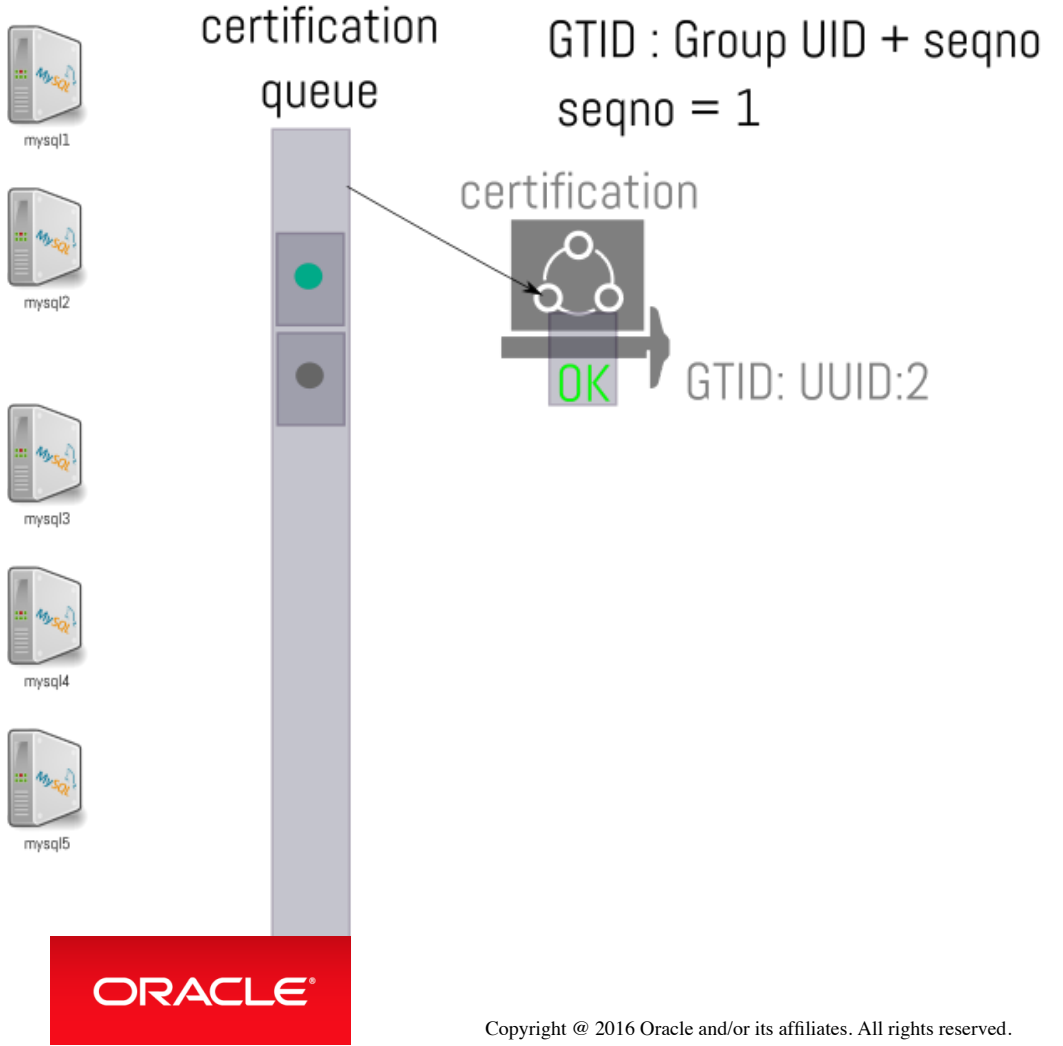
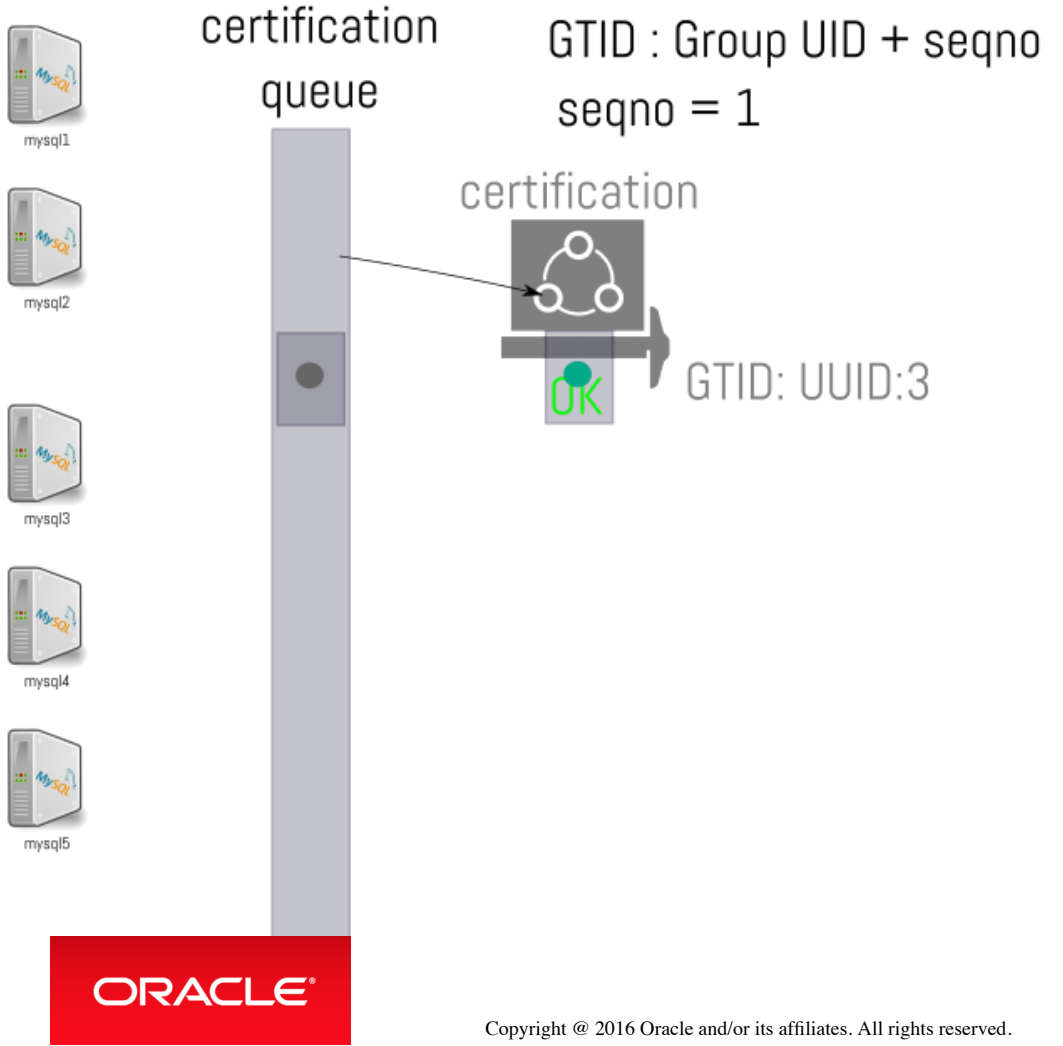


Group Replication : Total Order Delivery - GTID



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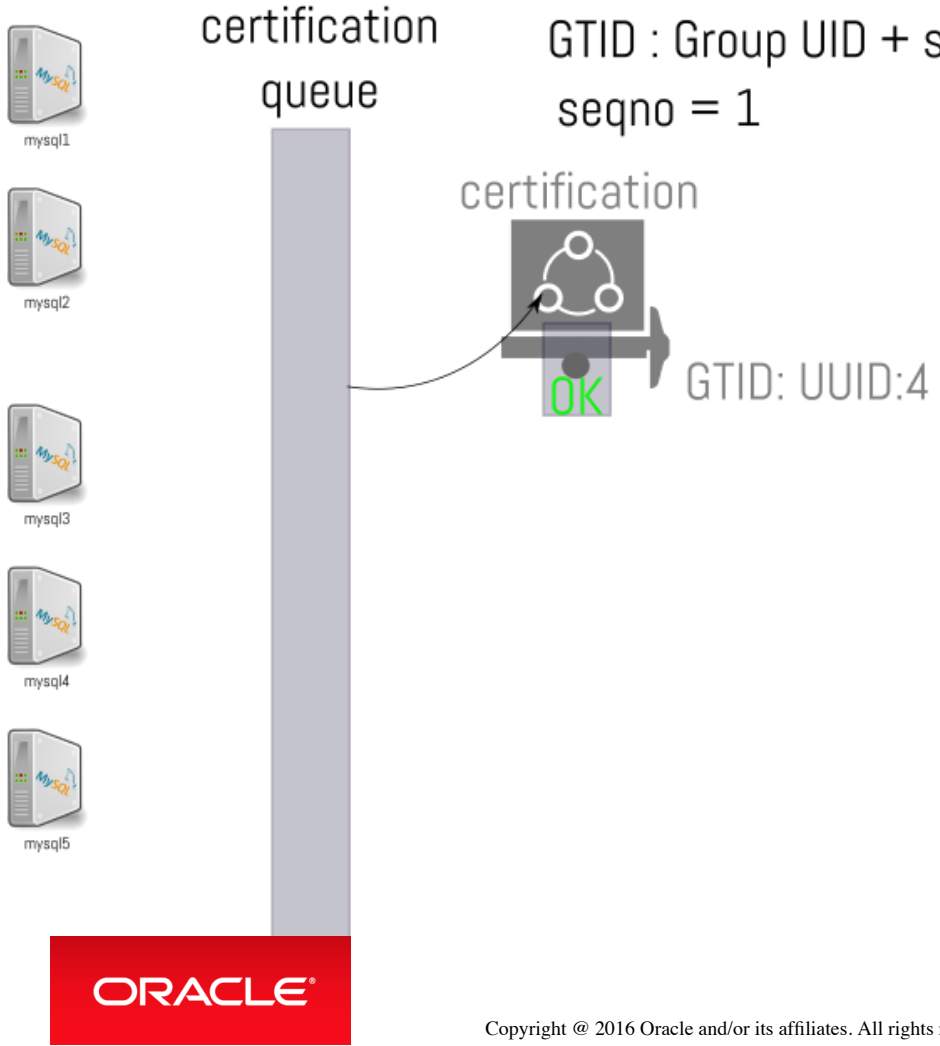


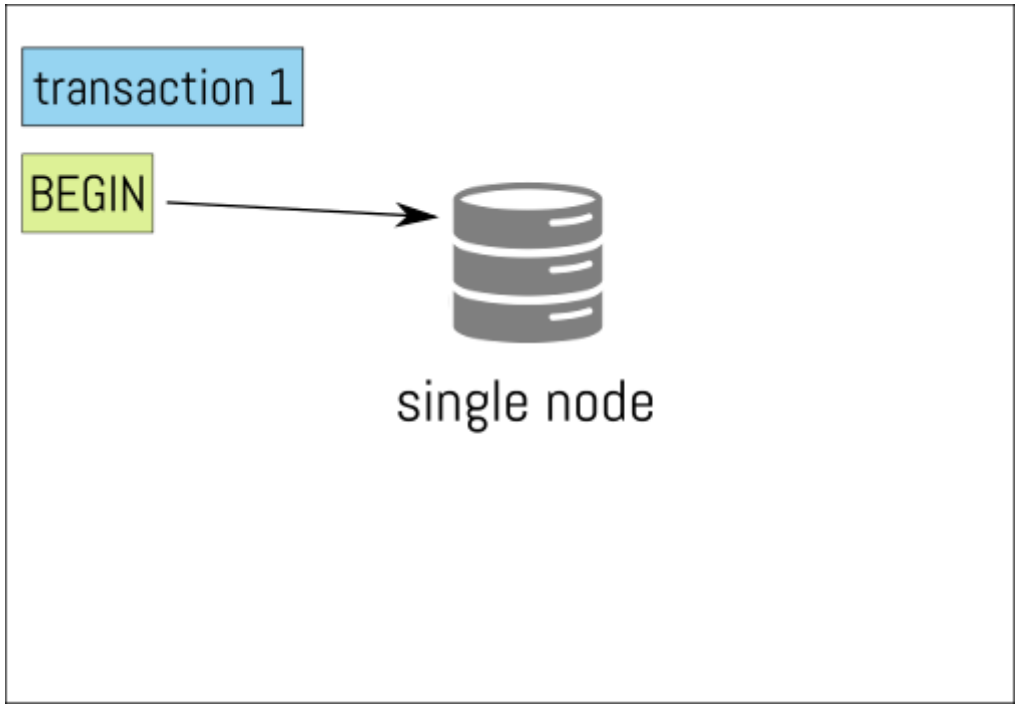
Group Replication : Optimistic Locking

Group Replication uses optimistic locking

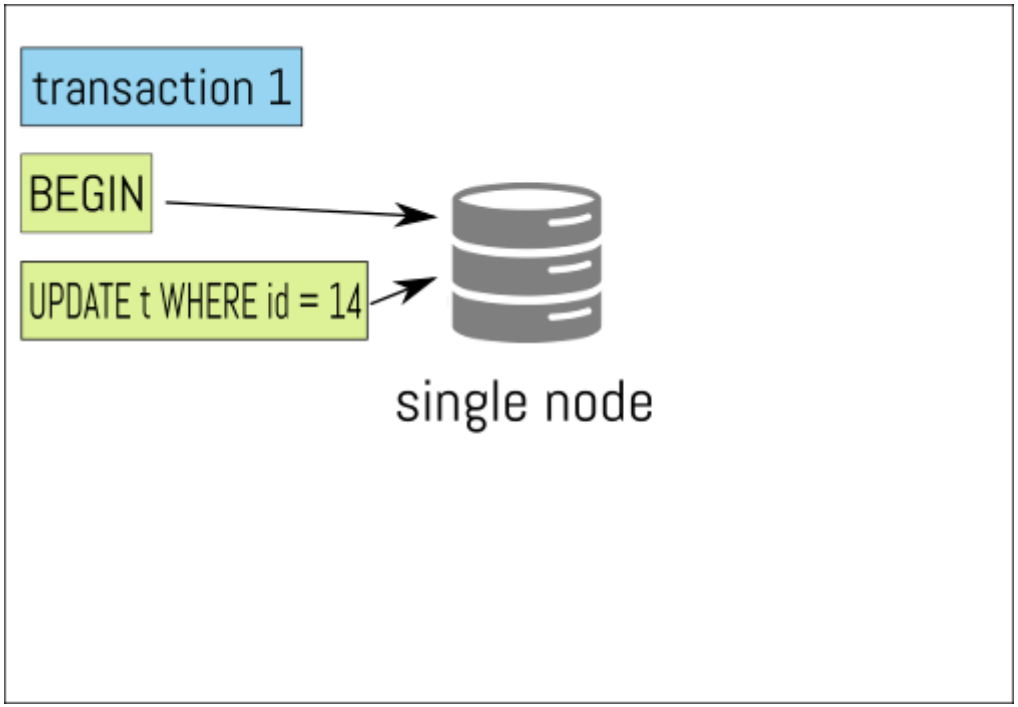
- during a transaction, **local (InnoDB) locking** happens
- **optimistically assumes** there will be no conflicts across nodes
  (no communication between nodes necessary)
- cluster-wide conflict resolution happens only at `COMMIT`, during **certification**

Let's first have a look at the traditional locking to compare.

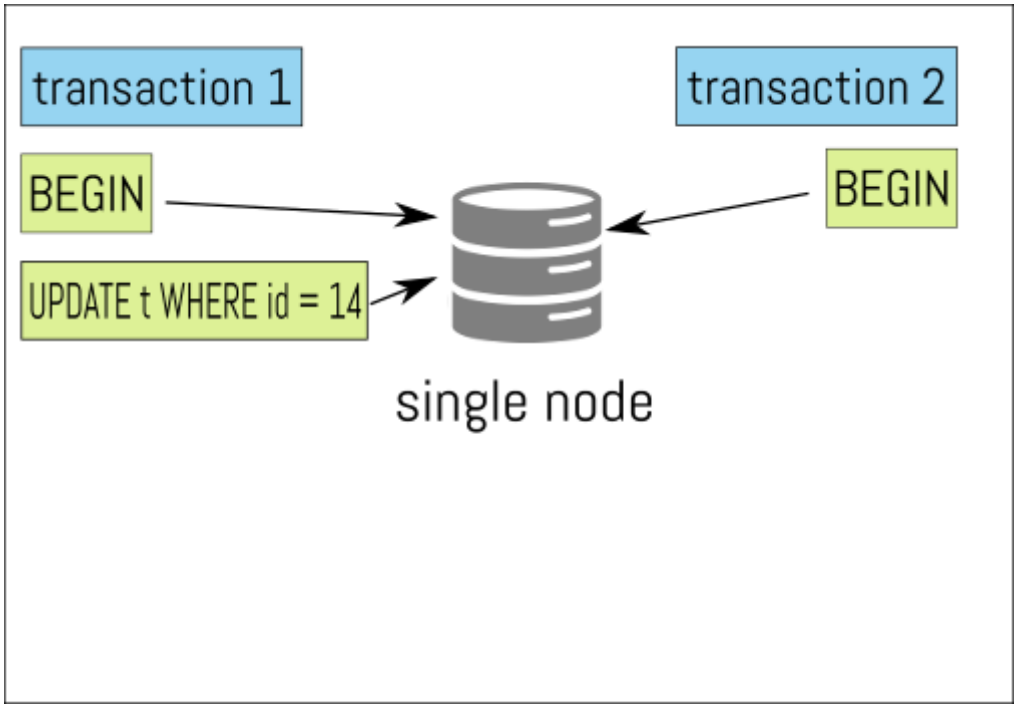
Traditional locking



Traditional locking



Traditional locking



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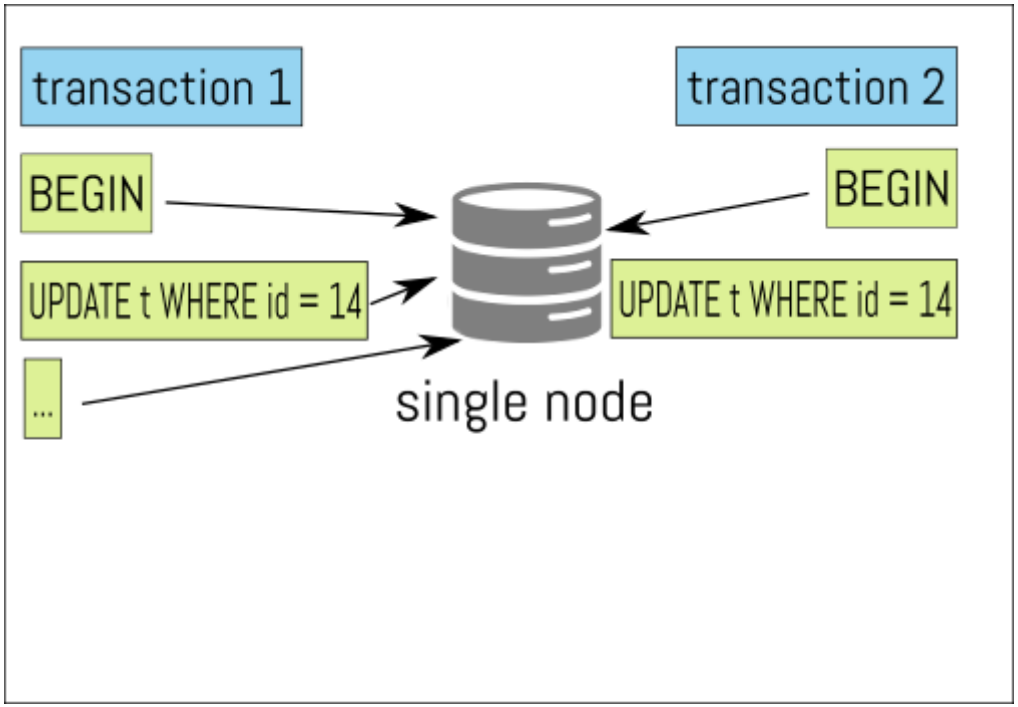

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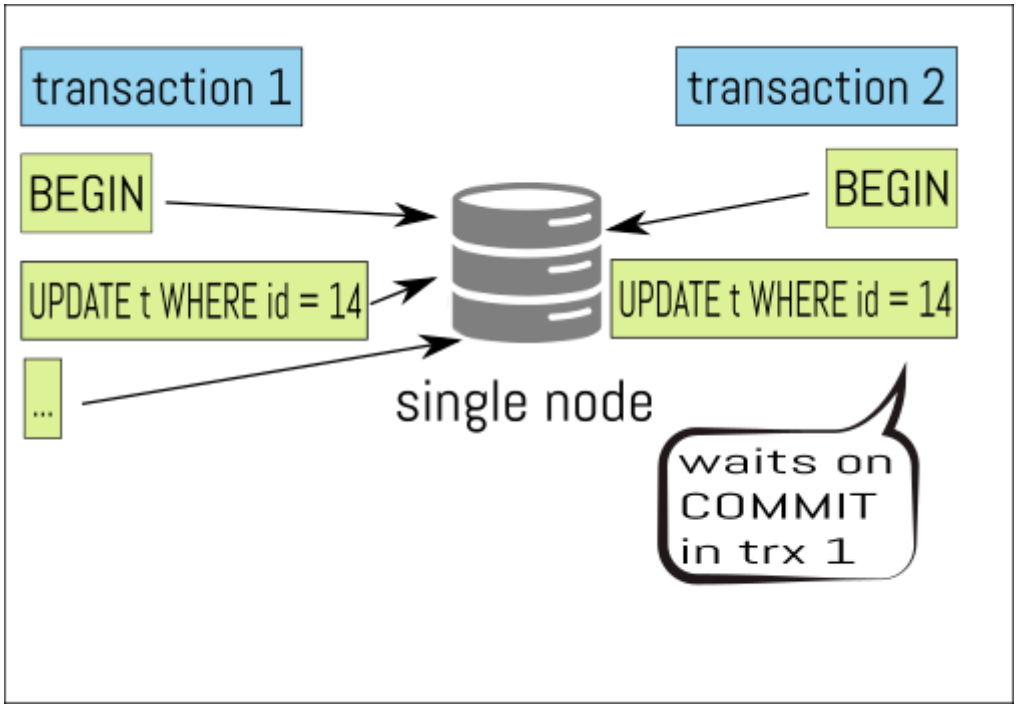

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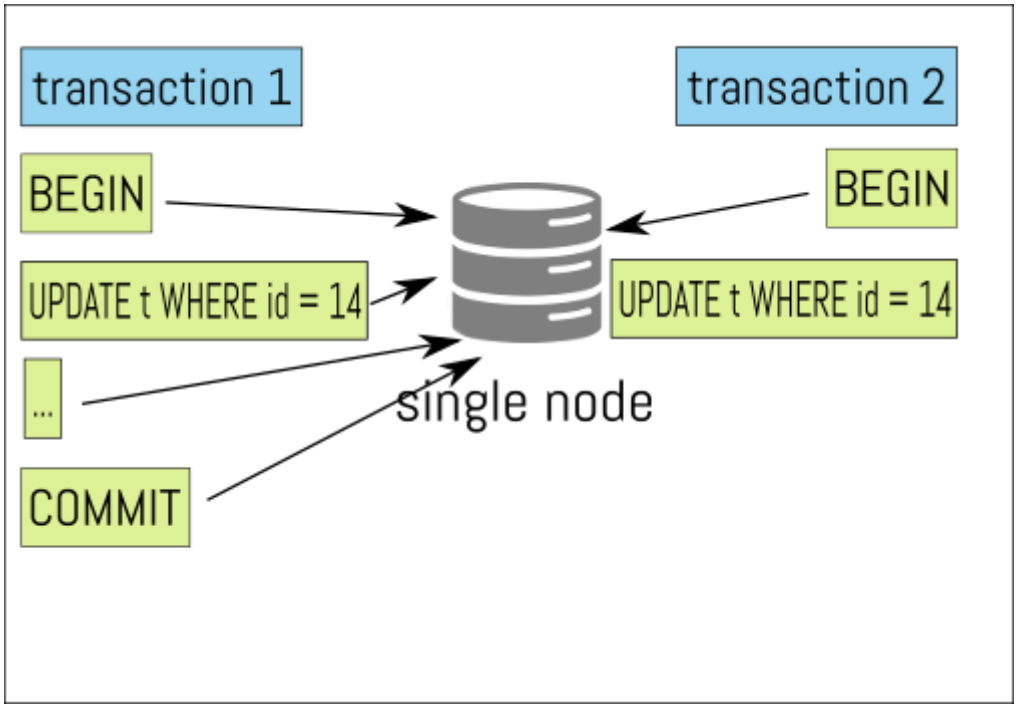

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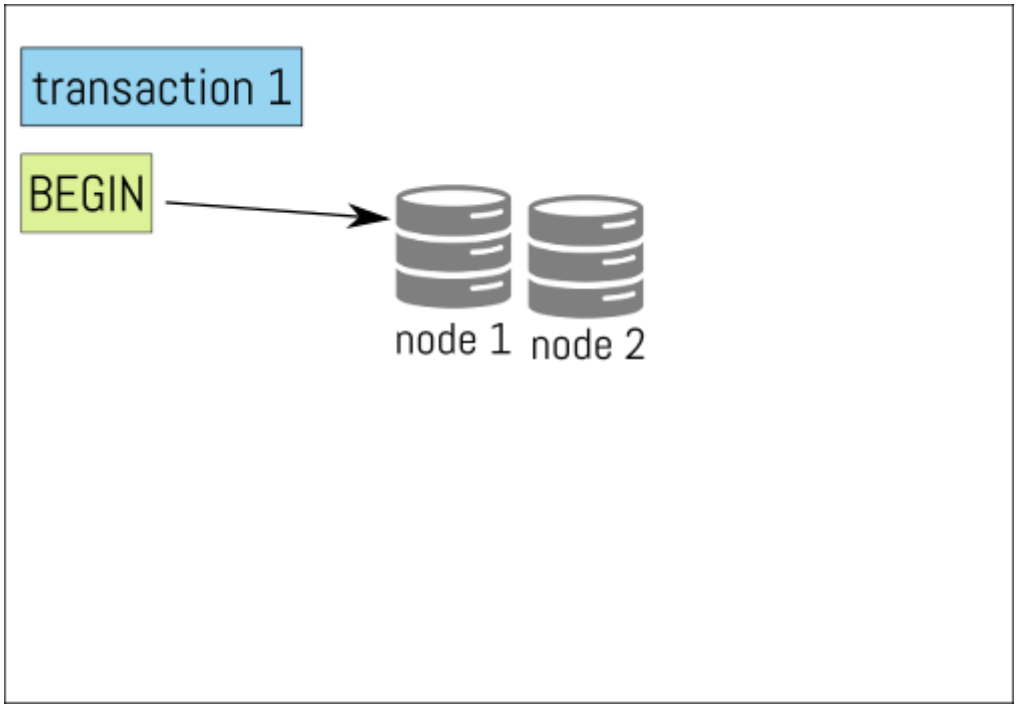

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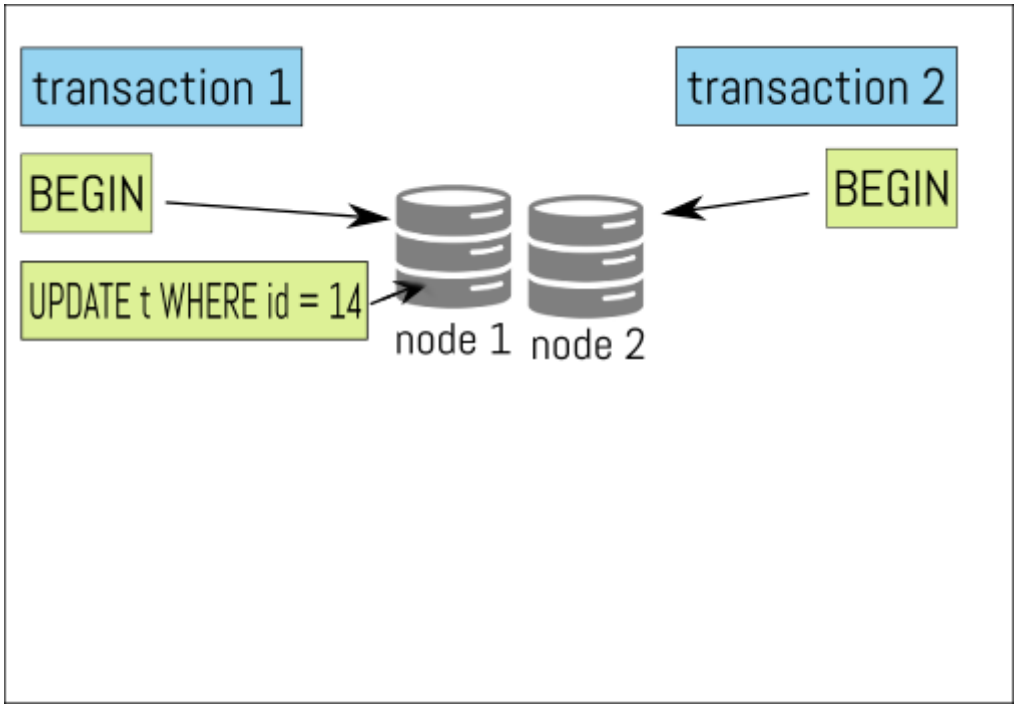

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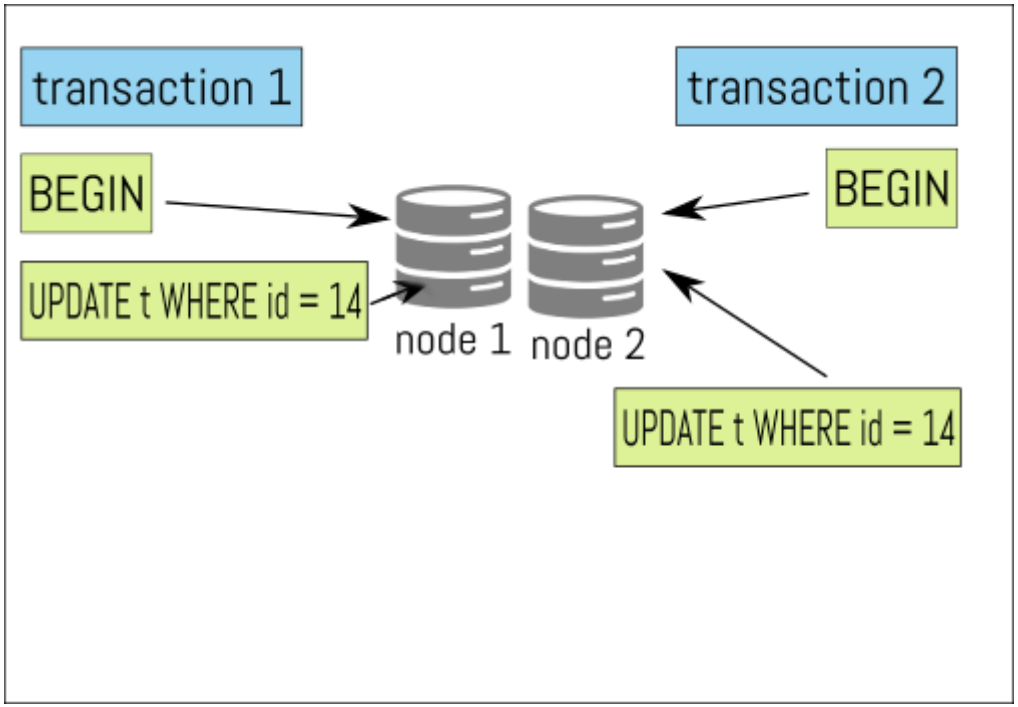

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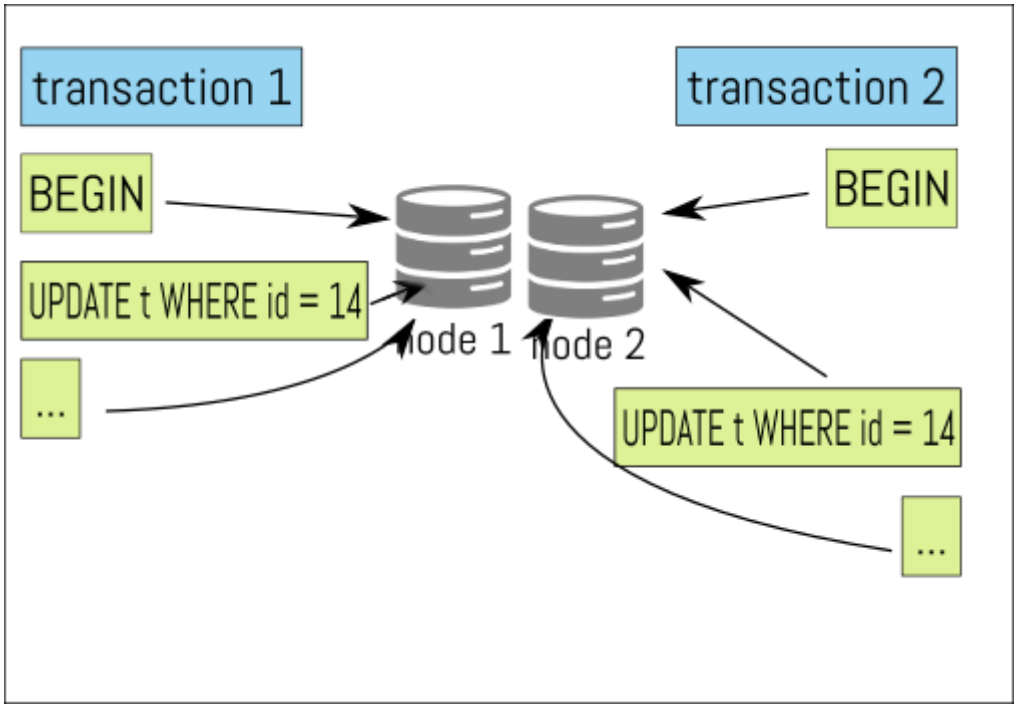
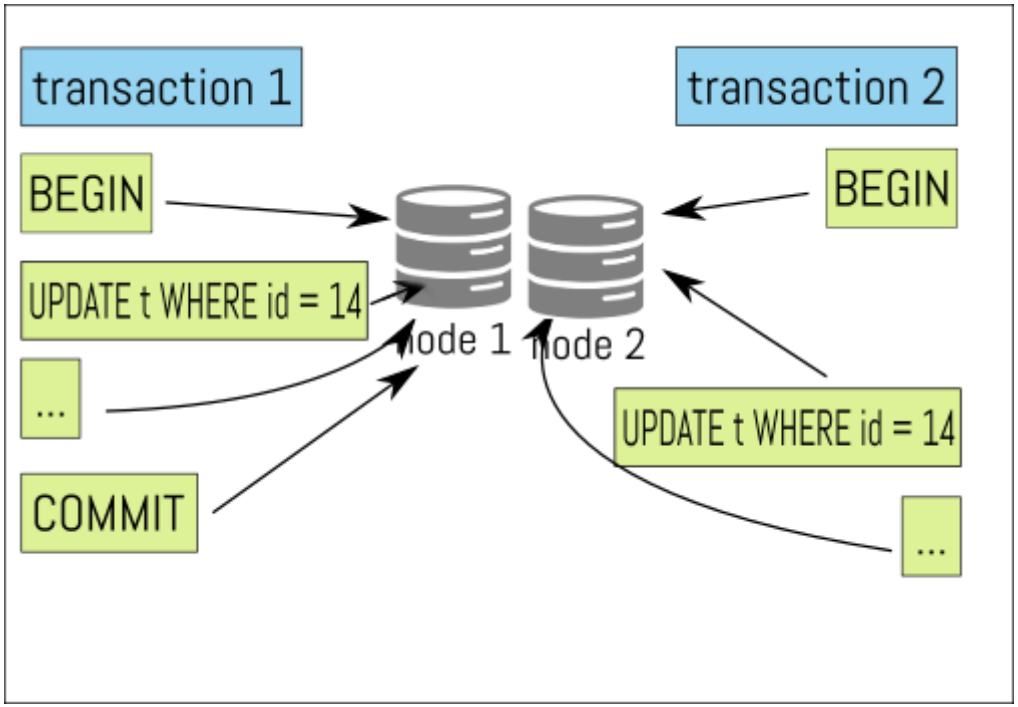
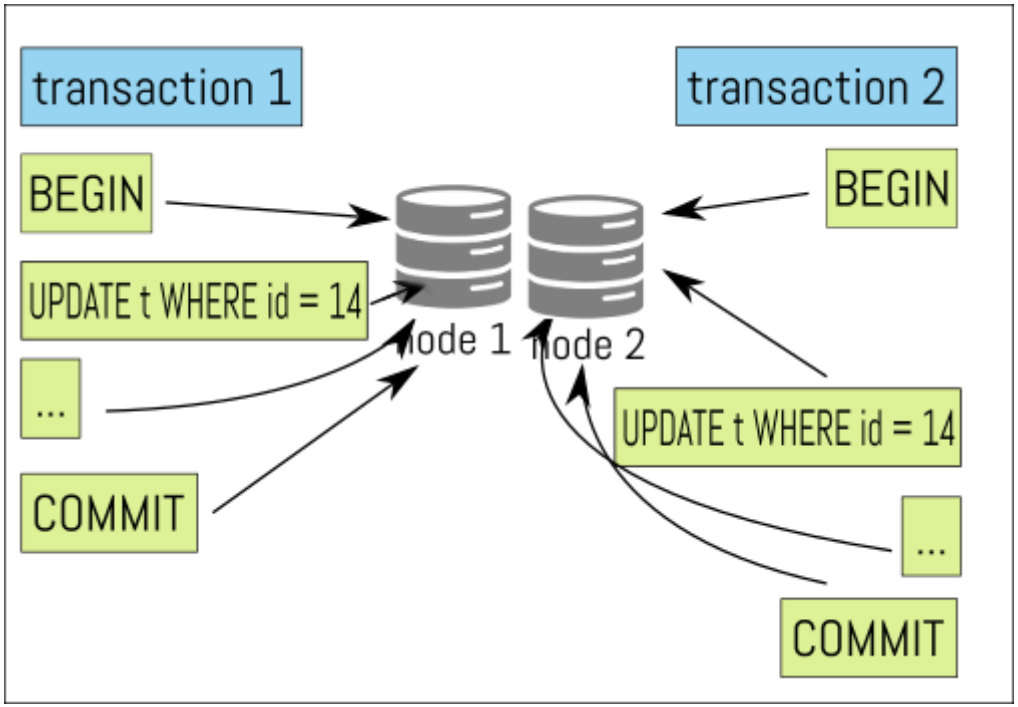


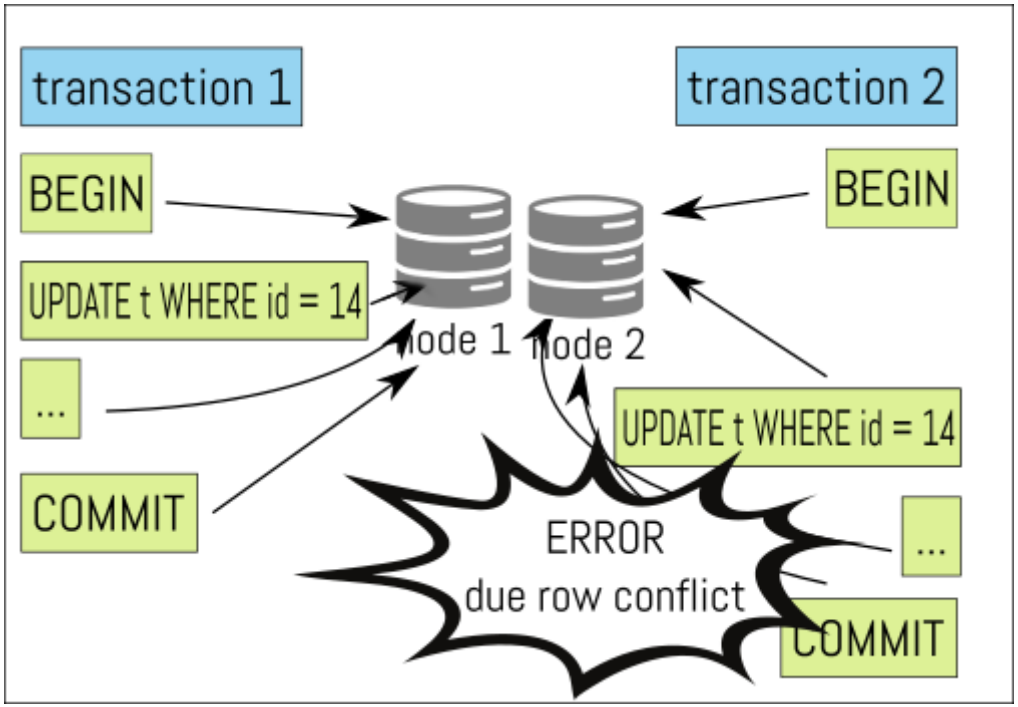
Optimistic Locking



Optimistic Locking



Optimistic Locking



The system returns error 149 as certification failed:

```
ERROR 1180 (HY000): Got error 149 during COMMIT
```

Group Replication : requirements

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- every tables must have a PK defined
- only IPV4 is supported
- a good network with low latency is important
- maximum of 9 members per group
- `log-bin` must be enabled and only **ROW** format is supported

Group Replication : requirements (2)

- enable GTIDs

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- replication meta-data must be stored on system tables

```
--master-info-repository=TABLE
--relay-log-info-repository=TABLE
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```
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- `log-slave-updates` must be enabled

Group Replication : limitations

There are also some technical limitations:

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Group Replication : limitations

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- binlog checksum is not supported

```
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```

- Savepoints are not supported
- *SERIALIZABLE* is not supported as transaction isolation level
- an object cannot be changed concurrently at different servers by two operations, where one of them is a **DDL** and the other is either a DML or DDL.

Is my workload ready for Group Replication ?

As the writesets (transactions) are replicated to all available nodes on commit, and as they are certified on every node, a very large writeset could increase the amount of certification errors.

Additionally, changing the same record on all the nodes (hotspot) concurrently will also cause problems.

And finally, the certification uses the primary key of the tables, a table without PK is also a problem.

Is my workload ready for Group Replication ?

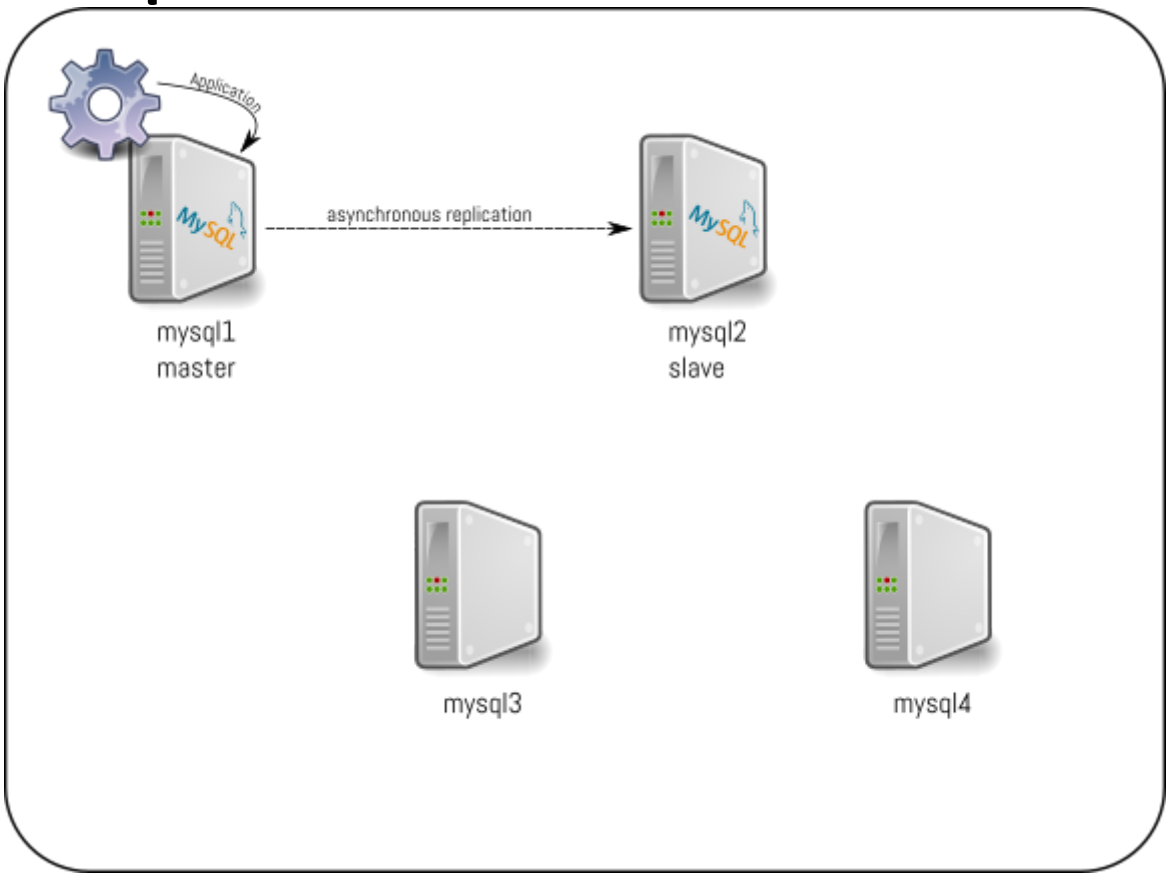
Therefore, when using Group Replication, we should pay attention to these points:

- PK is mandatory (and a good one is better)
- avoid large transactions
- avoid hotspot

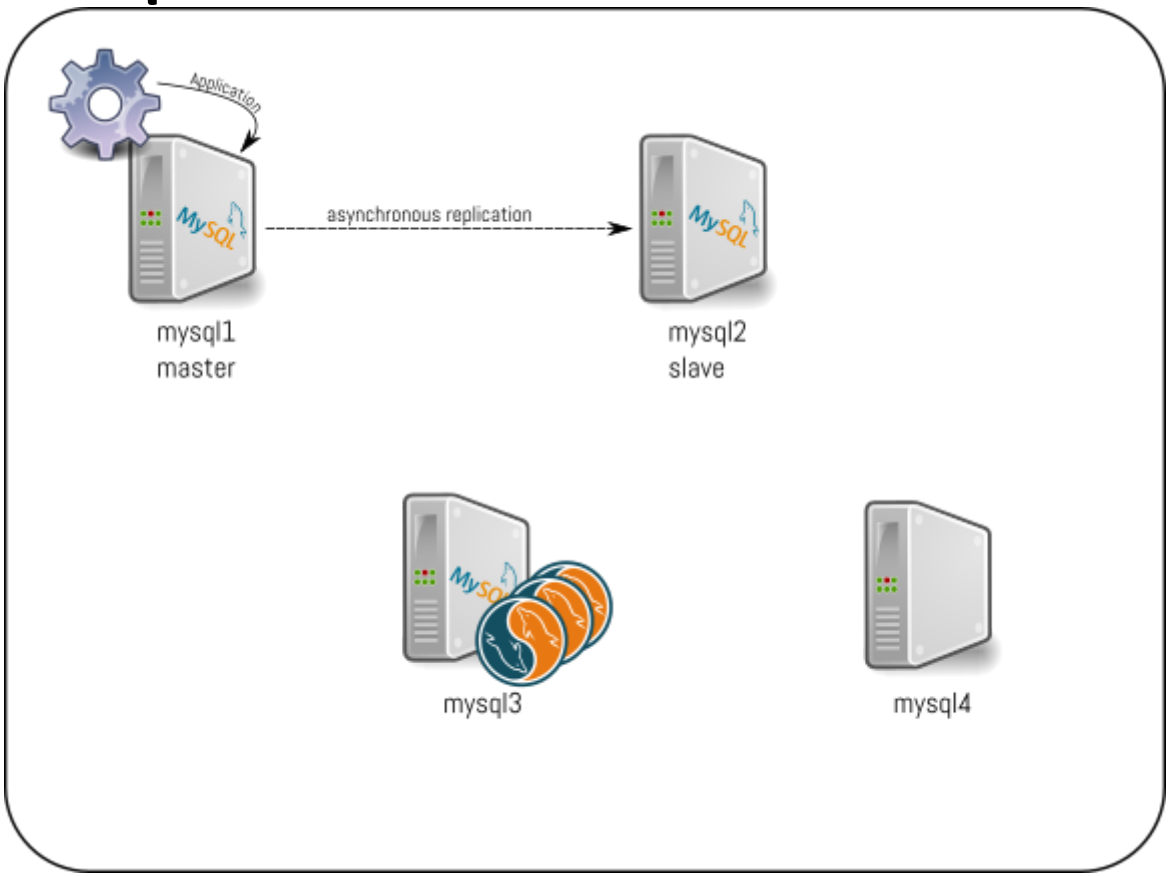
ready ?

Migration from Master-Slave to GR

The plan

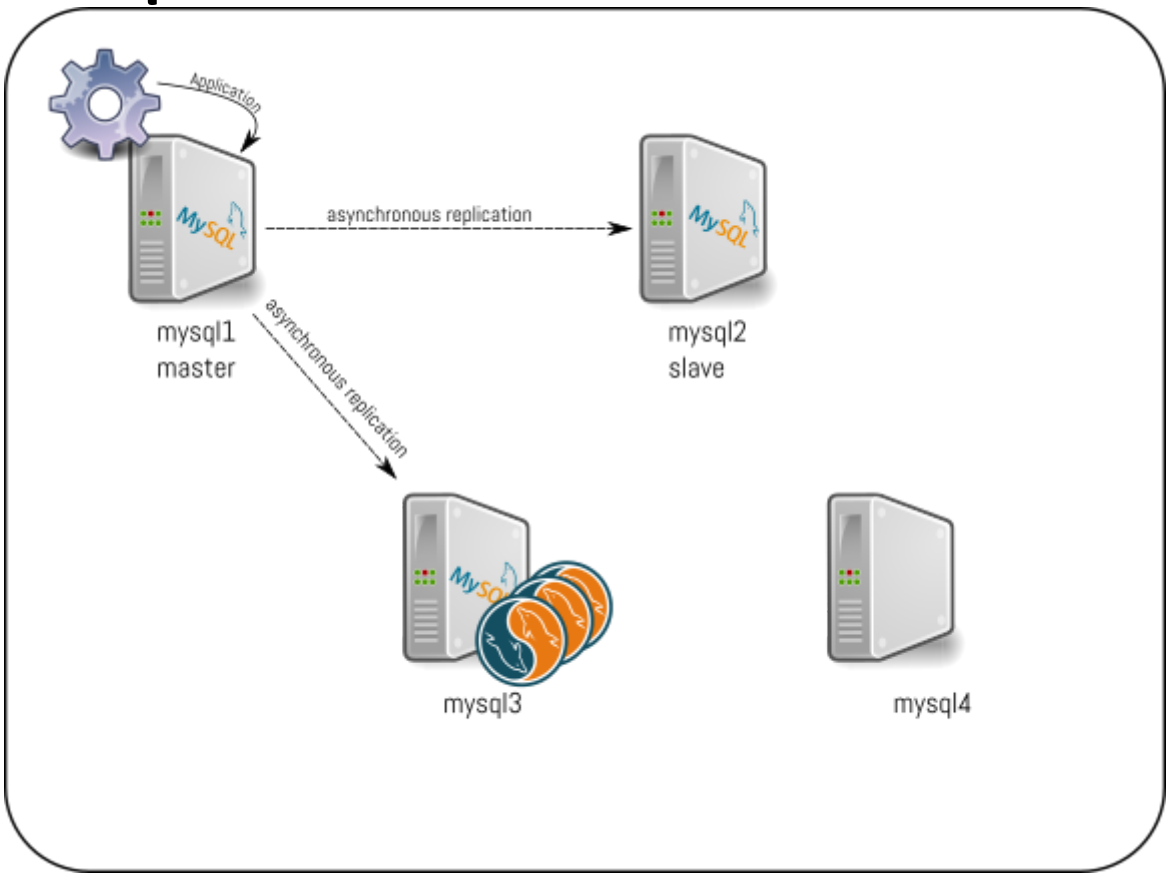


The plan



1) We install and setup MySQL InnoDB Cluster on one of the new servers

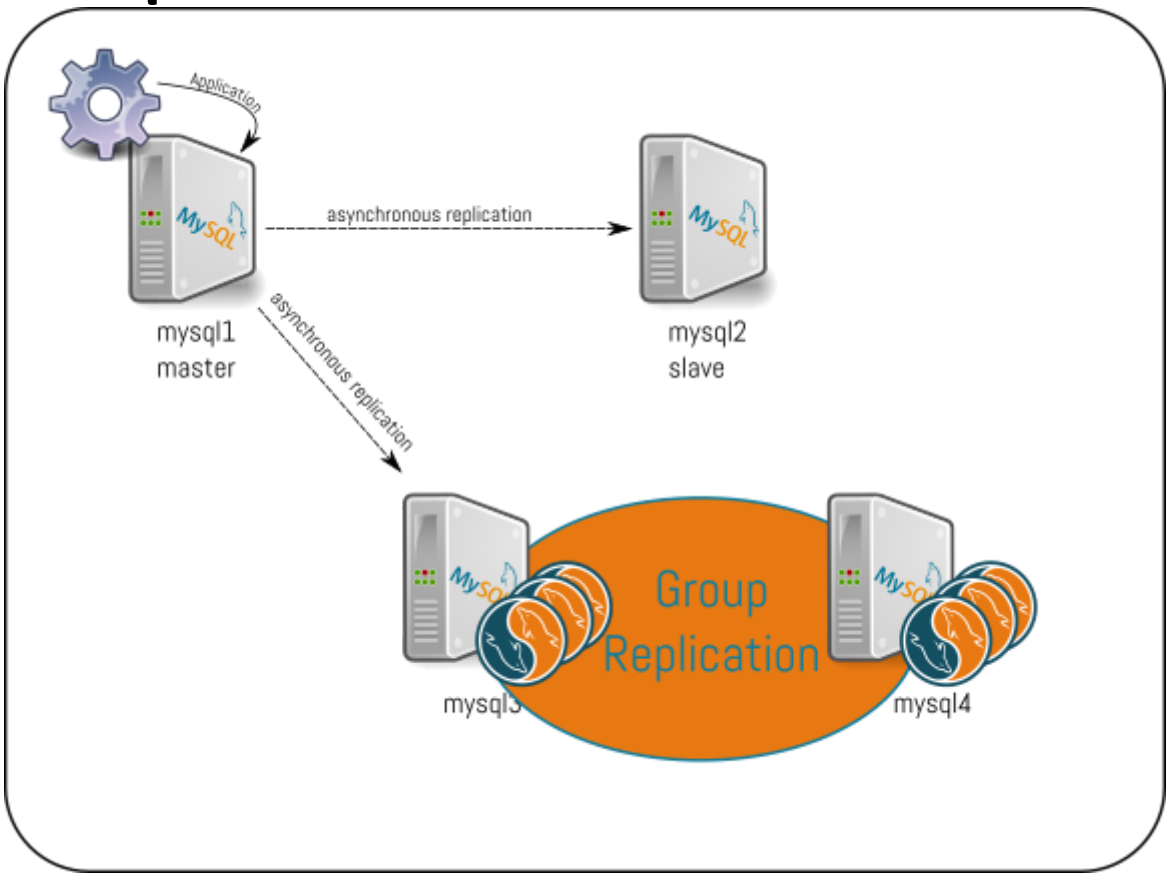
The plan



2) We restore a backup

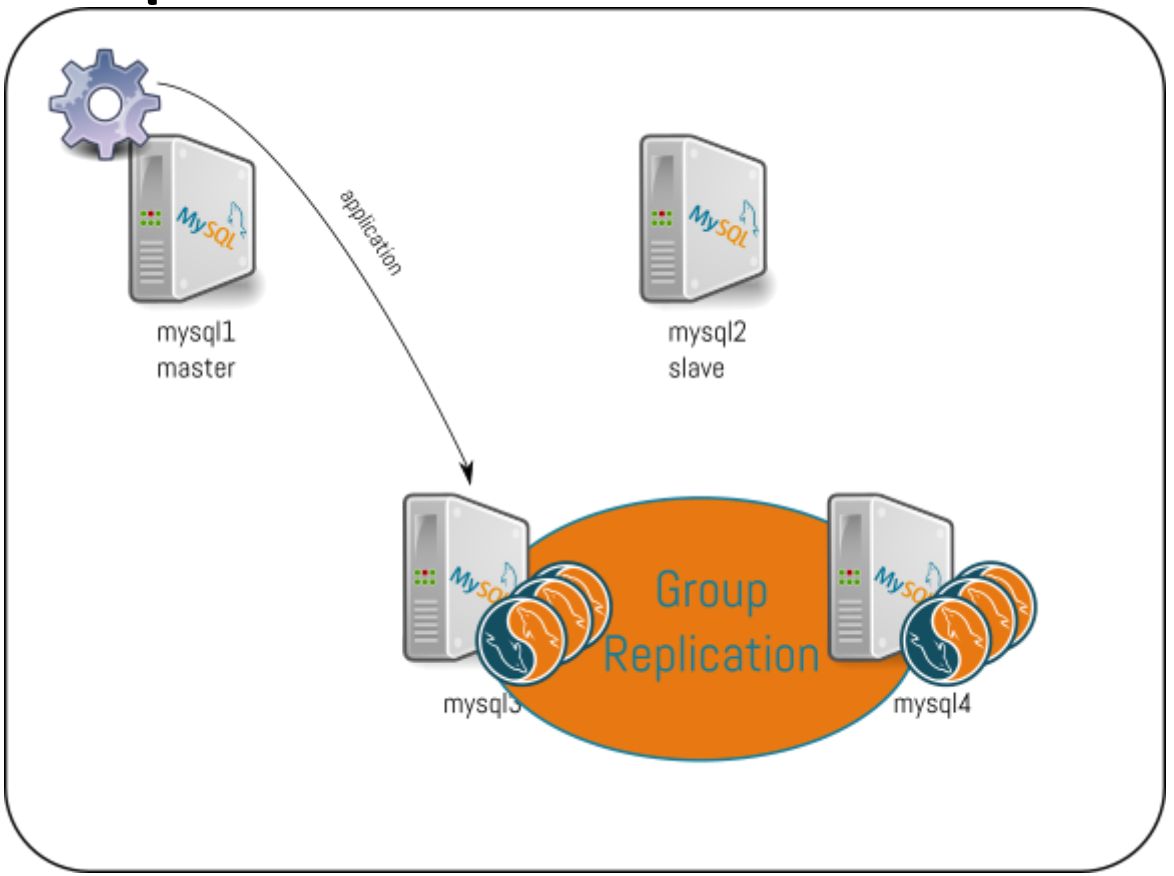
3) setup asynchronous replication on the new server.

The plan



4) We add a new instance to our group

The plan

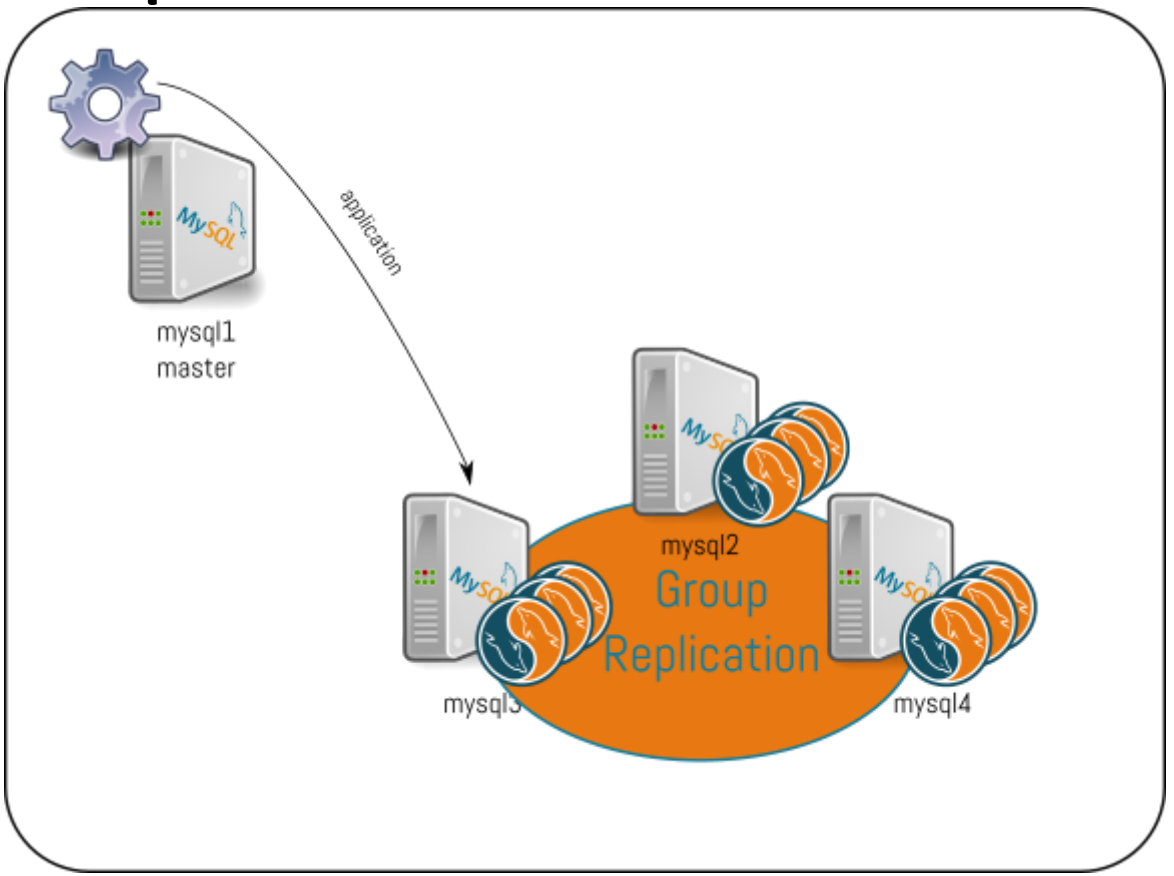


5) We point the application to one of our new nodes.

6) We wait and check that asynchronous replication is caught up

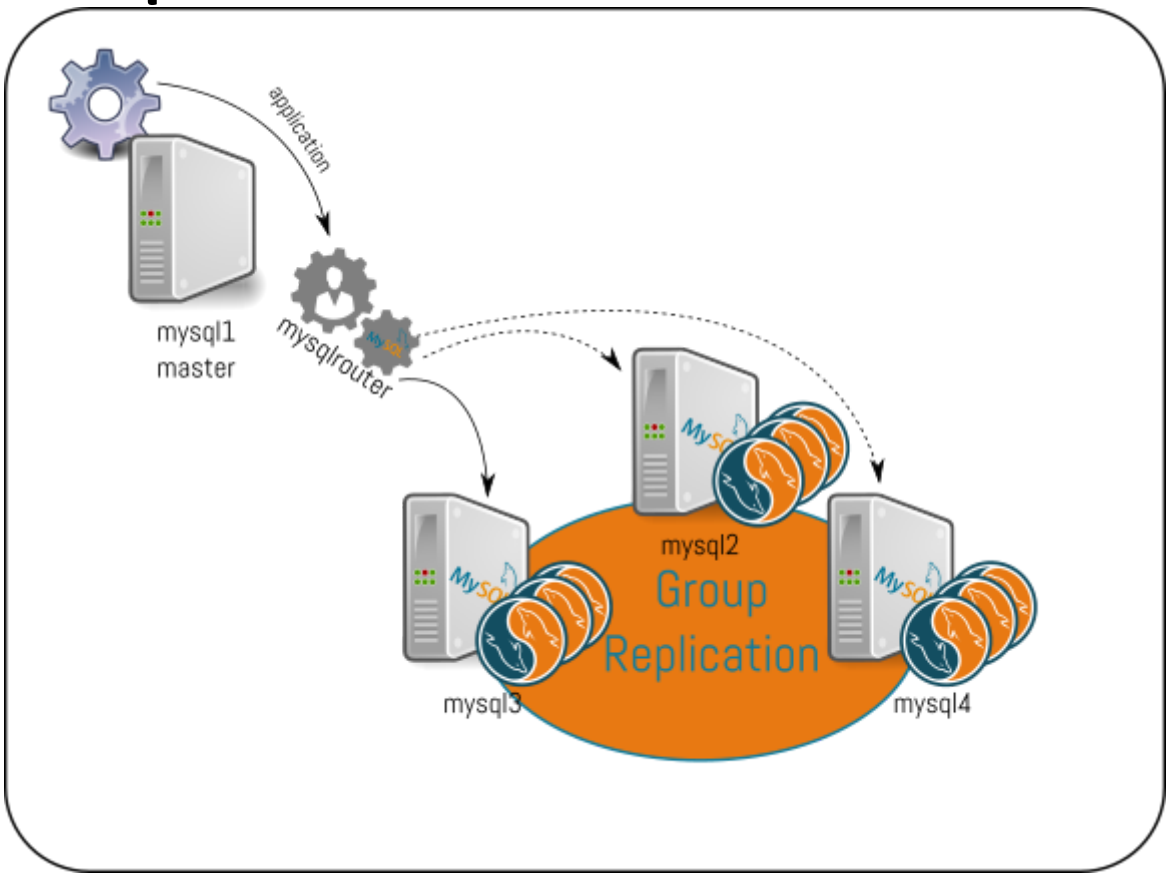
7) we stop those asynchronous slaves

The plan

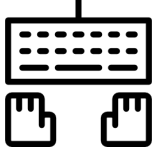


8) We attach the mysql2 slave to the group

The plan



9) Use MySQL Router for directing traffic



LAB2: Prepare mysql3

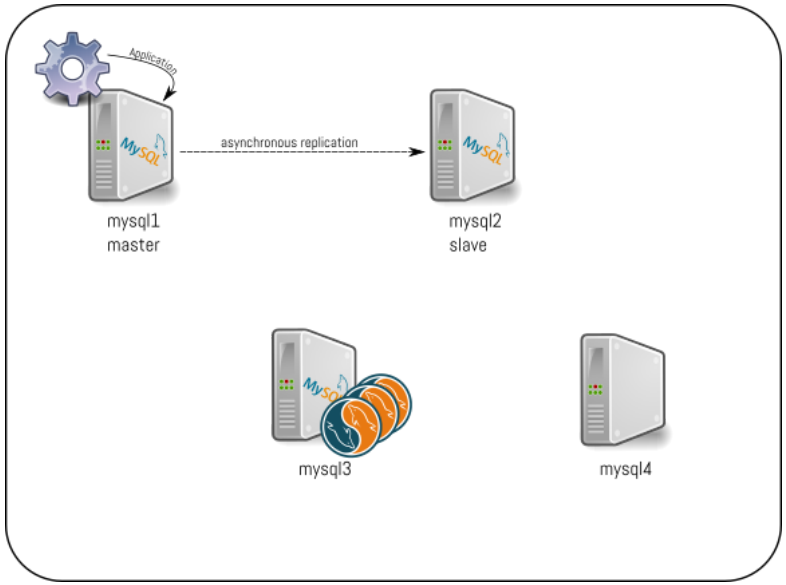
Asynchronous slave

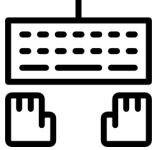
MySQL InnoDB Cluster from Labs is already installed on `mysql3`.

Let's take a backup on `mysql1`:

```
[mysql1 ~]# xtrabackup --backup \
  --target-dir=/tmp/backup \
  --user=root \
  --password=X --host=127.0.0.1

[mysql1 ~]# xtrabackup --prepare \
  --target-dir=/tmp/backup
```





LAB2: Prepare mysql3 (2)

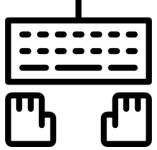
Asynchronous slave

Copy the backup from `mysql1` to `mysql3`:

```
[mysql1 ~]# scp -r /tmp/backup mysql3:/tmp
```

And restore it:

```
[mysql3 ~]# xtrabackup --copy-back --target-dir=/tmp/backup
[mysql3 ~]# chown -R mysql. /var/lib/mysql
```

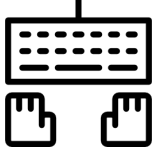


LAB3: mysql3 as asynchronous slave (2)

Asynchronous slave

Configure `/etc/my.cnf`:

```
[mysqld]
...
server_id=3
enforce_gtid_consistency = on
gtid_mode  = on
log_bin
log_slave_updates
```

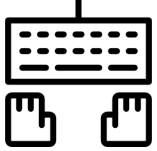



LAB2: Prepare mysql3 (3)

Asynchronous slave

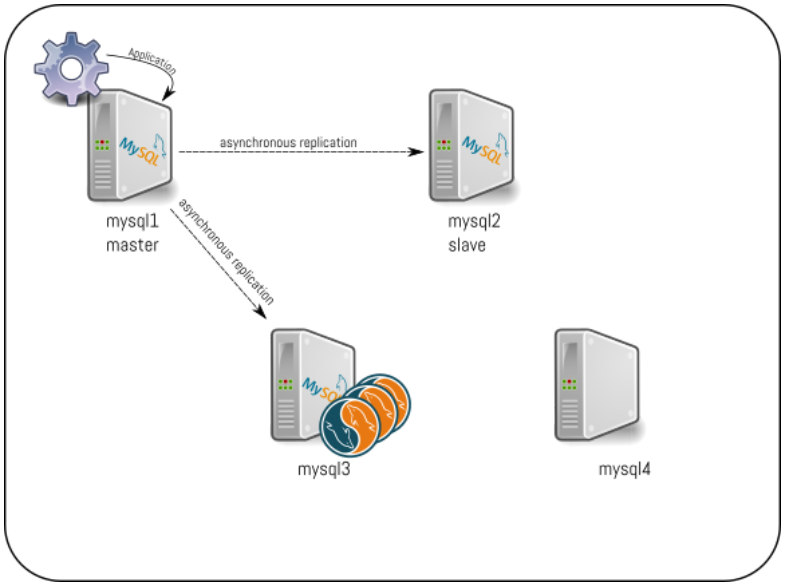
Let's start MySQL on `mysql3`:

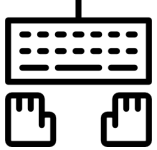
```
[mysql3 ~]# systemctl start mysqld
```



LAB3: mysql3 as asynchronous slave (1)

- find the GTIDs purged
- change MASTER
- set the purged GTIDs
- start replication





LAB3: mysql3 as asynchronous slave (2)

Find the latest purged GTIDs:

```
[mysql3 ~]# cat /tmp/backup/xtrabackup_binlog_info
mysql-bin.000002   167646328  b346474c-8601-11e6-9b39-08002718d305:1-771
```

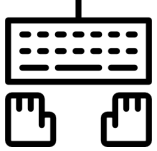
Connect to mysql3 and setup replication:

```
mysql> CHANGE MASTER TO MASTER_HOST="mysql1",
       MASTER_USER="repl_async", MASTER_PASSWORD='Xslave',
       MASTER_AUTO_POSITION=1;

mysql> RESET MASTER;
mysql> SET global gtid_purged="VALUE FOUND PREVIOUSLY";

mysql> START SLAVE;
```

Check that you receive the application's traffic



LAB4: MySQL InnoDB Cluster

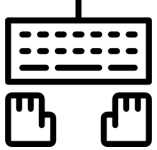
Create a single instance cluster

Time to use the new MySQL Shell !

```
[mysql3 ~]# mysqlsh
```

Let's verify if our server is ready to become a member of a new cluster:

```
mysql-js> dba.validateInstance('root@mysql3:3306')
```



LAB4: configuration settings (2)

mysql3's my.cnf

Configure `/etc/my.cnf`:

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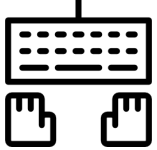
log_bin
log_slave_updates

binlog_checksum = none
master_info_repository = TABLE
relay_log_info_repository = TABLE
transaction_write_set_extraction = XXHASH64
```



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```
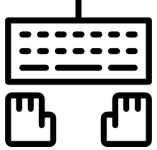

```
[mysql3 ~]# systemctl restart mysqld
```



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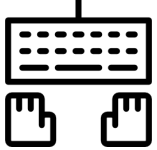
[mysql3 ~]# mysqlsh
```



LAB4: MySQL InnoDB Cluster (3)

Create a single instance cluster

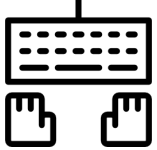
```
[mysql3 ~]# mysqlsh
```

```
mysql-js> dba.validateInstance('root@mysql3:3306')

mysql-js> \c root@mysql3:3306

mysql-js> cluster = dba.createCluster('plam')
```

The KEY is the only credential we need to remember to manage our cluster.



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mysql-js> \c root@mysql3:3306

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```
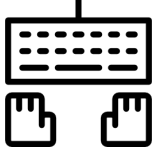
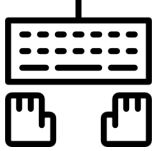

The KEY is the only credential we need to remember to manage our cluster.

```
mysql-js> cluster.status()
```



Cluster Status

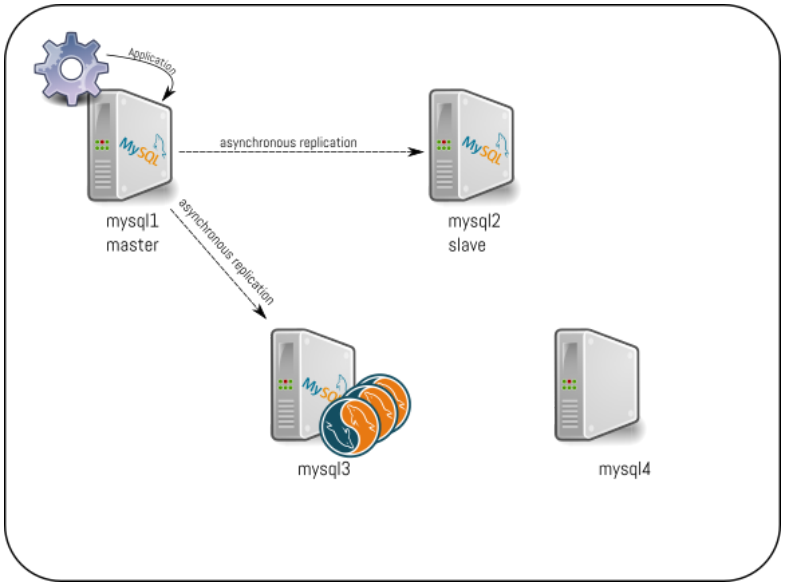
```
mysql-js> cluster.status()
{
    "clusterName": "plam",
    "defaultReplicaSet": {
        "status": "Cluster is NOT tolerant to any failures.",
        "topology": {
            "mysql3:3306": {
                "address": "mysql3:3306",
                "status": "ONLINE",
                "role": "HA",
                "mode": "R/W",
                "leaves": {}
            }
        }
    }
}
```

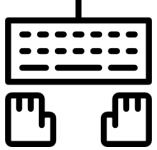


LAB5: add mysql4 to the cluster (1)

Add `mysql4` to the Group:

- restore the backup
- set the purged GTIDs
- use MySQL shell





LAB5: add mysql4 to the cluster (2)

Copy the backup from `mysql1` to `mysql4`:

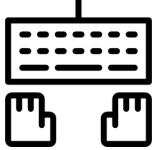
```
[mysql1 ~]# scp -r /tmp/backup mysql4:/tmp
```

And restore it:

```
[mysql4 ~]# xtrabackup --copy-back --target-dir=/tmp/backup
[mysql4 ~]# chown -R mysql. /var/lib/mysql
```

Start MySQL on `mysql4`:

```
[mysql4 ~]# systemctl start mysqld
```

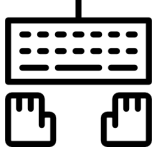


LAB5: MySQL shell to add an instance (3)

```
[mysql4 ~]# mysqlsh
```

Let's verify the config:

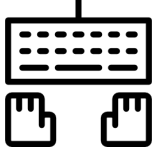
```
mysql-js> dba.validateInstance('root@mysql4:3306')
```



LAB5: MySQL shell to add an instance (4)

Configure `/etc/my.cnf`:

```
[mysqld]
...
server_id=4
enforce_gtid_consistency = on
gtid_mode  = on
log_bin
log_slave_updates

binlog_checksum = none
master_info_repository = TABLE
relay_log_info_repository = TABLE
transaction_write_set_extraction = XXHASH64
```



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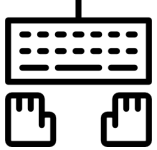
[mysqld]
...
server_id=4
enforce_gtid_consistency = on
gtid_mode  = on
log_bin
log_slave_updates

binlog_checksum = none
master_info_repository = TABLE
relay_log_info_repository = TABLE
transaction_write_set_extraction = XXHASH64
```

```
[mysql4 ~]# systemctl restart mysqld
```



LAB5: MySQL InnoDB Cluster (4)

Group of 2 instances

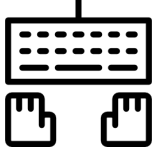
Find the latest purged GTIDs:

```
[mysql4 ~]# cat /tmp/backup/xtrabackup_binlog_info
mysql-bin.000002     167646328    b346474c-8601-11e6-9b39-08002718d305:1-77177
```

Connect to `mysql4` and set `GTID_PURGED`

```
[mysql4 ~]# mysqlsh
```

```
mysql-js> \c root@mysql4:3306
mysql-js> \sql
mysql-sql> RESET MASTER;
mysql-sql> SET global gtid_purged="VALUE FOUND PREVIOUSLY";
```



LAB5: MySQL InnoDB Cluster (5)

```
mysql-sql> \js

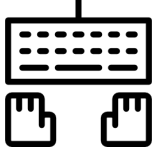
mysql-js> dba.validateInstance('root@mysql4:3306')

mysql-js> \c root@mysql3:3306

mysql-js> cluster = dba.getCluster('plam')

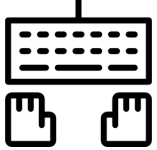
mysql-js> cluster.addInstance("root@mysql4:3306")

mysql-js> cluster.status()
```



Cluster Status

```
mysql-js> cluster.status()
{
    "clusterName": "plam",
    "defaultReplicaSet": {
        "status": "Cluster is NOT tolerant to any failures.",
        "topology": {
            "mysql3:3306": {
                "address": "mysql3:3306",
                "status": "ONLINE",
                "role": "HA",
                "mode": "R/W",
                "leaves": {
                    "mysql4:3306": {
                        "address": "mysql4:3306",
                        "status": "RECOVERING",
                        "role": "HA",
                        "mode": "R/O",
                        "leaves": {}
                    }
                }
            }
        }
    }
}
```

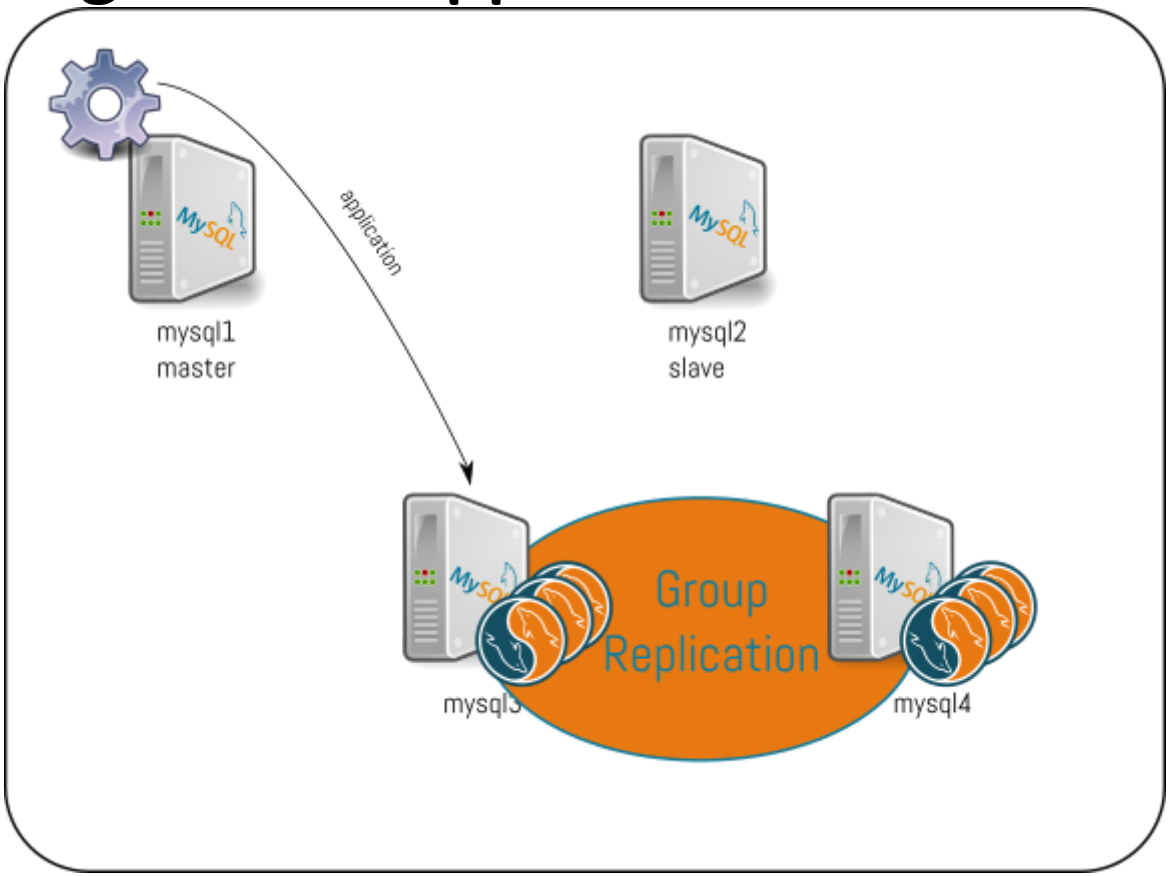


Recovering progress

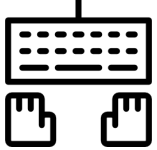
On standard MySQL, monitor the `group_replication_recovery` channel to see the progress:

```
mysql> show slave status for channel 'group_replication_recovery'\G
*************************** 1. row ***************************
               Slave_IO_State: Waiting for master to send event
                  Master_Host: mysql3
                  Master_User: mysql_innodb_cluster_rpl_user
                             ...
              Slave_IO_Running: Yes
             Slave_SQL_Running: Yes
                             ...
           Retrieved_Gtid_Set: 6e7d7848-860f-11e6-92e4-08002718d305:1-6,
7c1f0c2d-860d-11e6-9df7-08002718d305:1-15,
b346474c-8601-11e6-9b39-08002718d305:1964-77177,
e8c524df-860d-11e6-9df7-08002718d305:1-2
            Executed_Gtid_Set: 7c1f0c2d-860d-11e6-9df7-08002718d305:1-7,
b346474c-8601-11e6-9b39-08002718d305:1-45408,
e8c524df-860d-11e6-9df7-08002718d305:1-2
                             ...
```

Migrate the application



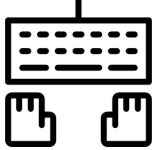
point the application
to the cluster



LAB6: Migrate the application

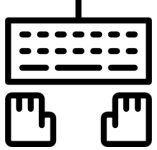
Now we need to point the application to `mysql3`, this is the only downtime !

```
...
[  21257s] threads: 4, tps: 12.00, reads: 167.94, writes: 47.98, response time:
[  21258s] threads: 4, tps: 6.00,  reads: 83.96, writes:  23.99, response time:
[  21259s] threads: 4, tps: 7.00,  reads: 98.05, writes:  28.01, response time:
[  31250s] threads: 4, tps: 8.00,  reads: 111.95, writes: 31.99, response time:
[  31251s] threads: 4, tps: 11.00, reads: 154.01, writes: 44.00, response time:
[  31252s] threads: 4, tps: 11.00, reads: 153.94, writes: 43.98, response time:
[  31253s] threads: 4, tps: 10.01, reads: 140.07, writes: 40.02, response time:
^C
[mysql1 ~]# run_app.sh mysql3
```



LAB6: Migrate the application

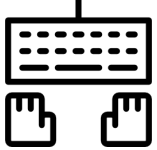
Make sure replication is running properly on `mysql2` and `mysql3`.



LAB6: Migrate the application

Make sure replication is running properly on `mysql2` and `mysql3`.

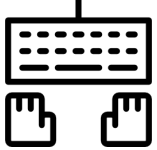
```
*************************** 1. row ***************************
...
                Master_Host: mysql1
            Slave_IO_Running: Yes
            Slave_SQL_Running: No
...
              Last_SQL_Errno: 3100
               Last_SQL_Error: Error in Xid_log_event: Commit could not be comp
   'Error on observer while running replication hook 'before_commit'.'
  Replicate_Ignore_Server_Ids:
            Master_Server_Id: 1
                Master_UUID: 8fbcd944-8760-11e6-9b4e-08002718d305
...
     Last_SQL_Error_Timestamp: 160930 23:04:07
           Retrieved_Gtid_Set: 8fbcd944-8760-11e6-9b4e-08002718d305:360-3704
            Executed_Gtid_Set: 0b31b4f3-8762-11e6-bb35-08002718d305:1-7,
30212757-8762-11e6-ad73-08002718d305:1-2,
8fbcd944-8760-11e6-9b4e-08002718d305:1-2652
                Auto_Position: 1
```



LAB6: Migrate the application

Fix replication if necessary:

```
mysql3> start slave;
mysql3> show slave status;
```



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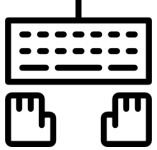
Fix replication if necessary:

```
mysql3> start slave;
mysql3> show slave status;
```

Stop asynchronous replication on `mysql2` and `mysql3`:

```
mysql2> stop slave;
mysql3> stop slave;
```

Make sure `gtid_executed` range on `mysql2` is lower or equal than on `mysql3`



LAB6: Migrate the application

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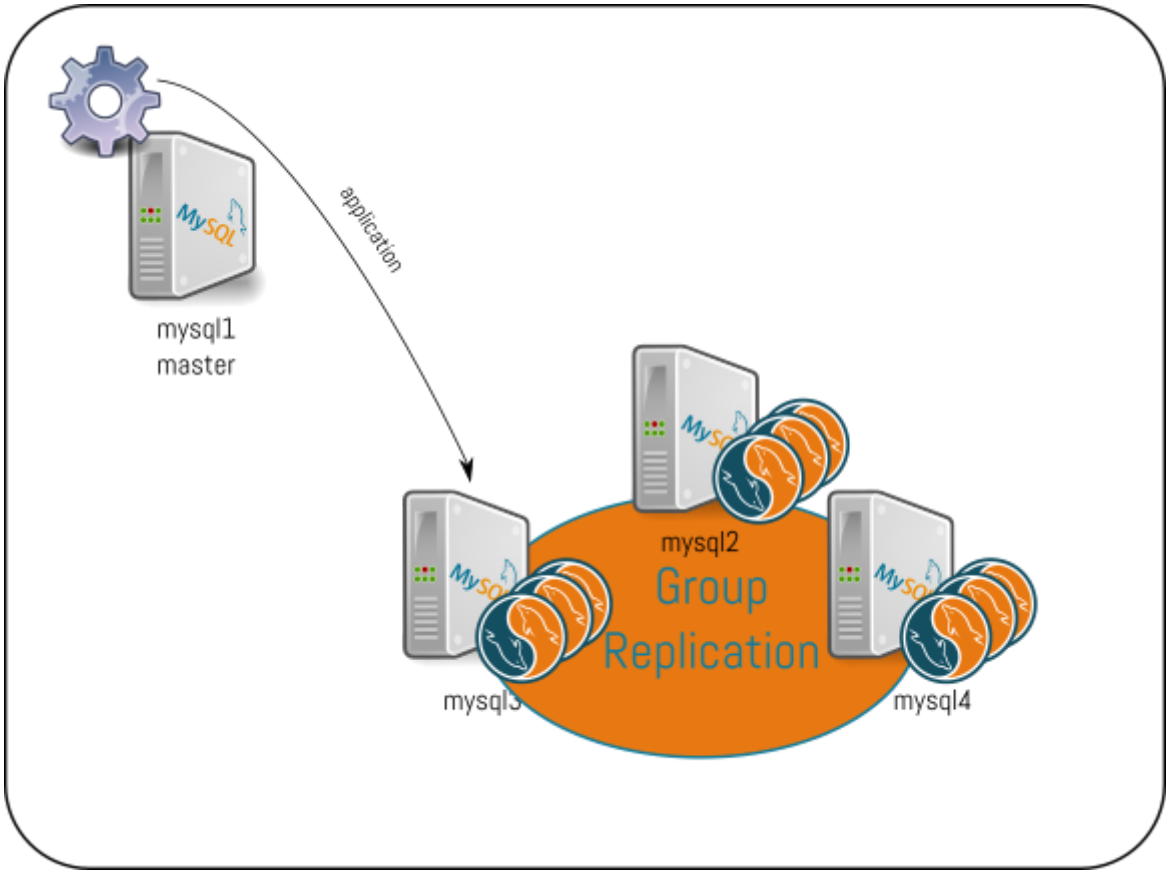
Stop asynchronous replication on `mysql2` and `mysql3`:

```
mysql2> stop slave;
mysql3> stop slave;
```

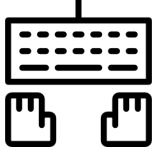
Make sure `gtid_executed` range on `mysql2` is lower or equal than on `mysql3`

```
mysql2> set global super_read_only=off;# http://bugs.mysql.com/bug.php?id=83234
mysql2> reset slave all;
mysql3> reset slave all;
```

Add a third instance

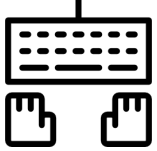


previous slave (`mysql2`) can now be part of the cluster



LAB7: Add mysql2 to the group

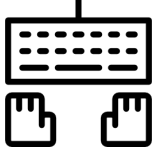
We first validate the instance using MySQL shell and we modify the configuration.



LAB7: Add mysql2 to the group

We first validate the instance using MySQL shell and we modify the configuration.

```
[mysqld]
...
super_read_only=0
server_id=2
binlog_checksum = none
enforce_gtid_consistency = on
gtid_mode  = on
log_bin
log_slave_updates
master_info_repository = TABLE
relay_log_info_repository = TABLE
transaction_write_set_extraction = XXHASH64
```

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binlog_checksum = none
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gtid_mode  = on
log_bin
log_slave_updates
master_info_repository = TABLE
relay_log_info_repository = TABLE
transaction_write_set_extraction = XXHASH64
```
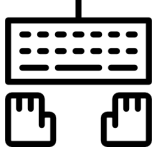
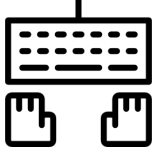

```
[mysql2 ~]# systemctl restart mysqld
```



LAB7: Add mysql2 to the group (2)

Back in MySQL shell we add the new instance:

```
[mysql2 ~]# mysqlsh
```

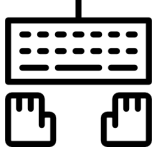


LAB7: Add mysql2 to the group (2)

Back in MySQL shell we add the new instance:

```
[mysql2 ~]# mysqlsh
```

```
mysql-js> dba.validateInstance('root@mysql2:3306')

mysql-js> \c root@mysql3:3306

mysql-js> cluster = dba.getCluster('plam')

mysql-js> cluster.addInstance("root@mysql2:3306")

mysql-js> cluster.status()
```



LAB7: Add mysql2 to the group (3)


```
{
    "clusterName": "plam",
    "defaultReplicaSet": {
        "status": "Cluster tolerant to up to ONE failure.",
        "topology": {
            "mysql3:3306": {
                "address": "mysql3:3306",
                "status": "ONLINE",
                "role": "HA",
                "mode": "R/W",
                "leaves": {
                    "mysql4:3306": {
                        "address": "mysql4:3306",
                        "status": "ONLINE",
                        "role": "HA",
                        "mode": "R/O",
                        "leaves": {}
                    },
                    "mysql2:3306": {
                        "address": "mysql2:3306",
                        "status": "ONLINE",
                        "role": "HA",
                        "mode": "R/O",
                        "leaves": {}
                    }
```

WOOHOOOOW

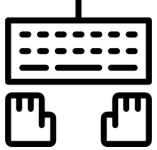
IT WORKS!

writing to a single server

Single Primary Mode

Default = Single Primary Mode

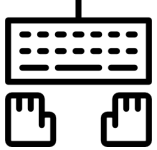
By default, MySQL InnoDB Cluster enables `Single Primary Mode`.



Default = Single Primary Mode

By default, MySQL InnoDB Cluster enables `Single Primary Mode`.

```
mysql> show global variables like 'group_replication_single_primary_mode';
+----------------------------------------+-------+
| Variable_name                          | Value |
+----------------------------------------+-------+
| group_replication_single_primary_mode | ON    |
+----------------------------------------+-------+
```



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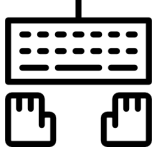
```
mysql> show global variables like 'group_replication_single_primary_mode';
+----------------------------------------+-------+
| Variable_name                          | Value |
+----------------------------------------+-------+
| group_replication_single_primary_mode | ON    |
+----------------------------------------+-------+
```

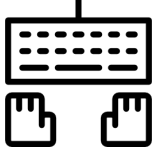
In Single Primary Mode, a single member acts as the writable master (`PRIMARY`) and the rest of the members act as hot-standbys (`SECONDARY`).

The group itself coordinates and configures itself automatically to determine which member will act as the `PRIMARY`, through a leader election mechanism.



Who's the Primary Master ?

As the Primary Master is elected, all nodes part of the group knows which one was elected. This value is exposed in status variables:



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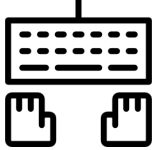
```
mysql> show status like 'group_replication_primary_member';
+----------------------------------+--------------------------------------+
| Variable_name                    | Value                                |
+----------------------------------+--------------------------------------+
| group_replication_primary_member | 28a4e51f-860e-11e6-bdc4-08002718d305 |
+----------------------------------+--------------------------------------+
```



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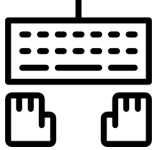
| Variable_name                    | Value                                |
+----------------------------------+--------------------------------------+
| group_replication_primary_member | 28a4e51f-860e-11e6-bdc4-08002718d305 |
+----------------------------------+--------------------------------------+
```

```
mysql> select member_host as "primary master"
       from performance_schema.global_status
       join  performance_schema.replication_group_members
       where variable_name = 'group_replication_primary_member'
       and member_id=variable_value;
+---------------+
| primary master|
+---------------+
| mysql3        |
+---------------+
```

get more info

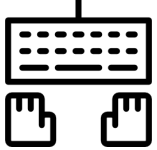
Monitoring



Performance Schema

Group Replication uses `Performance_Schema` to expose status

```
mysql3> SELECT * FROM performance_schema.replication_group_members\G
*************************** 1. row ***************************
CHANNEL_NAME: group_replication_applier
   MEMBER_ID: 00db47c7-3e23-11e6-afd4-08002774c31b
 MEMBER_HOST: mysql3.localdomain
 MEMBER_PORT: 3306
MEMBER_STATE: ONLINE
```



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 MEMBER_PORT: 3306
MEMBER_STATE: ONLINE
```
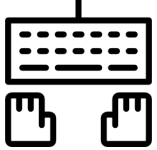

```
mysql3> SELECT * FROM performance_schema.replication_connection_status\G
*************************** 1. row ***************************
             CHANNEL_NAME: group_replication_applier
               GROUP_NAME: afb80f36-2bff-11e6-84e0-0800277dd3bf
              SOURCE_UUID: afb80f36-2bff-11e6-84e0-0800277dd3bf
                THREAD_ID: NULL
            SERVICE_STATE: ON
COUNT_RECEIVED_HEARTBEATS: 0
 LAST_HEARTBEAT_TIMESTAMP: 0000-00-00 00:00:00
 RECEIVED_TRANSACTION_SET: afb80f36-2bff-11e6-84e0-0800277dd3bf:1-2
        LAST_ERROR_NUMBER: 0
                  MESSAGE:
                TIMESTAMP: 0000-00-00 00:00:00
```

Member State

These are the different possible state for a node member:

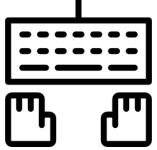
- `ONLINE`
- `OFFLINE`
- `RECOVERING`
- `ERROR`: when a node is leaving but the plugin was not instructed to stop
- `UNREACHABLE`



Status information & metrics

Members

```
mysql>  SELECT * FROM performance_schema.replication_group_members\G
```



Status information & metrics

Members

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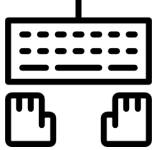
```

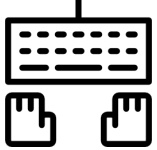
```
*************************** 1. row ***************************
CHANNEL_NAME: group_replication_applier
   MEMBER_ID: 00db47c7-3e23-11e6-afd4-08002774c31b
 MEMBER_HOST: mysql3.localdomain
 MEMBER_PORT: 3306
  MEMBER_STATE: ONLINE
*************************** 2. row ***************************
CHANNEL_NAME: group_replication_applier
   MEMBER_ID: e1544c9d-4451-11e6-9f5a-08002774c31b
 MEMBER_HOST: mysql4.localdomain.localdomain
 MEMBER_PORT: 3306
  MEMBER_STATE: ONLINE
```



Status information & metrics

Connections

```
mysql> SELECT * FROM performance_schema.replication_connection_status\G
```

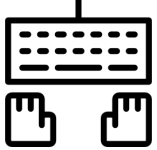


Status information & metrics

Connections

```
mysql> SELECT * FROM performance_schema.replication_connection_status\G
```

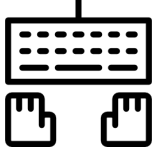
```
*************************** 1. row ***************************
             CHANNEL_NAME: group_replication_applier
               GROUP_NAME: afb80f36-2bff-11e6-84e0-0800277dd3bf
              SOURCE_UUID: afb80f36-2bff-11e6-84e0-0800277dd3bf
                THREAD_ID: NULL
            SERVICE_STATE: ON
COUNT_RECEIVED_HEARTBEATS: 0
 LAST_HEARTBEAT_TIMESTAMP: 0000-00-00 00:00:00
 RECEIVED_TRANSACTION_SET: 5de4400b-3dd7-11e6-8a71-08002774c31b:1-814089,
                           afb80f36-2bff-11e6-84e0-0800277dd3bf:1-2834
        LAST_ERROR_NUMBER: 0
       LAST_ERROR_MESSAGE:
     LAST_ERROR_TIMESTAMP: 0000-00-00 00:00:00
*************************** 2. row ***************************
             CHANNEL_NAME: group_replication_recovery
               GROUP_NAME:
              SOURCE_UUID:
                THREAD_ID: NULL
            SERVICE_STATE: OFF
```



Status information & metrics

Local node status

```
mysql> select * from performance_schema.replication_group_member_stats\G
```



Status information & metrics

Local node status

```
mysql> select * from performance_schema.replication_group_member_stats\G
```

```
*************************** 1. row ***************************
                      CHANNEL_NAME: group_replication_applier
                           VIEW_ID: 14679667214442885:4
                         MEMBER_ID: e1544c9d-4451-11e6-9f5a-08002774c31b
       COUNT_TRANSACTIONS_IN_QUEUE: 0
       COUNT_TRANSACTIONS_CHECKED: 5961
          COUNT_CONFLICTS_DETECTED: 0
COUNT_TRANSACTIONS_ROWS_VALIDATING: 0
TRANSACTIONS_COMMITTED_ALL_MEMBERS: 5de4400b-3dd7-11e6-8a71-08002774c31b:1-81408
                                    afb80f36-2bff-11e6-84e0-0800277dd3bf:1-5718
    LAST_CONFLICT_FREE_TRANSACTION: afb80f36-2bff-11e6-84e0-0800277dd3bf:5718
```

Performance_Schema

You can find GR information in the following **Performance_Schema** tables:

- `replication_applier_configuration`
- `replication_applier_status`
- `replication_applier_status_by_worker`
- `replication_connection_configuration`
- `replication_connection_status`
- `replication_group_member_stats`
- `replication_group_members`

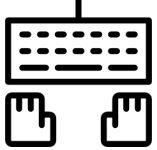
Status during recovery

```
mysql> SHOW SLAVE STATUS FOR CHANNEL 'group_replication_recovery'\G
```

Status during recovery

```
mysql> SHOW SLAVE STATUS FOR CHANNEL 'group_replication_recovery'\G
```

```
*************************** 1. row ***************************
               Slave_IO_State:
                  Master_Host: <NULL>
                  Master_User: gr_repl
                  Master_Port: 0
                        ...
               Relay_Log_File: mysql4-relay-bin-group_replication_recovery.0000
                        ...
            Slave_IO_Running: No
           Slave_SQL_Running: No
                        ...
           Executed_Gtid_Set: 5de4400b-3dd7-11e6-8a71-08002774c31b:1-814089,
afb80f36-2bff-11e6-84e0-0800277dd3bf:1-5718
             ...
                Channel_Name: group_replication_recovery
```



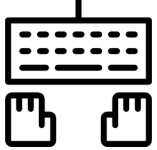
Sys Schema

The easiest way to detect if a node is a member of the primary component (when there are partitioning of your nodes due to network issues for example) and therefore a valid candidate for routing queries to it, is to use the sys table.

Additional information for `sys` can be downloaded at https://github.com/lefred/mysql_gr_routing_check/blob/master/addition_to_sys.sql

On the primary node:

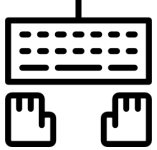
```
[mysql3 ~]# mysql < /tmp/gr_addition_to_sys.sql
```



Sys Schema

Is this node part of PRIMARY Partition:

```
mysql3> SELECT sys.gr_member_in_primary_partition();
+------------------------------------+
| sys.gr_node_in_primary_partition() |
+------------------------------------+
| YES                                |
+------------------------------------+
```



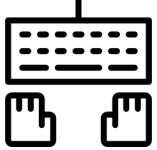
Sys Schema

Is this node part of PRIMARY Partition:

```
mysql3> SELECT sys.gr_member_in_primary_partition();
+------------------------------------+
| sys.gr_node_in_primary_partition() |
+------------------------------------+
| YES                                |
+------------------------------------+
```

To use as healthcheck:

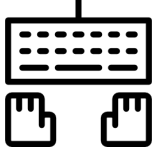
```
mysql3> SELECT * FROM sys.gr_member_routing_candidate_status;
+------------------+-----------+---------------------+----------------------+
| viable_candidate | read_only | transactions_behind | transactions_to_cert |
+------------------+-----------+---------------------+----------------------+
| YES              | YES       | 0                   | 0                    |
+------------------+-----------+---------------------+----------------------+
```



Sys Schema - Heath Check

On one of the non Primary nodes, run the following command:

```
mysql-sql> flush tables with read lock;
```



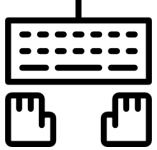
Sys Schema - Heath Check

On one of the non Primary nodes, run the following command:

```
mysql-sql> flush tables with read lock;
```

Now you can verify what the healthcheck exposes to you:

```
mysql-sql> SELECT * FROM sys.gr_member_routing_candidate_status;
+------------------+-----------+---------------------+----------------------+
| viable_candidate | read_only | transactions_behind | transactions_to_cert |
+------------------+-----------+---------------------+----------------------+
| YES              | YES       |                 950 |                    0 |
+------------------+-----------+---------------------+----------------------+
```



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+------------------+-----------+---------------------+----------------------+
| viable_candidate | read_only | transactions_behind | transactions_to_cert |
+------------------+-----------+---------------------+----------------------+
| YES              | YES       |                 950 |                    0 |
+------------------+-----------+---------------------+----------------------+
```
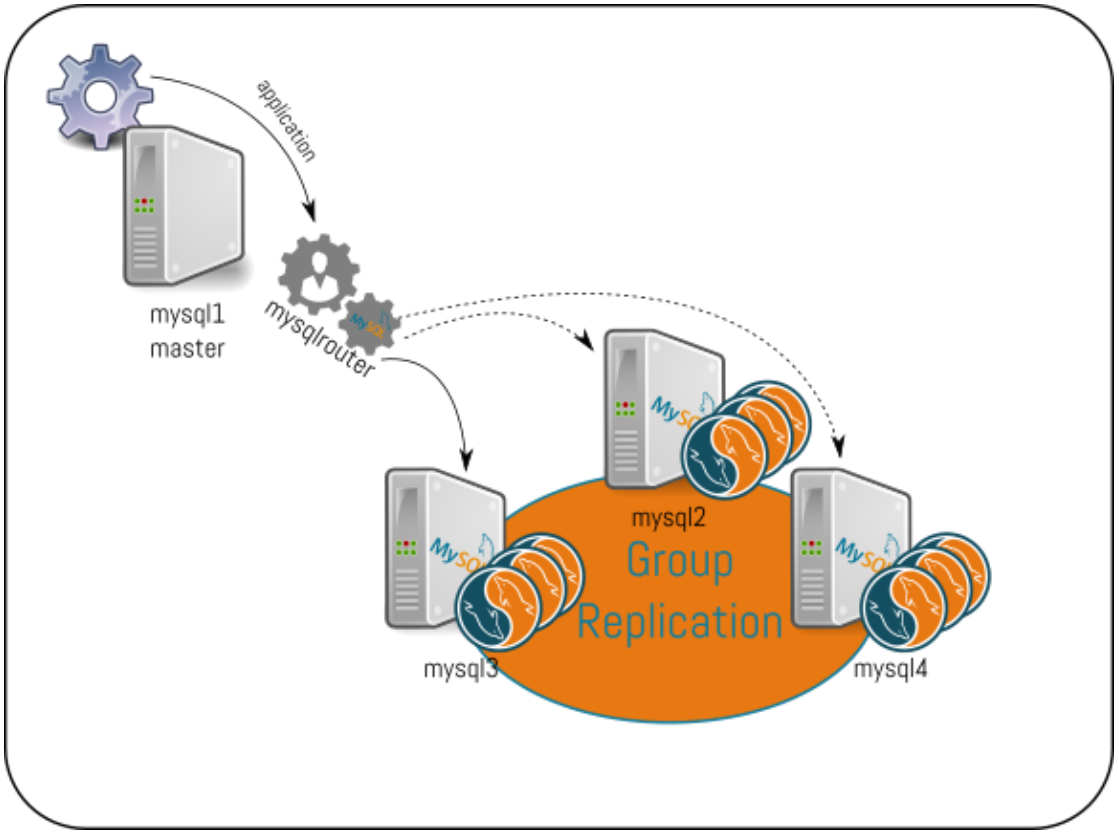

```
mysql-sql> UNLOCK tables;
```

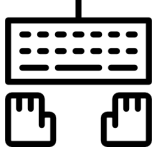
application interaction

MySQL Router

MySQL Router

We will now use `mysqlrouter` between our application and the cluster.

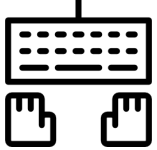




MySQL Router (2)

Configure MySQL Router (bootstrap it using an instance):

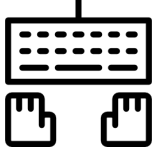
```
[mysql2 ~]#  mysqlrouter --bootstrap mysql2:3306
Please enter the administrative MASTER key for the MySQL InnoDB cluster:
MySQL Router has now been configured for the InnoDB cluster 'plam'.

The following connection information can be used to connect to the cluster.

Classic MySQL protocol connections to cluster 'plam':
- Read/Write Connections: localhost:6446
- Read/Only Connections: localhost:6447
```



MySQL Router (3)

Now let's copy the configuration to `mysql1` (our app server) and modify it to listen to port 3306:

```
[mysql2 ~]# scp /etc/mysqlrouter/mysqlrouter.conf mysql1:/etc/mysqlrouter/
```



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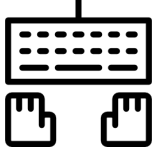
```
[mysql2 ~]# scp /etc/mysqlrouter/mysqlrouter.conf mysql1:/etc/mysqlrouter/
```

```
[routing:default_rw]
-bind_port=6446
+bind_port=3306
+bind_address=mysql1
```



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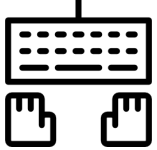
```
[mysql2 ~]# scp /etc/mysqlrouter/mysqlrouter.conf mysql1:/etc/mysqlrouter/
```

```
[routing:default_rw]
-bind_port=6446
+bind_port=3306
+bind_address=mysql1
```

We can stop `mysqld` on `mysql1` and start `mysqlrouter` into a **screen** session:

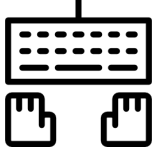
```
[mysql1 ~]# systemctl stop mysqld
[mysql1 ~]# mysqlrouter
```



MySQL Router (4)

Now we can point the application to the router:

```
[mysql1 ~]# run_app.sh mysql1
```



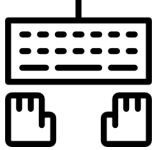
MySQL Router (4)

Now we can point the application to the router:

```
[mysql1 ~]# run_app.sh mysql1
```

Check app and kill `mysqld` on **mysql3** (the Primary Master R/W node) !

```
[mysql3 ~]# kill -9 $(pidof mysqld)
```



MySQL Router (4)

Now we can point the application to the router:

```
[mysql1 ~]# run_app.sh mysql1
```

Check app and kill `mysqld` on **mysql3** (the Primary Master R/W node) !

```
[mysql3 ~]# kill -9 $(pidof mysqld)
```

```
mysql> select member_host as "primary" from performance_schema.global_status
       join  performance_schema.replication_group_members
       where variable_name = 'group_replication_primary_member'
       and member_id=variable_value;
+---------+
| primary |
+---------+
| mysql4  |
+---------+
```

Thank you !

Questions ?