MySQL™ Group Replication

the Magic Explained

Frédéric Descamps

OPEN SOURCE DATABASE CONFERENCE

PERCONA LIVE EUROPE FRANKFURT


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about.me/lefred

Who am I ?

Frédéric Descamps

- @lefred
- MySQL Evangelist
- Managing MySQL since 3.23
- devops believer
- living in Belgium **B E**
- https://lefred.be

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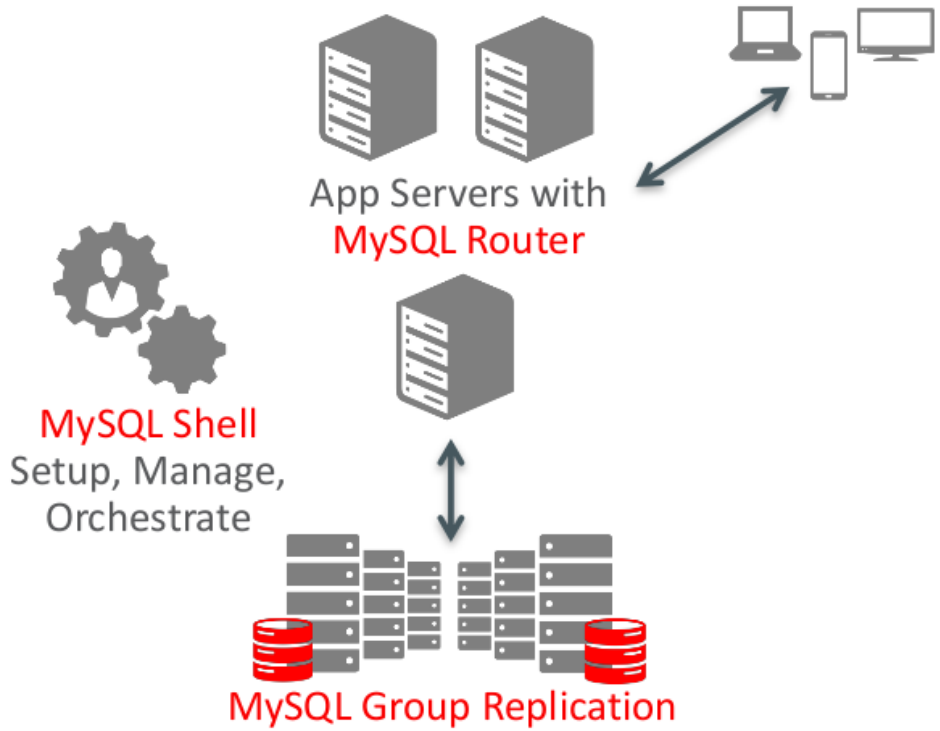
Group Replication: heart of MySQL InnoDB Cluster



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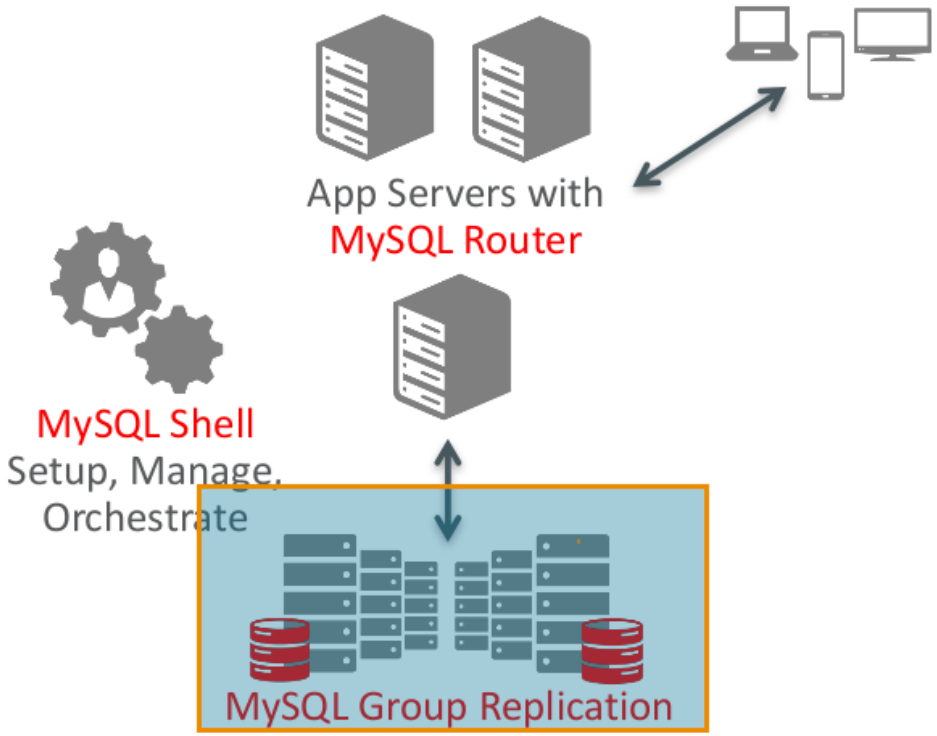

MySQL Group Replication

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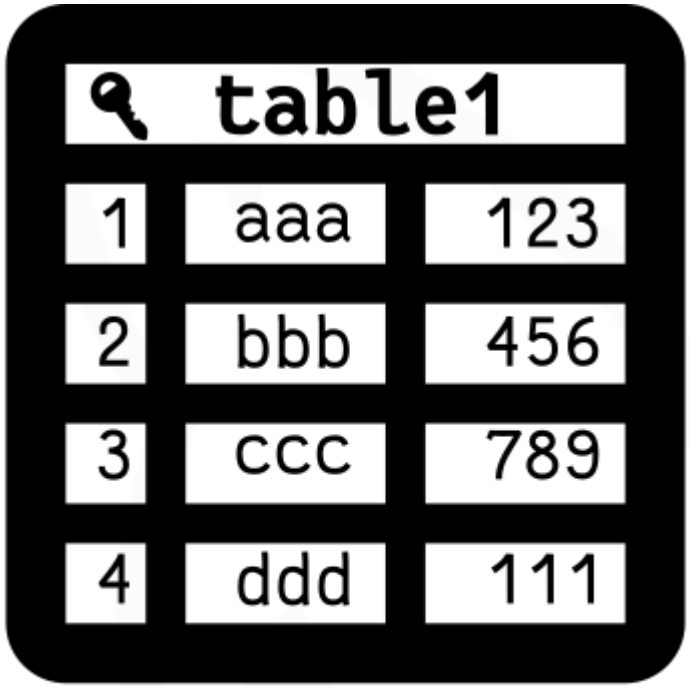
- GR implements conflict detection and resolution
- GR allows automatic distributed recovery
- Supported on **all MySQL platforms** !!
  - Linux, Windows, Solaris, OSX, FreeBSD

terminology

Write vs Writeset

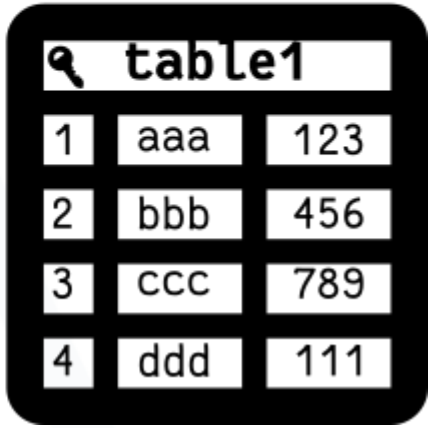
Let's illustrate a table:




```
CREATE TABLE `table1` (
  `id` int(11) NOT NULL AUTO_INCREMENT,
  `b` char(20) NOT NULL DEFAULT '',
  `c` int(11) NOT NULL DEFAULT '0',
  PRIMARY KEY (`id`)
) ENGINE=InnoDB
```

Now let's make a change

```
start transaction;
update table1 set c = 999 where id =2;
update table1 set b = "eee" where id = 3;
commit;
```



and at commit time:

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Writesets

Contain the hash for the rows PKs that are changed and in some cases the hashes of foreign keys or others dependencies that need to be captured (e.g. non NULL UKs). Writesets are gathered during transaction execution.

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Writes

Called also write values, refers to the actual changes. Write values are also gathered during transaction execution.

Writeset - examples

```
+-------+-----------+------+-----+---------+-------+
| Field | Type      | Null | Key | Default | Extra |
+-------+-----------+------+-----+---------+-------+
| id    | binary(1) | NO   | PRI | NULL    |       |
| name  | binary(2) | YES  |     | NULL    |       |
+-------+-----------+------+-----+---------+-------+
```

Writeset - examples

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pke: PRIMARY | test | t2 | 1 | 1     hash: 11853456929268668462
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Writeset - examples (2)

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| id    | binary(1) | NO   | PRI | NULL    |       |
| name  | binary(2) | YES  | UNI | NULL    |       |
| name2 | binary(1) | YES  |     | NULL    |       |
+-------+-----------+------+-----+---------+-------+
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Writeset - examples (2)

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+-------+-----------+------+-----+---------+-------+
| Field | Type      | Null | Key | Default | Extra |
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pke: name    | test |t3 | 2       hash: 11034644986657565827
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[after image]
[before image]
```

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... no, in fact the writesets replication is **synchronous** and then certification and apply of the changes are local to each nodes and asynchronous.

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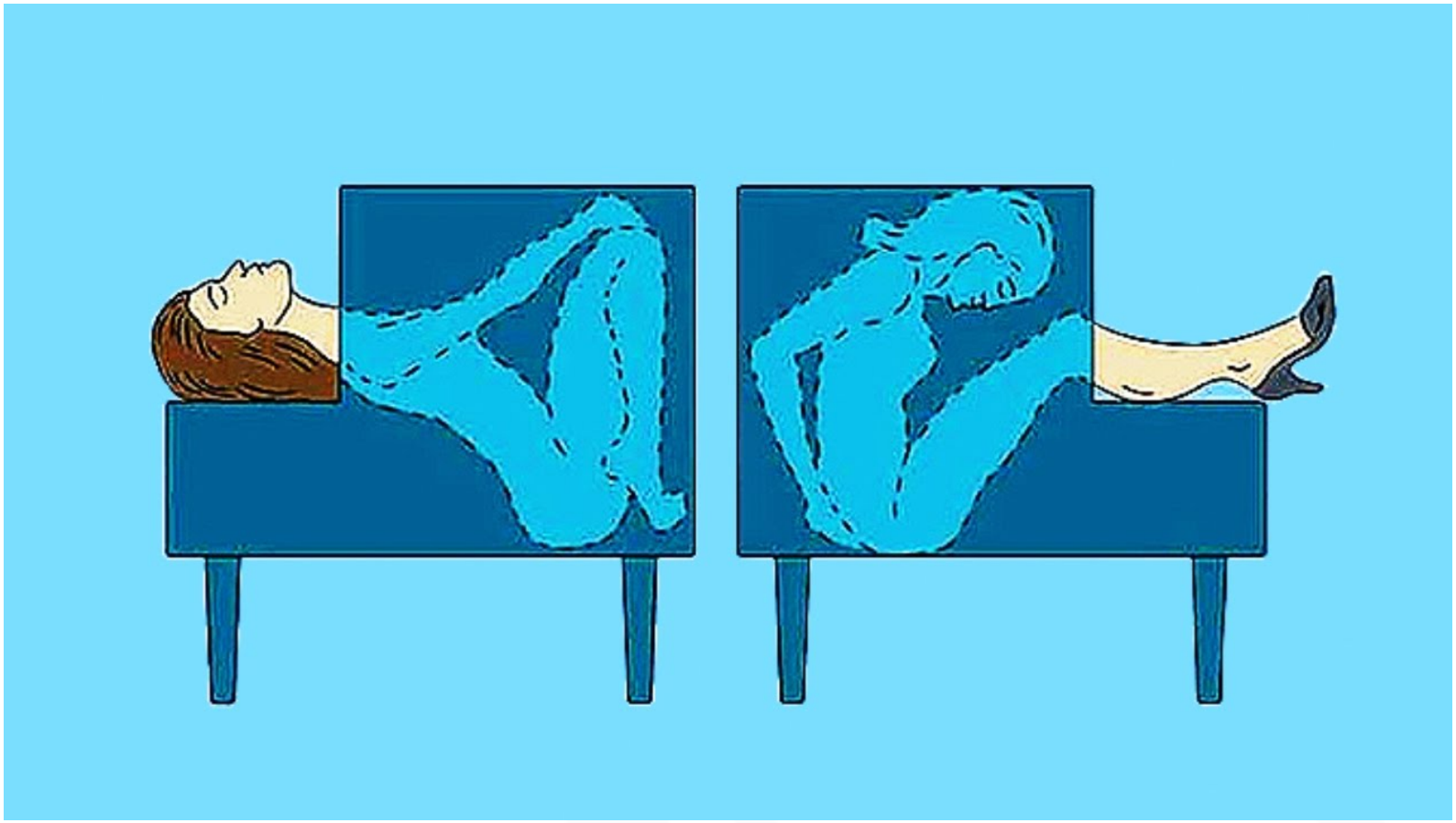
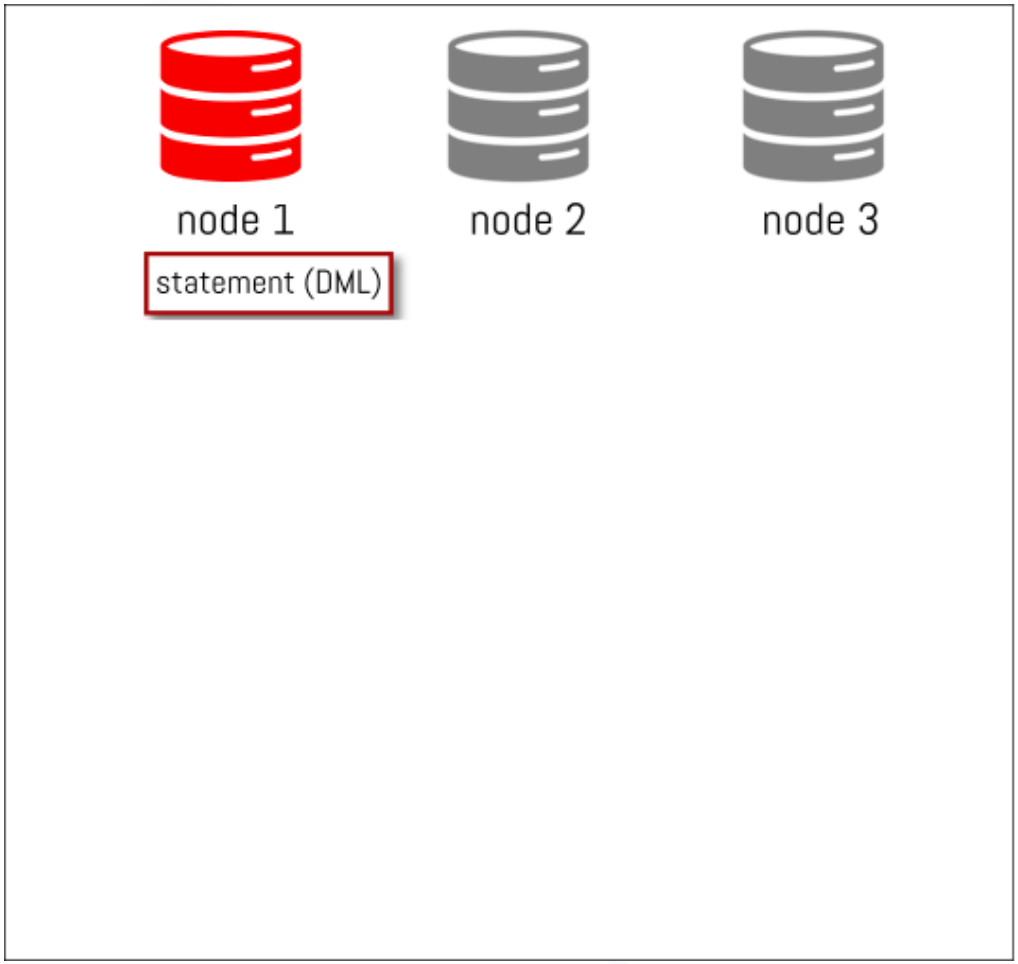
... no, in fact the writesets replication is **synchronous** and then certification and apply of the changes are local to each nodes and asynchronous.

not that easy to understand... right ? As a picture is worth a 1000 words, let´s illustrate this...



MySQL Group Replication



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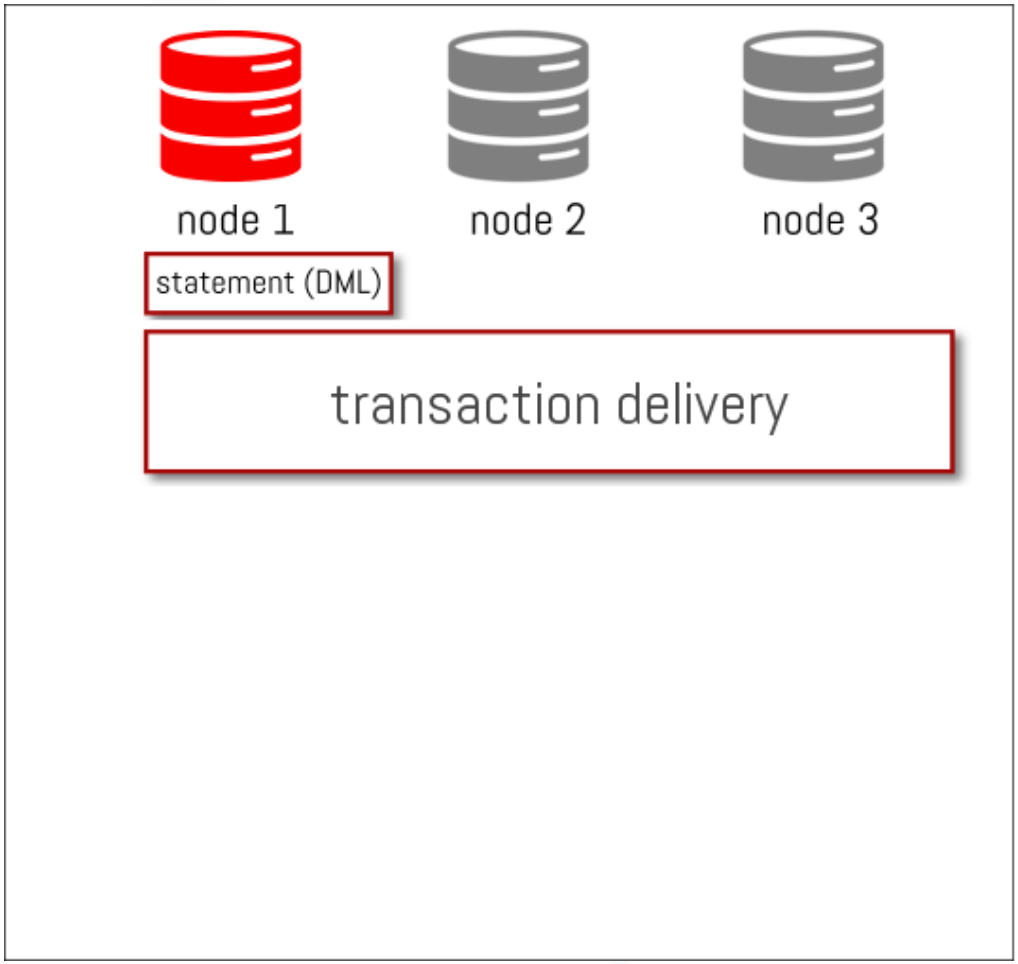

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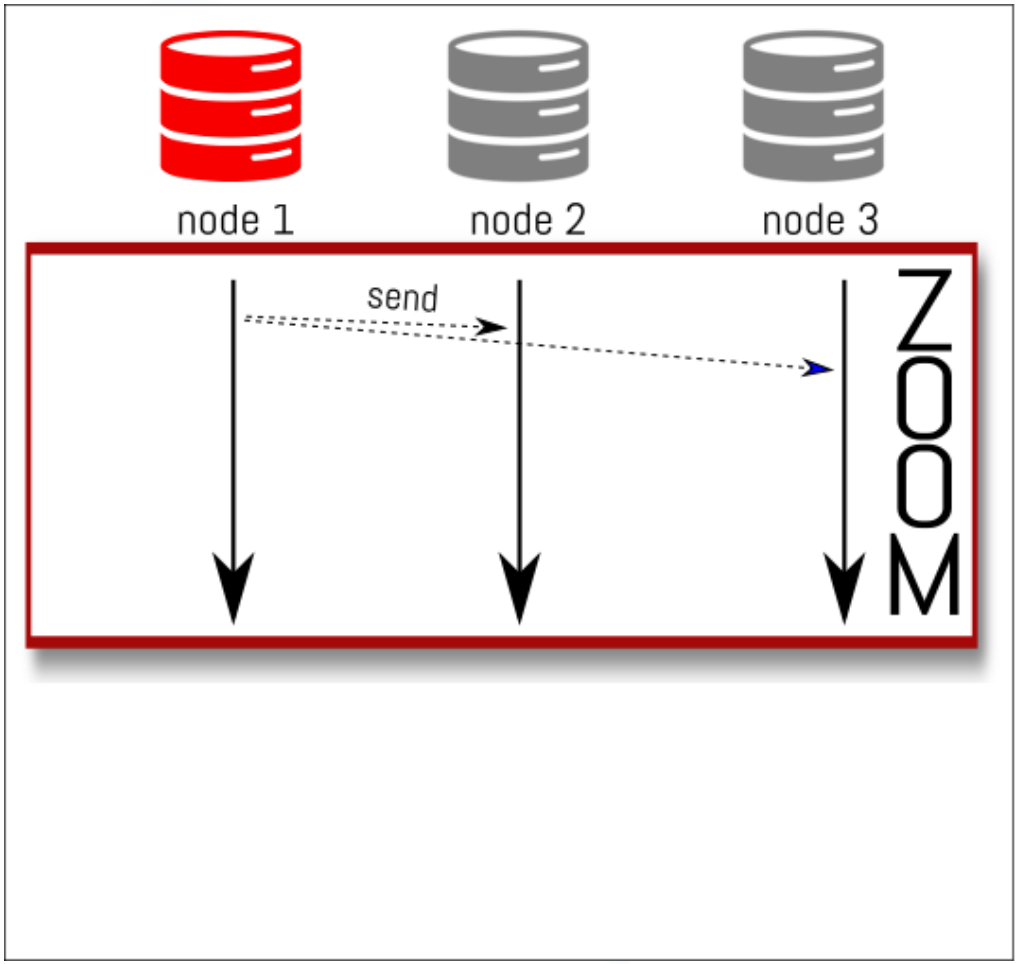

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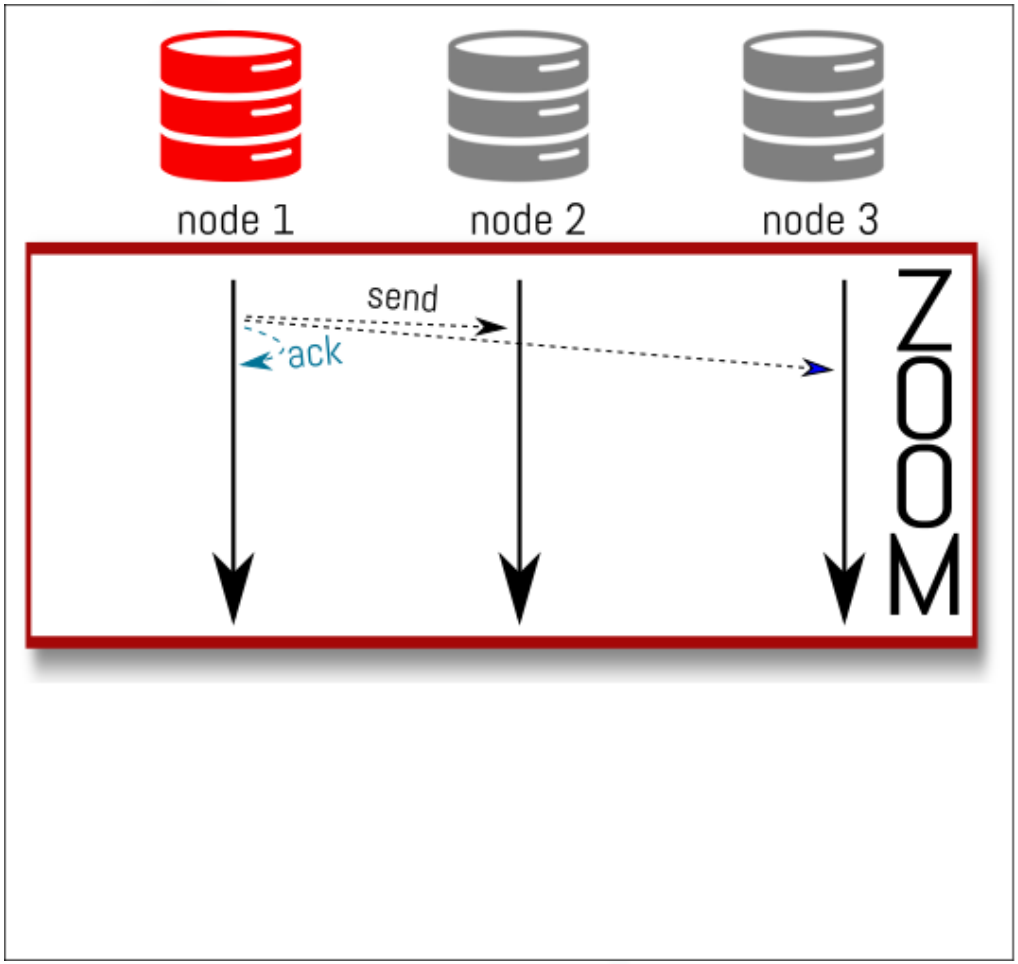

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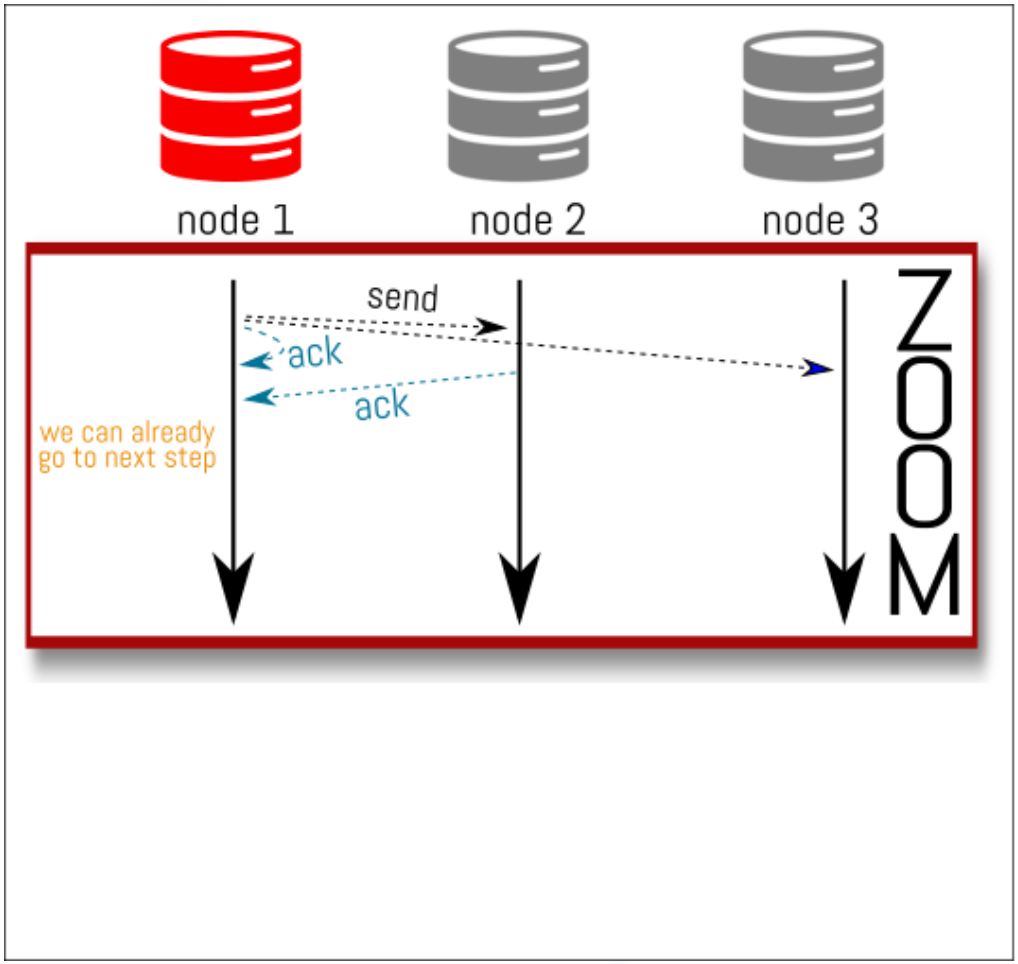

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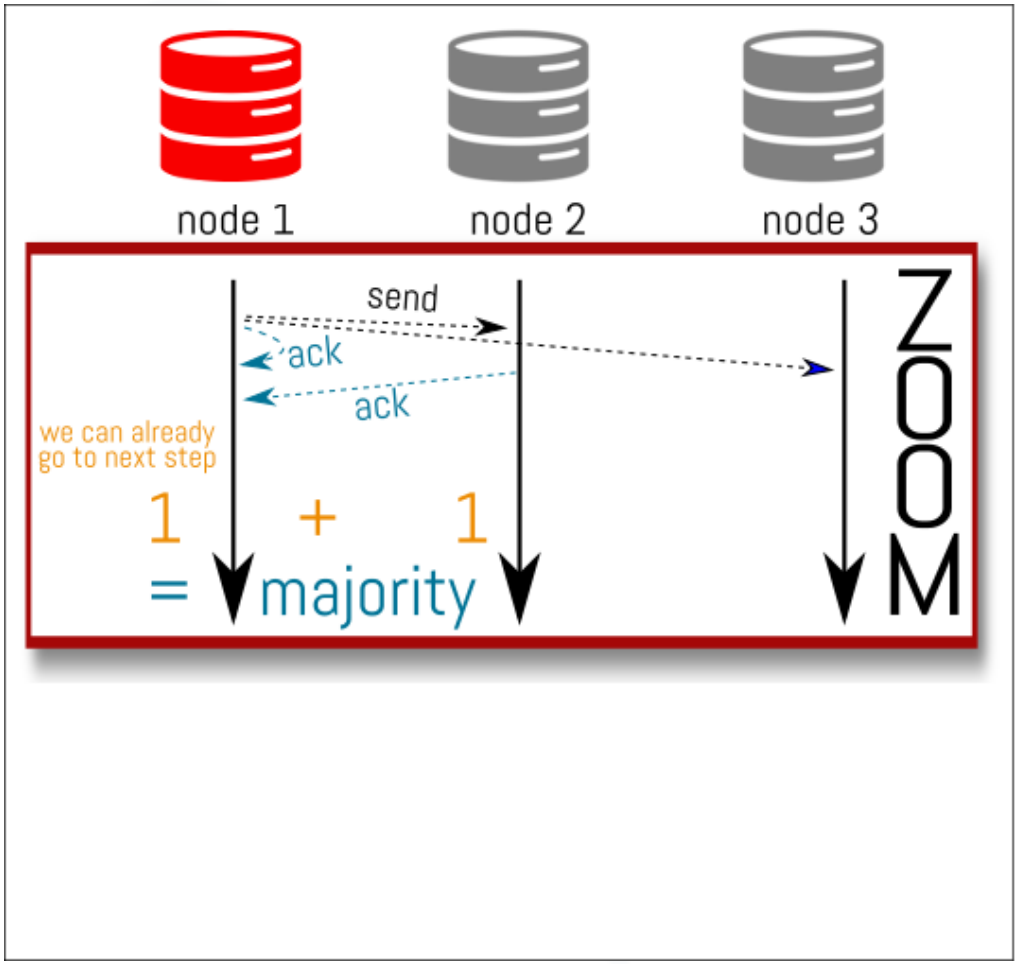

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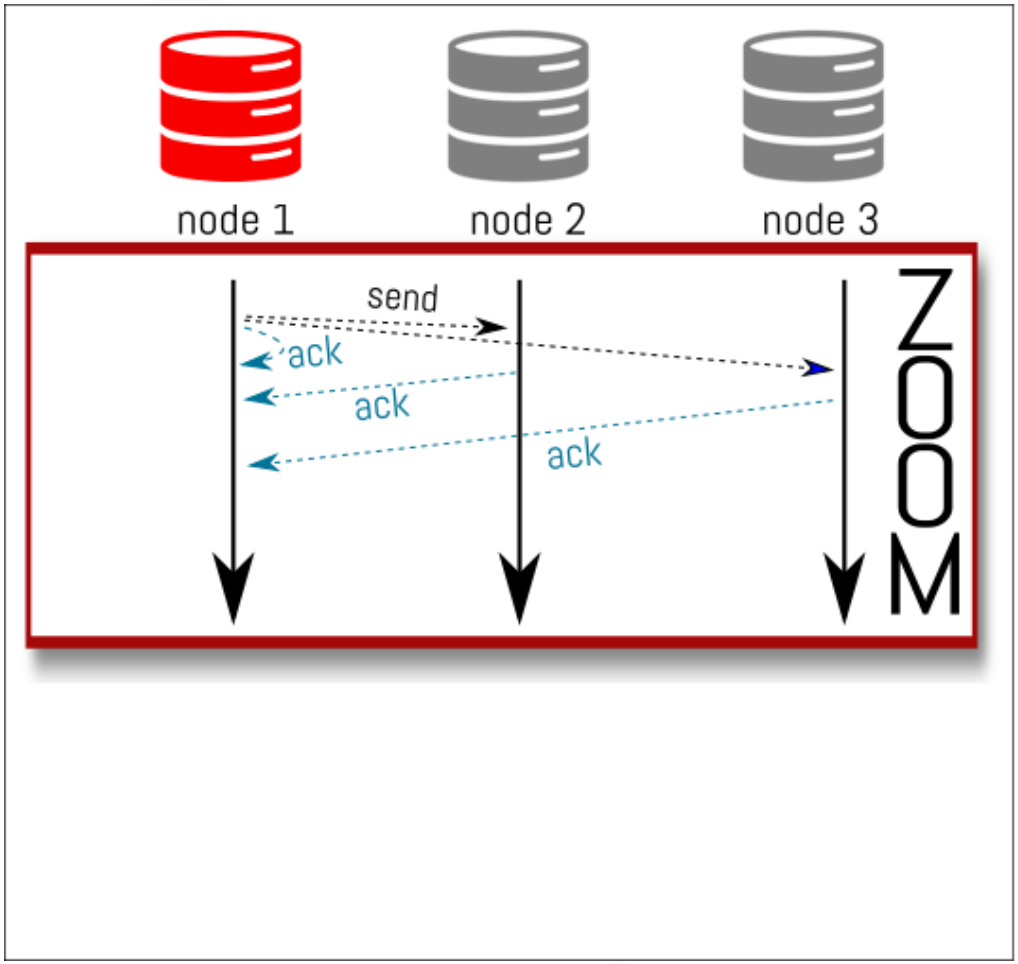

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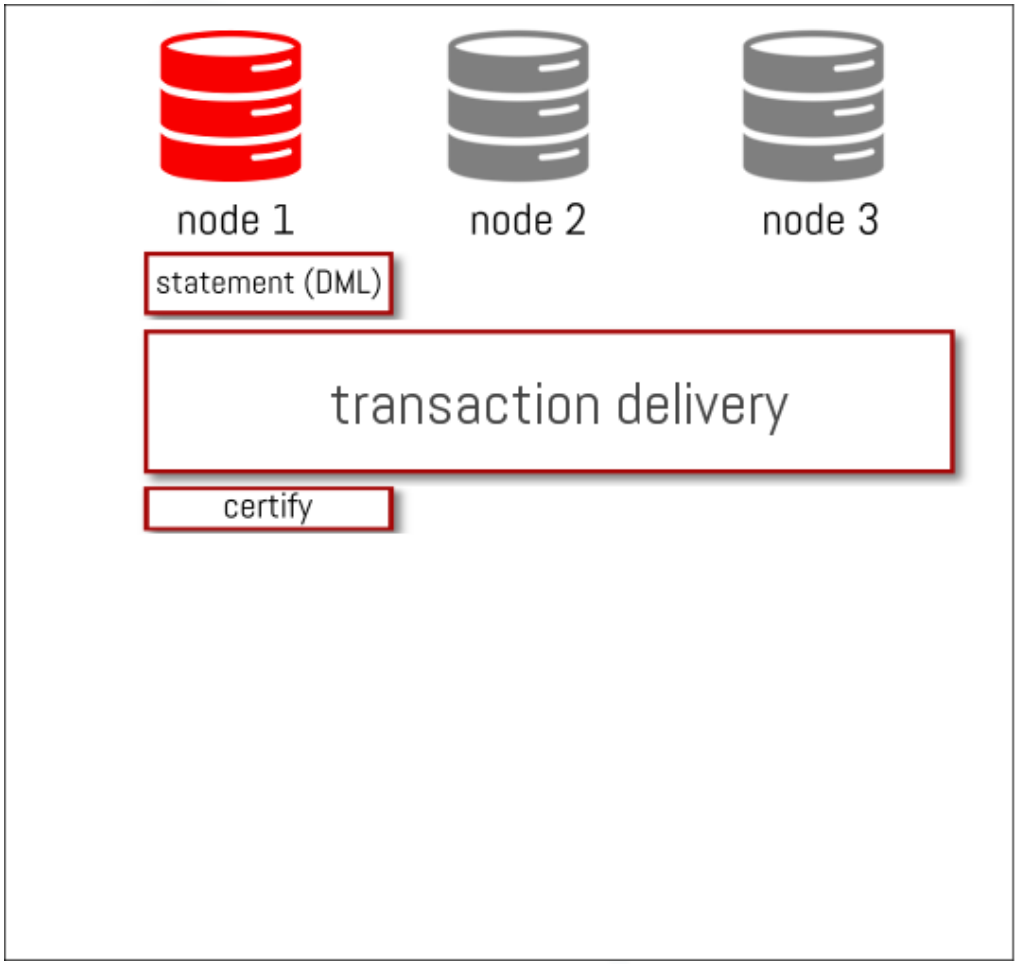

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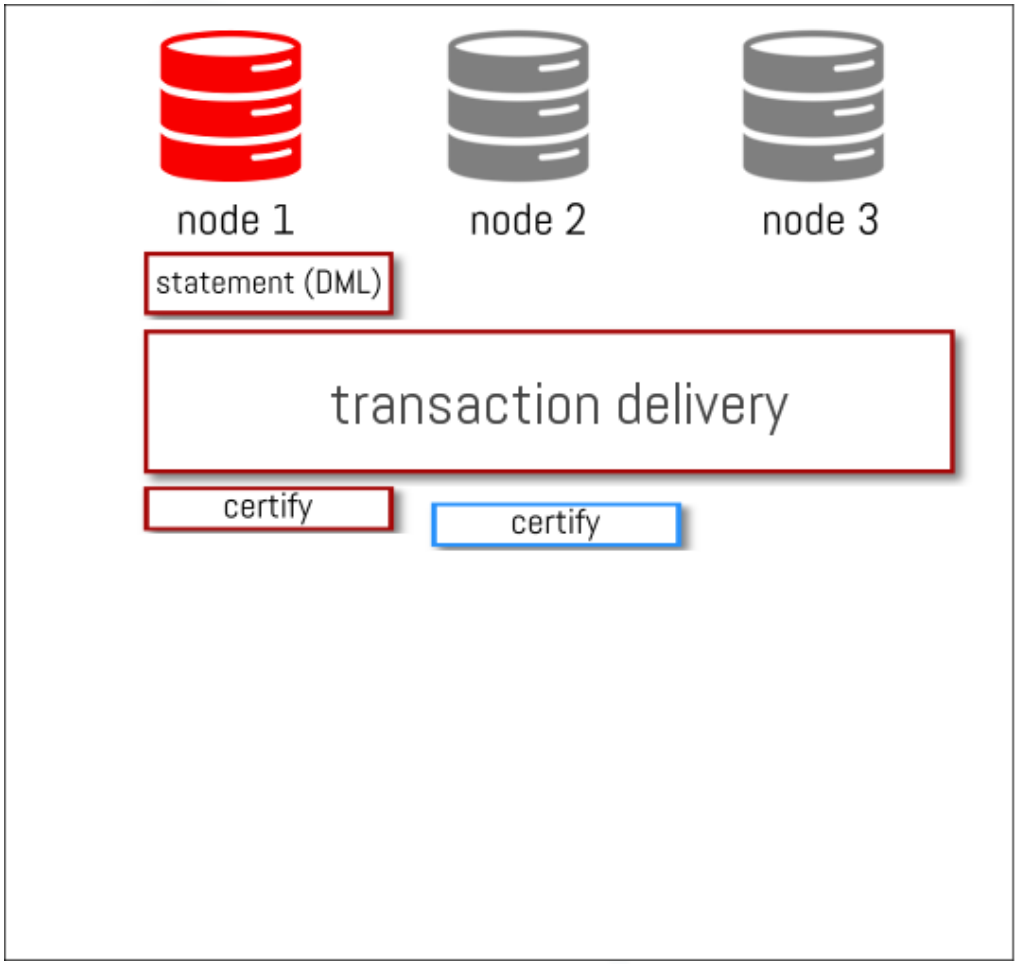

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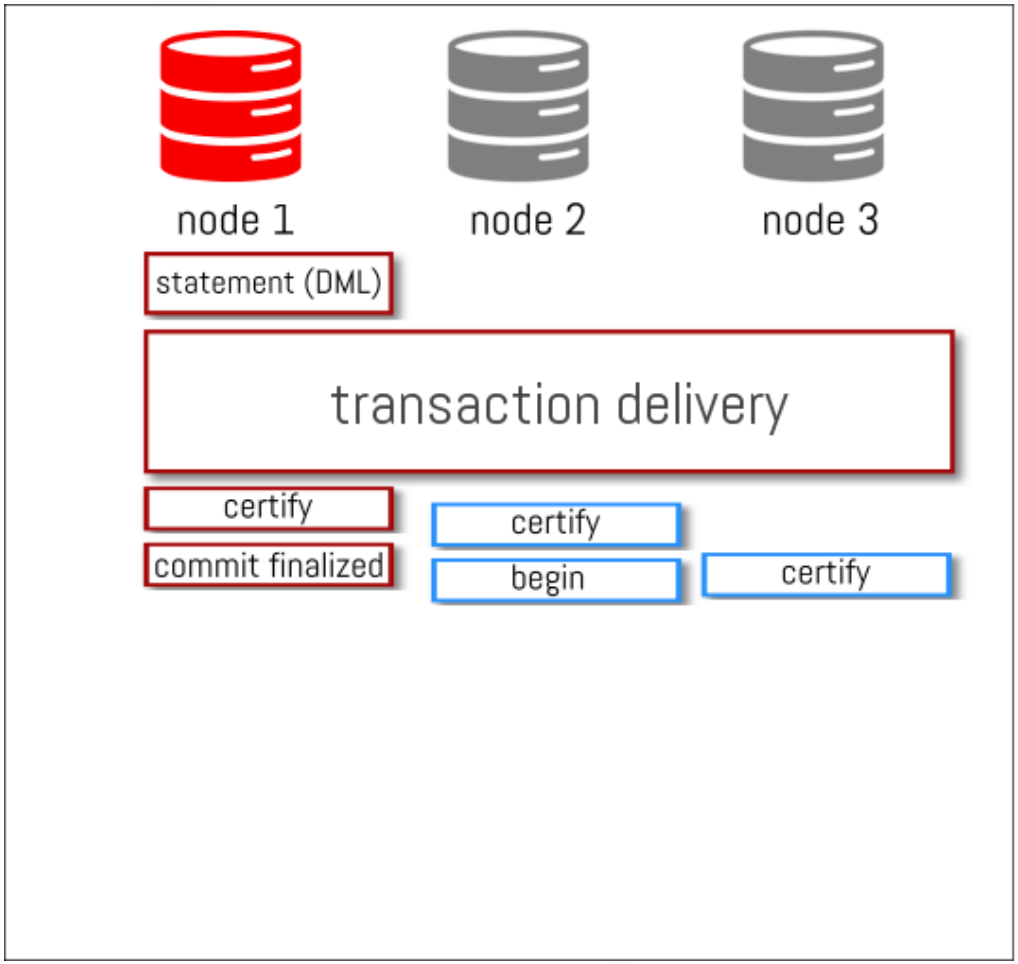

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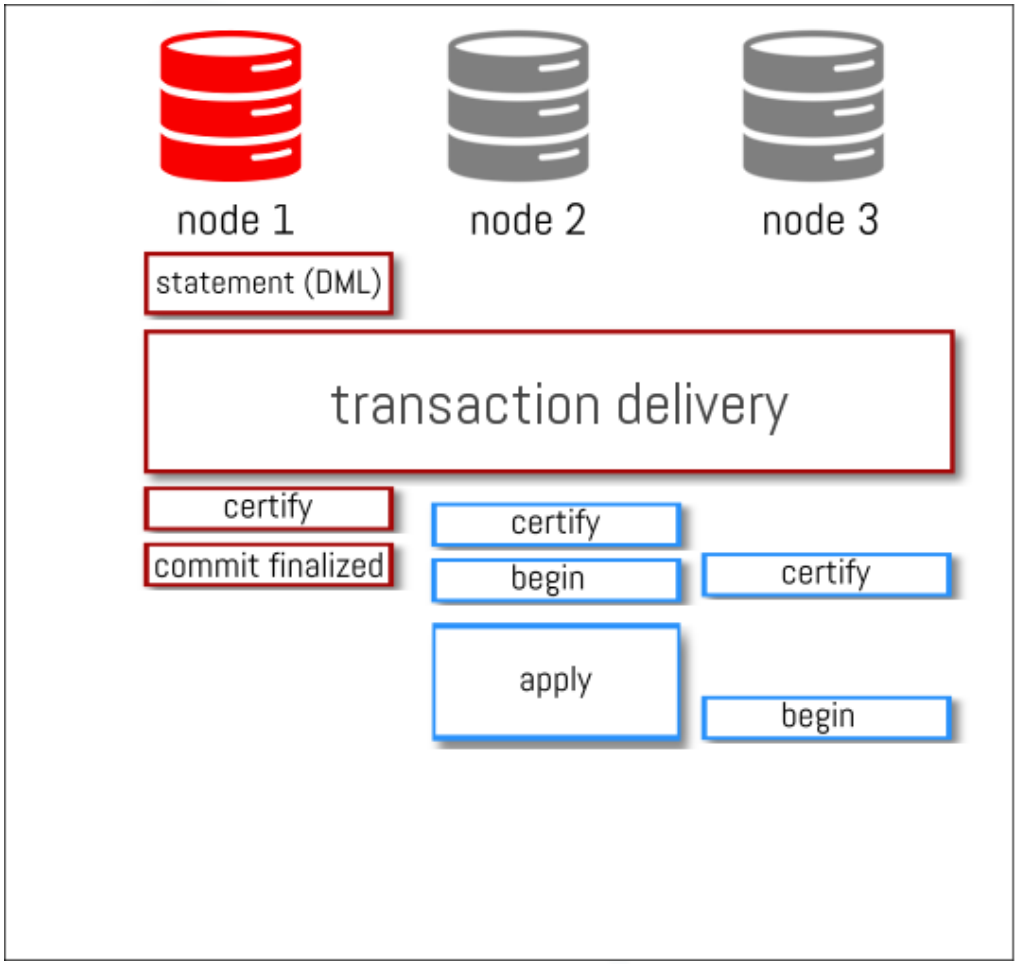

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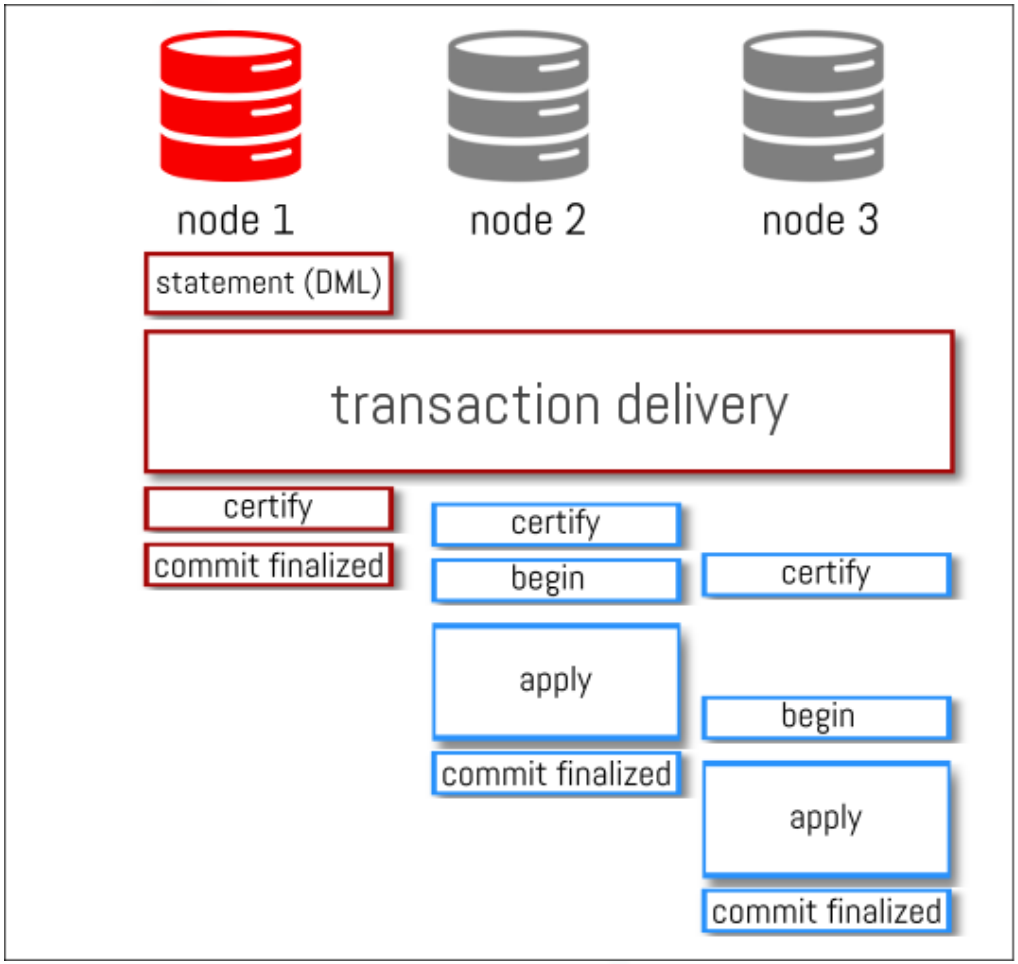

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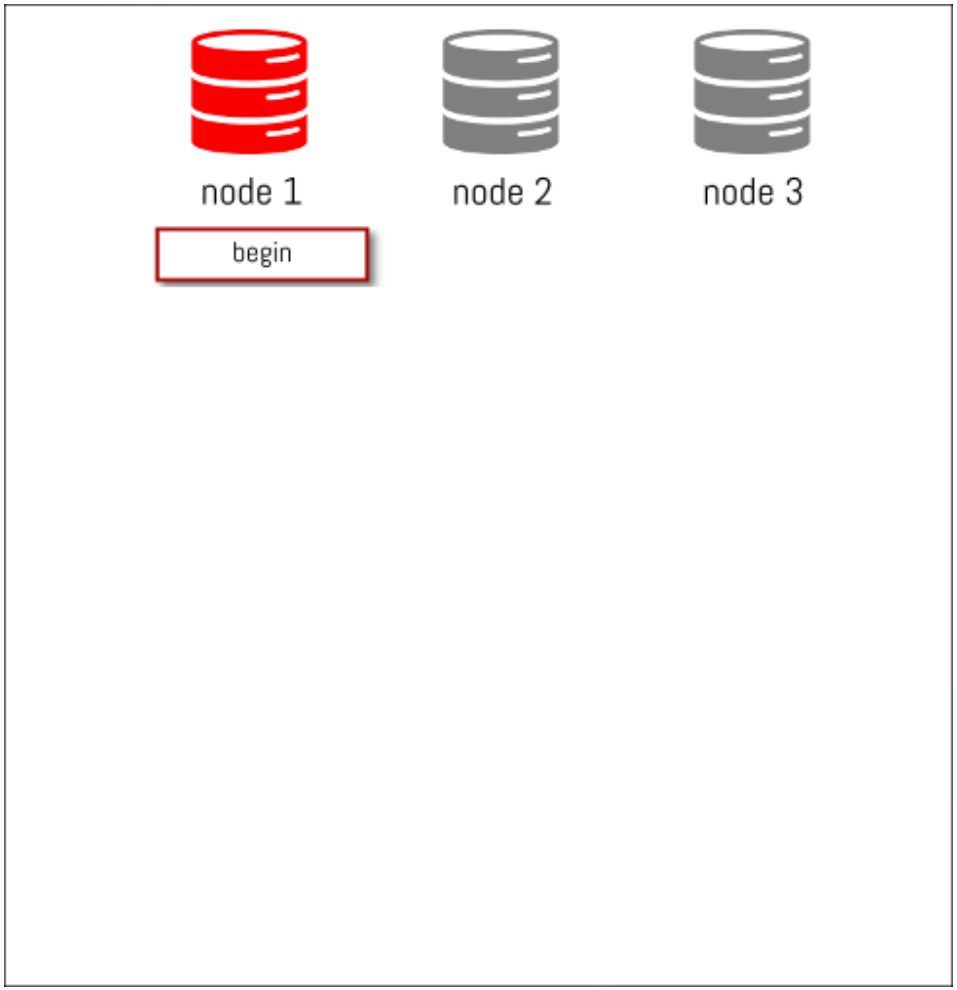

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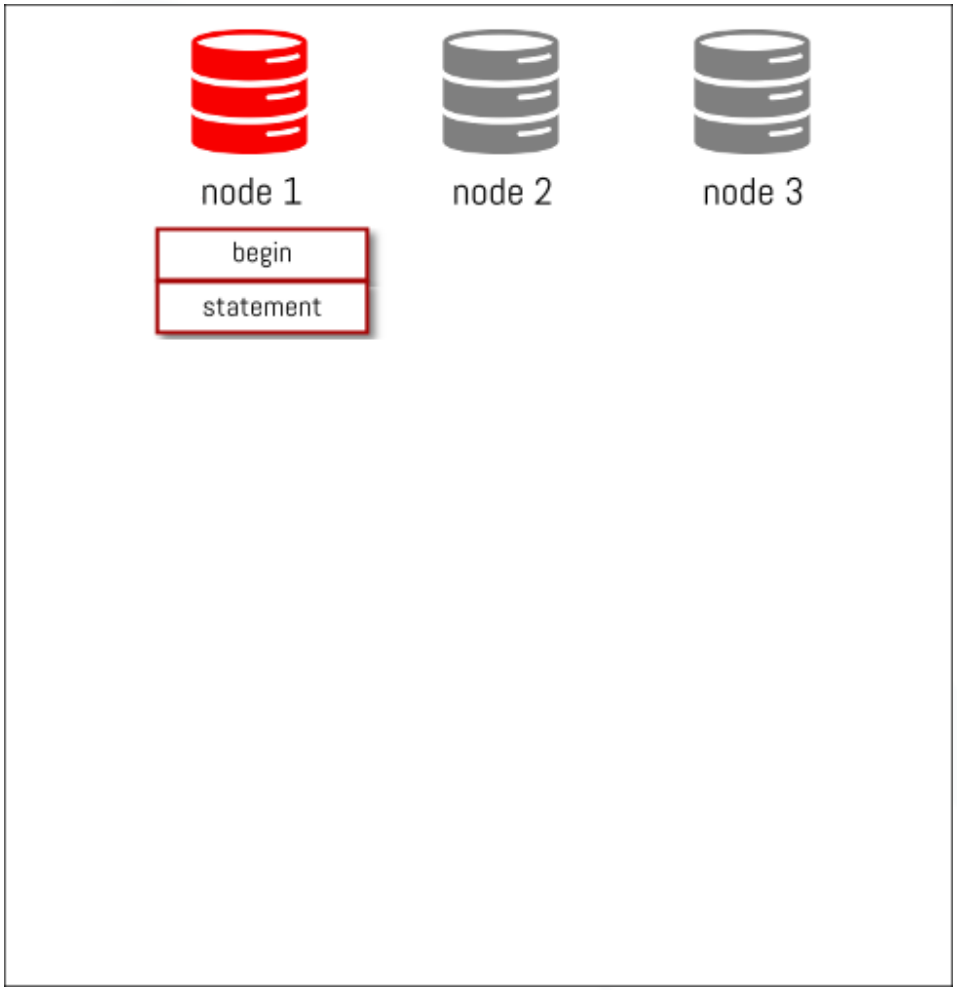

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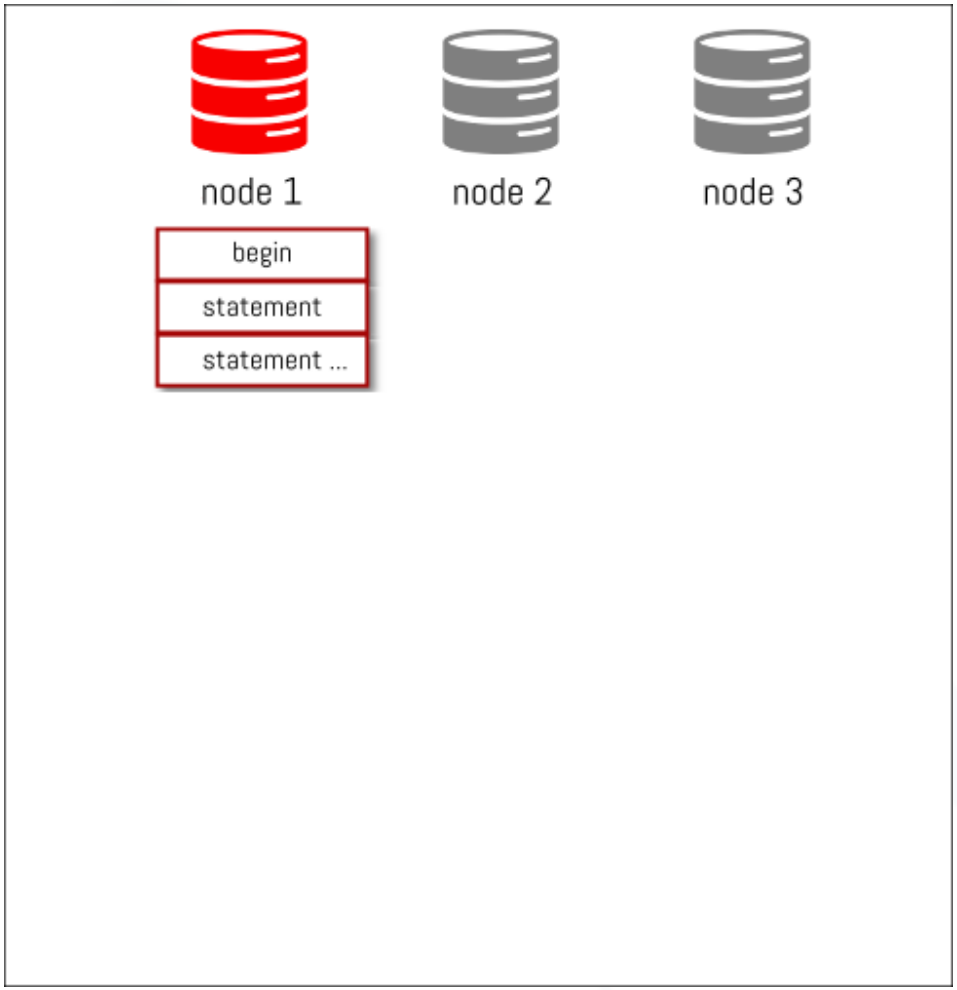

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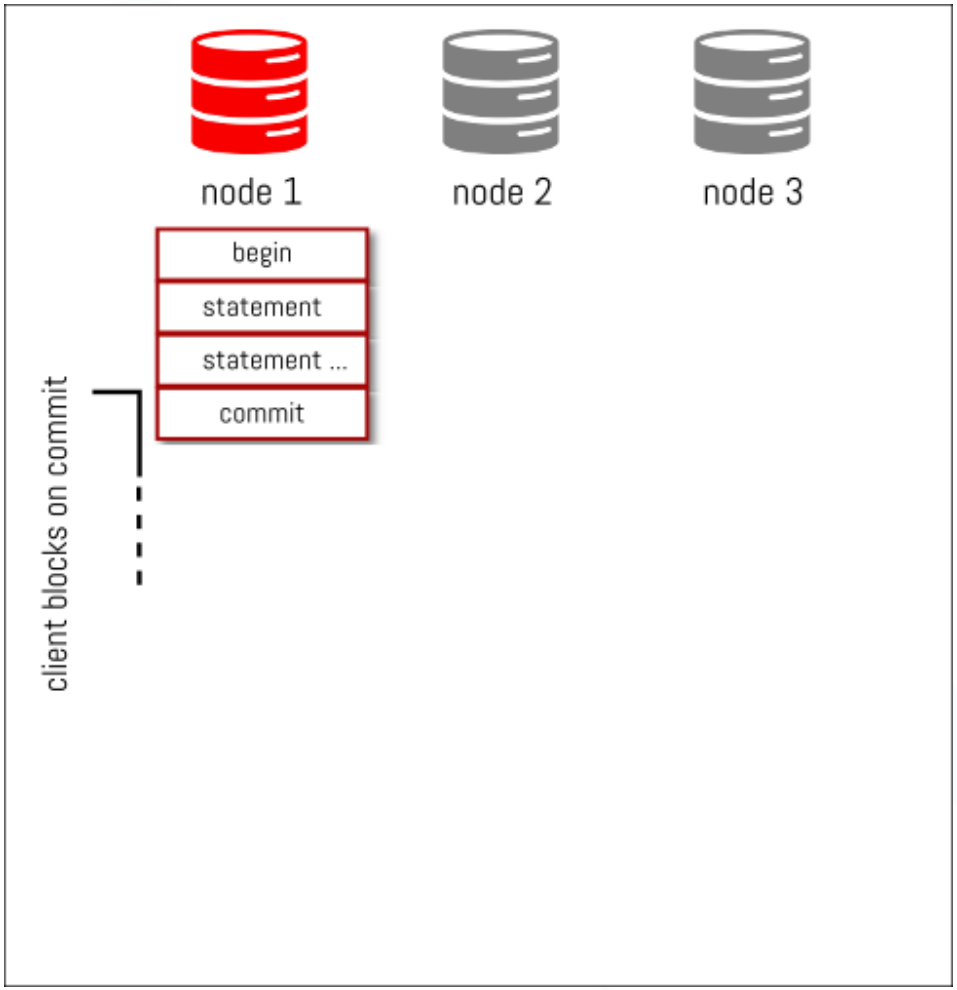

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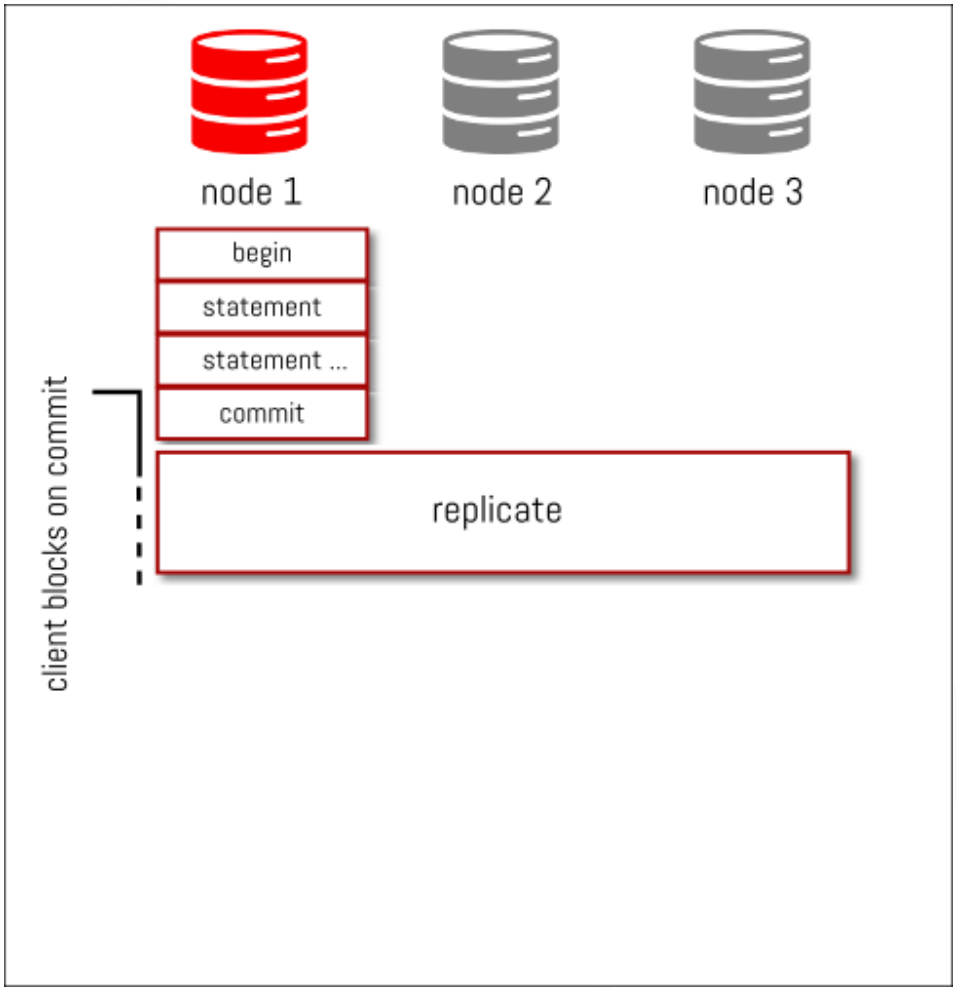

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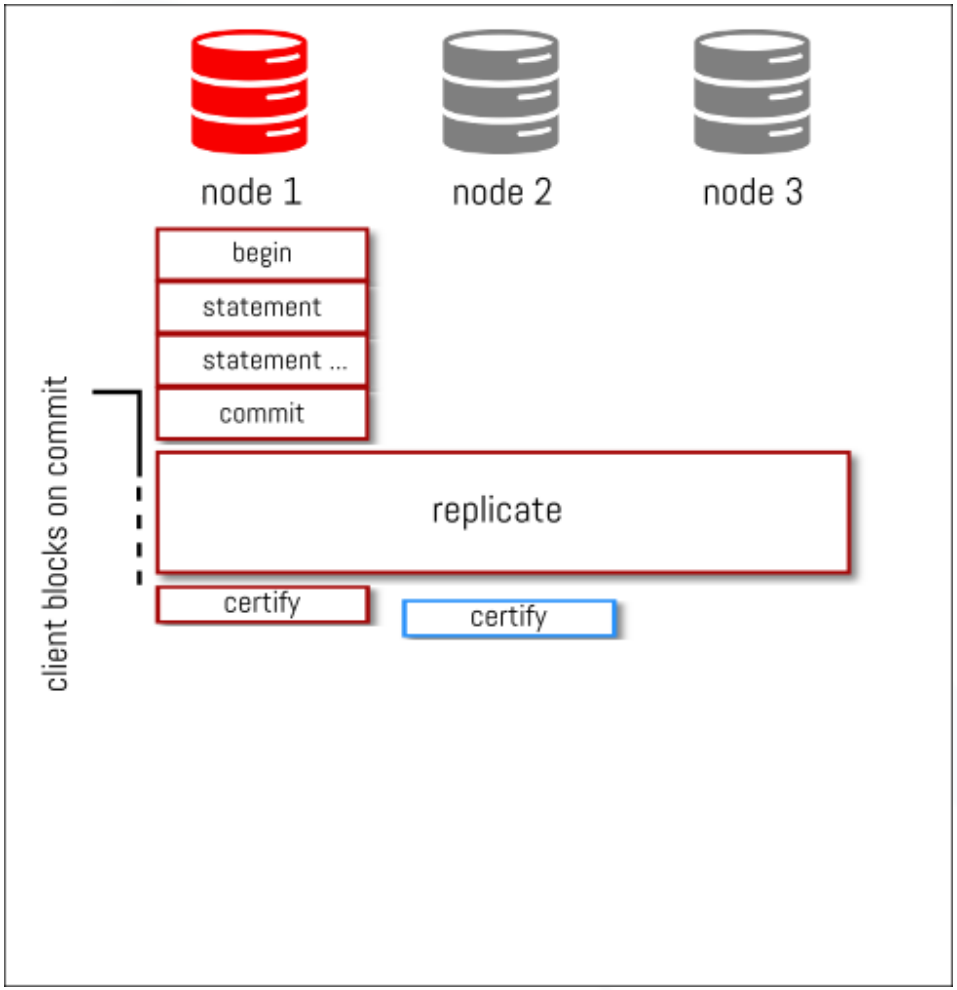

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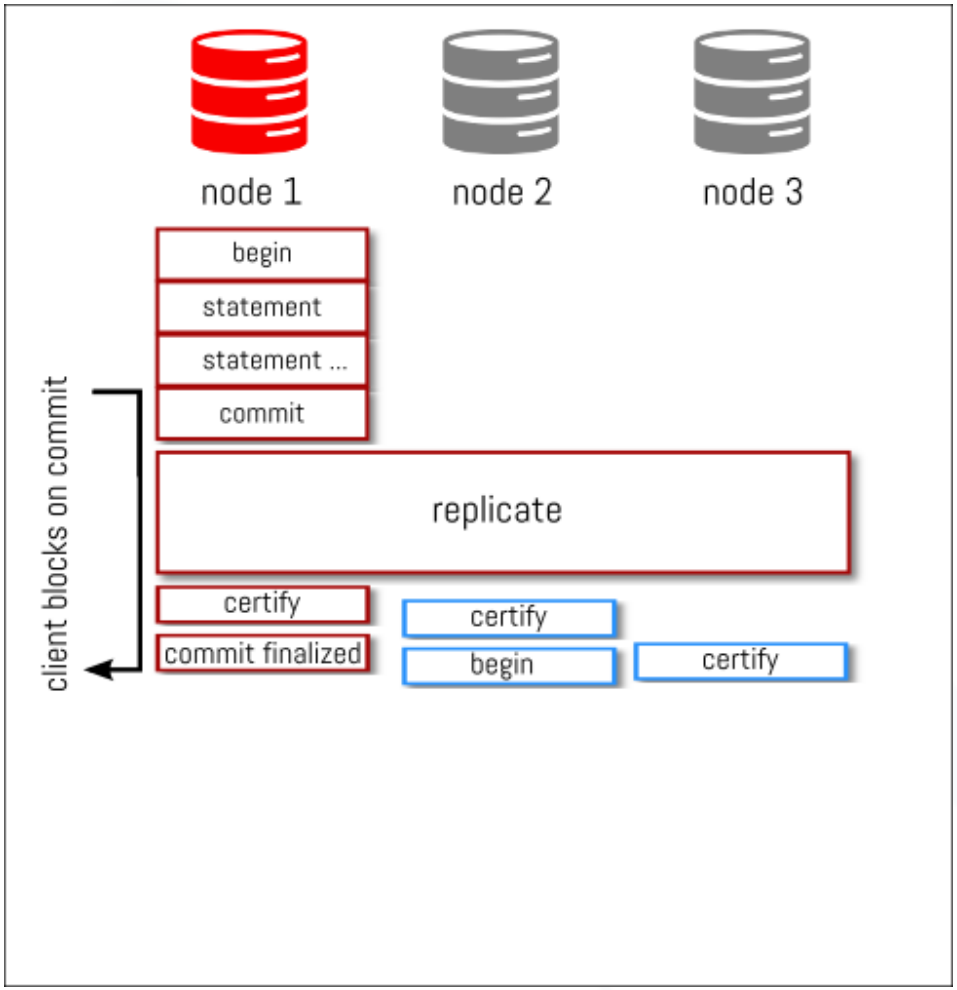

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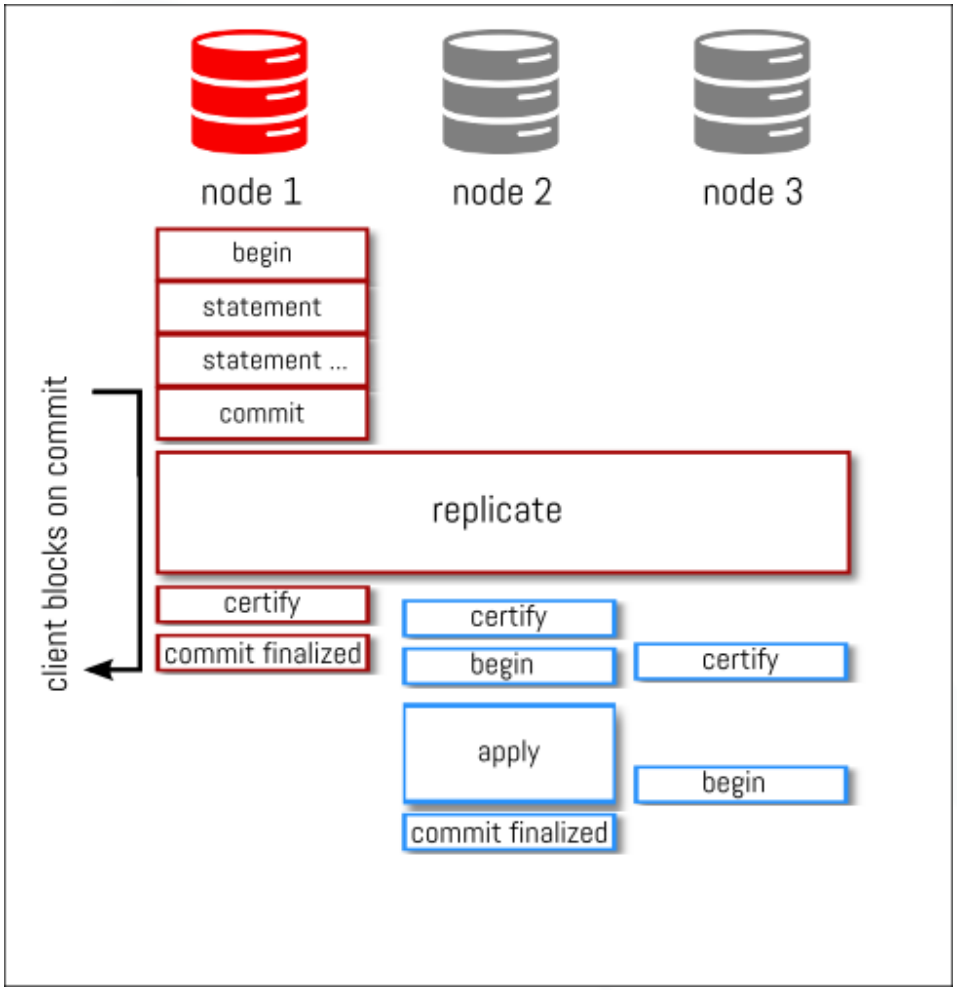

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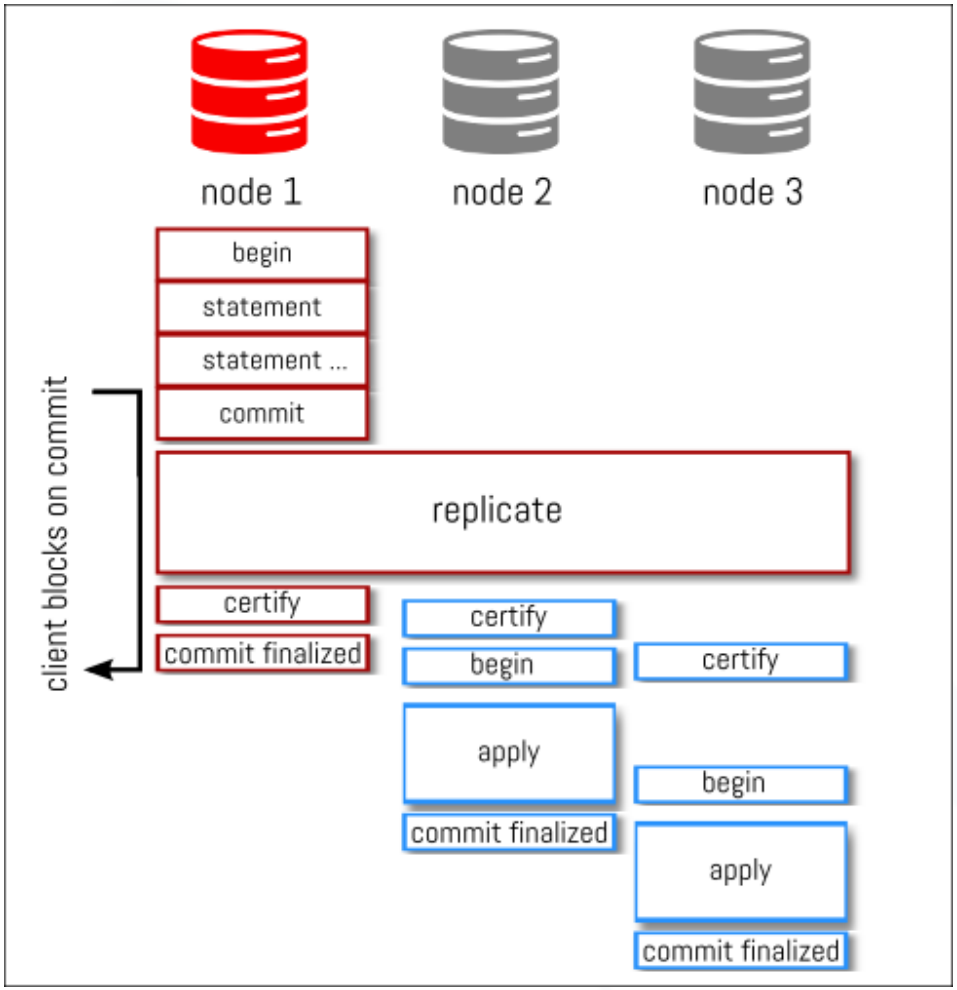

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  - atomically
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- MySQL Group Replication receives the Ordered 'tickets' from this GCS subsystem.

Total Order

GTID generation

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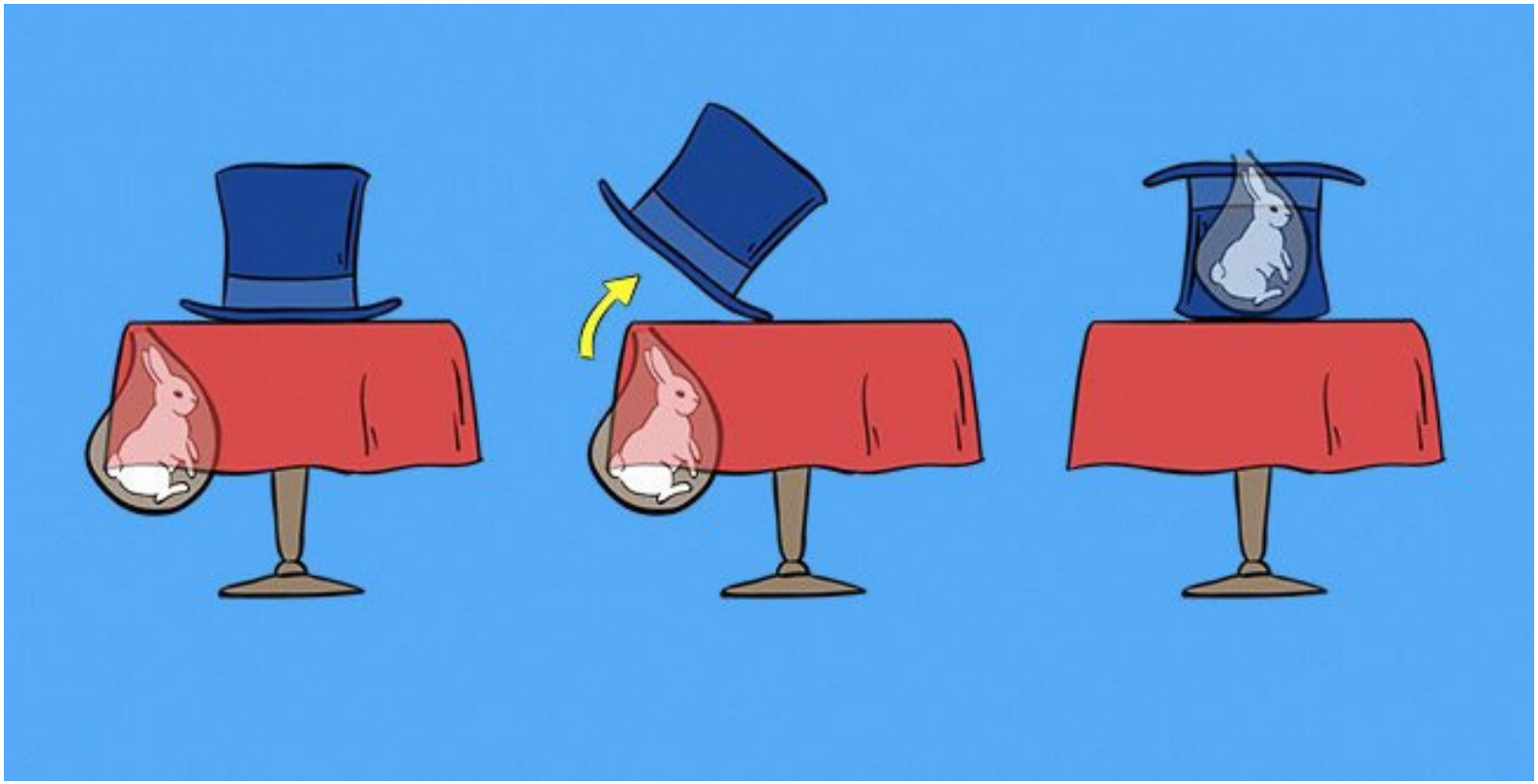
- **AUTOMATIC**: the transaction is assigned with an automatically generated id during commit. Where regular replication uses the source server UUID, on Group Replication, the group name is used.

- **ASSIGNED**: the user assigns manually a GTID through `SET GTID_NEXT` to the transaction. This is common to any replication format and the id is assigned before the transaction starts.



Group Replication : Total Order Delivery - GTID

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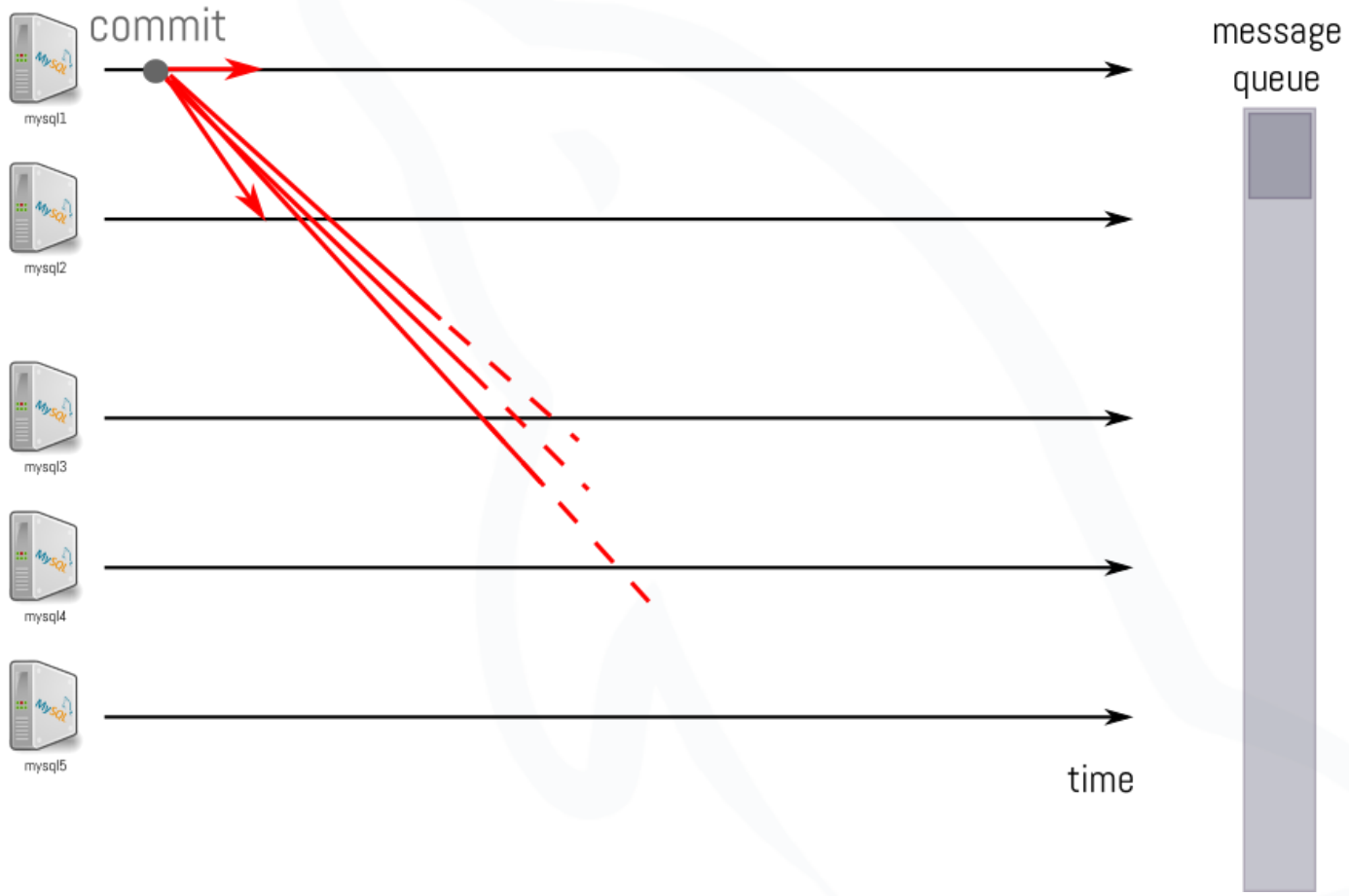
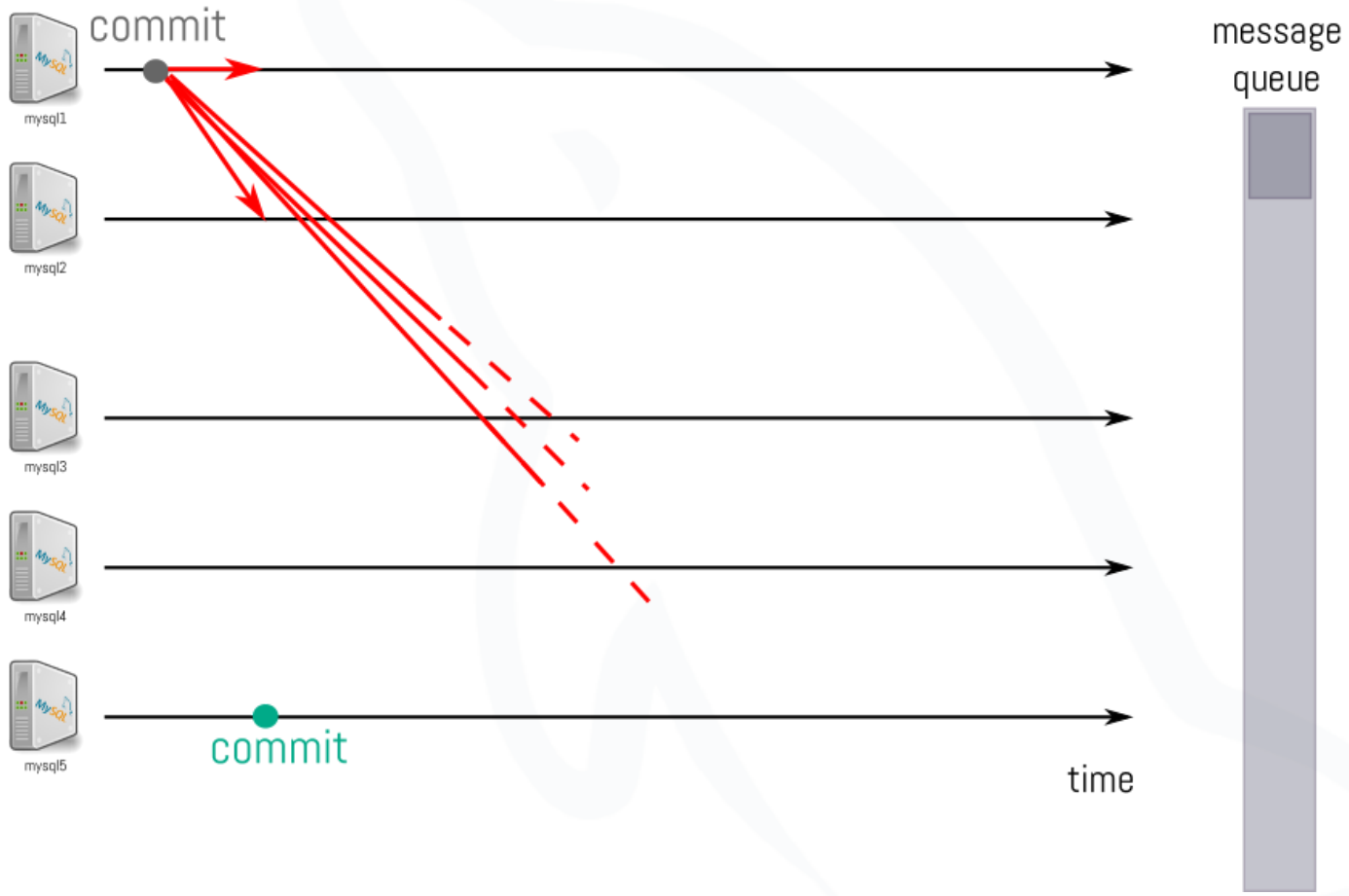
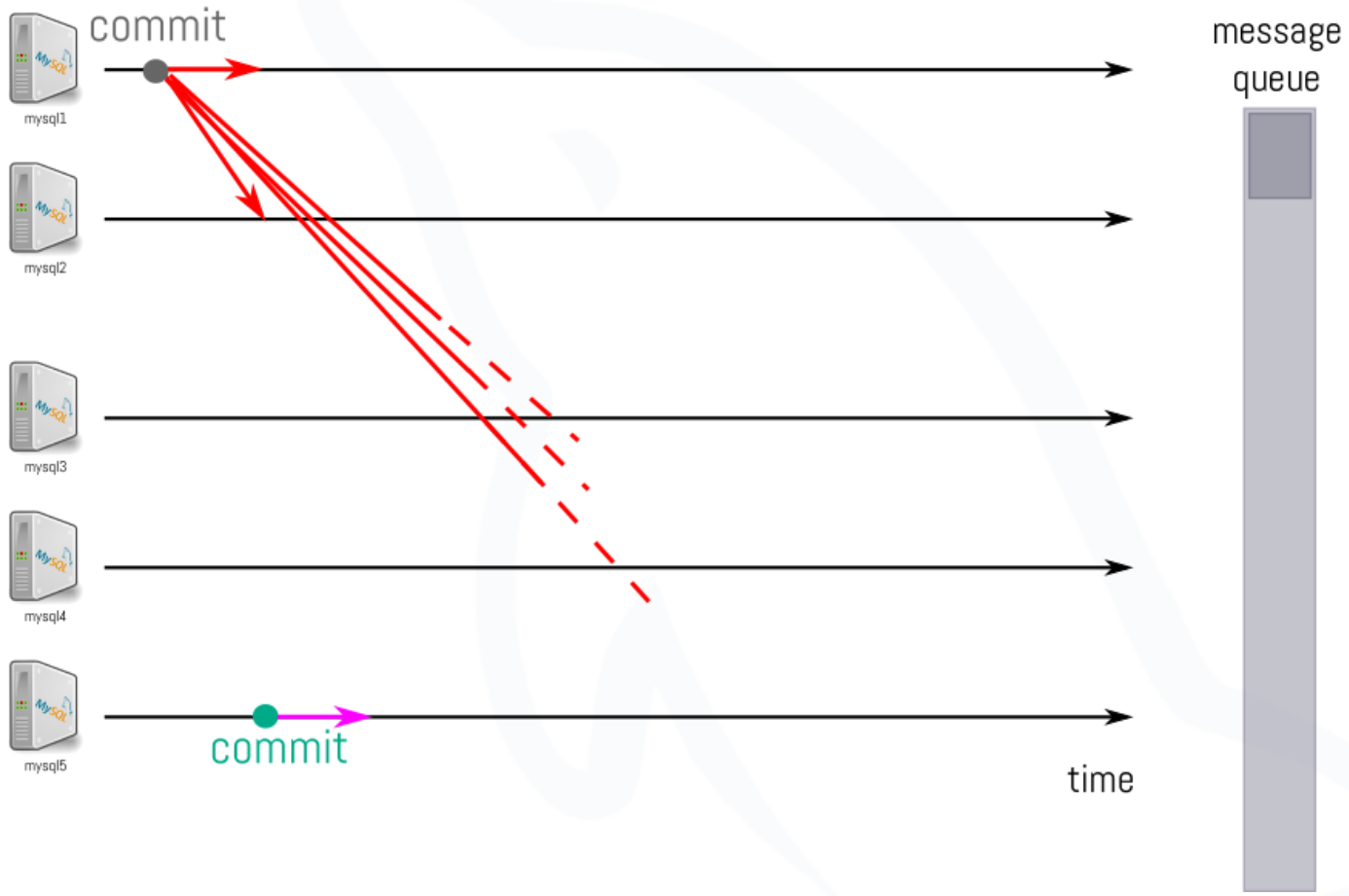


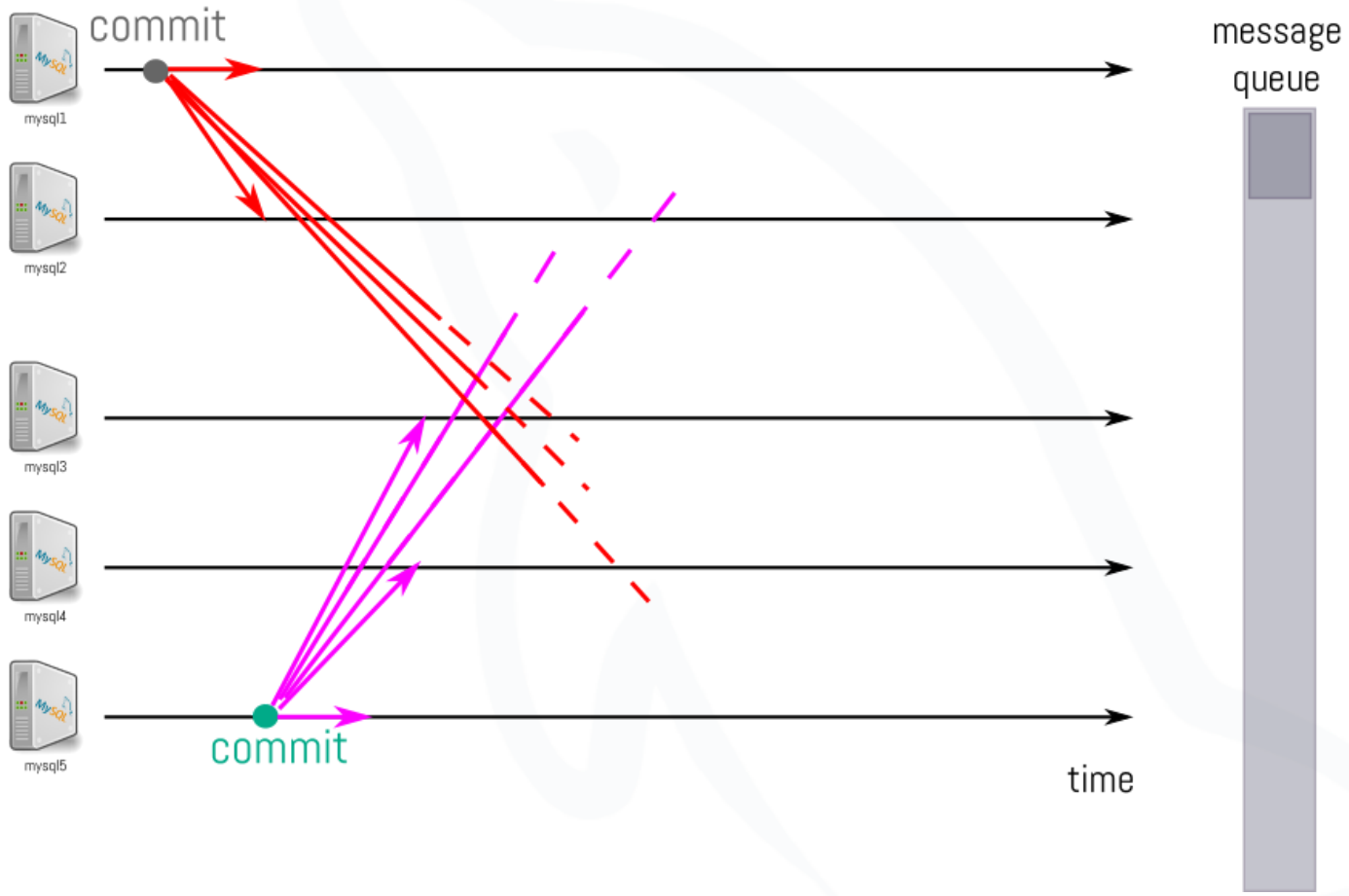
Group Replication : Total Order Delivery - GTID



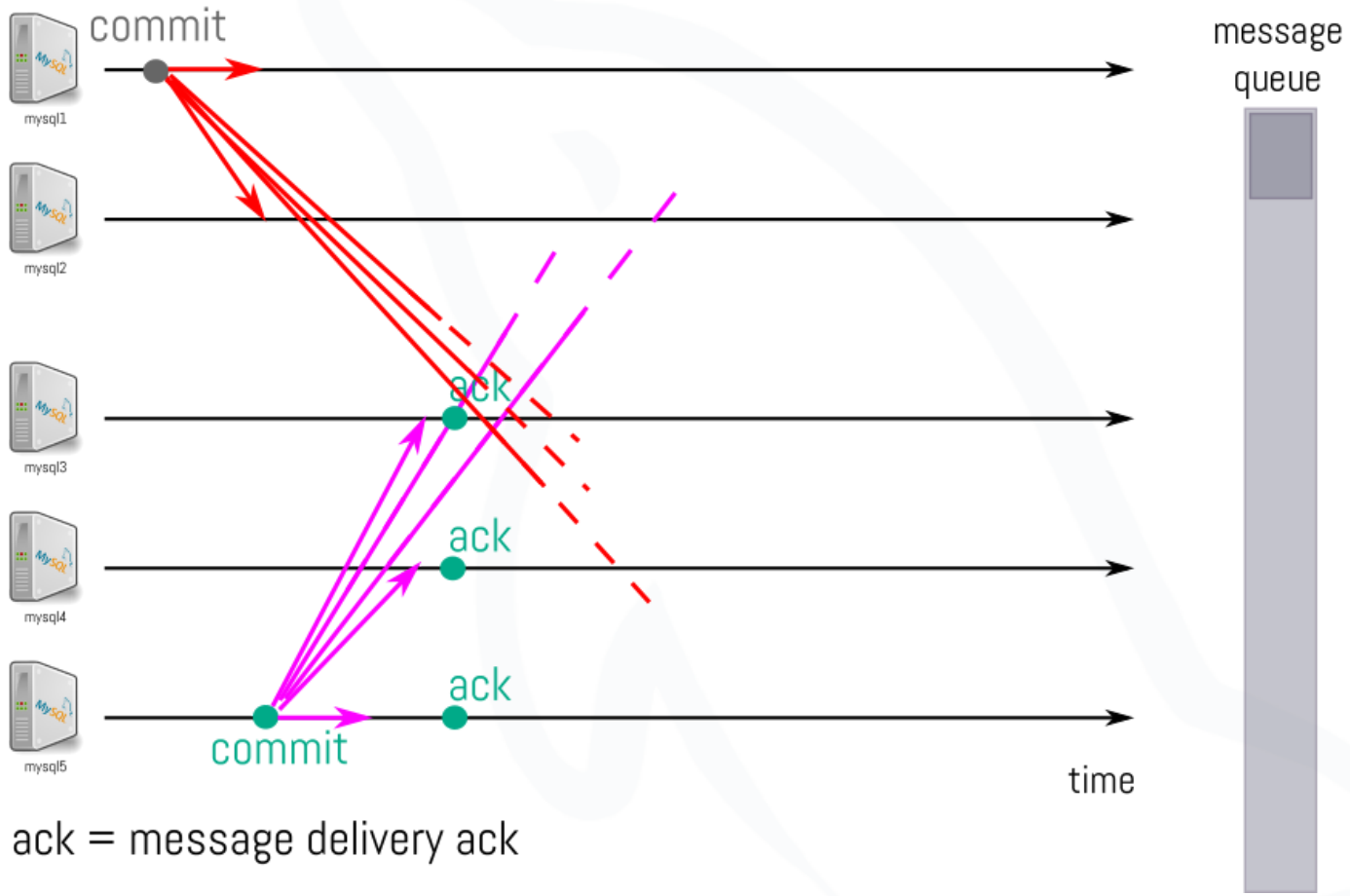
Group Replication : Total Order Delivery - GTID



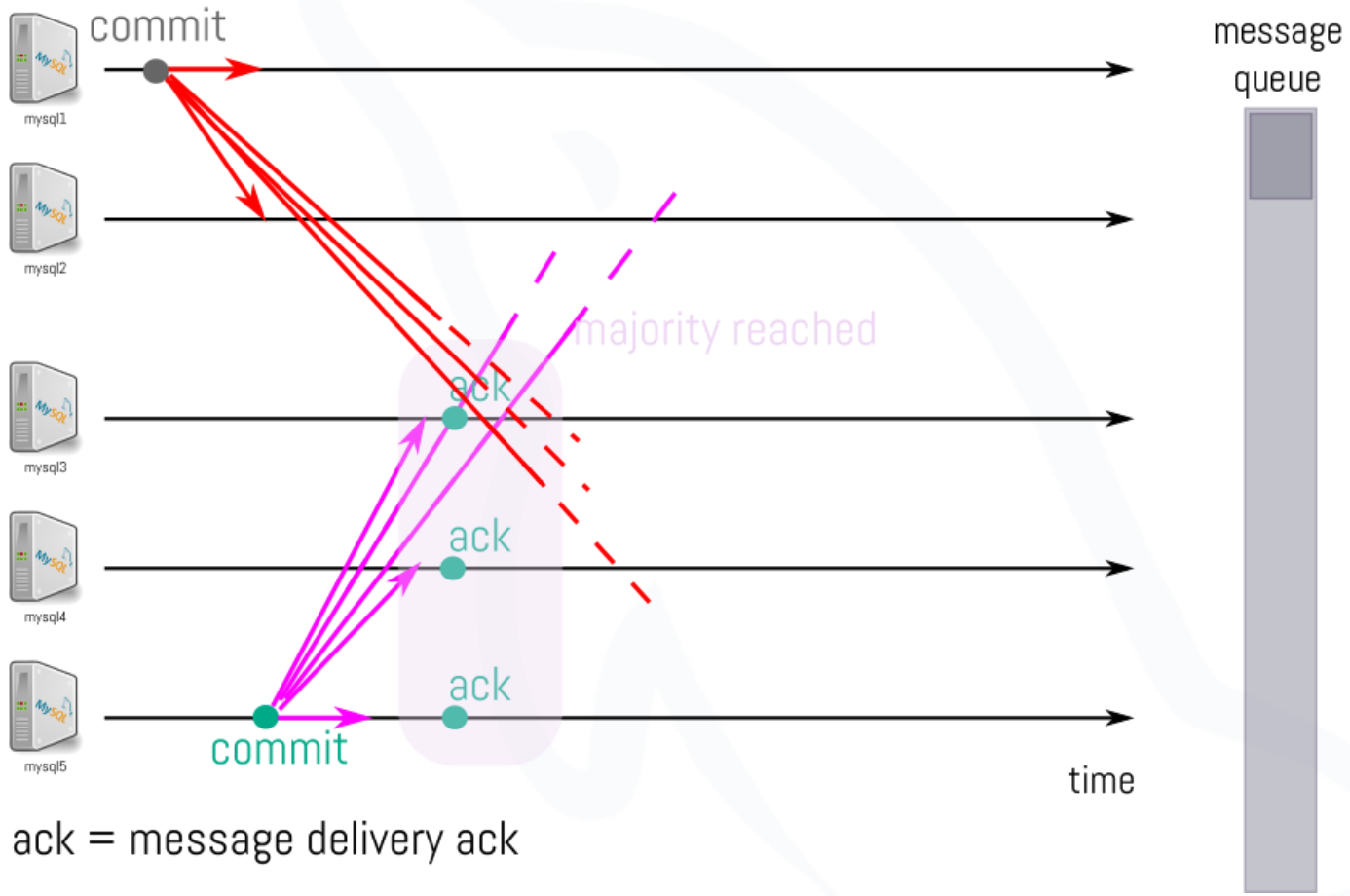
Group Replication : Total Order Delivery - GTID



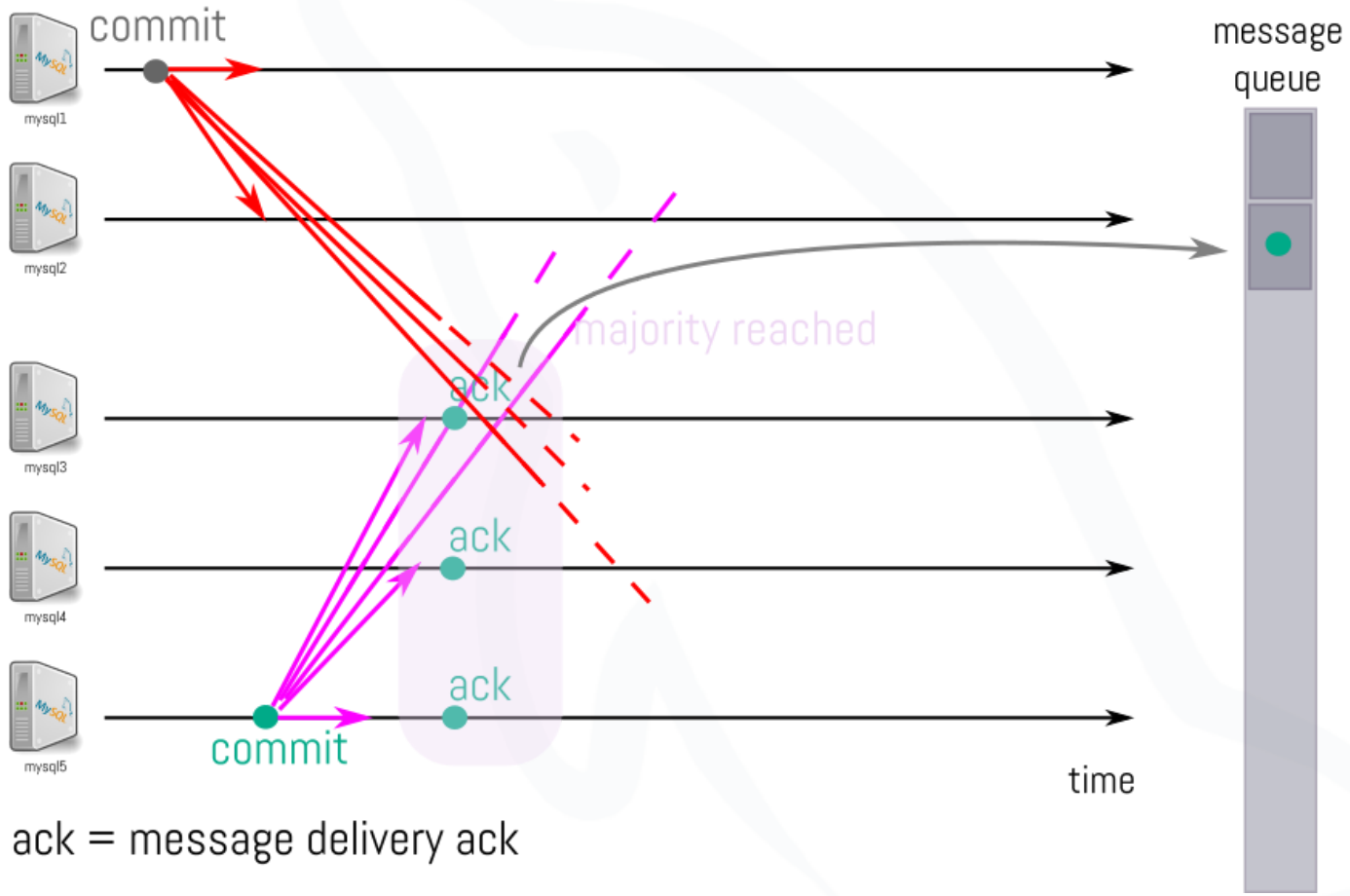
Group Replication : Total Order Delivery - GTID



Group Replication : Total Order Delivery - GTID



Group Replication : Total Order Delivery - GTID



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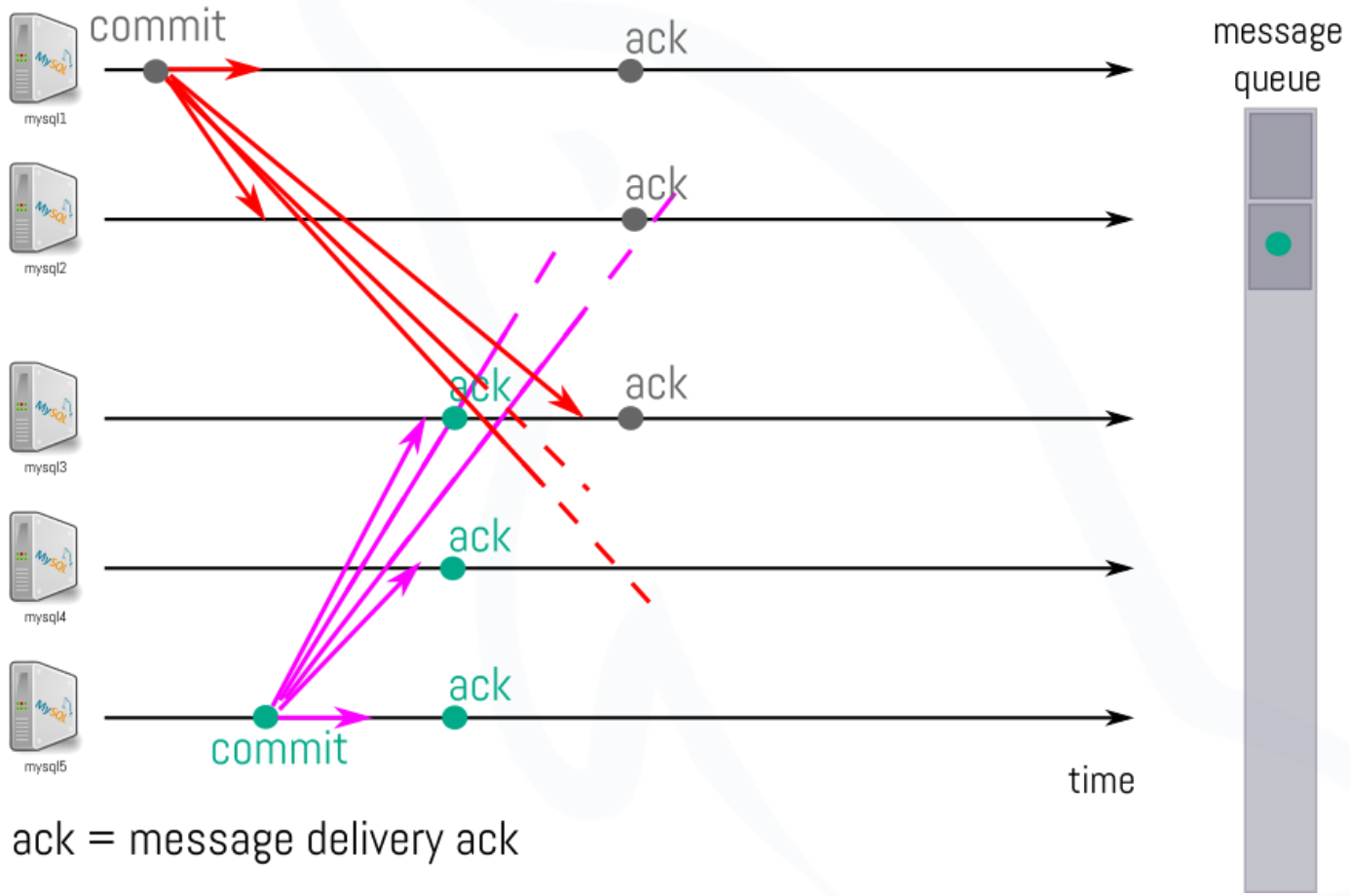

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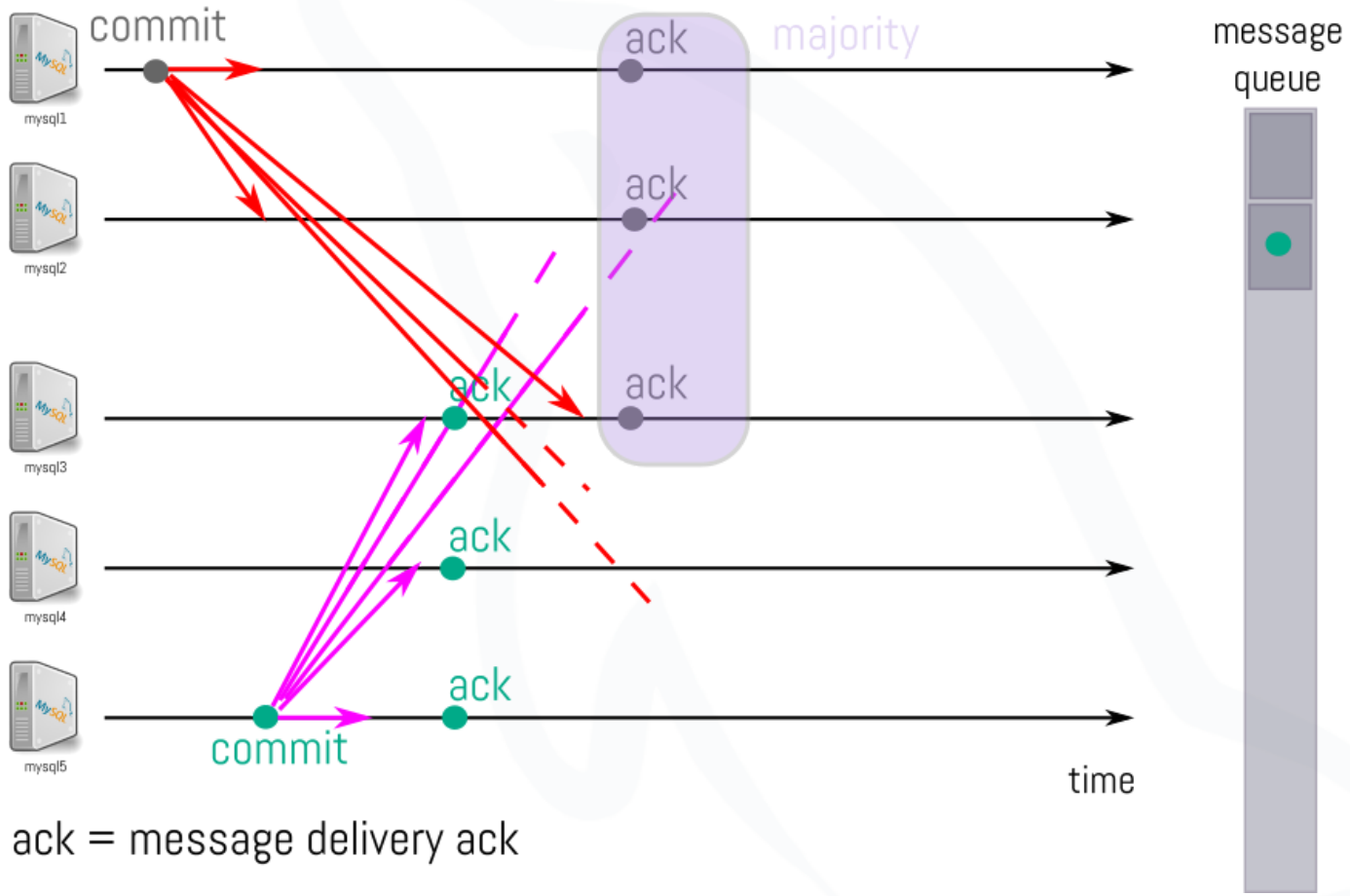
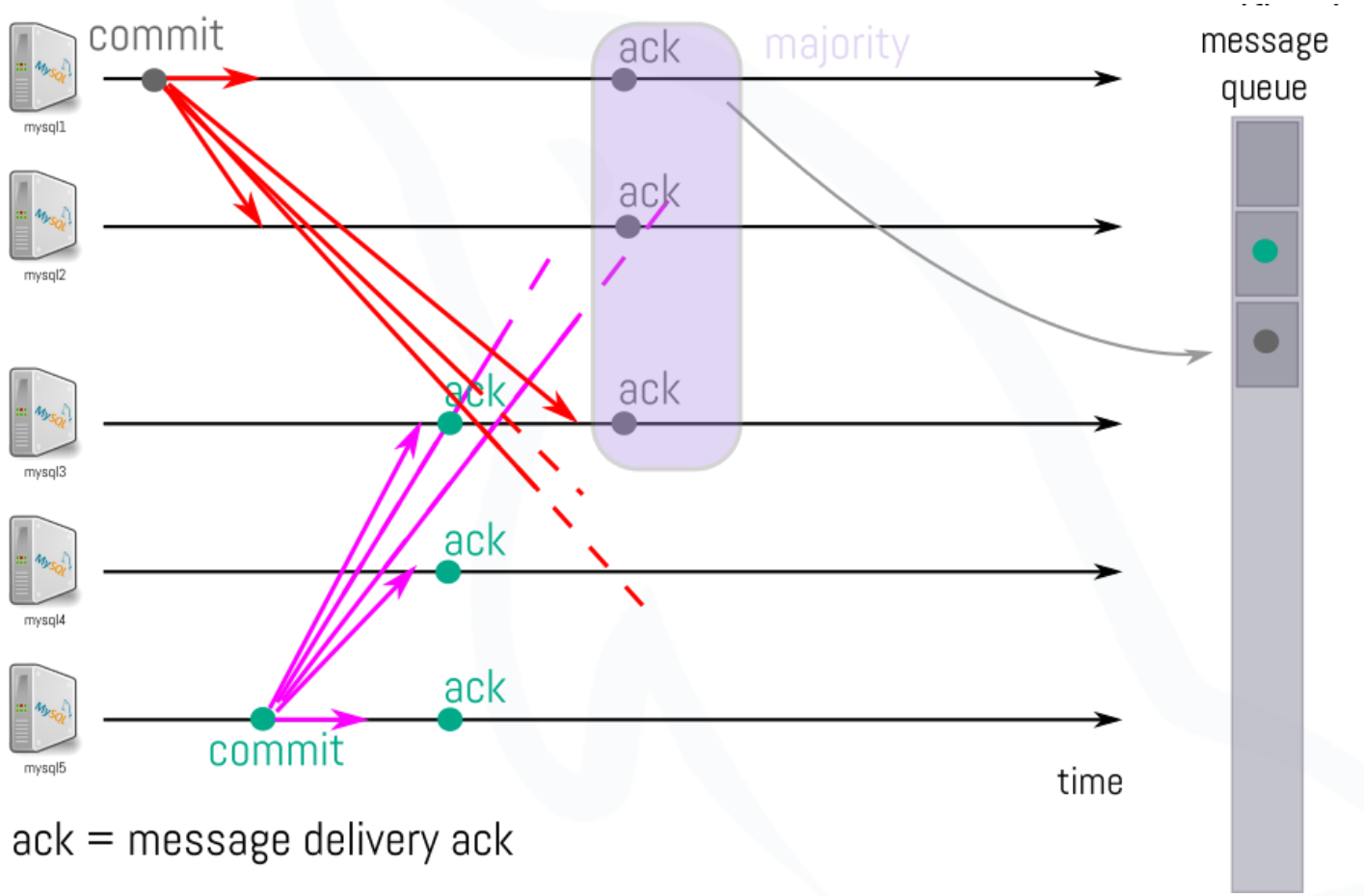


Group Replication : Total Order Delivery - GTID



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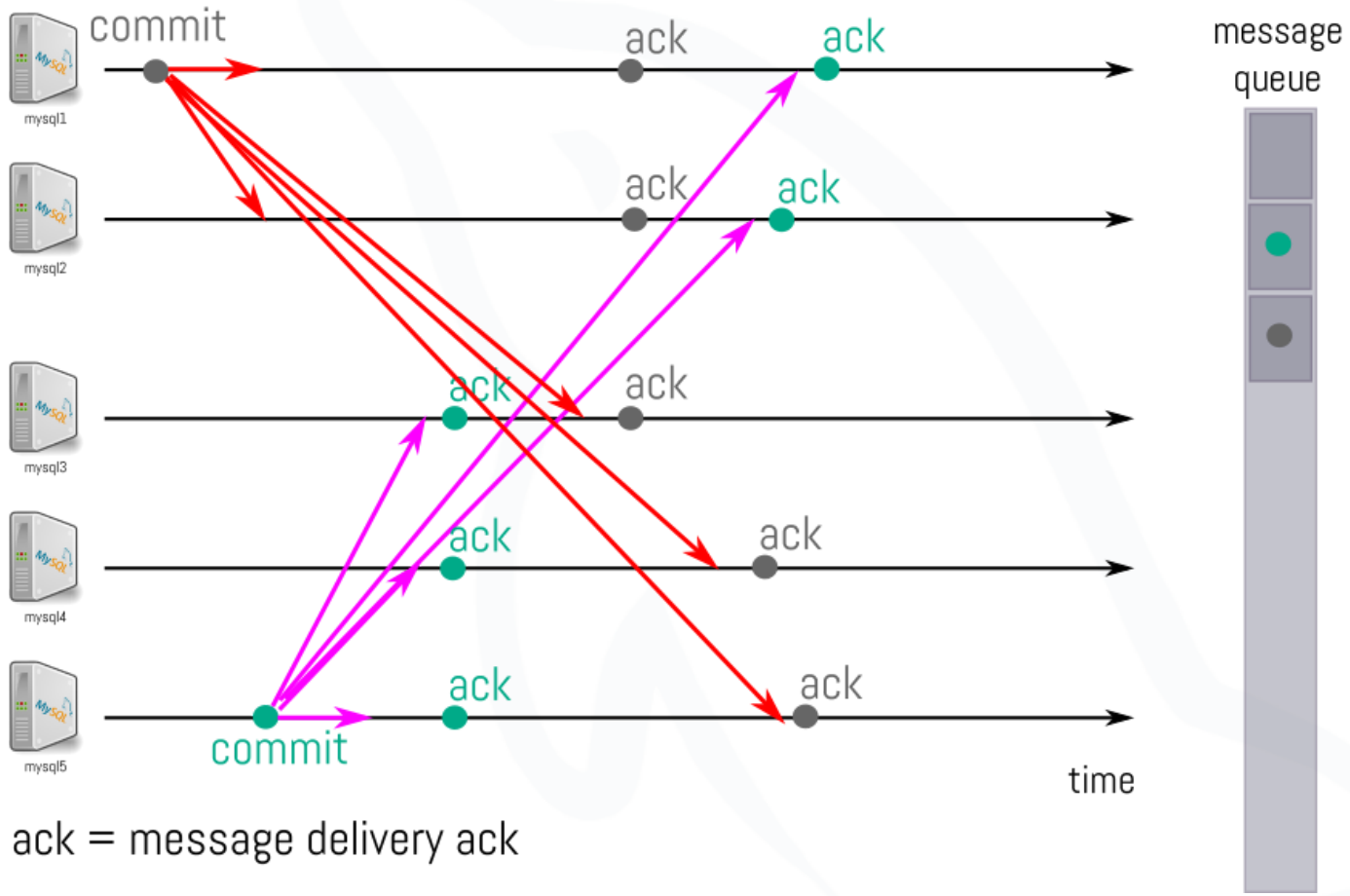
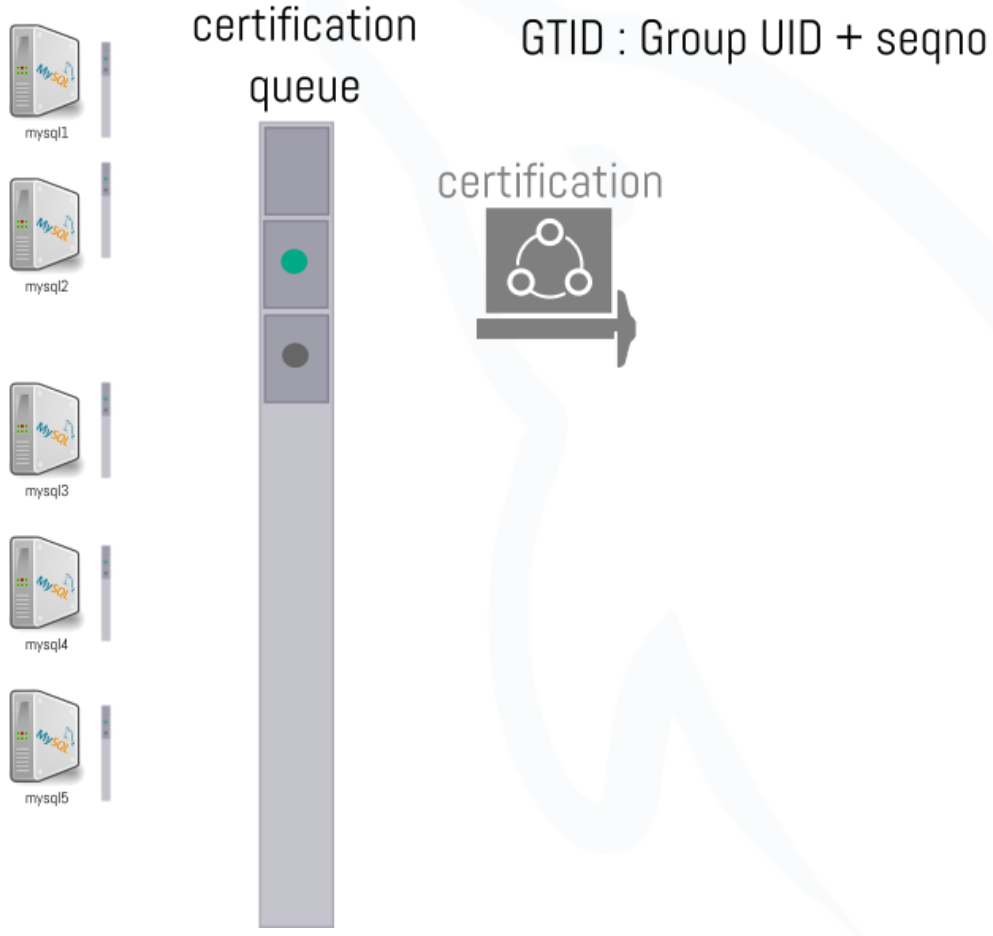


Group Replication : Total Order Delivery - GTID



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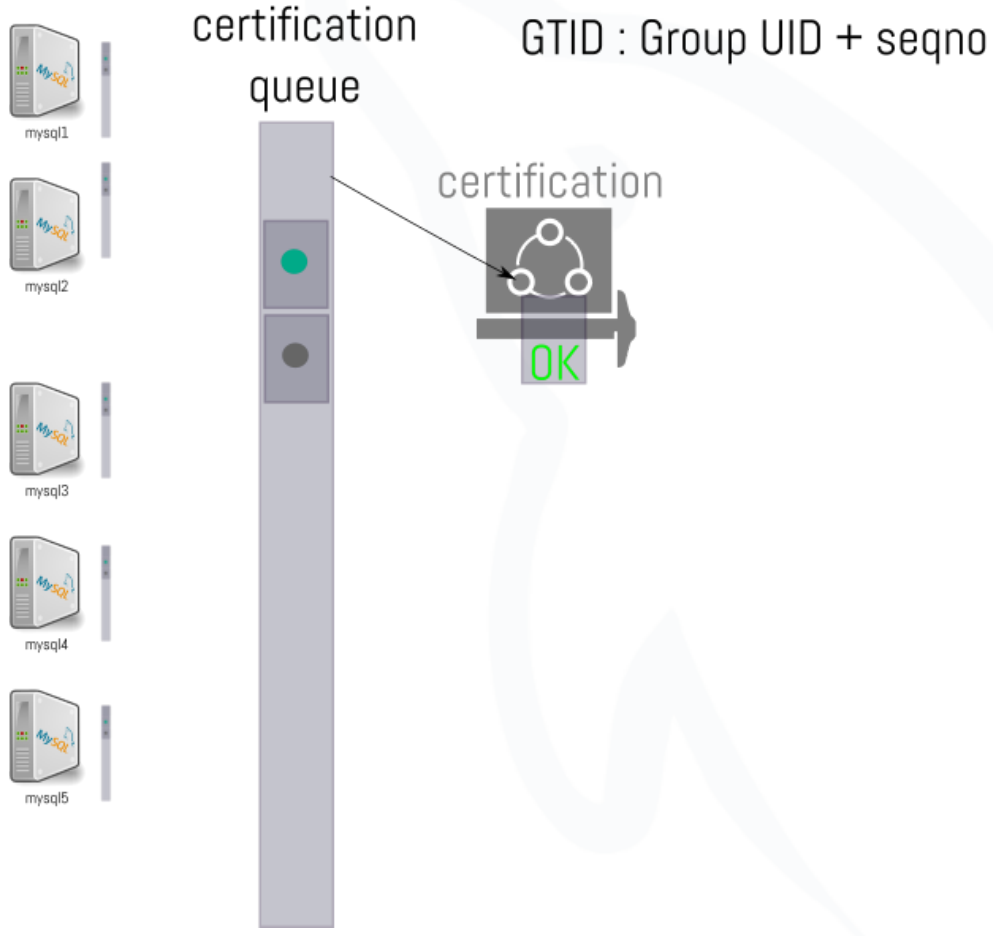

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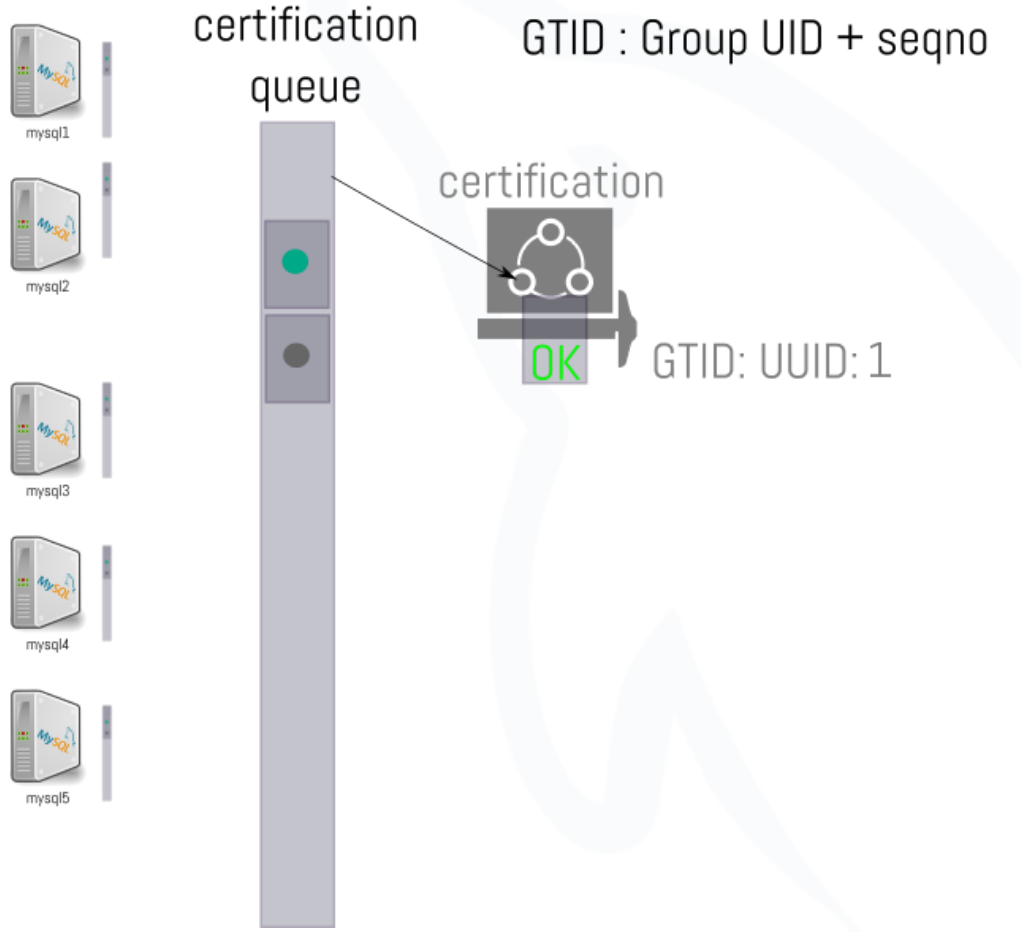

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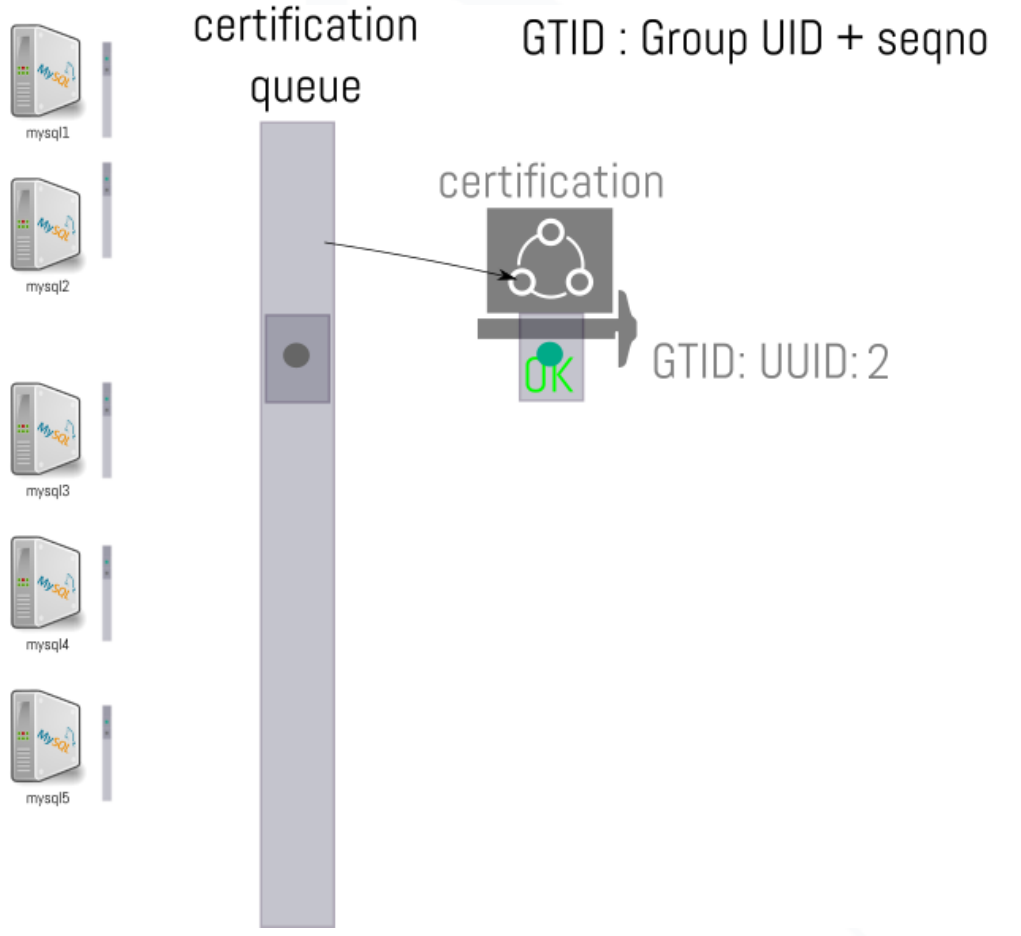
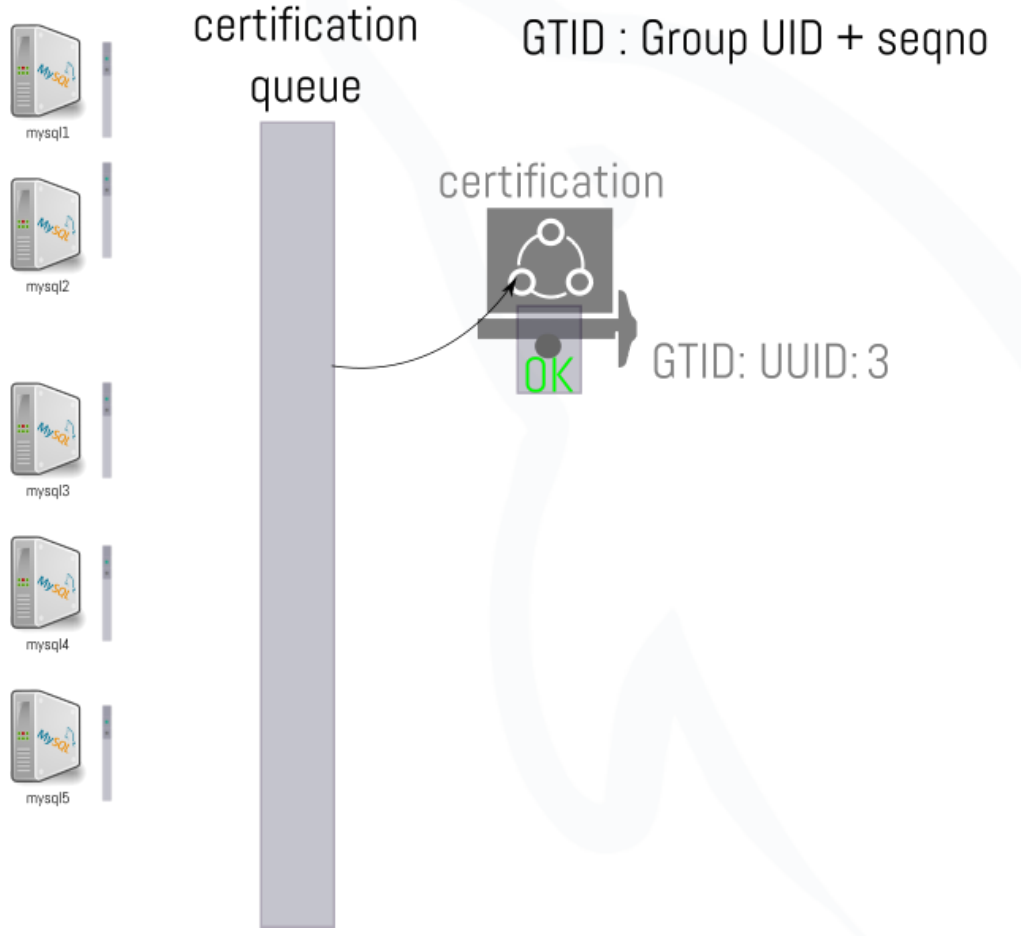


Group Replication : Total Order Delivery - GTID



Group Replication : GTID

The previous example was not totally in sync with reality. In fact, a writer allocates a block of GTID and when we have multiple writes (*multi-primary mode*) all writers will use GTID sequence numbers in their allocated block.

The size of the block is defined by `group_replication_gtid_assignment_block_size` (default to 1M)

Group Replication : GTID

Example:

```
Executed_Gtid_Set: 0b5c746d-d552-11e8-bef0-08002718d305:1-355
```

Group Replication : GTID

Example:

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Executed_Gtid_Set: 0b5c746d-d552-11e8-bef0-08002718d305:1-355
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New write on an other node:

```
Executed_Gtid_Set: 0b5c746d-d552-11e8-bef0-08002718d305:1-355,1000354
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Example:

```
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New write on an other node:

```
Executed_Gtid_Set: 0b5c746d-d552-11e8-bef0-08002718d305:1-355,1000354
```

Let's write on the third node:

```
Executed_Gtid_Set: 0b5c746d-d552-11e8-bef0-08002718d305:1-355:1000354:2000354
```

Group Replication : GTID

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Let's write on the third node:

```
Executed_Gtid_Set: 0b5c746d-d552-11e8-bef0-08002718d305:1-355:1000354:2000354
```

And writing back on the first one:

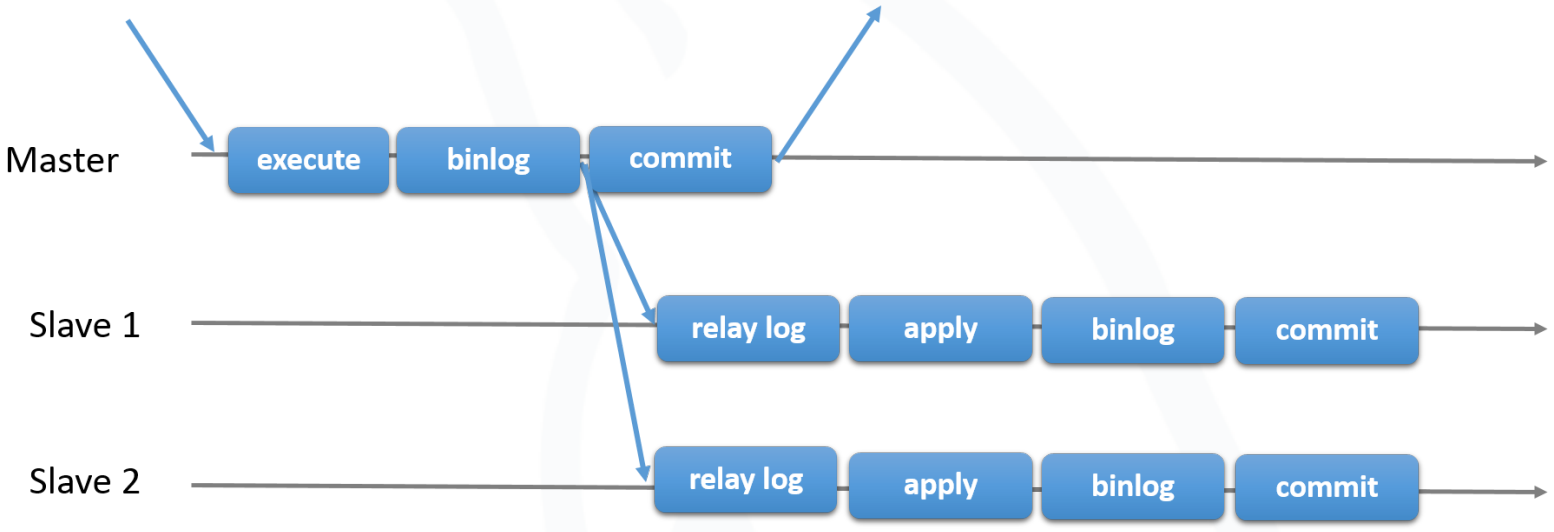
```
Executed_Gtid_Set: 0b5c746d-d552-11e8-bef0-08002718d305:1-356:1000354:2000354
```

done !

Return from Commit

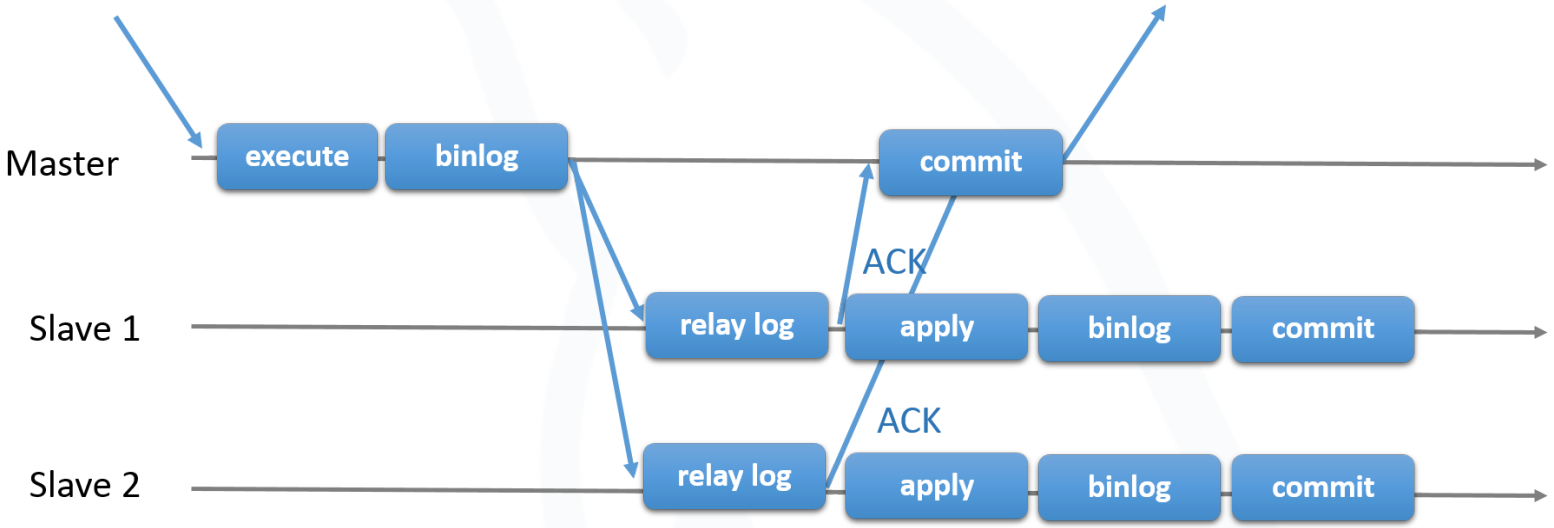
Group Replication: return from commit

Asynchronous Replication:



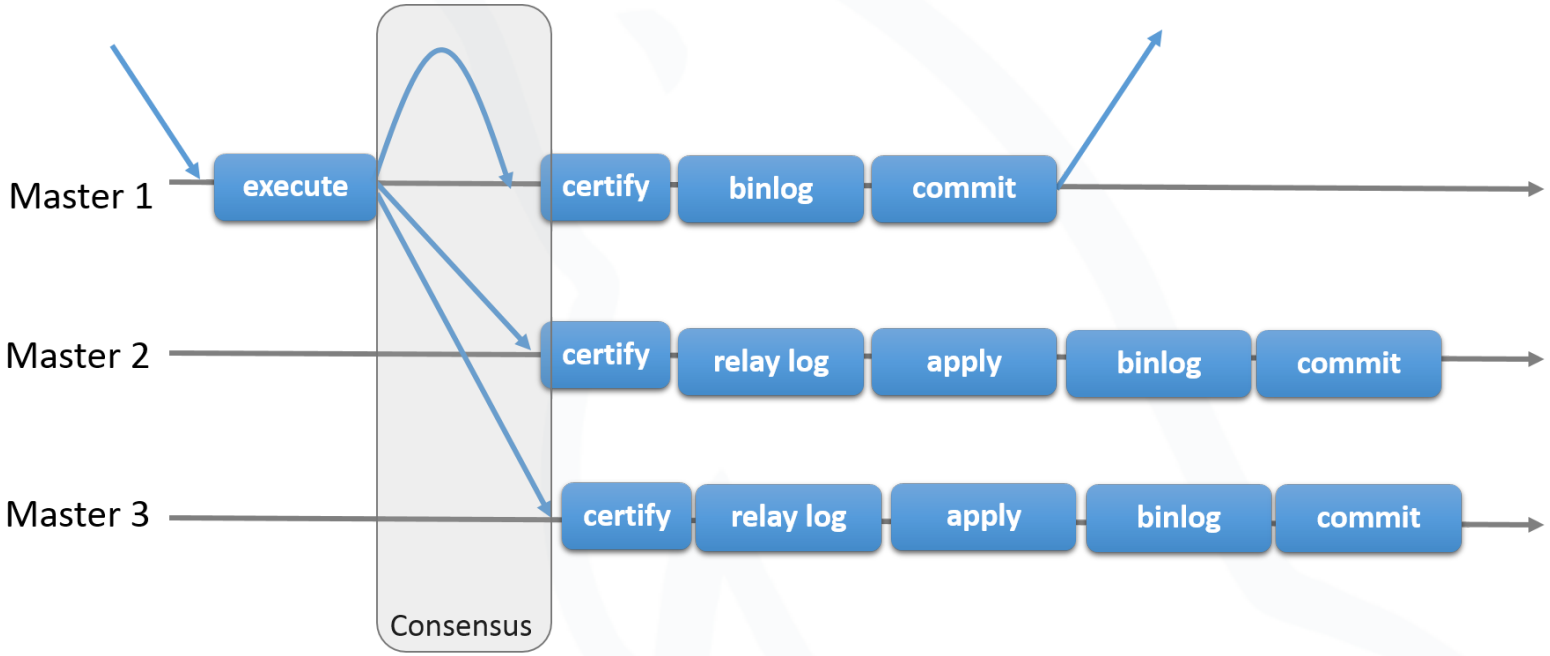
Group Replication: return from commit (2)

Semi-Sync Replication:



Group Replication: return from commit (3)

Group Replication:



Does this mean we can have a distant node and always let it ack later ?

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NO!

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NO!

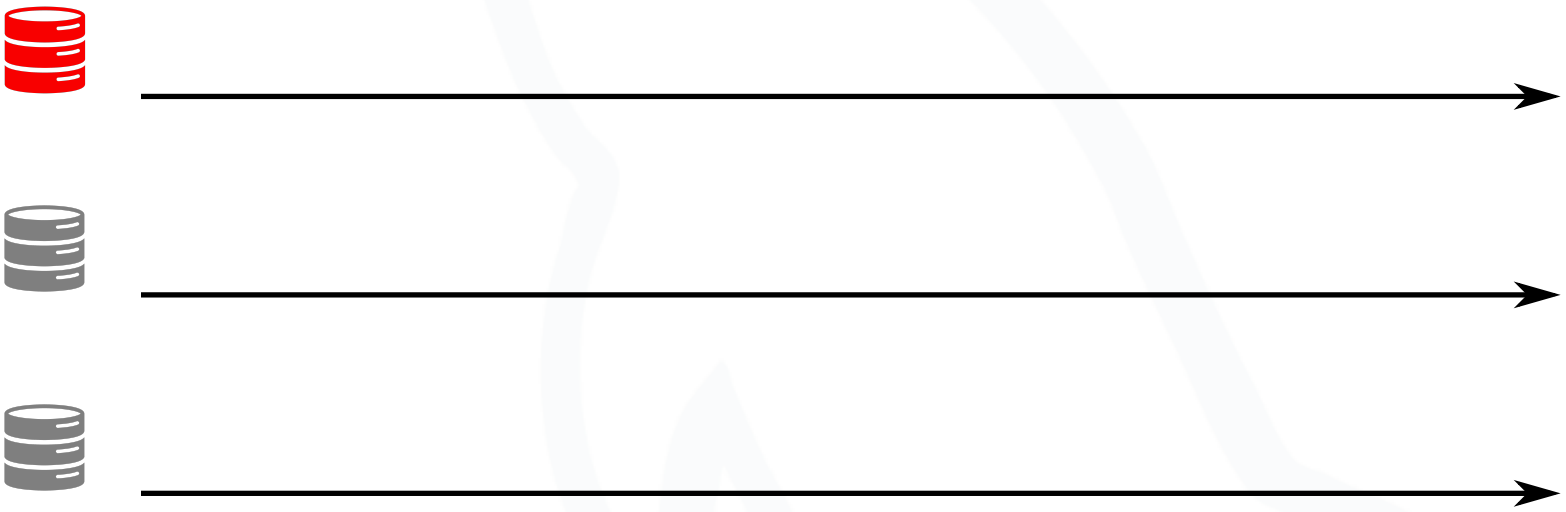
Because the system has to wait for the noop (single skip message) from the “distant” node where latency is higher

The size of the GCS consensus messages window can be get and set from UDF functions: *group_replication_get_write_concurrency()*, *group_replication_set_write_concurrency()*

```
mysql> select group_replication_get_write_concurrency();
+-----------------------------------------+
| group_replication_get_write_concurrency() |
+-----------------------------------------+
|                                      10 |
+-----------------------------------------+
```

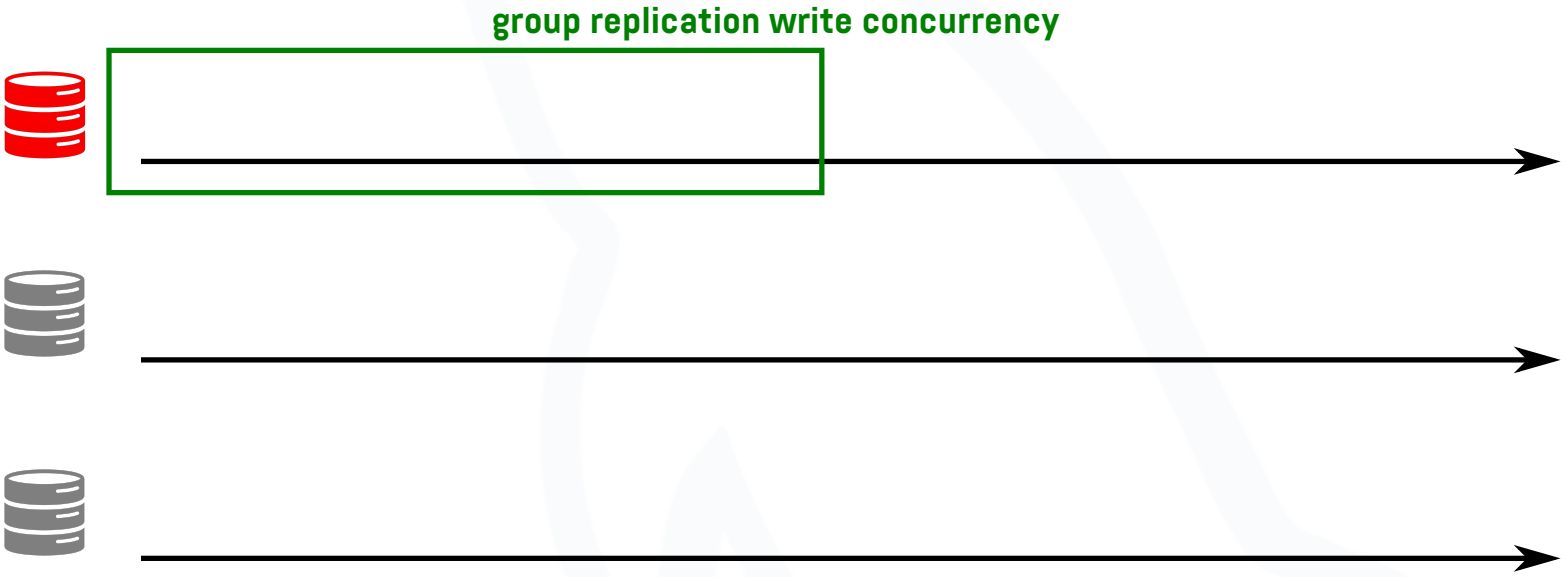
Event Horizon

GCS Write Consensus Concurrency



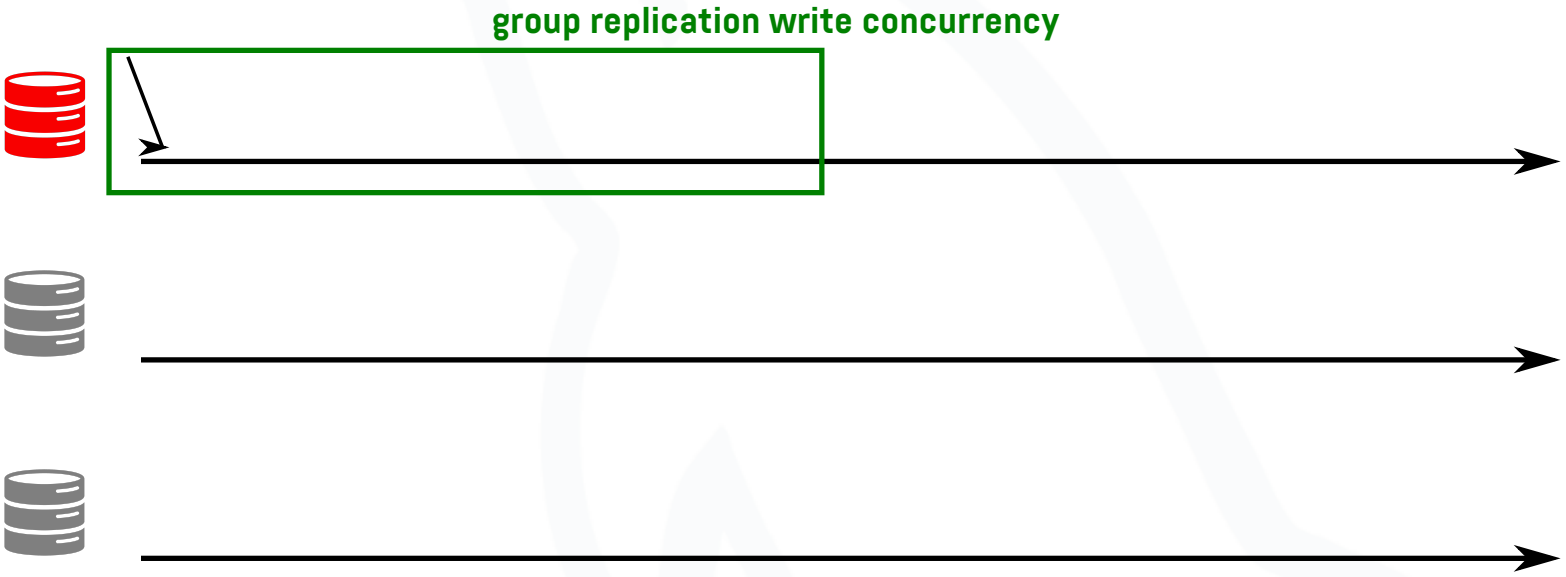
Event Horizon

GCS Write Consensus Concurrency



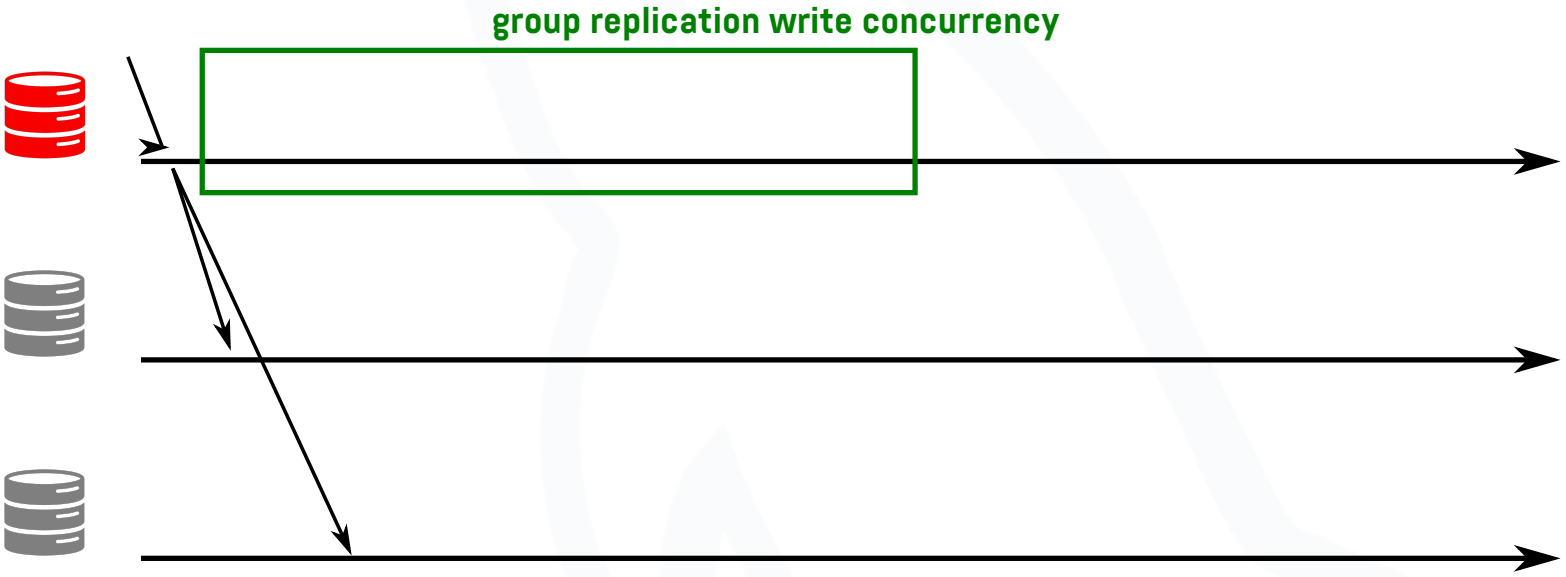
Event Horizon

GCS Write Consensus Concurrency



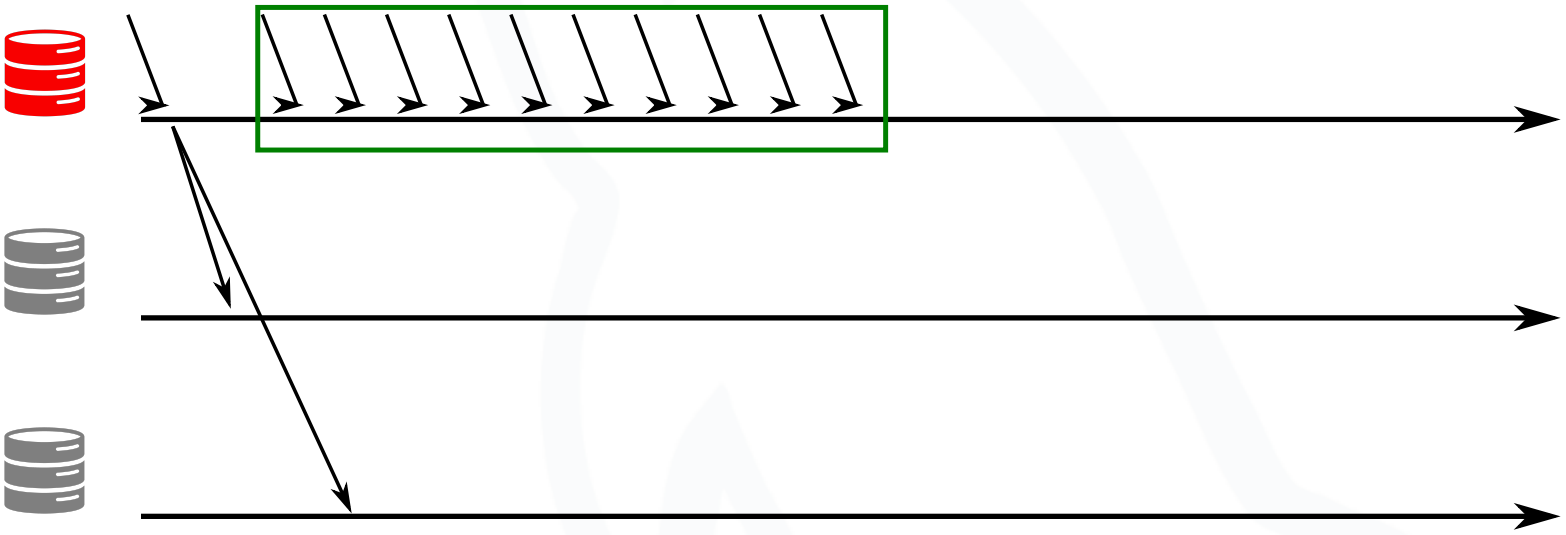
Event Horizon

GCS Write Consensus Concurrency



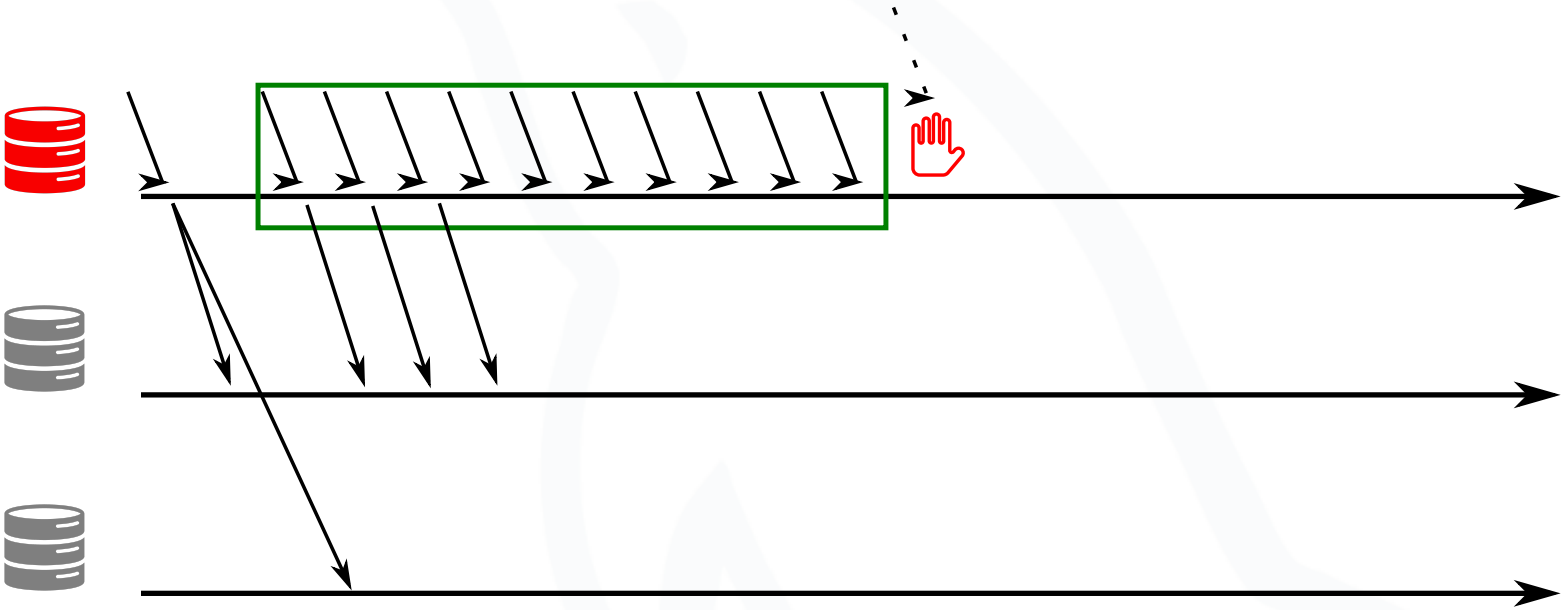
Event Horizon

GCS Write Consensus Concurrency



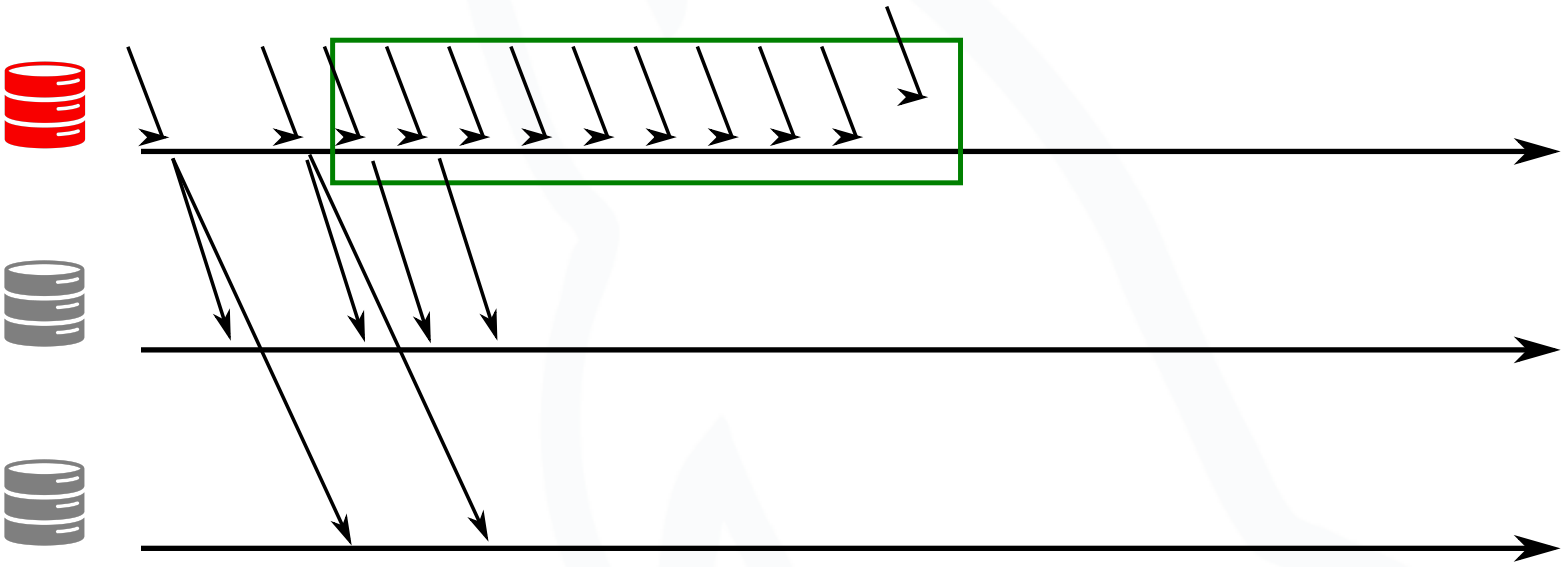
Event Horizon

GCS Write Consensus Concurrency



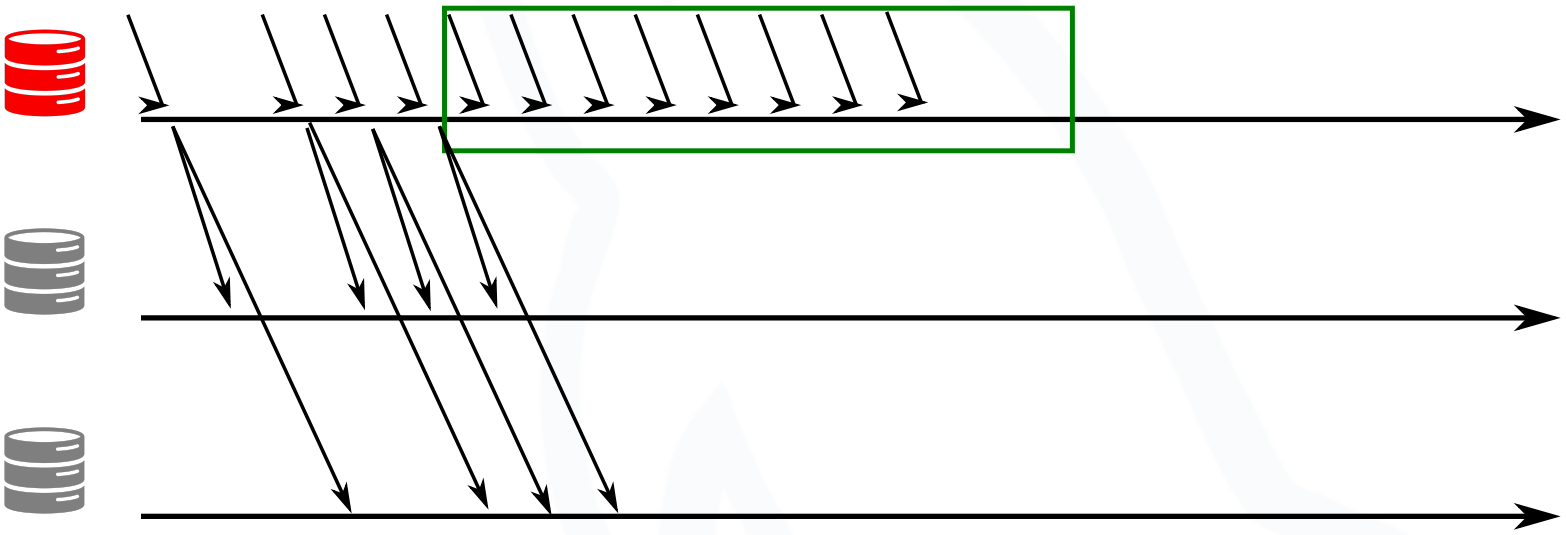
Event Horizon

GCS Write Consensus Concurrency



Event Horizon

GCS Write Consensus Concurrency



conflict

Optimistic Locking

Group Replication : Optimistic Locking

Group Replication uses optimistic locking

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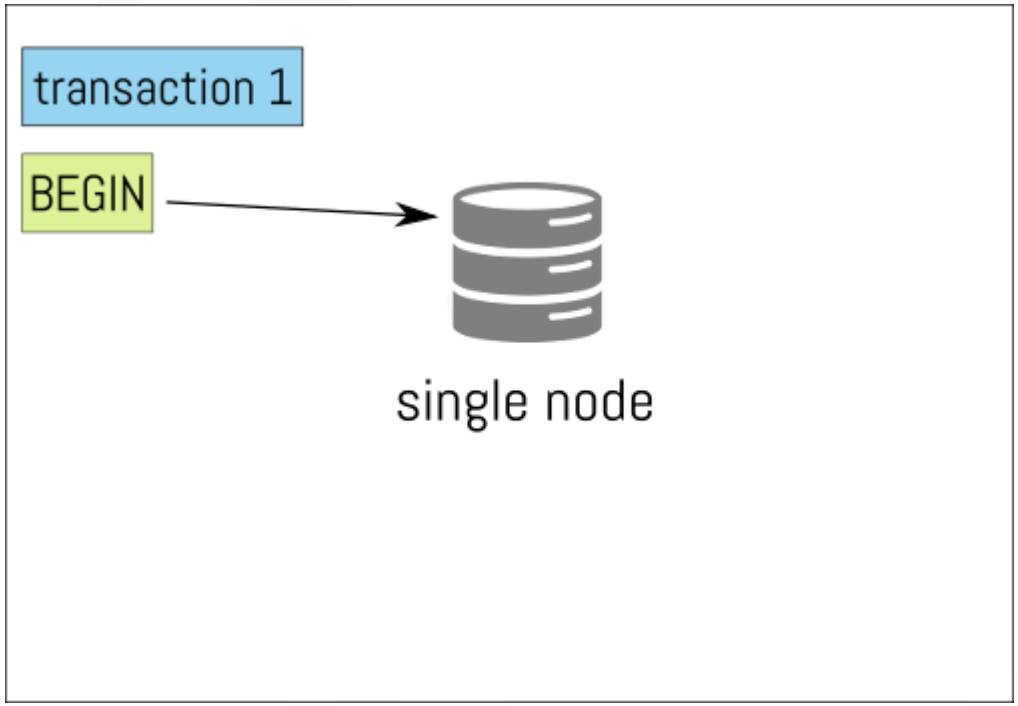
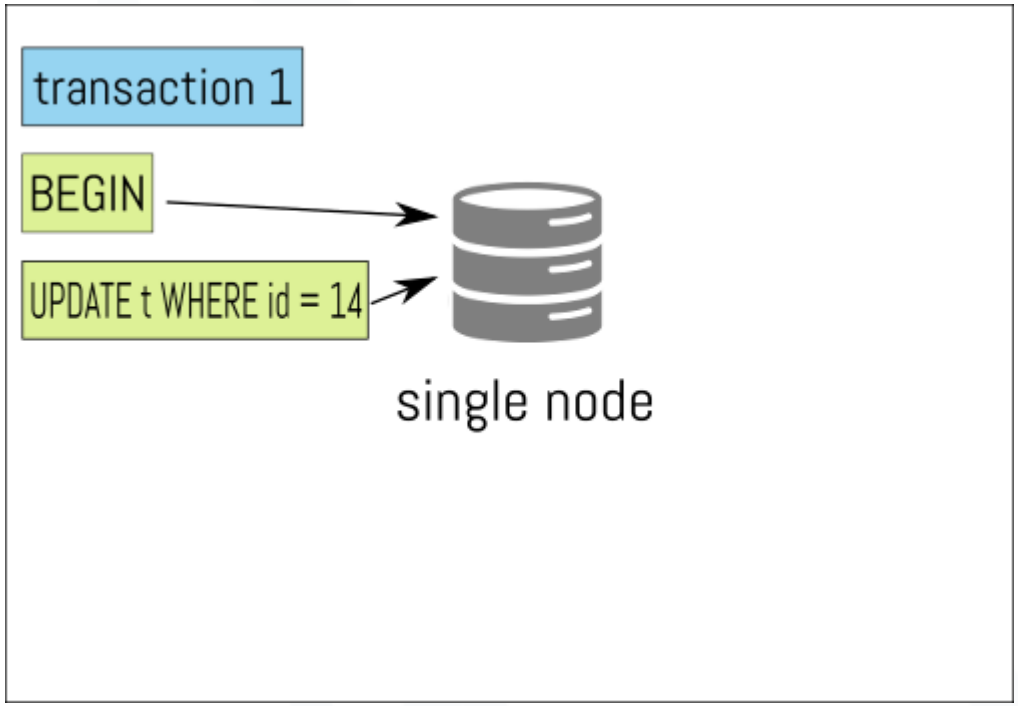
Let´s first have a look at the traditional locking to compare.

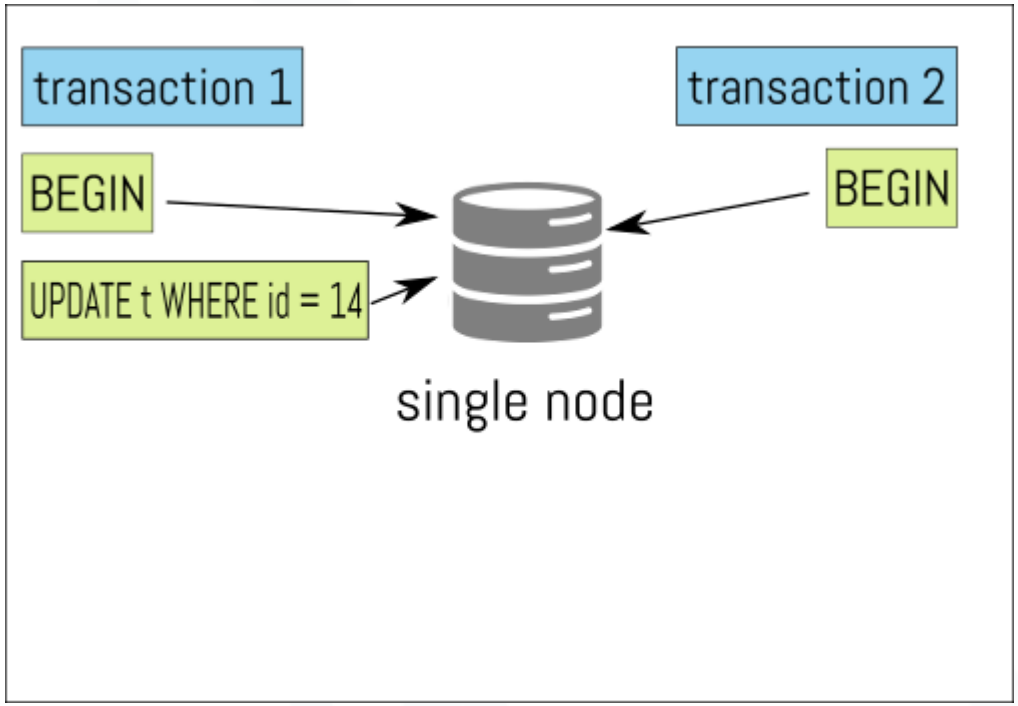
Traditional locking



Traditional locking



Traditional locking



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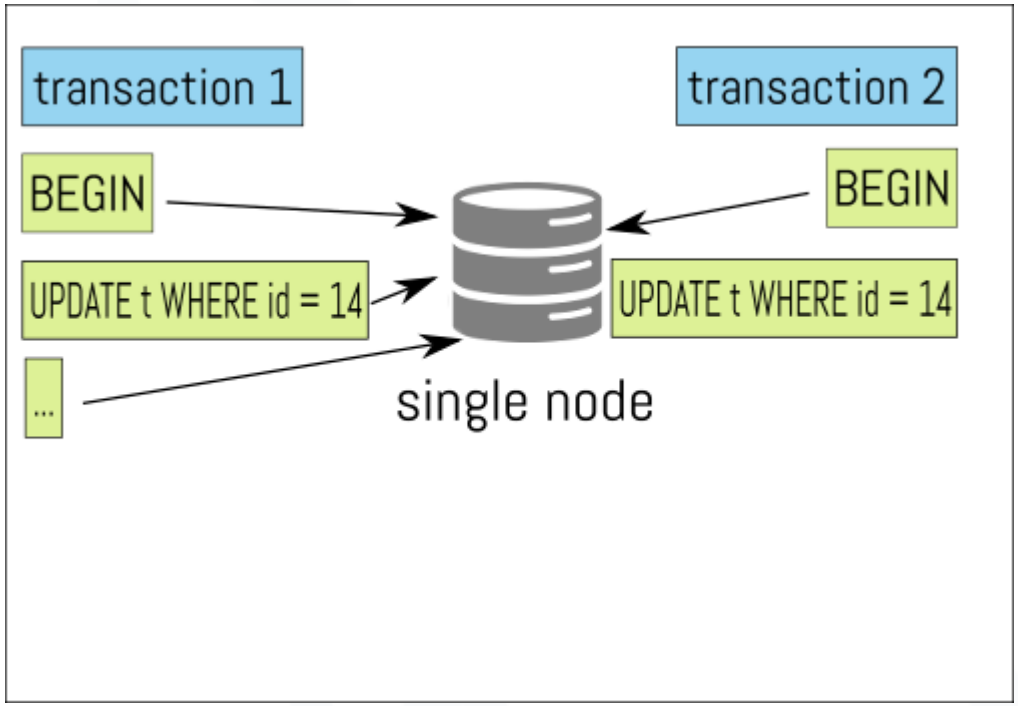
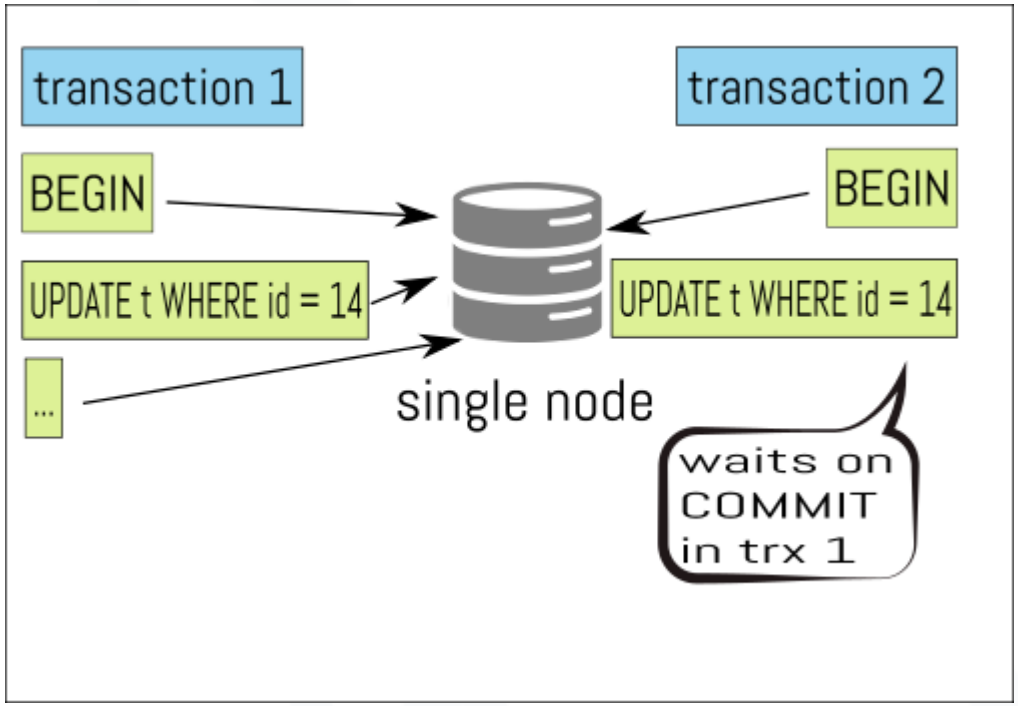
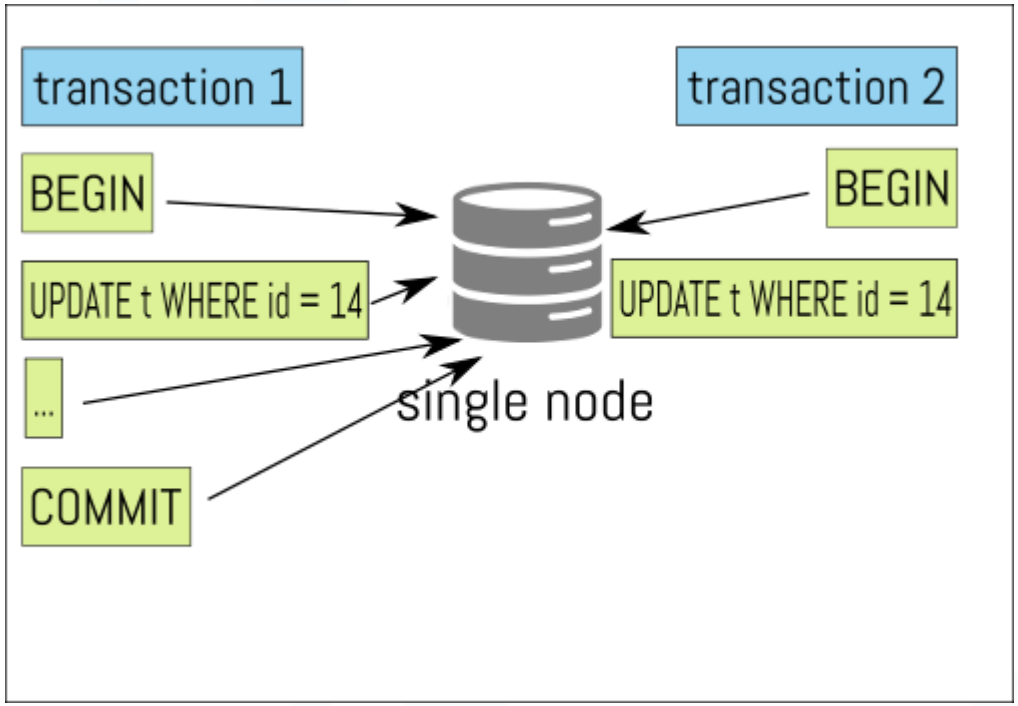


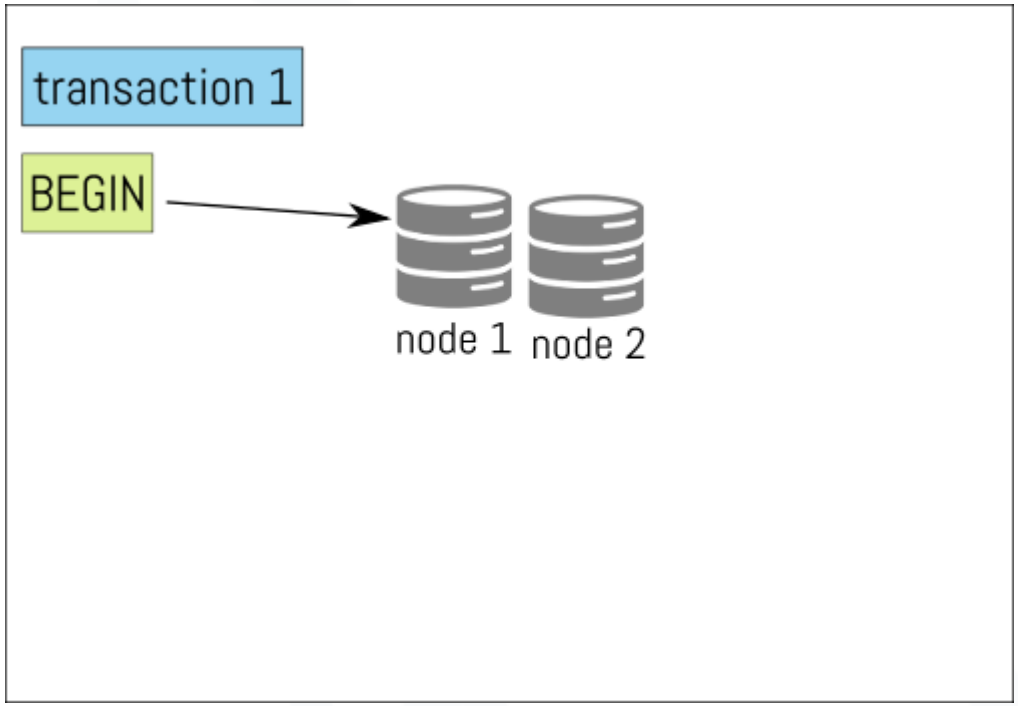
Traditional locking



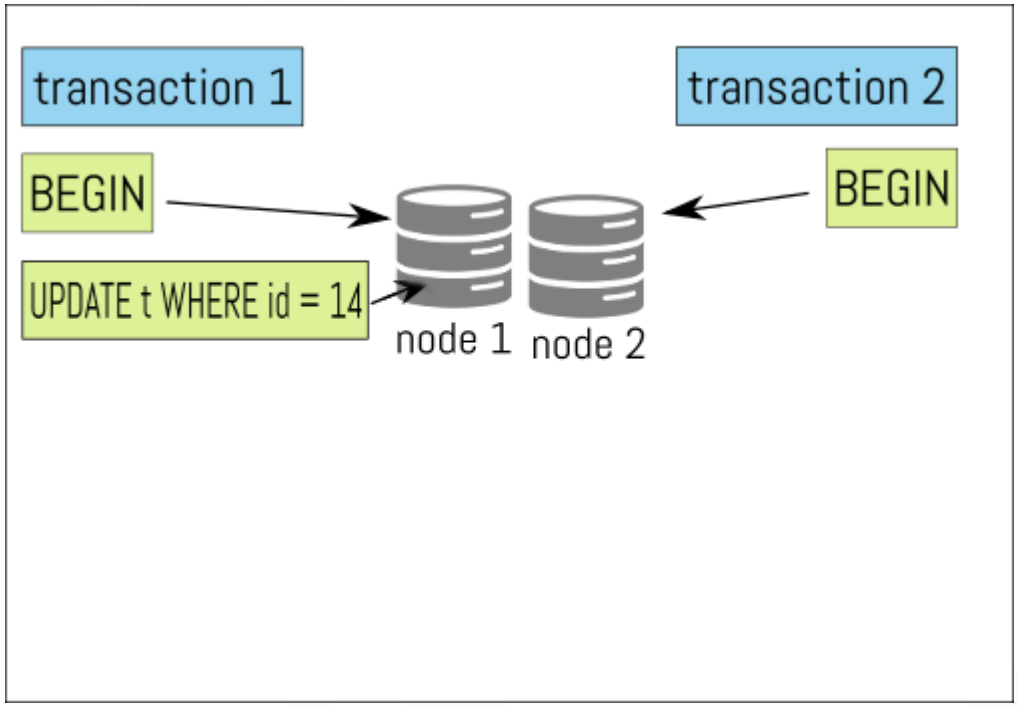
Traditional locking



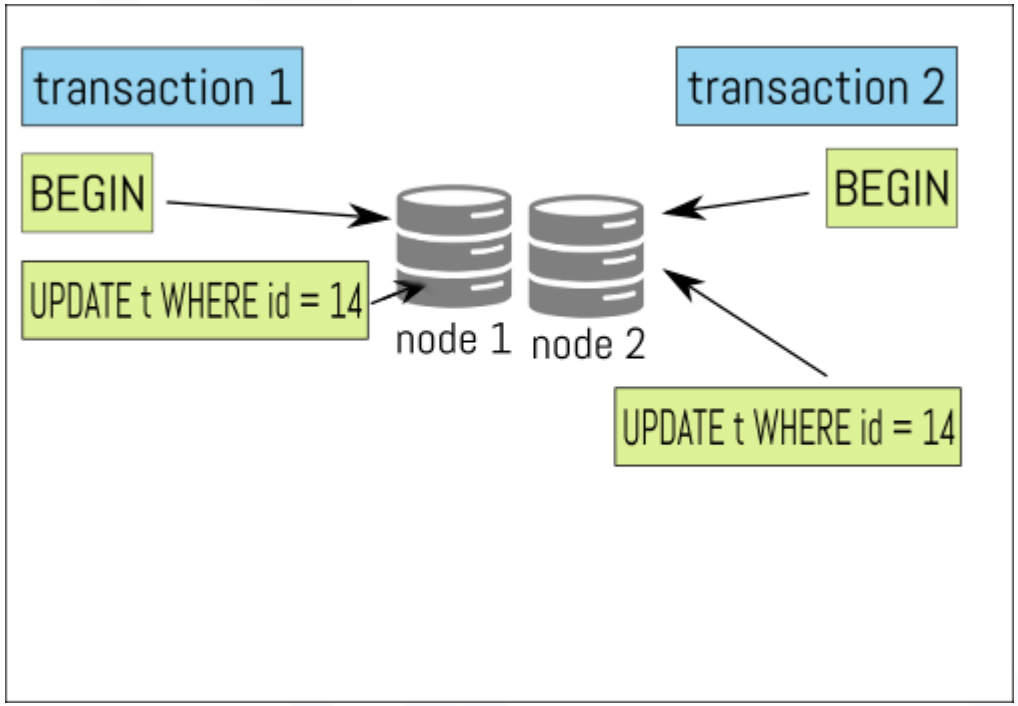
Optimistic Locking



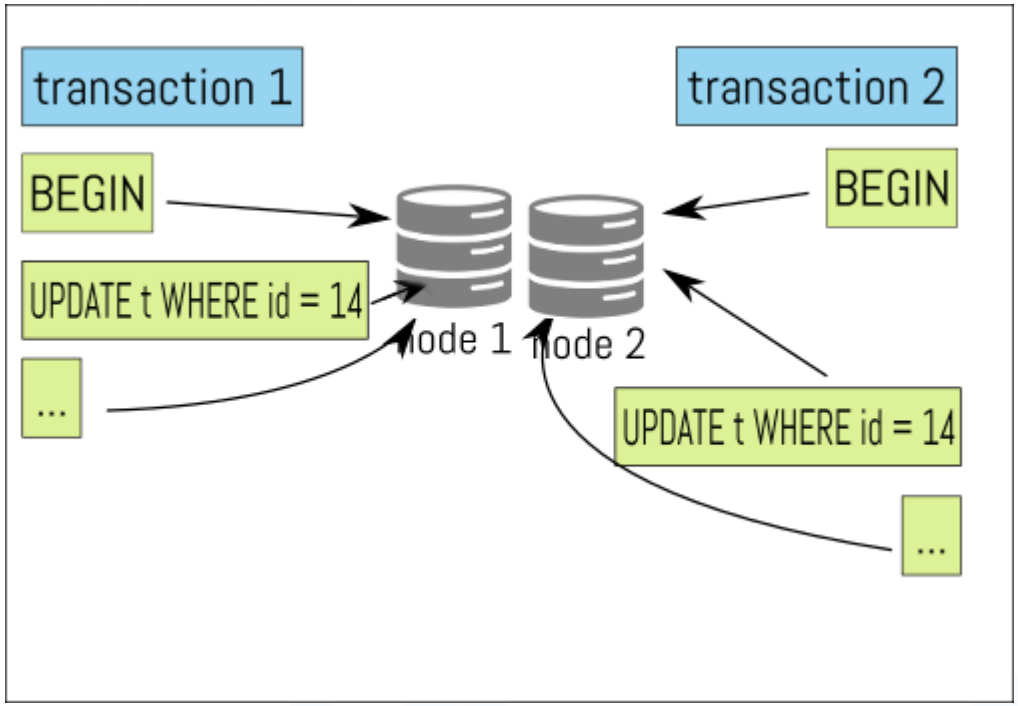
Optimistic Locking



Optimistic Locking



Optimistic Locking



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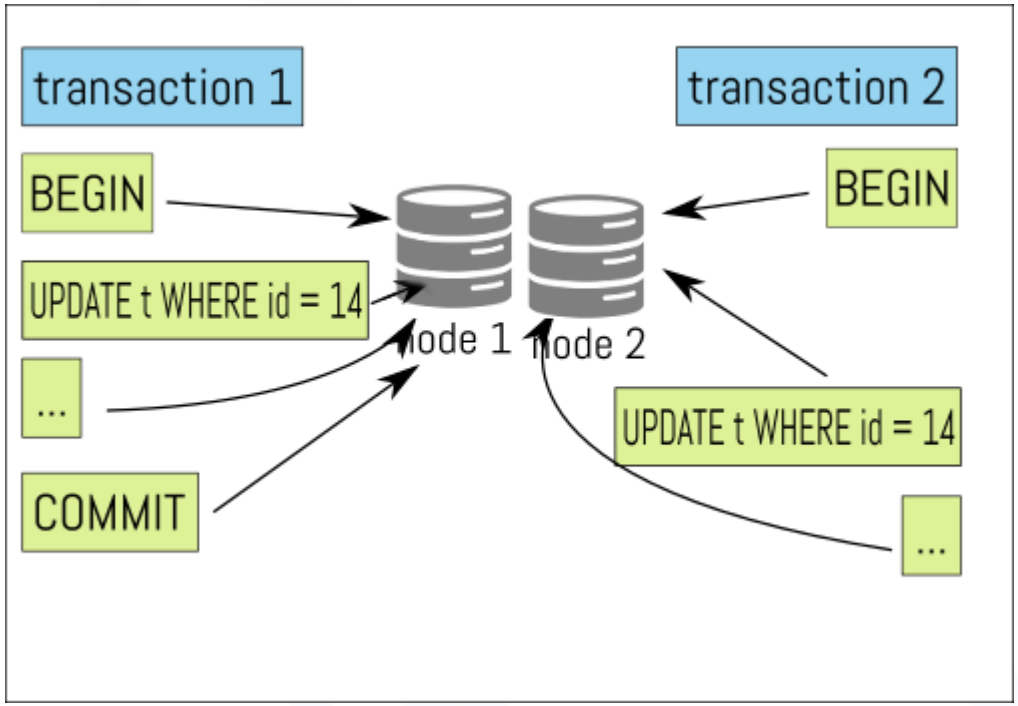

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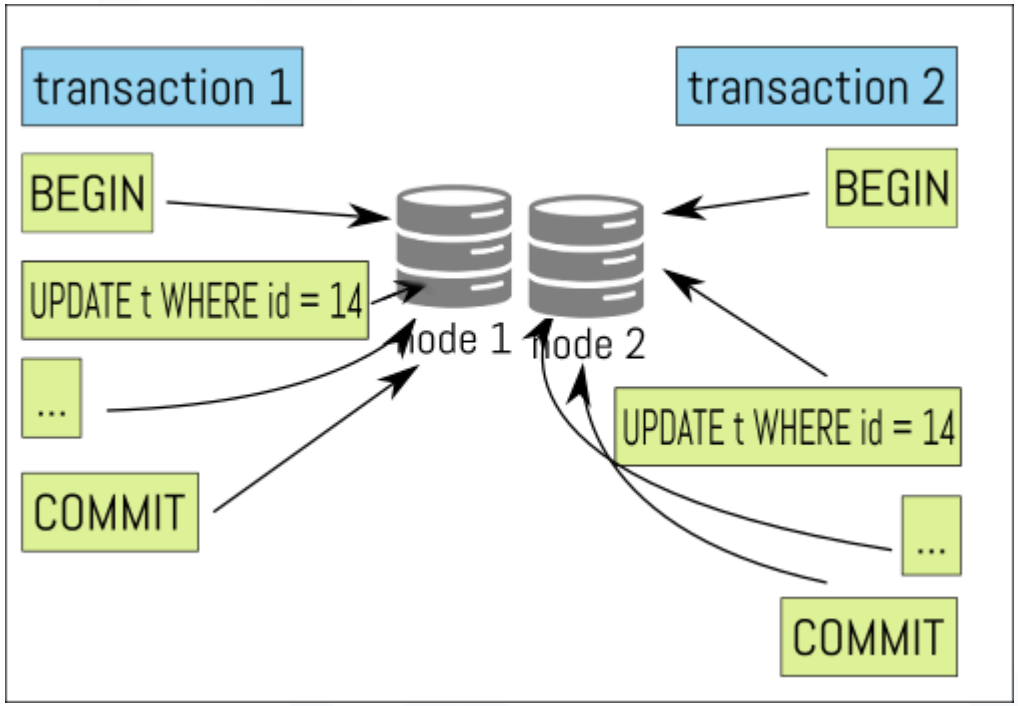
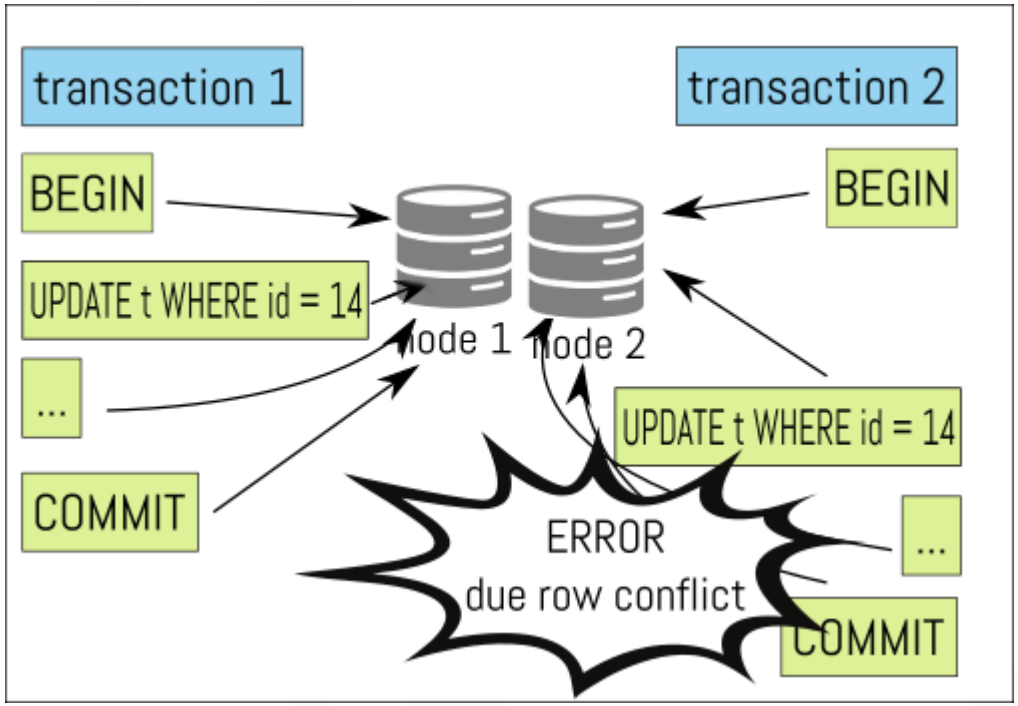


Optimistic Locking



The system returns error 149 as certification failed:

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

Such conflicts happen only when using multi-primary group !

not totally true in MySQL < 8.0.13 when failover happens

Drawbacks of optimistic locking

having a first-committer-wins system means conflicts will more likely happen when writing on multiple members with:

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- large transactions
- long running transactions
- hotspot records

can the transaction be committed ?

Certification

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- *can the write (transaction) be committed ?*

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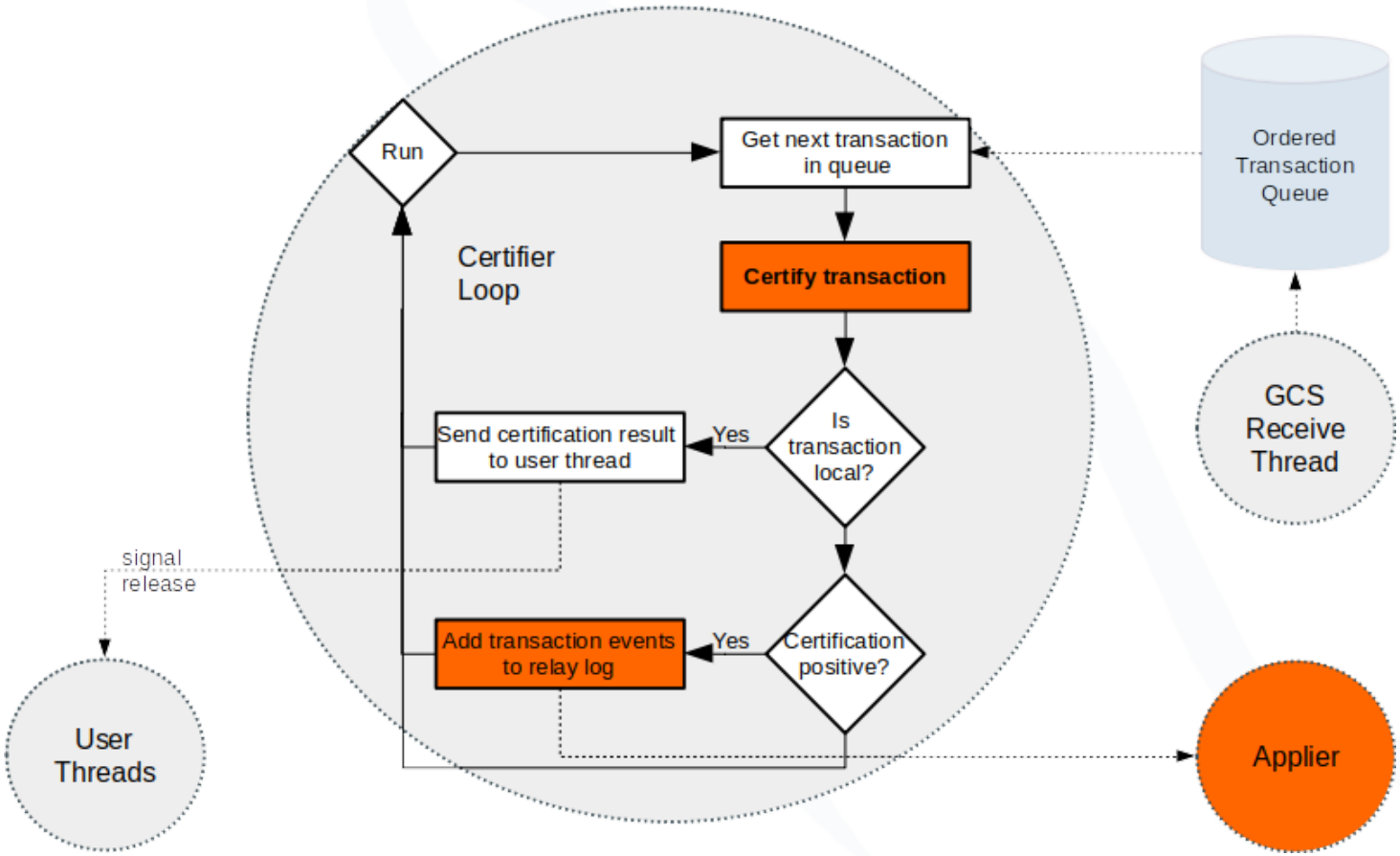
Certification



Houston we have a problem !

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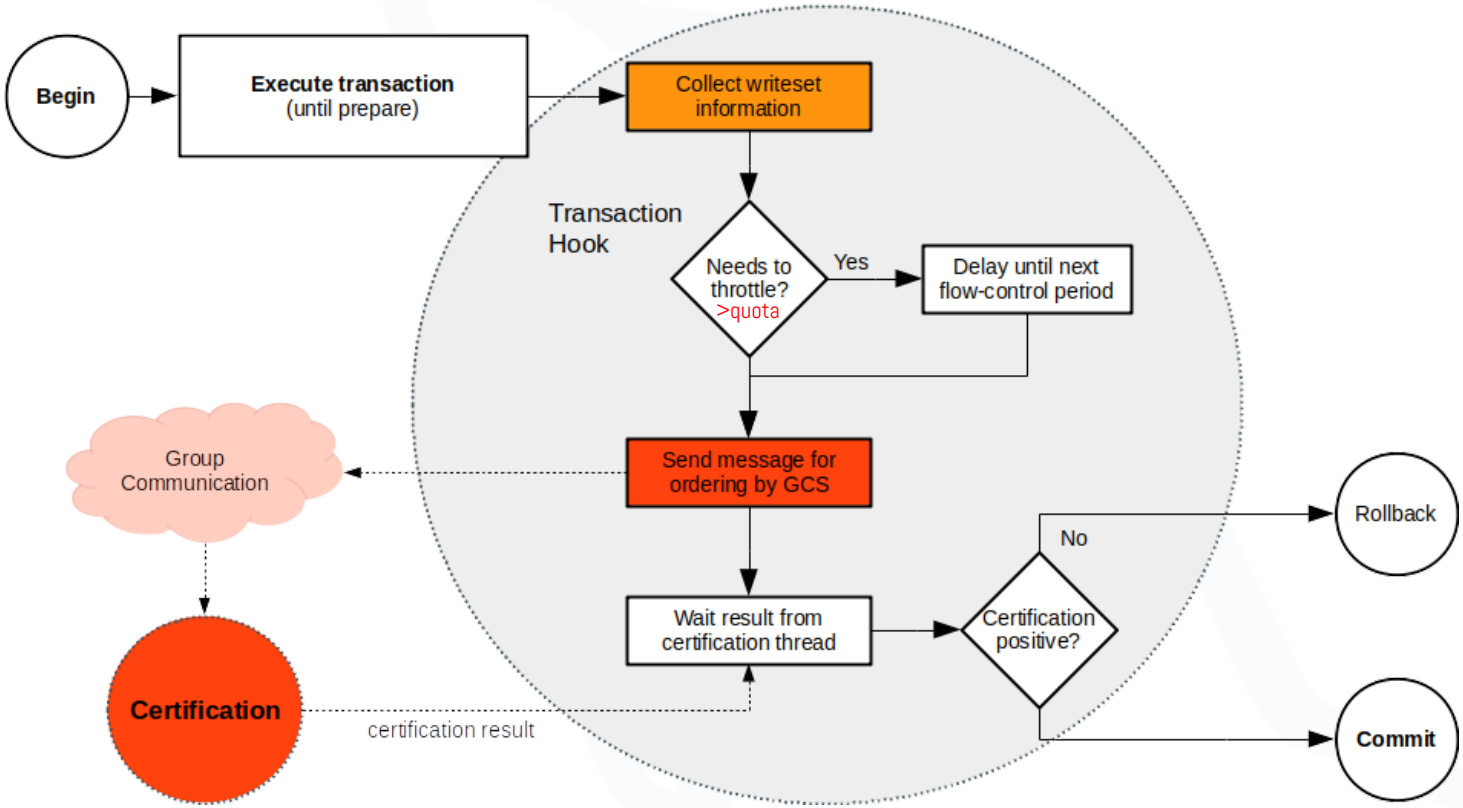
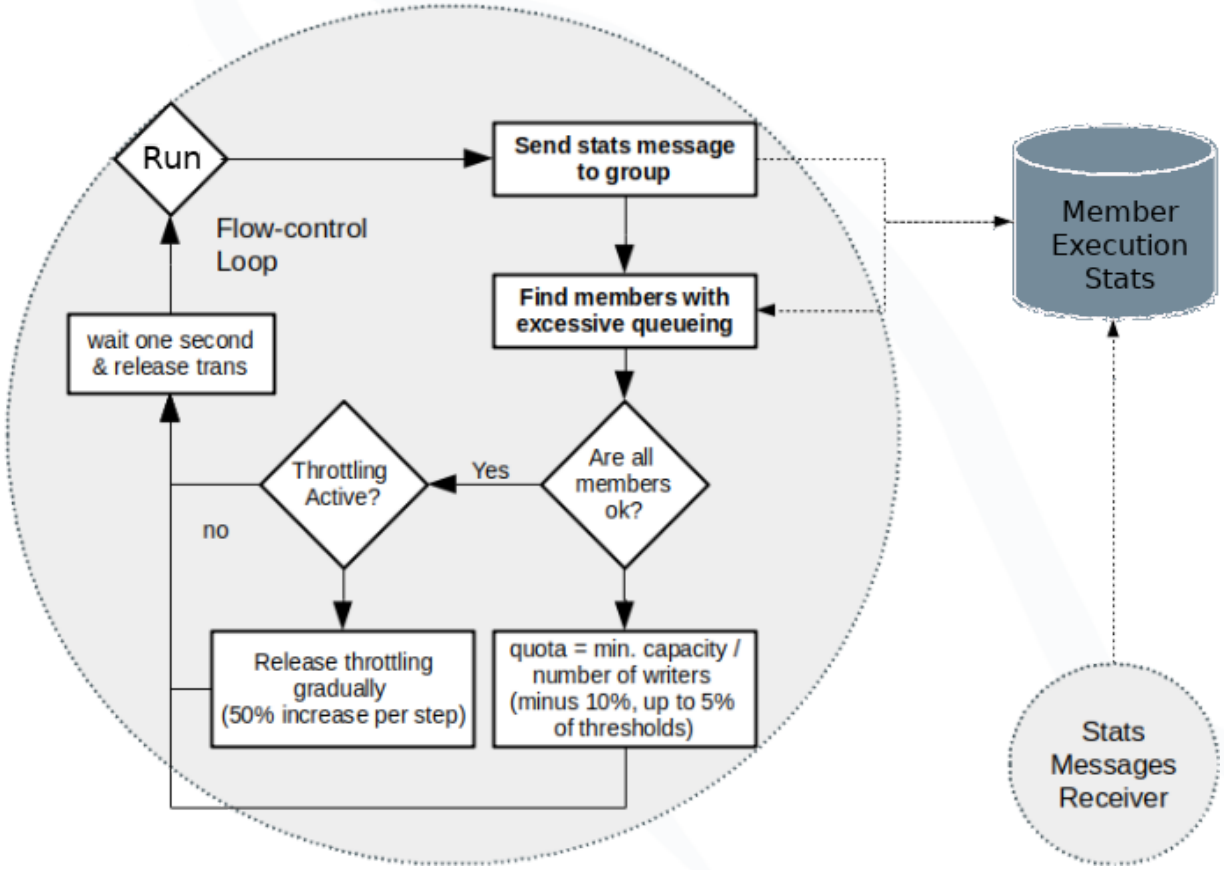
This mean that the threshold is *NOT* decided on the node being slow, but the node writing a transaction checks its threshold flow control values and compare them to the statistics from the other nodes to decide to throttle or not.

Flow Control - on writer



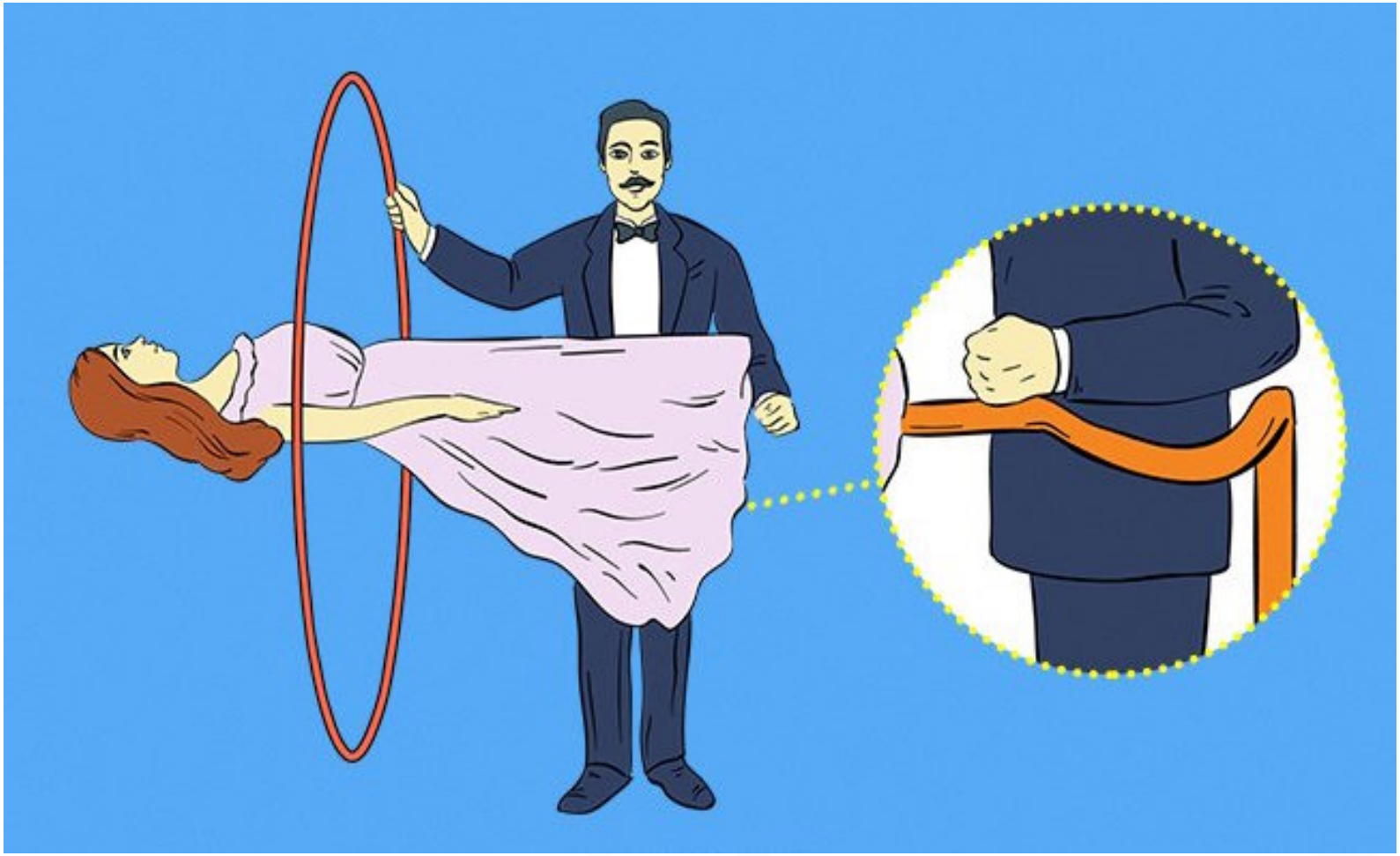
Flow Control - on all members



Flow Control - configuration variables

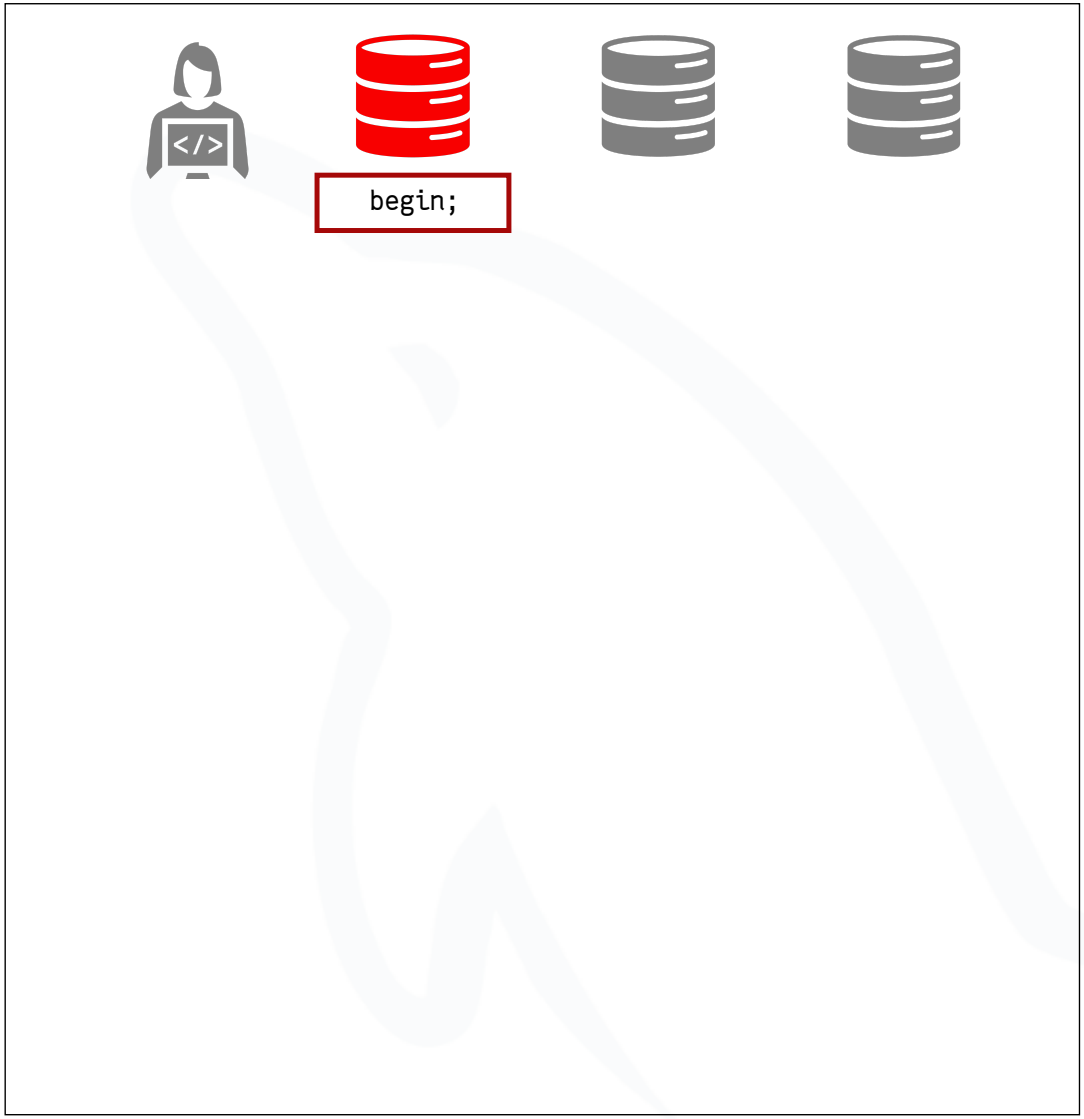
As in MySQL 8.0.13:

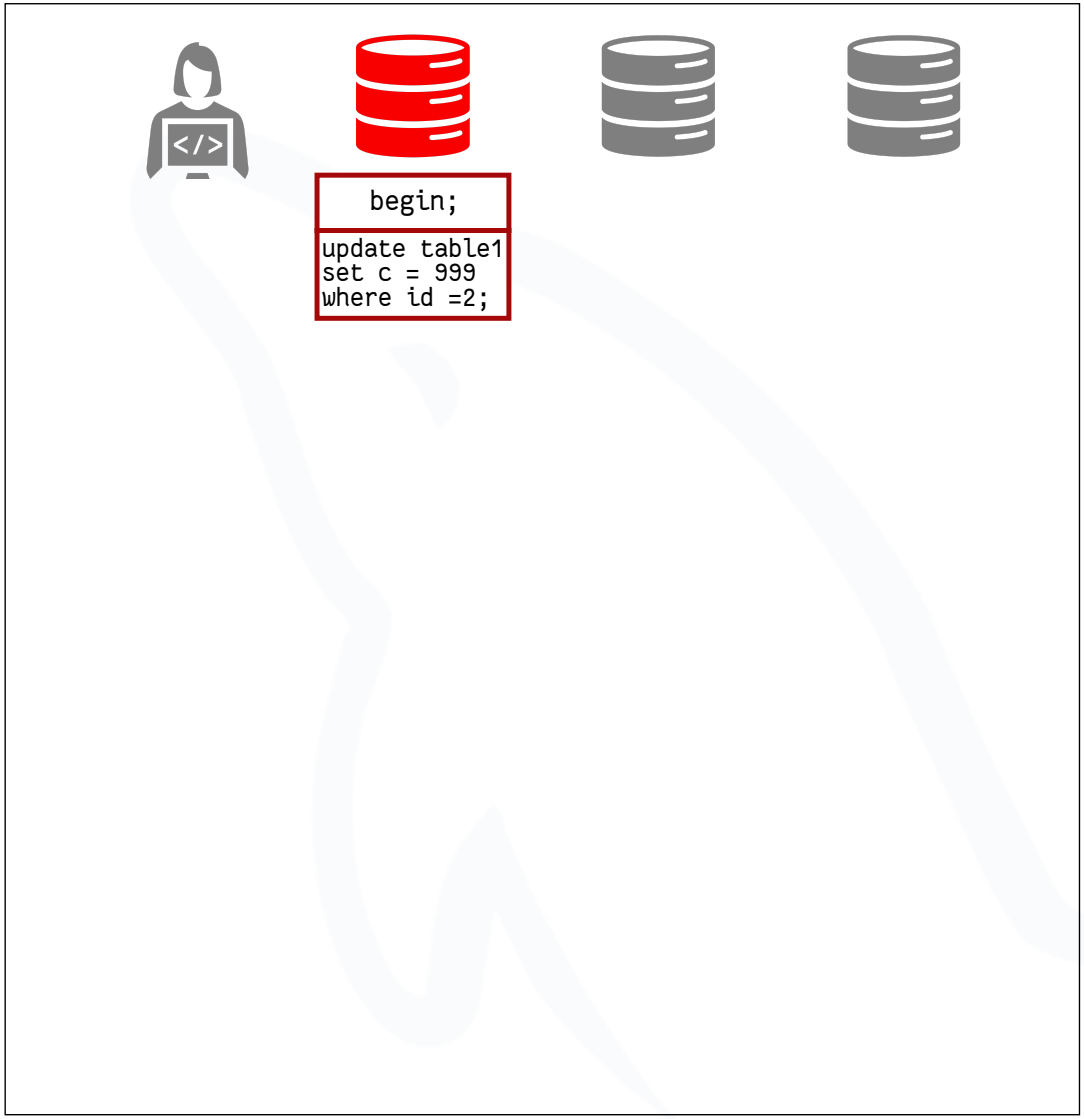
```
+-----------------------------------------------------+-------+
| Variable_name                                       | Value |
+-----------------------------------------------------+-------+
| group_replication_flow_control_applier_threshold    | 25000 |
| group_replication_flow_control_certifier_threshold  | 25000 |
| group_replication_flow_control_hold_percent         | 10    |
| group_replication_flow_control_max_quota            | 0     |
| group_replication_flow_control_member_quota_percent | 0     |
| group_replication_flow_control_min_quota            | 0     |
| group_replication_flow_control_min_recovery_quota   | 0     |
| group_replication_flow_control_mode                 | QUOTA |
| group_replication_flow_control_period               | 1     |
| group_replication_flow_control_release_percent      | 50    |
+-----------------------------------------------------+-------+
```

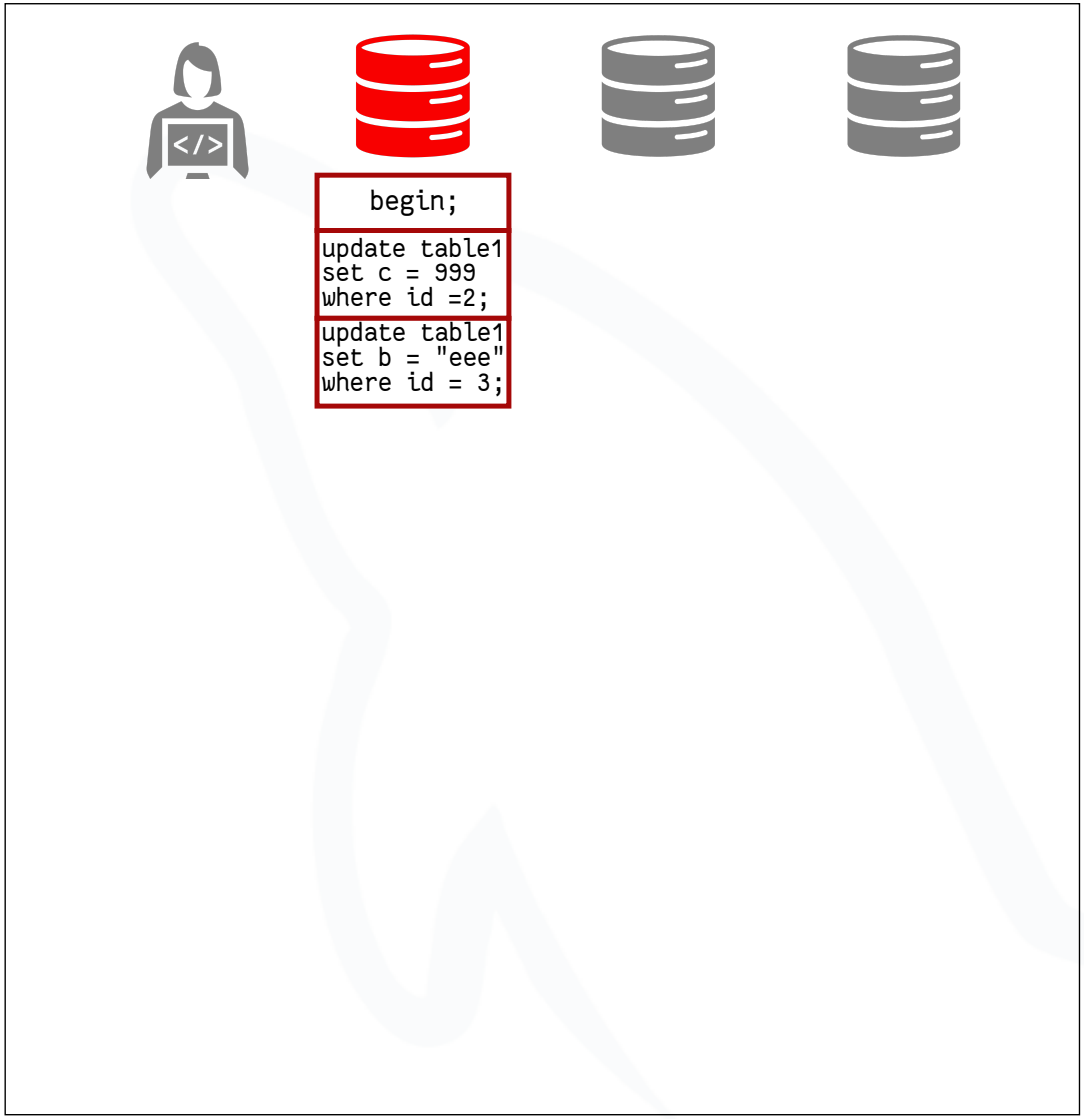


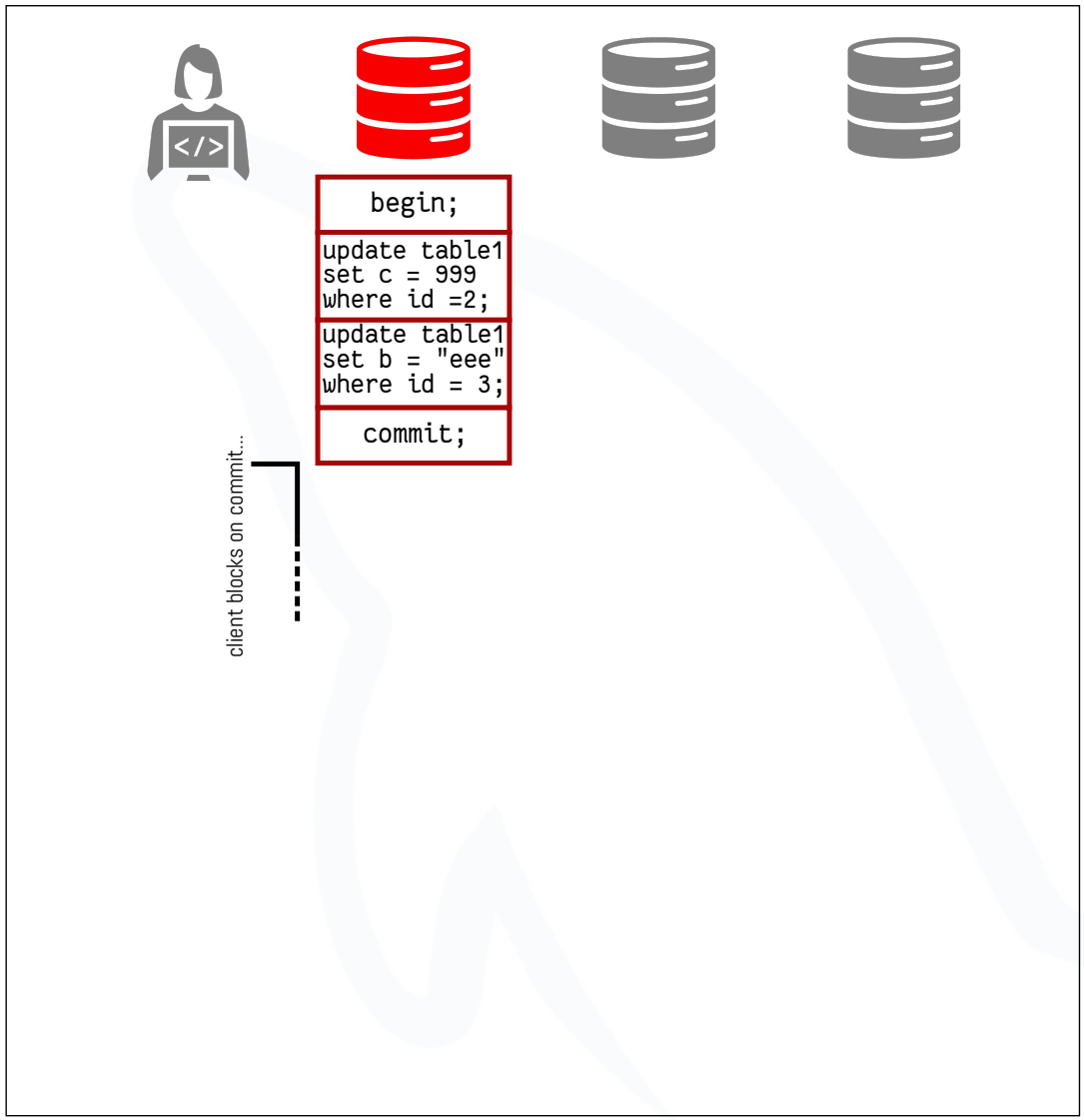
transaction's lifecycle in Group Replication

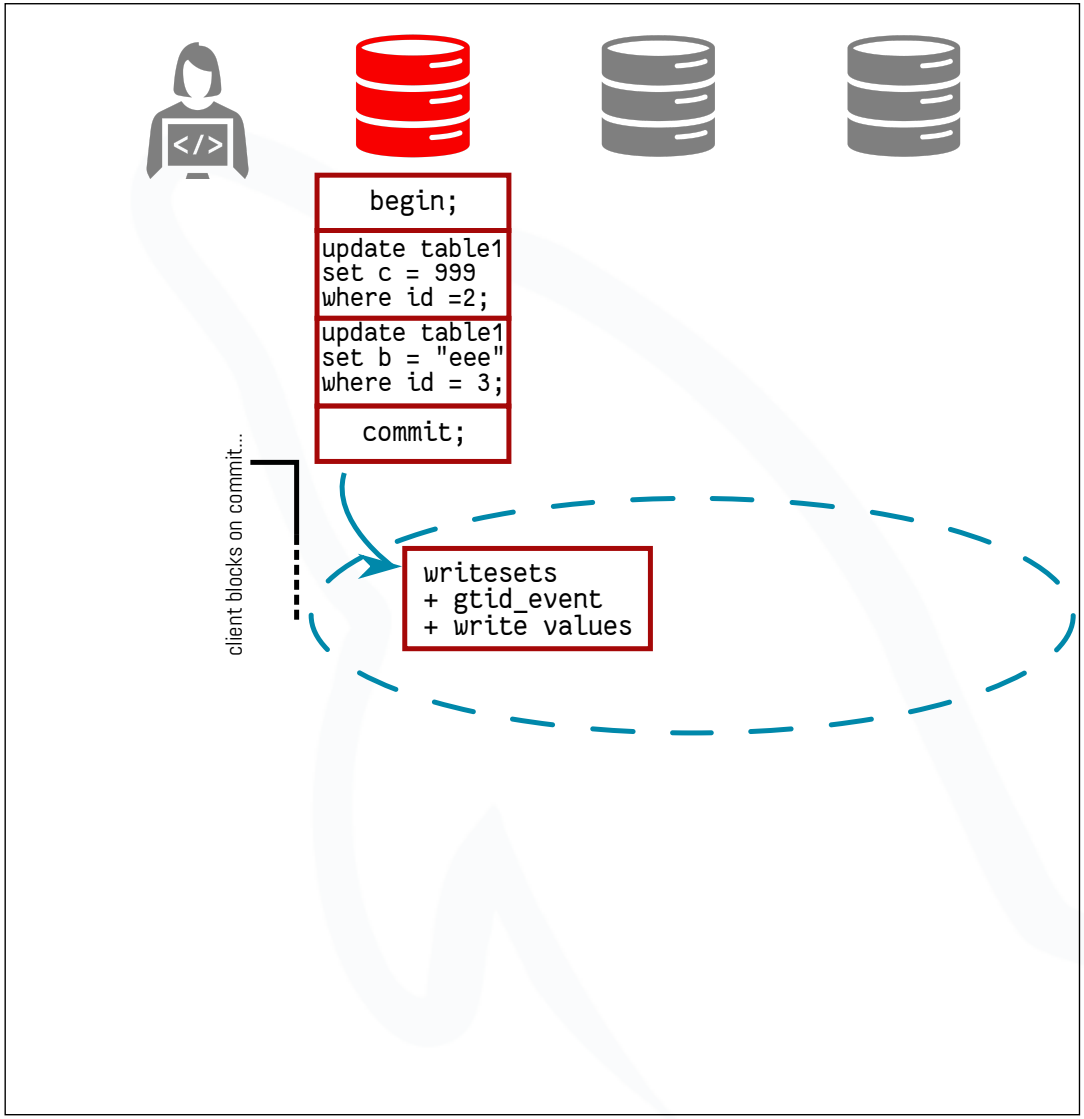
Summary

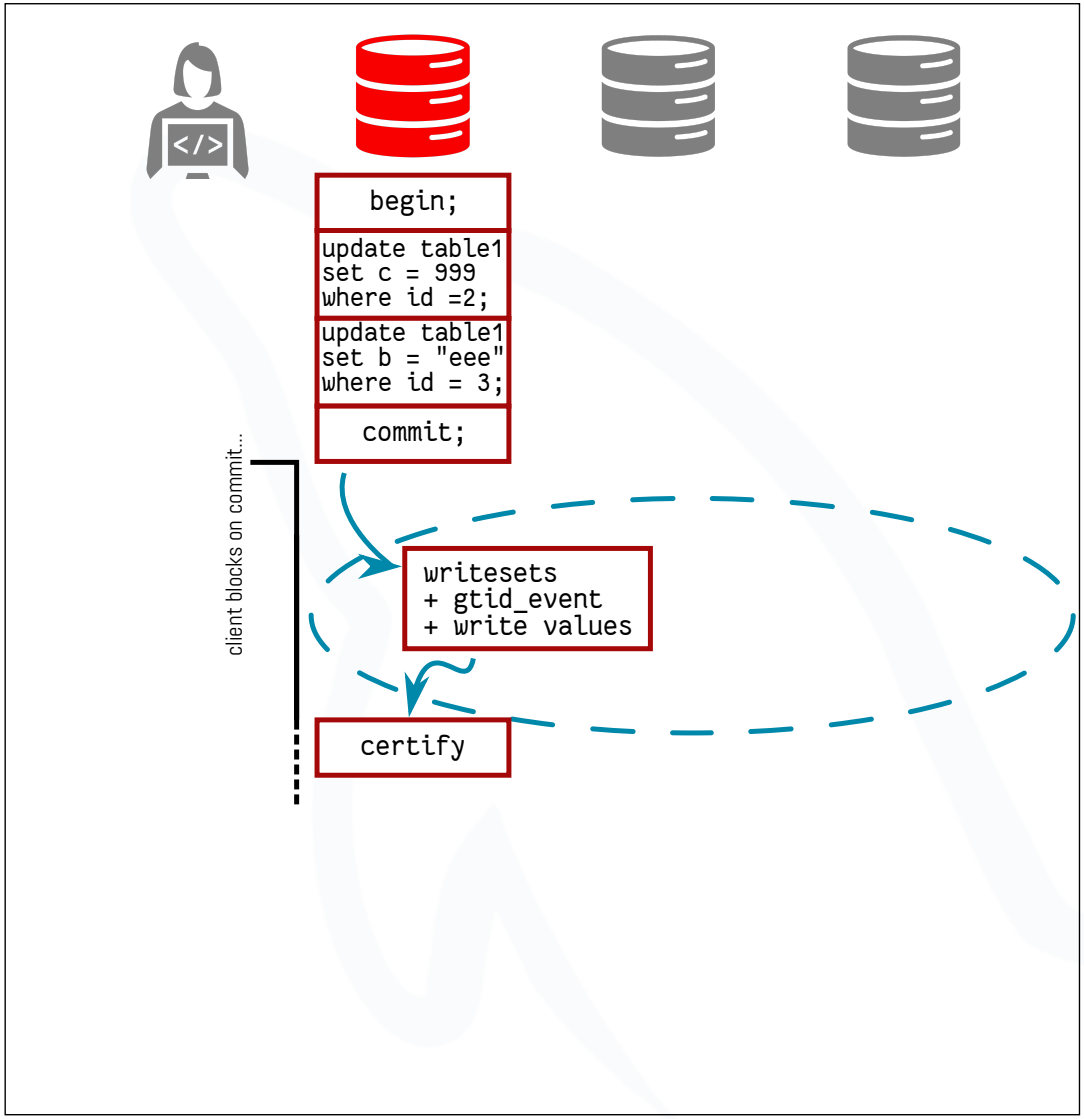


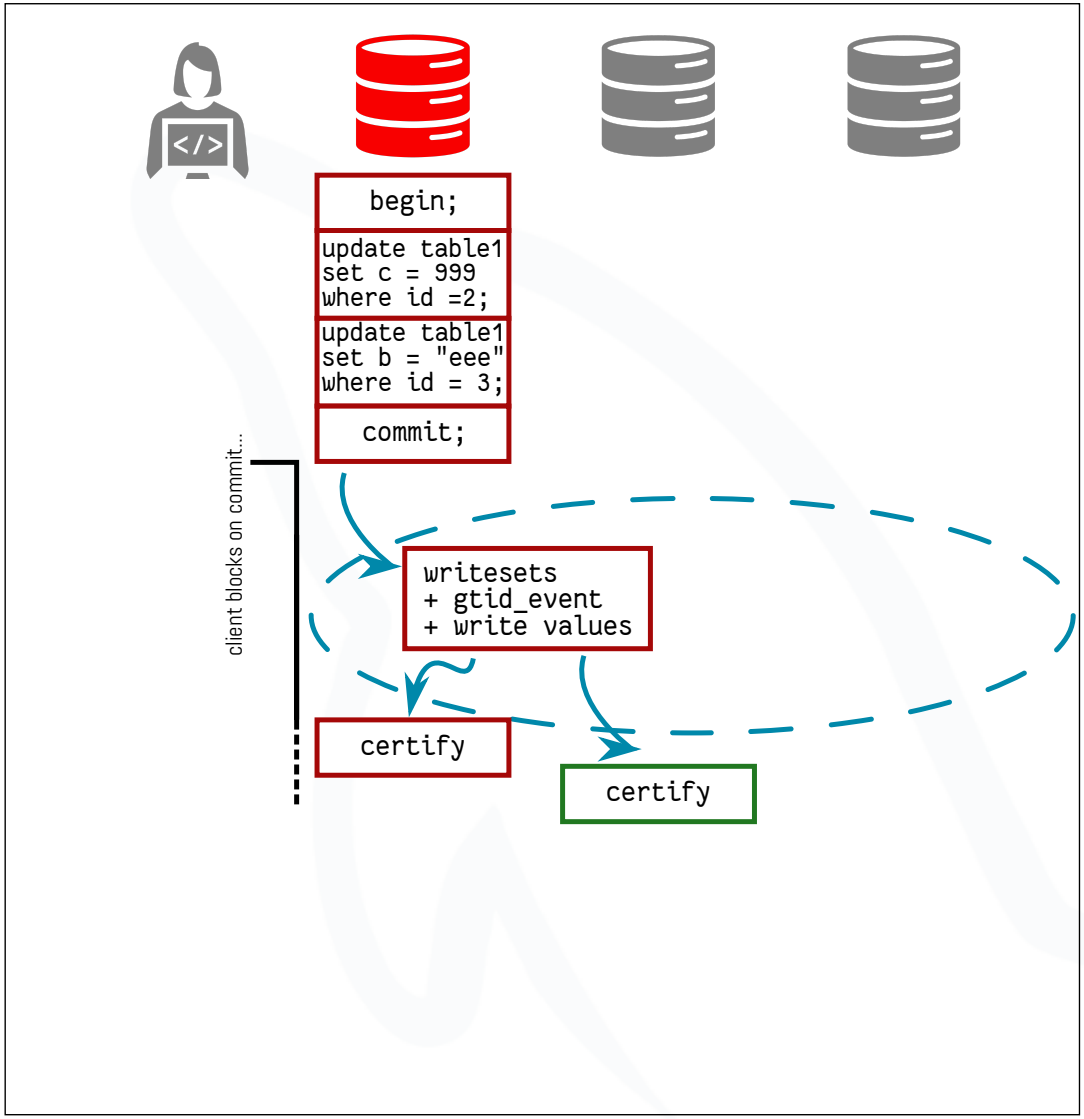


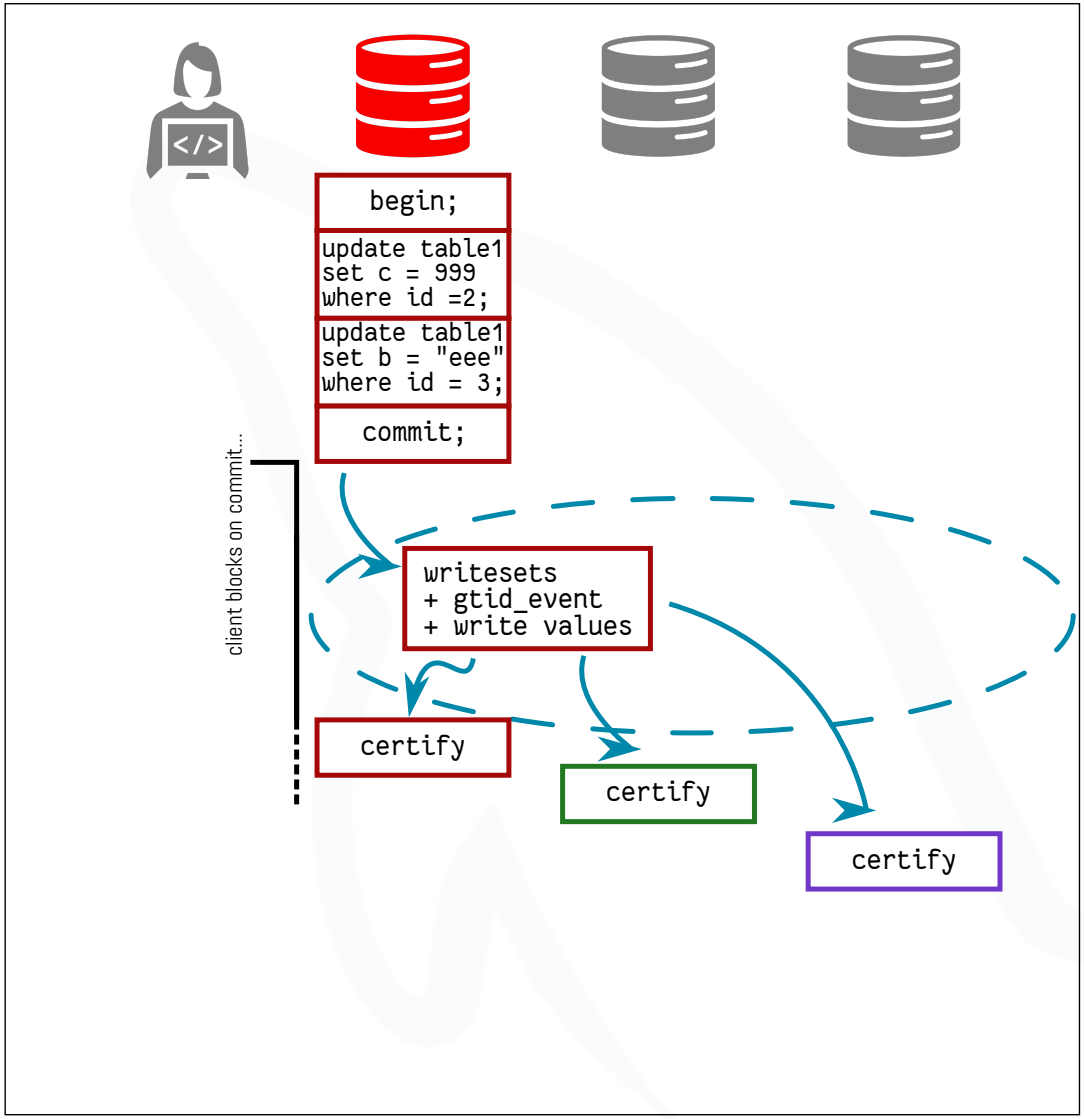


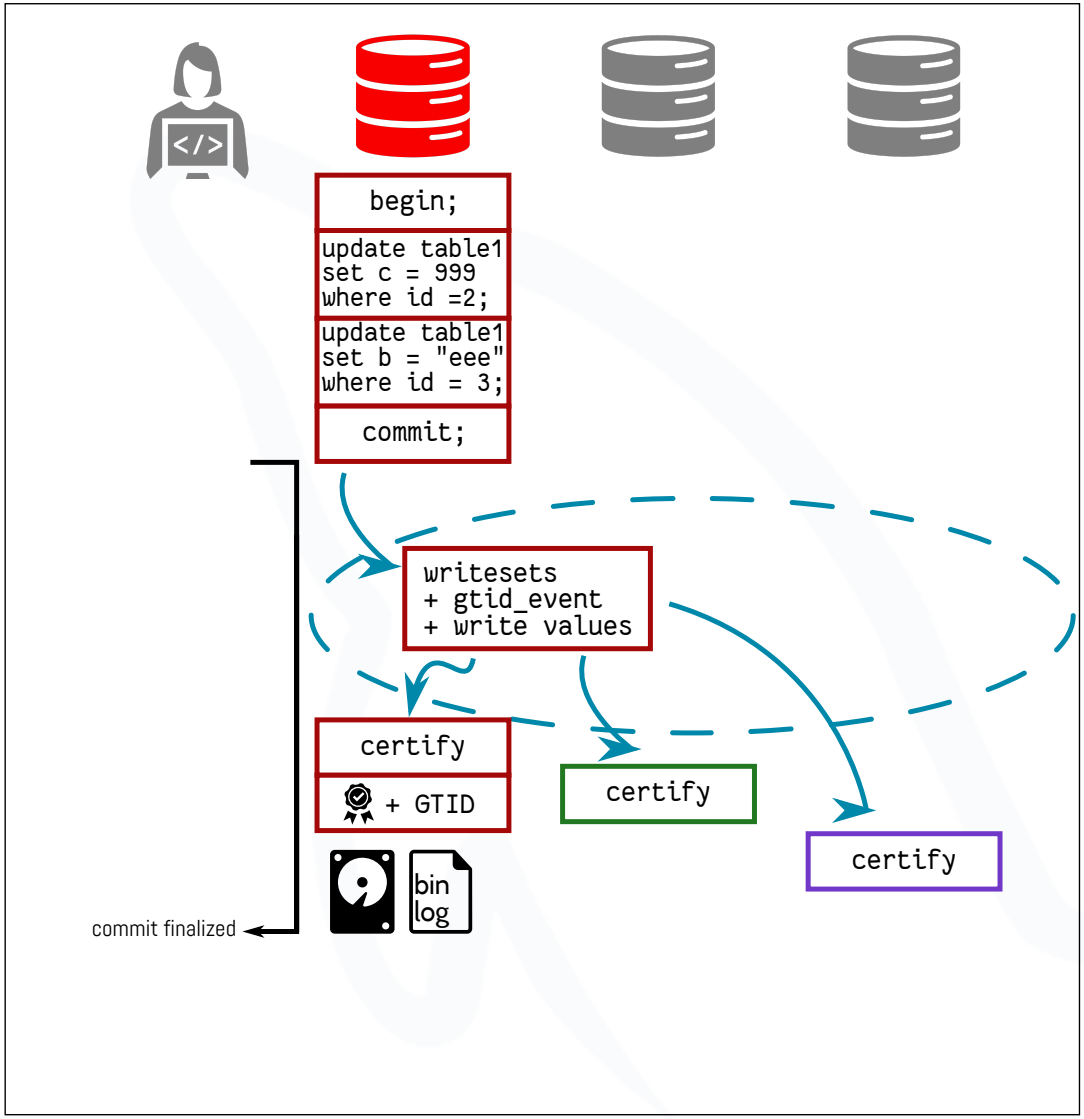


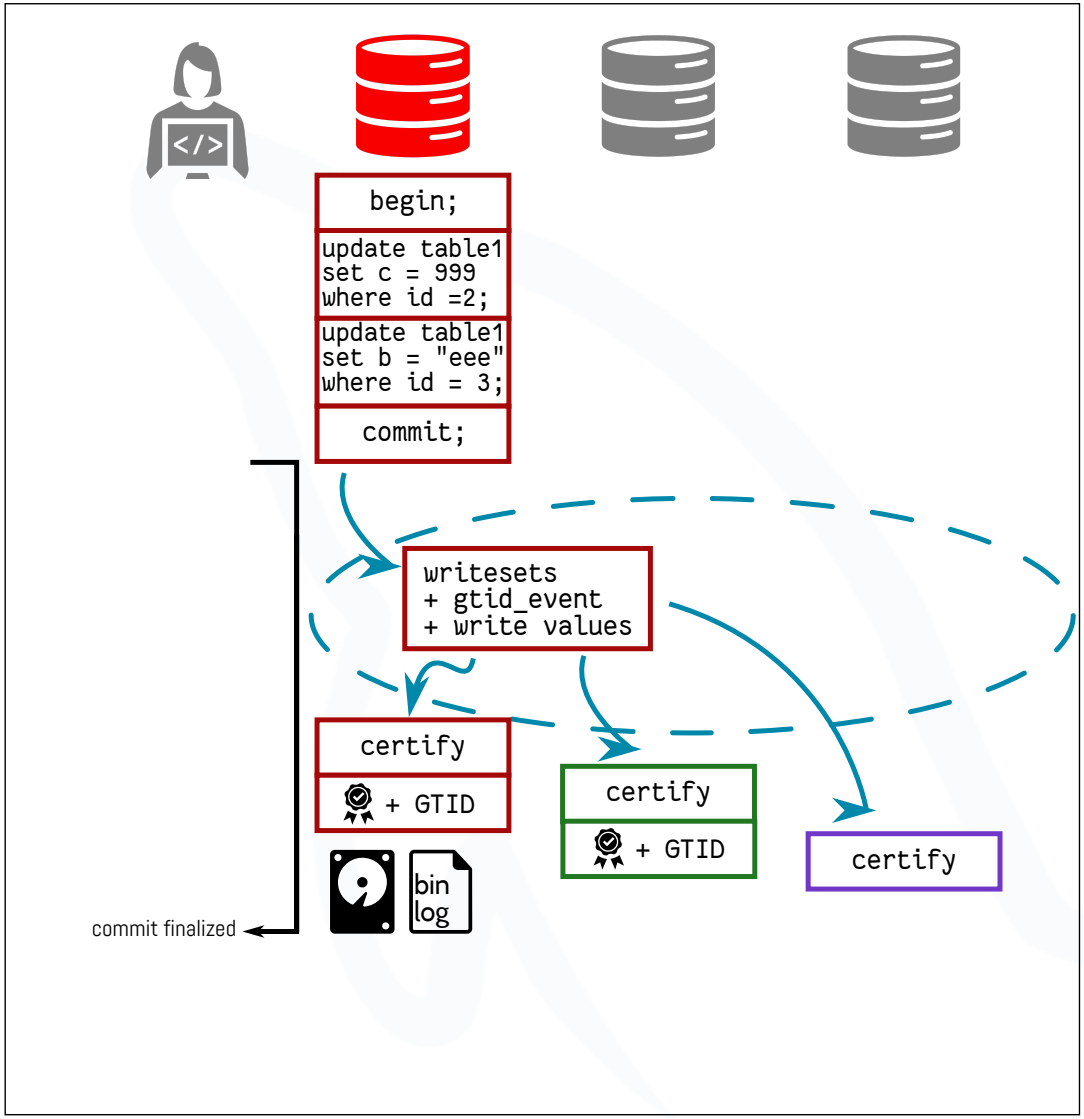


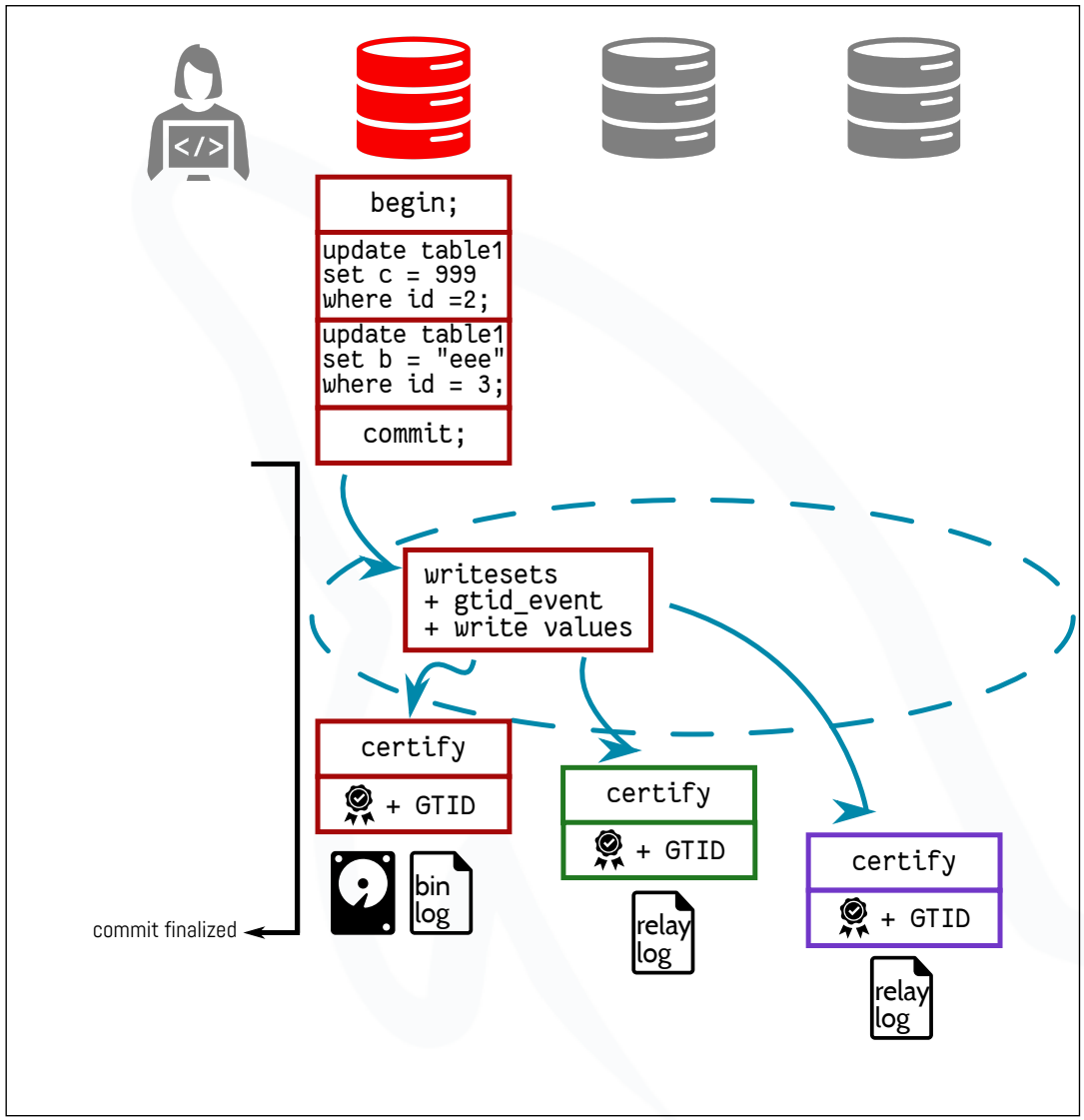


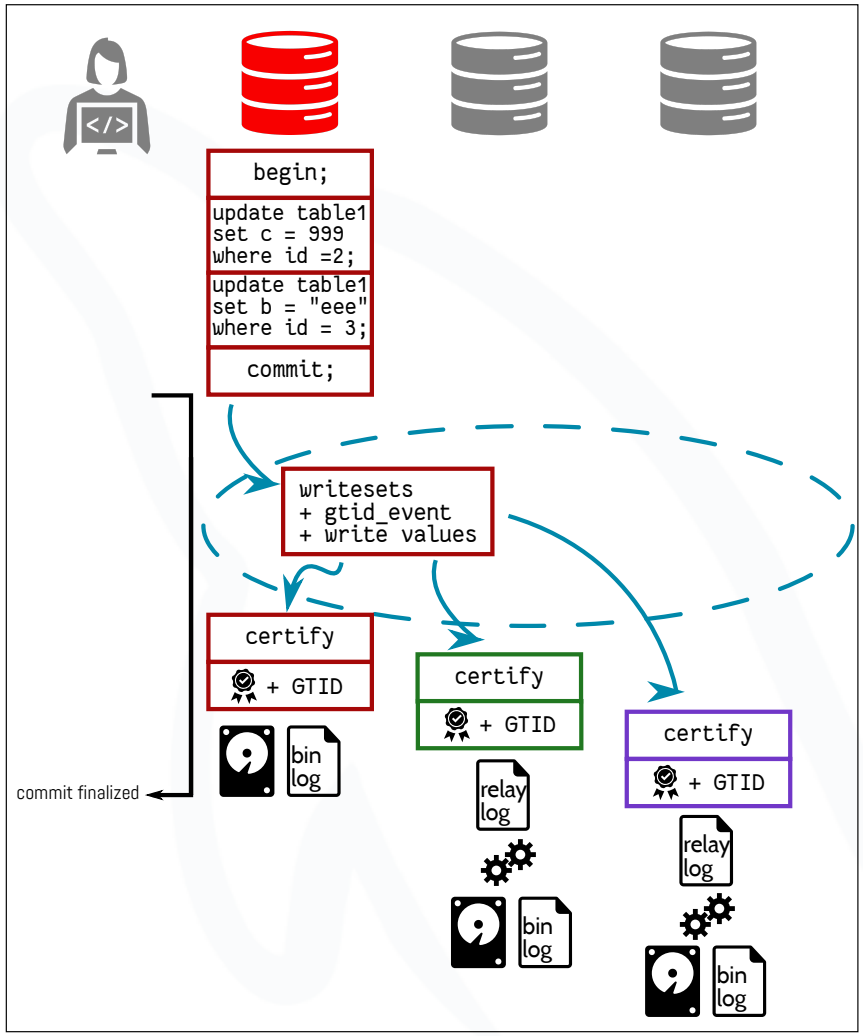












Thank you !

Any Questions ?