High Availability Using MySQL Group Replication

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Program Agenda

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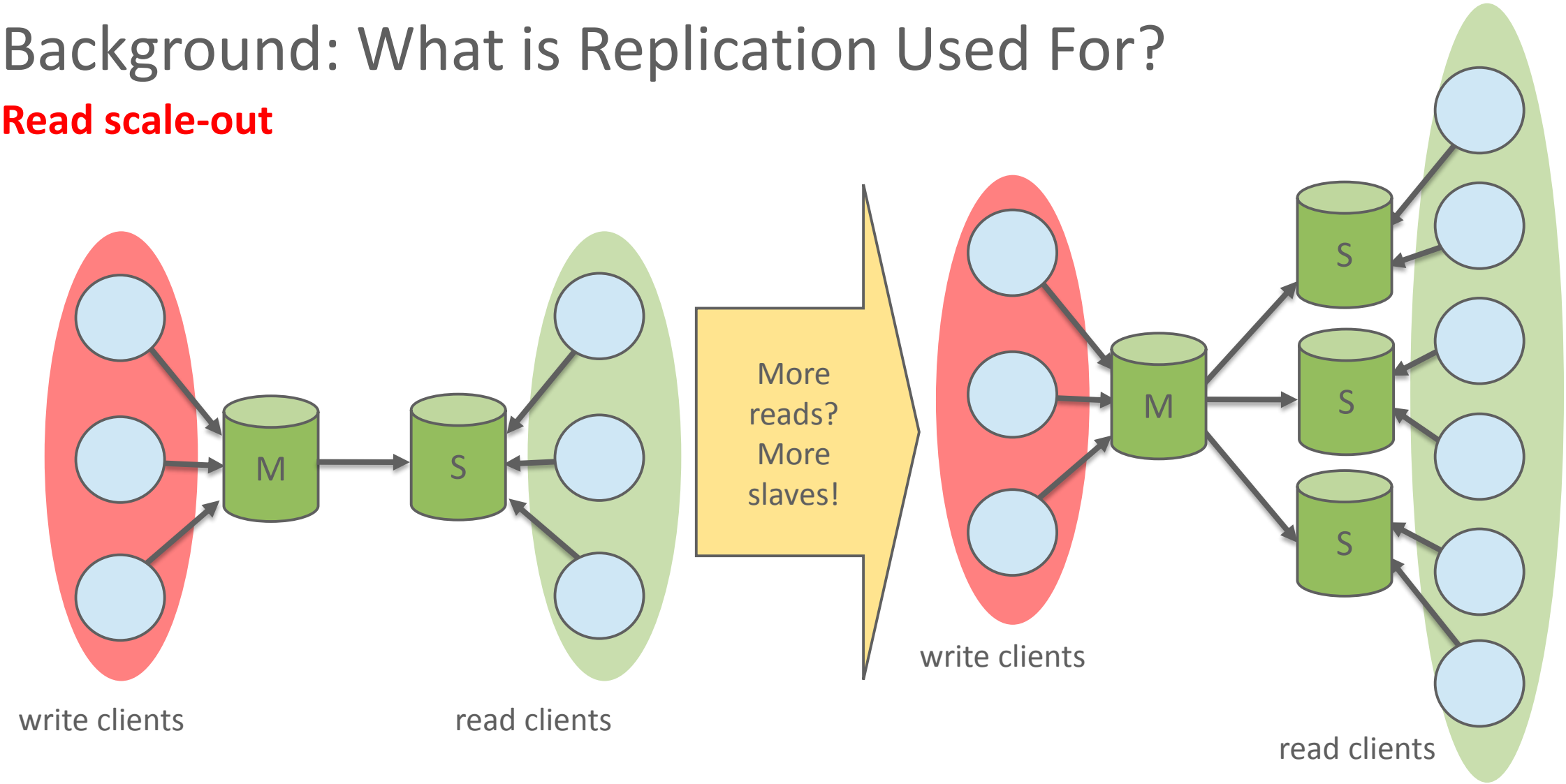
1. Background
2. MySQL Group Replication
3. Architecture
4. Big Picture
5. Conclusion

1 Background

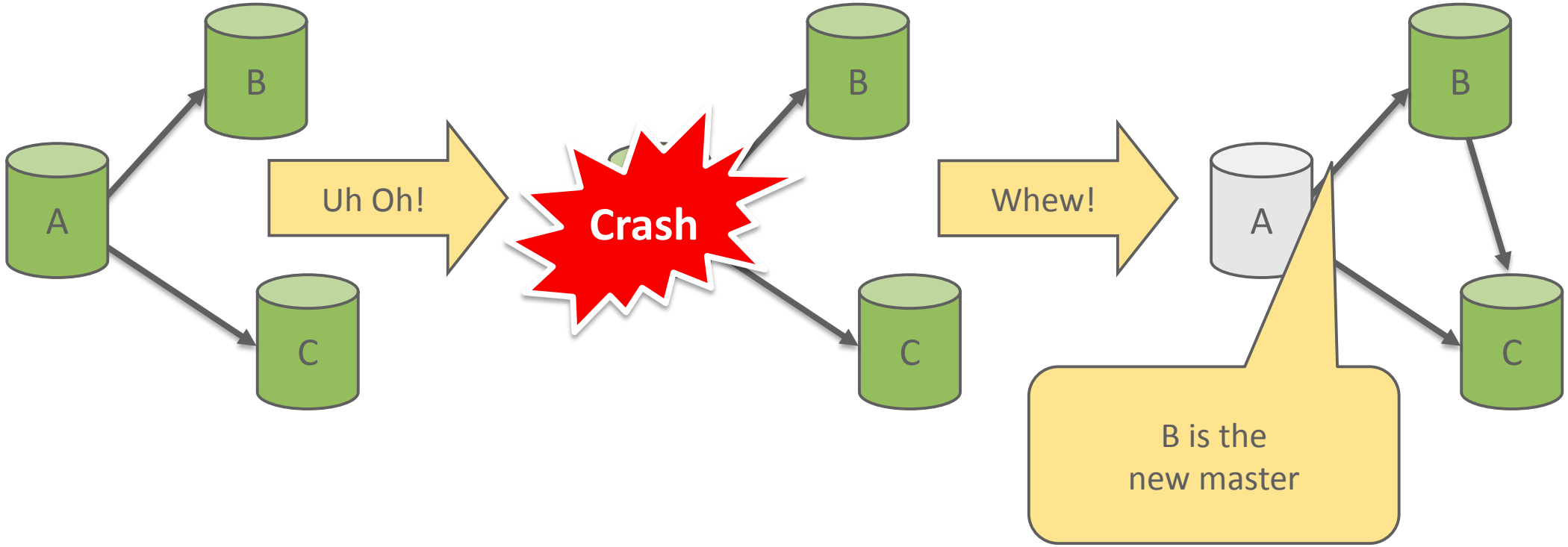
Background: What is Replication Used For?

Read scale-out



Background: What is Replication Used For?

Redundancy as a major building block for high availability: If master crashes, promote slave to master



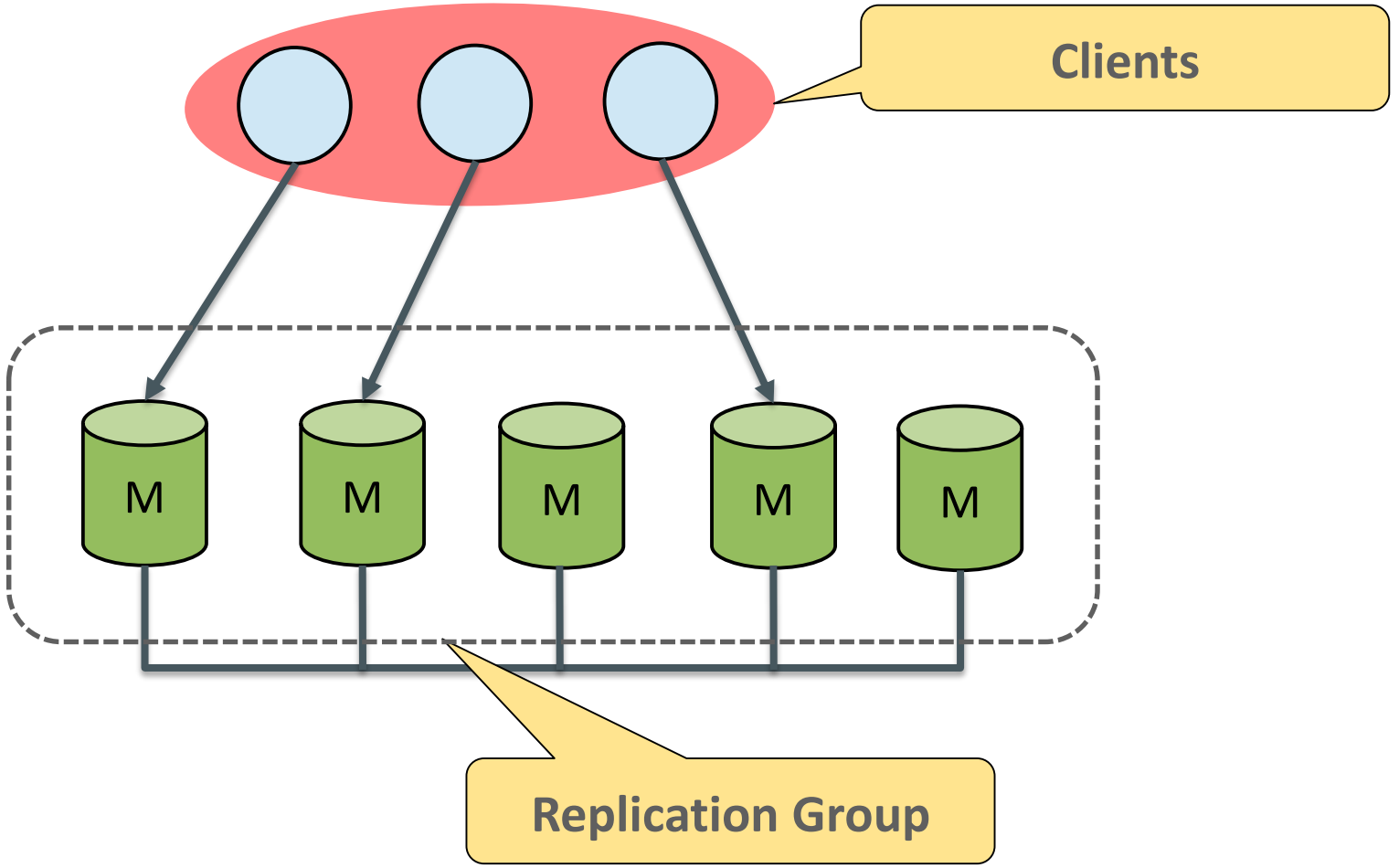
MySQL Group Replication

- **What is MySQL Group Replication?**

  "**Update everywhere** replication plugin for MySQL with built-in **automatic distributed recovery**, **conflict handling**, **group membership** and **distributed agreement**."

- **What does the MySQL Group Replication plugin do for the user?**
  - Removes the need for handling server fail-over.
  - Provides fault tolerance.
  - Enables update everywhere setups.
  - Automates group reconfiguration (handling of crashes, failures, re-connects).
  - Provides a highly available replicated database.
  - Automatic distributed coordination (protects against split-brain and message loss).
  - Less admin overhead, means more fun time!

MySQL Group Replication



Some Theory Behind It...

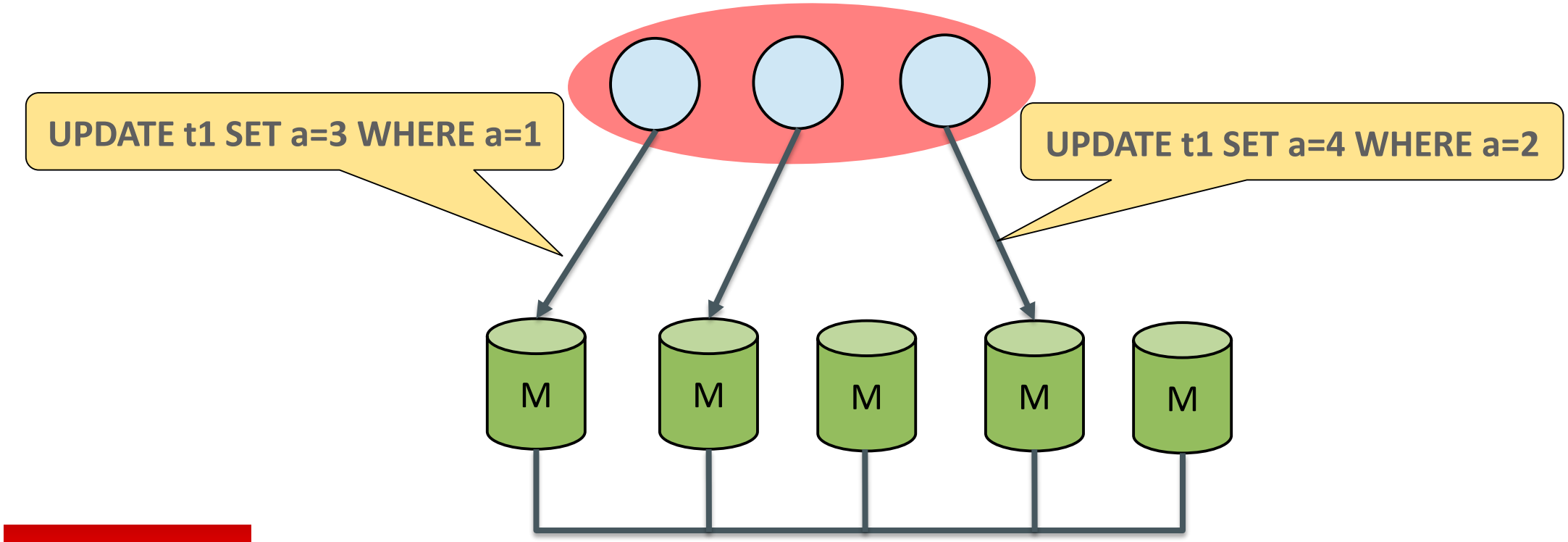
- Implementation based in Replicated Database State Machines
  - Group Communication Primitives resemble properties of Databases.
- Deferred update replication: **propagate atomically**, **check conflicts**, **eventually apply**
  - Distributed state machine requires agreed delivery – implies total order;
  - Deterministic certification requires total order delivery.
- Membership Service
  - Which servers are participating in the replication group at a given moment in time? (associated with a logical timestamp [- view identifier]).

2 MySQL Group Replication

2.1 Multi-Master

Multi-Master update everywhere!

- Any two transactions on different servers can write to the same tuple.
- Conflicts will be detected and dealt with.
  - First committer wins rule.



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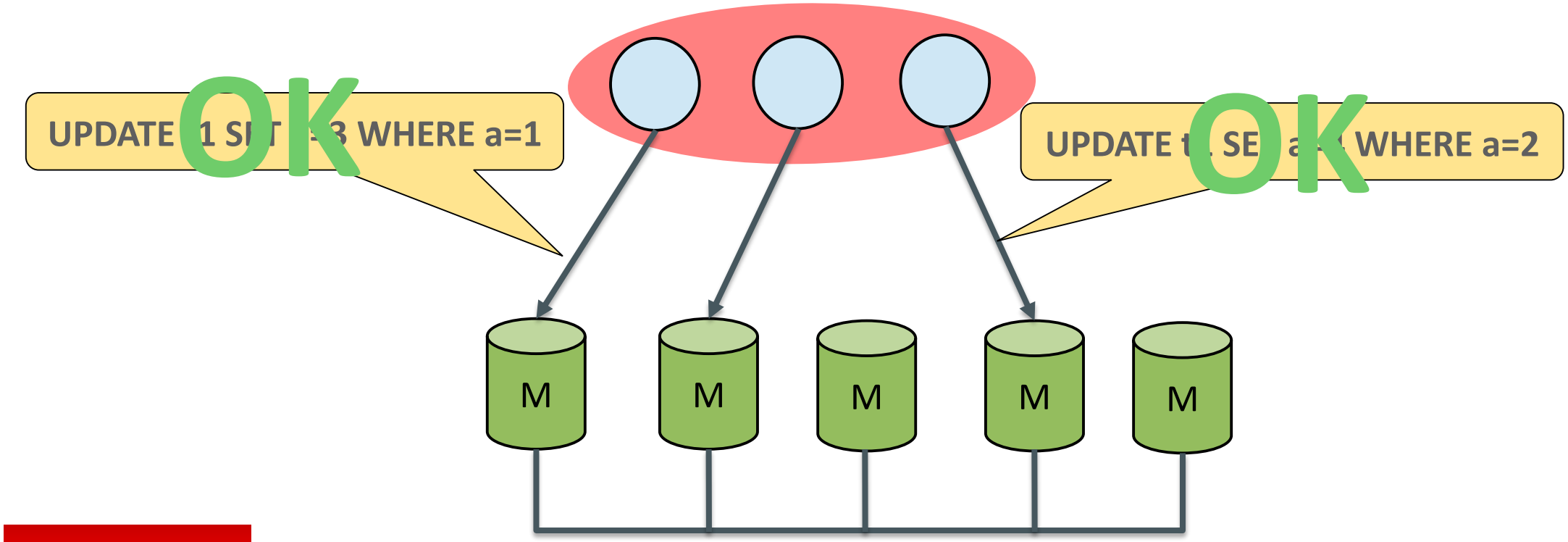

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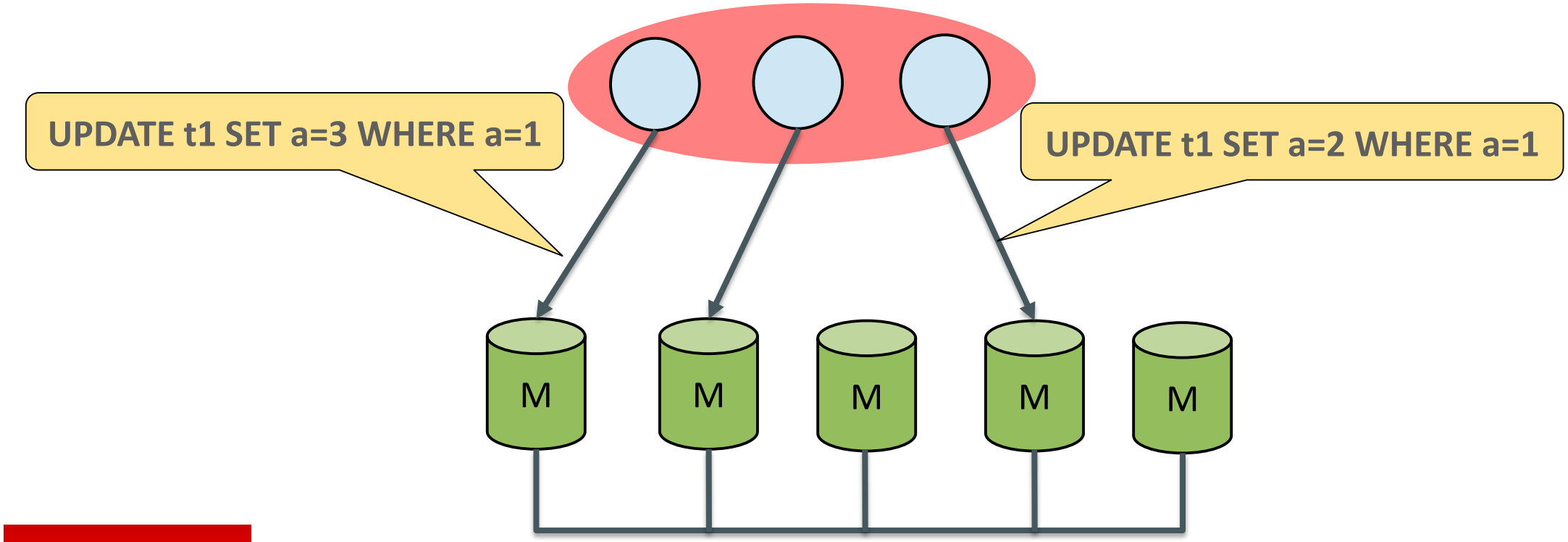

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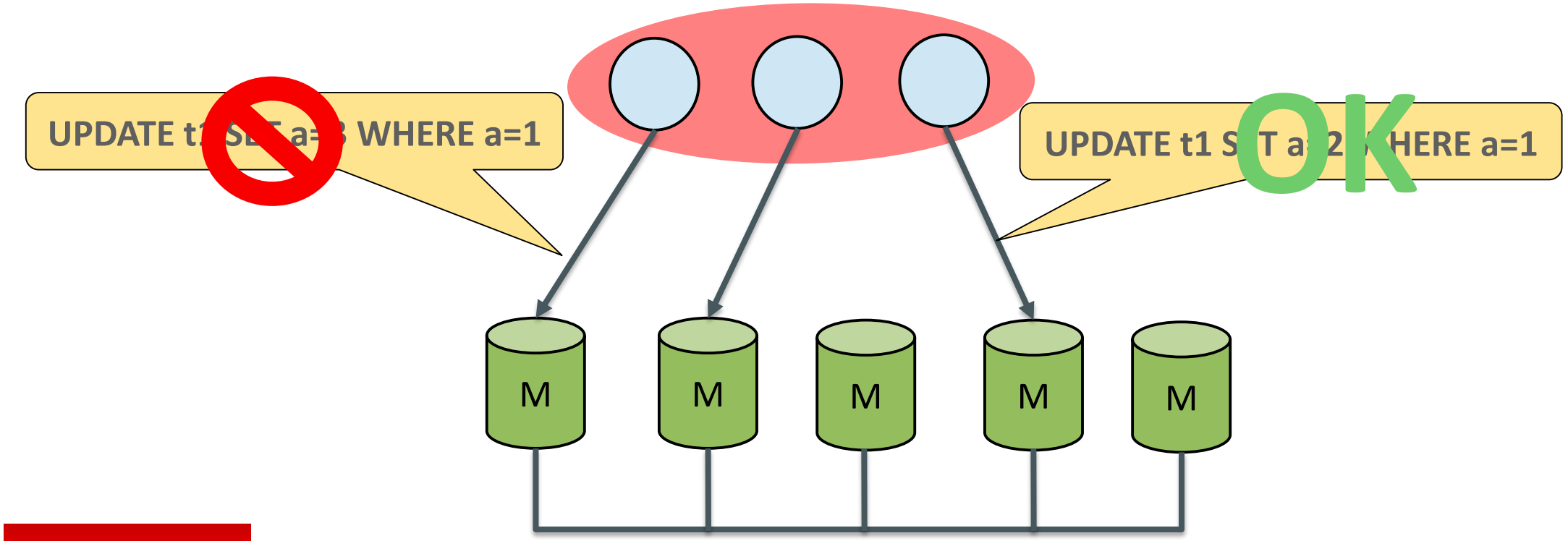


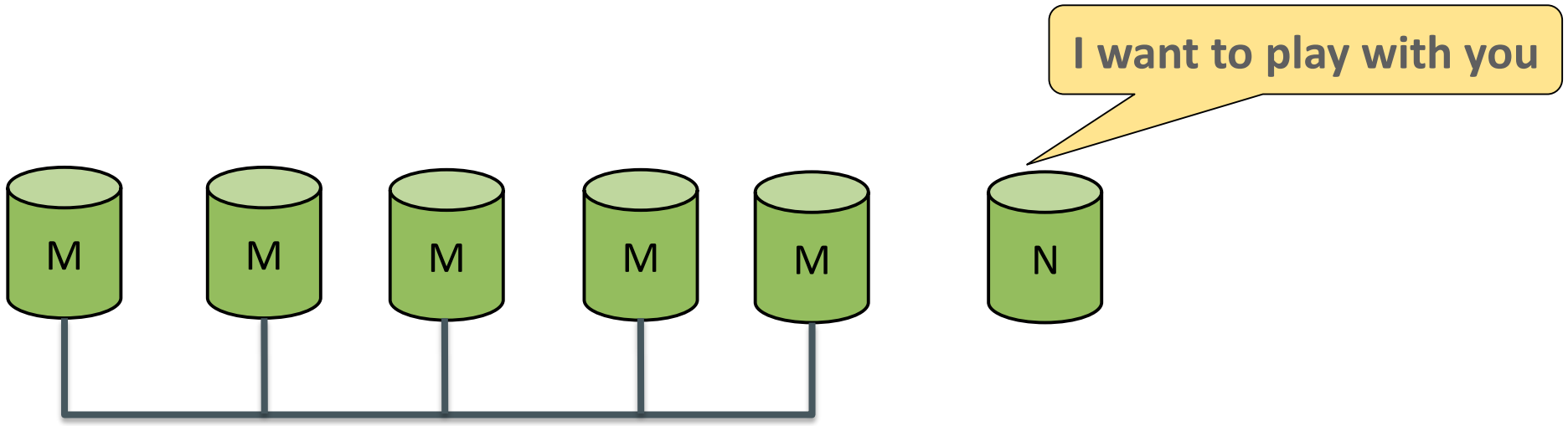
2 MySQL Group Replication

2.1 Multi-Master

2.2 Automatic distributed server recovery

Automatic distributed server recovery!

- Server that joins the group will automatically synchronize with the others.



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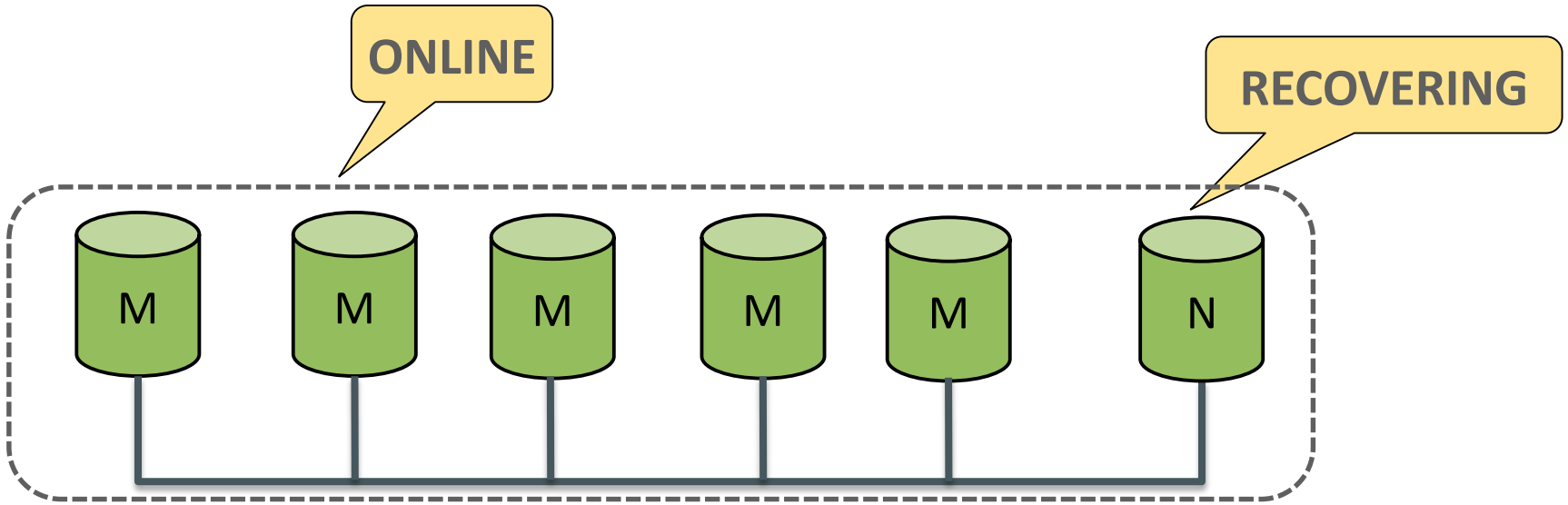

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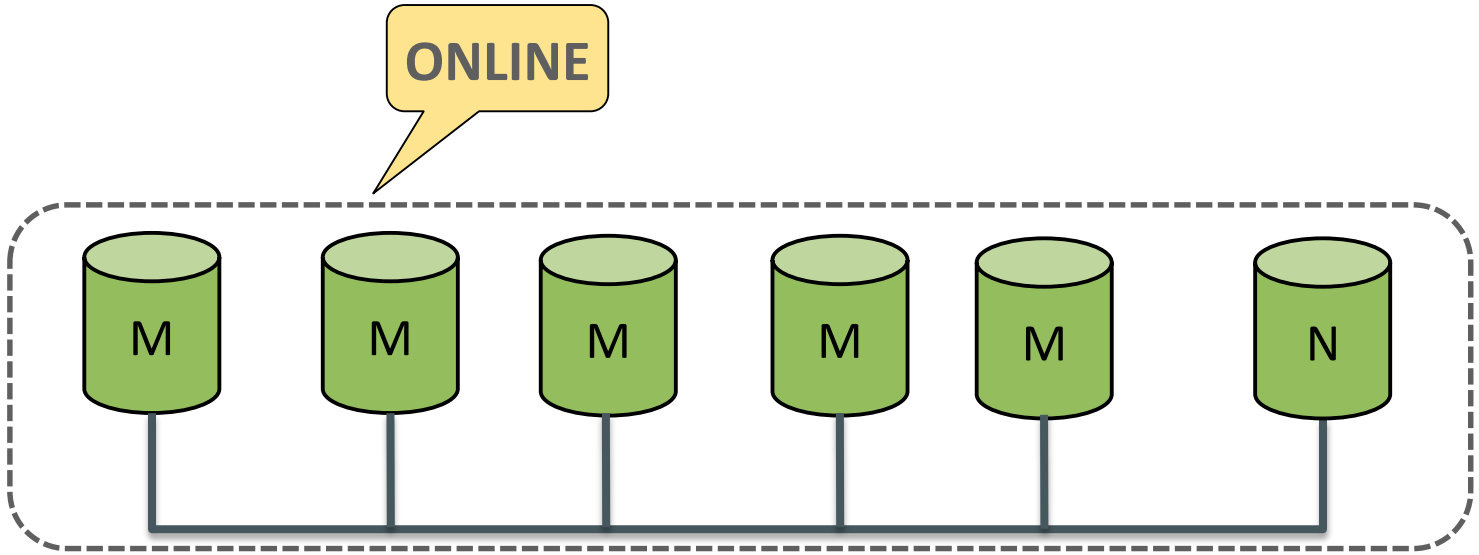
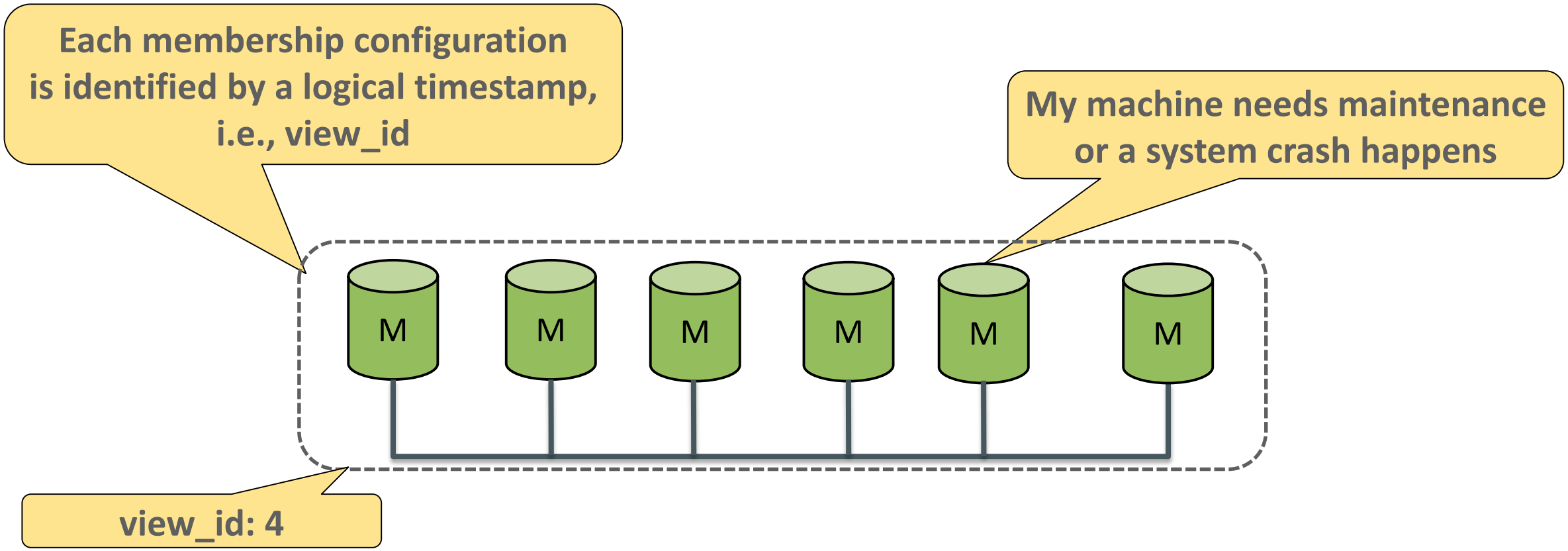


Automatic distributed server recovery!

- If a server leaves the group, the others will automatically be informed.



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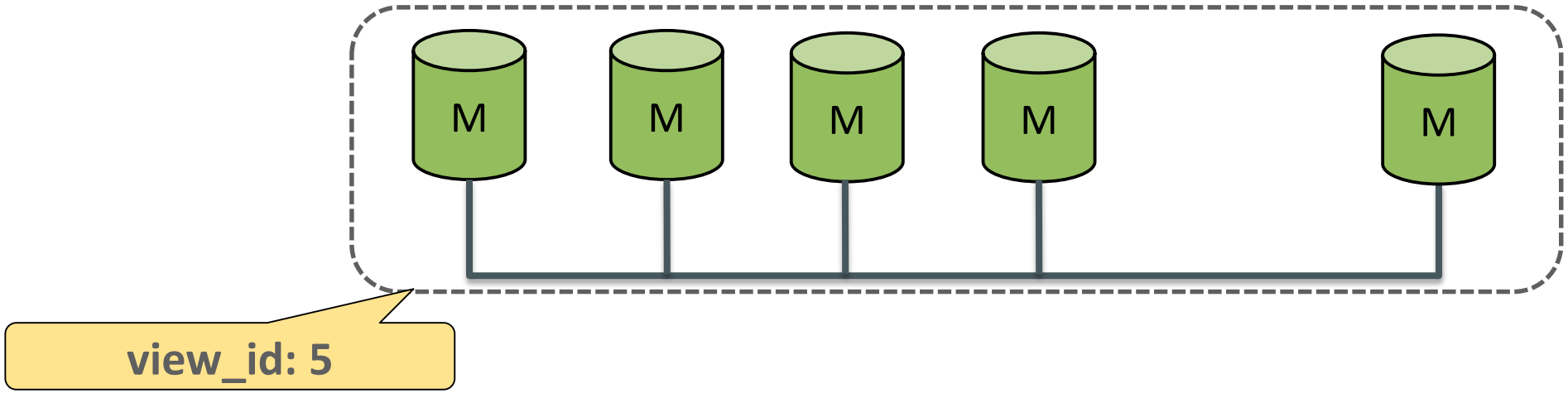
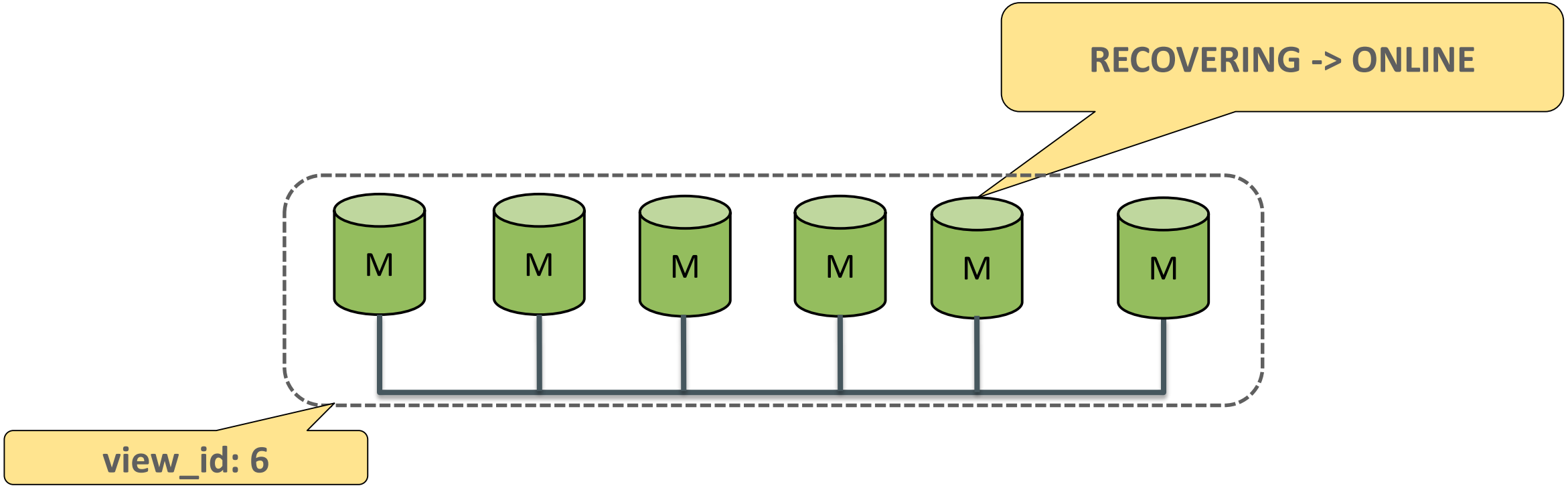


Automatic distributed server recovery!

- Server that (re)joins the group will automatically synchronize with the others.



2 MySQL Group Replication

2.1 Multi-Master

2.2 Automatic distributed server recovery

2.3 MySQL/InnoDB look & feel

MySQL/InnoDB look & feel!

- Load the plugin and start replicating.
- Monitor group replication stats though Performance Schema tables.

```
mysql> SET GLOBAL group_replication_group_name= "9eb07c6d-5e24-11e5-854b-34028662c0cd";
mysql> START GROUP_REPLICATION;

mysql> SELECT * FROM performance_schema.replication_group_members\G
*************************** 1. row ***************************
 CHANNEL_NAME: group_replication_applier
 MEMBER_ID: 597dbb72-3e2c-11e4-9d9d-ecf4bb227f3b
 MEMBER_HOST: nightfury
 MEMBER_PORT: 13000
 MEMBER_STATE: ONLINE
*************************** 2. row ***************************
 ...
```

MySQL/InnoDB look & feel!

- Load the plugin and start replicating.
- Monitor group replication stats though Performance Schema tables.

```
mysql> SELECT * FROM performance_schema.replication_group_member_stats\G
*************************** 1. row ***************************
 CHANNEL_NAME: group_replication_applier
 VIEW_ID: 1428497631:3
 MEMBER_ID: e38fdea8-dded-11e4-b211-e8b1fc3848de
 COUNT_TRANSACTIONS_IN_QUEUE: 0
 COUNT_TRANSACTIONS_CHECKED: 12
 COUNT_CONFLICTS_DETECTED: 5
 COUNT_TRANSACTIONS_VALIDATING: 6
 TRANSACTIONS_COMMITTED_ALL_MEMBERS: 8a84f397-aaa4-18df-89ab-c70aa9823561:1-7
 LAST_CONFLICT_FREE_TRANSACTION: 8a84f397-aaa4-18df-89ab-c70aa9823561:7
```

MySQL/InnoDB look & feel!

- Load the plugin and start replicating.
- Monitor group replication stats though Performance Schema tables.

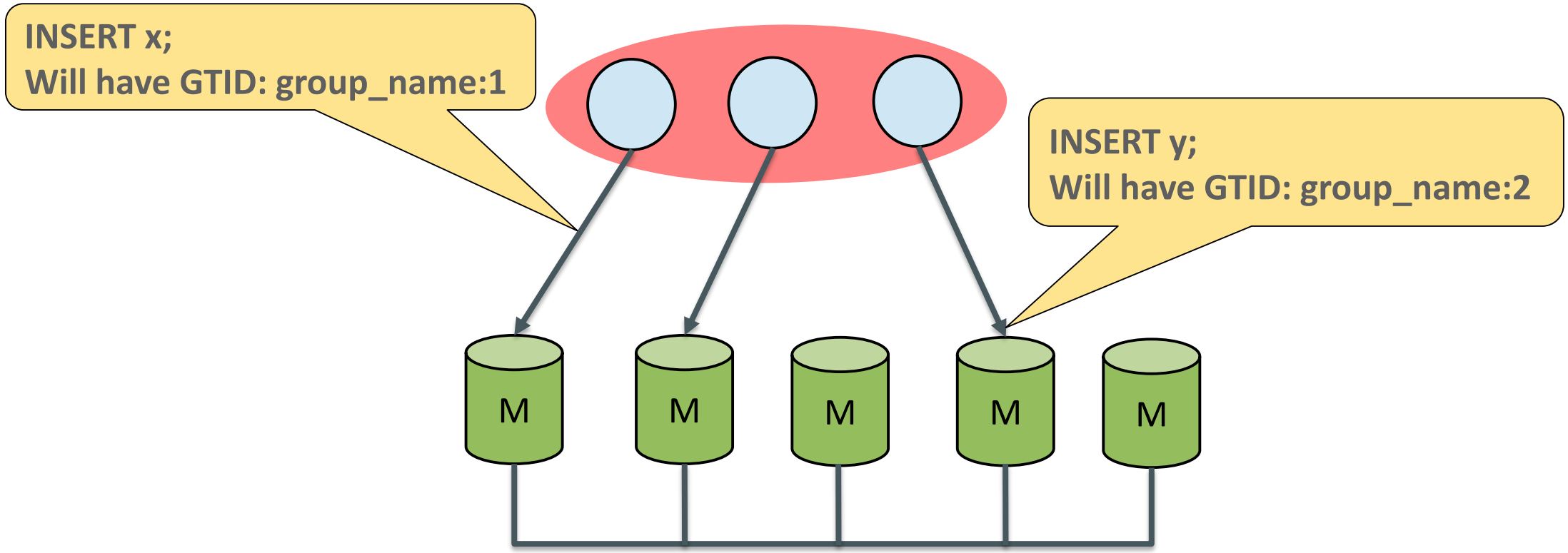
```
mysql> SELECT * FROM performance_schema.replication_connection_status\G
*************************** 1. row ***************************
 CHANNEL_NAME: group_replication_applier
 GROUP_NAME: 8a94f357-aab4-11df-86ab-c80aa9429563
 SOURCE_UUID: 8a94f357-aab4-11df-86ab-c80aa9429563
 THREAD_ID: NULL
 SERVICE_STATE: ON
 ...
```

2 MySQL Group Replication

- 2.1 Multi-Master
- 2.2 Automatic distributed server recovery
- 2.3 MySQL/InnoDB look & feel
- 2.4 Full GTID support

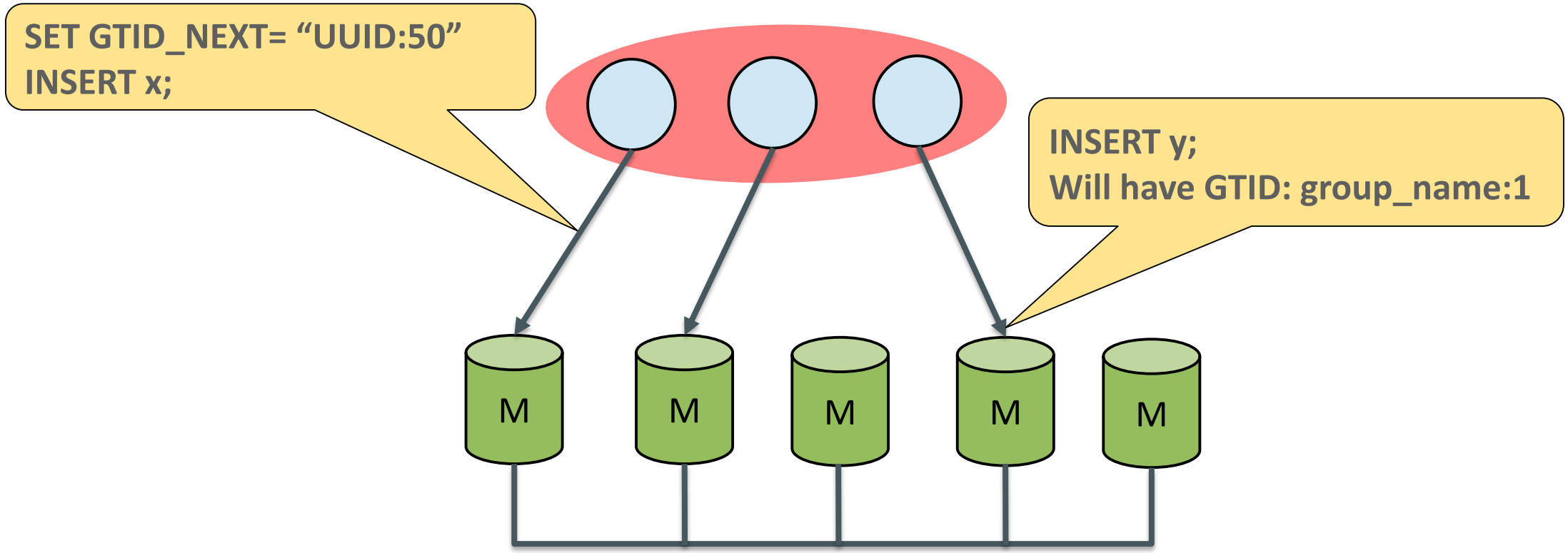
Full GTID support!

- All group members share the same UUID, the group name.



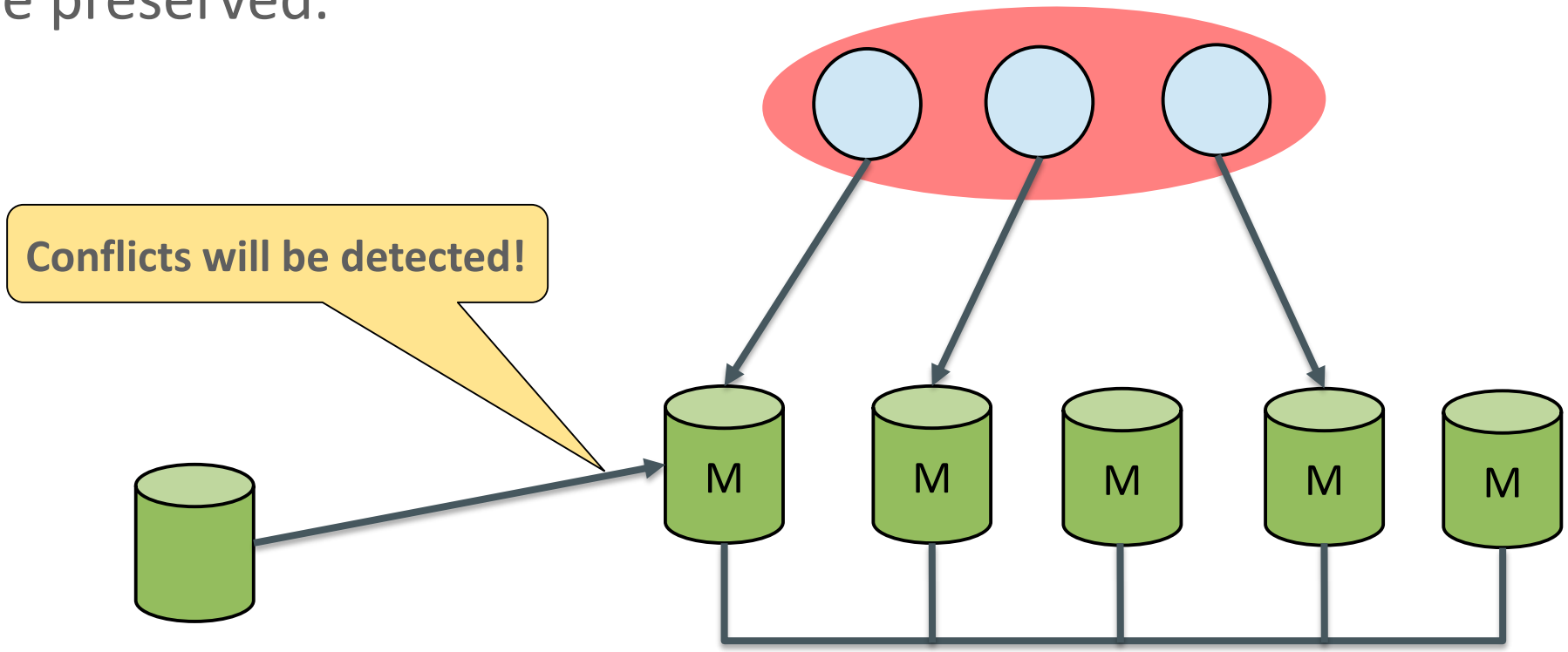
Full GTID support!

- Users can specify the identifier for the transaction.



Full GTID support!

- You can even replicate from a outside server to a group, global identifiers will be preserved.



2 MySQL Group Replication

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- 2.2 Automatic distributed server recovery
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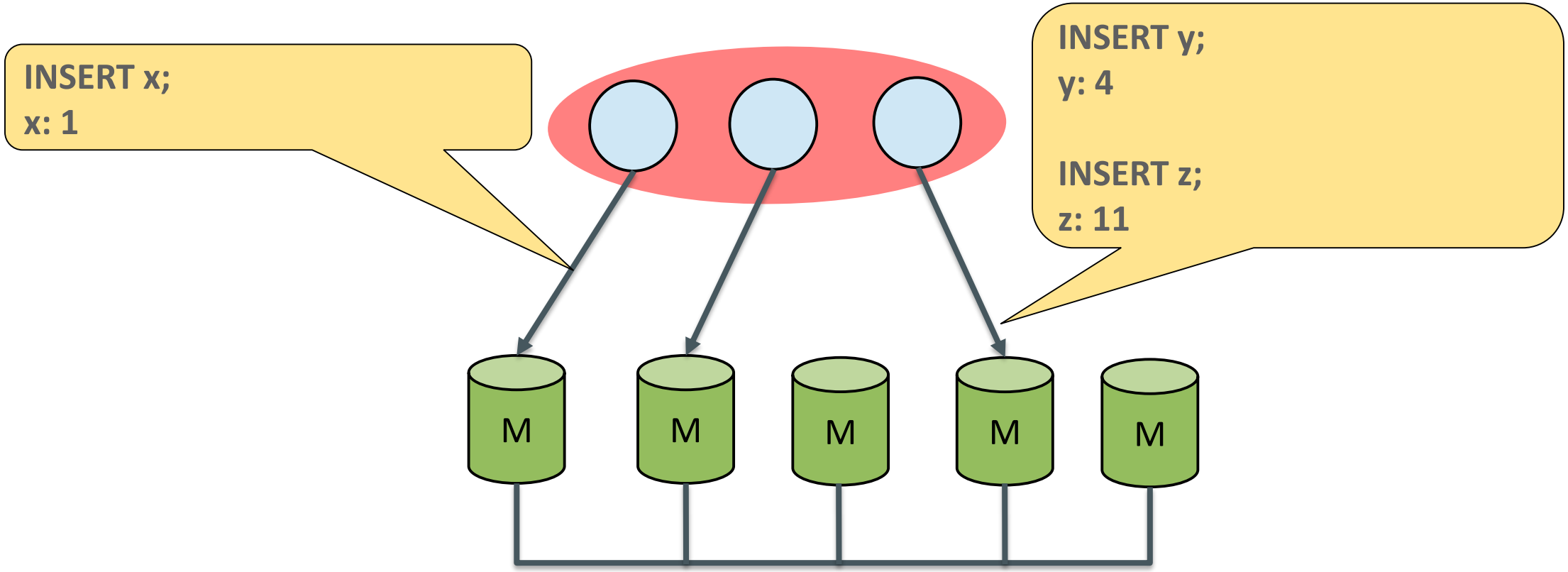
- 2.4 Full GTID support
- 2.5 Auto-increment configuration/handling

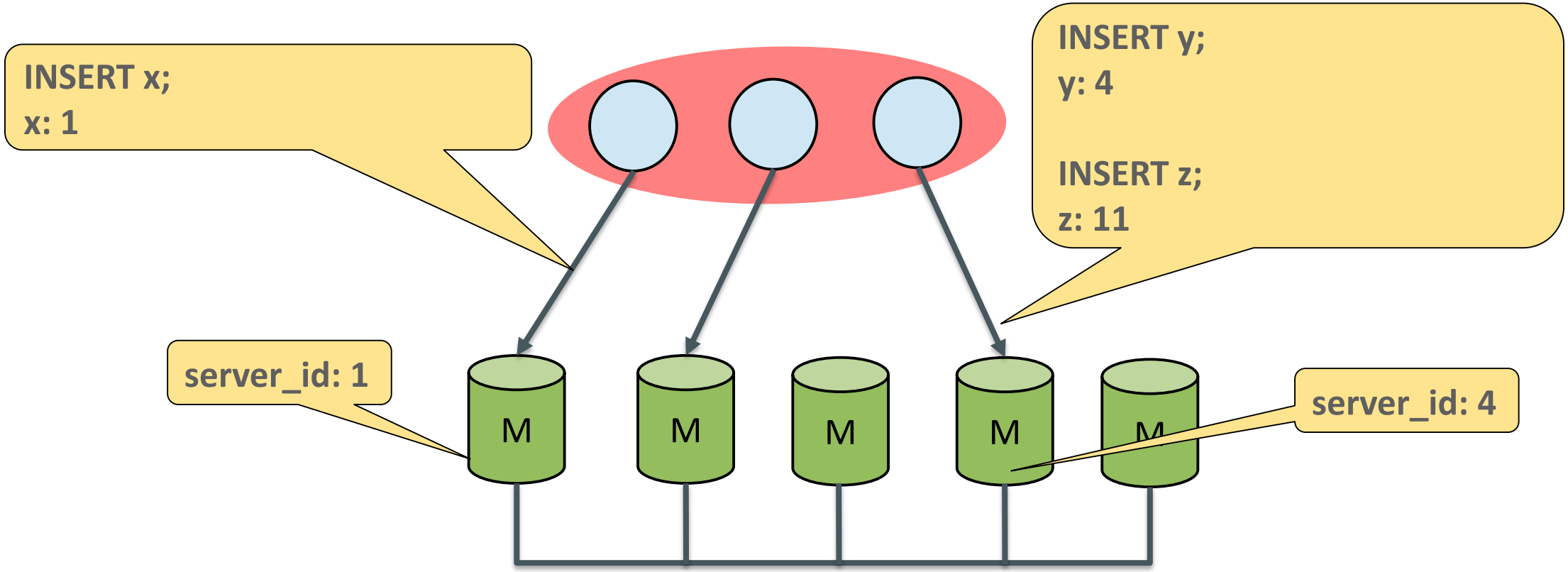
Auto-increment configuration/handling

- Group is configured not to generate the same auto-increment value on all members.



Auto-increment configuration/handling

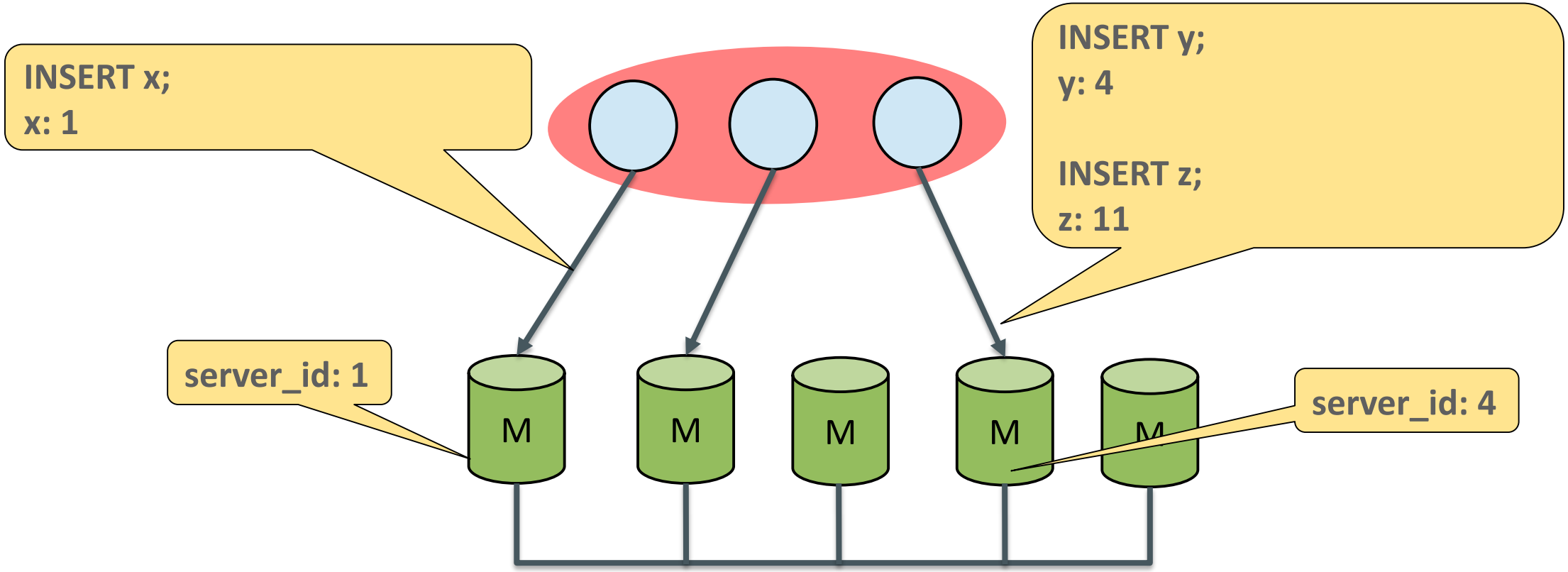
- By default, the offset is provided by server_id and increment is 7 [1].



[1]: http://mysqlhighavailability.com/mysql-group-replication-auto-increment-configuration-handling/

Auto-increment configuration/handling

- Users can change the increment size to their needs using GROUP_REPLICATION_AUTO_INCREMENT_INCREMENT option.



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- 2.5 Auto-increment configuration/handling
- 2.6 New distributed agreement and communication engine

New Distributed Agreement and Communications Engine

- Multiple OS support.
  - Linux, but also Windows, OSX, Solaris, FreeBSD…
- No third-party software required.
- No network multicast support required.
  - MySQL Group Replication can now operate on cloud based installations on which multicast is disallowed.
- No message size limit.
- No separate process.
  - MySQL Group Replication is now self-contained on the same software stack.

2 MySQL Group Replication

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- 2.7 Requirements
- 2.8 Limitations

Requirements (by design)

- Support for InnoDB only.
- Primary key is required on every table.
- Requires global transaction identifiers turned on.
- Optimistic execution: transactions may abort on COMMIT due to conflicts with concurrent transactions on other members.

2 MySQL Group Replication

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Limitations

- Concurrent schema changes are not supported.

3 Architecture

3.1 Introduction

MySQL Group Replication is

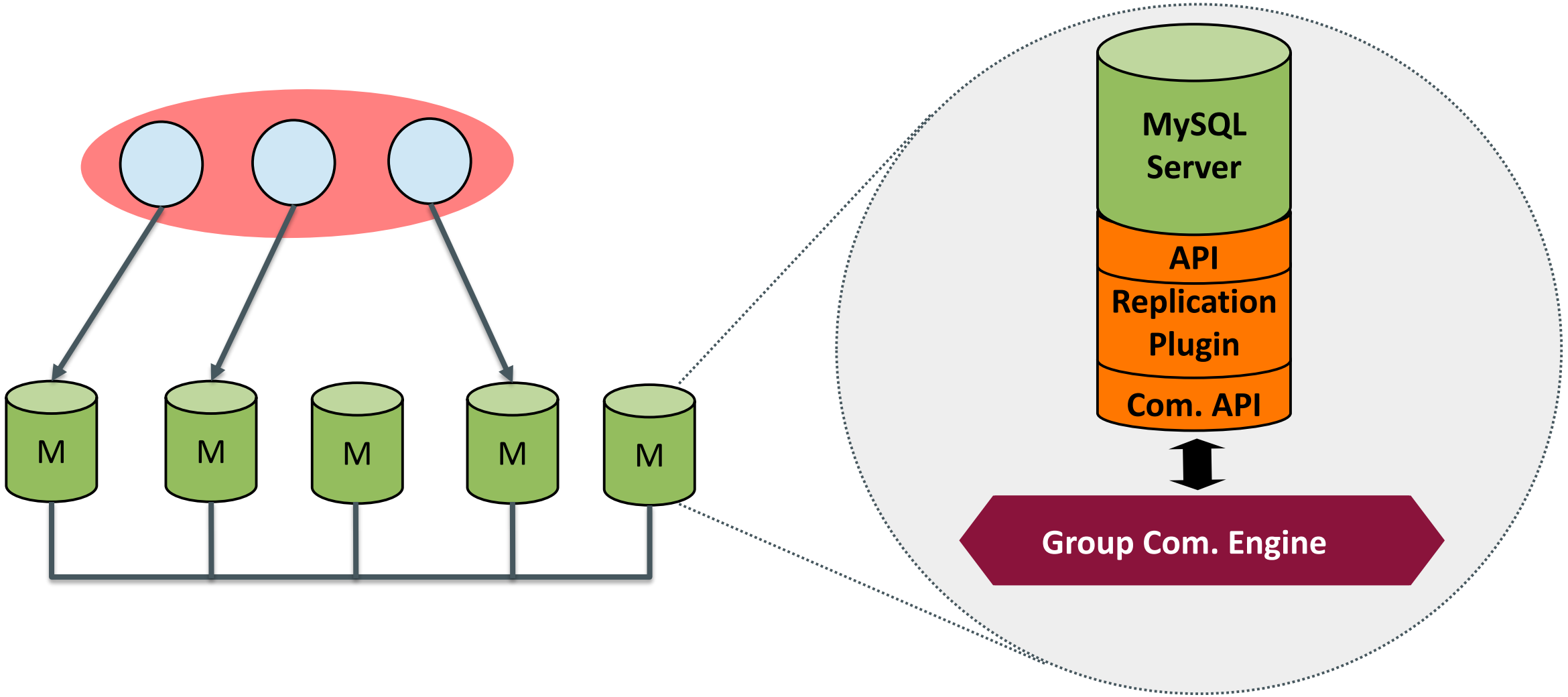
- **Built on top of proven technology!**
  - Shares much of MySQL Replication infrastructure – thence does not feel alien!
  - Multi-Master approach to replication.
- **Built on reusable components!**
  - Layered implementation approach.
  - Interface driven development.
  - Decoupled from the server core.
  - The plugin registers as listener to server events.
  - Reuses the capture procedure from regular replication.
  - Provides further decoupling from the communication infrasctructure.

3 Architecture

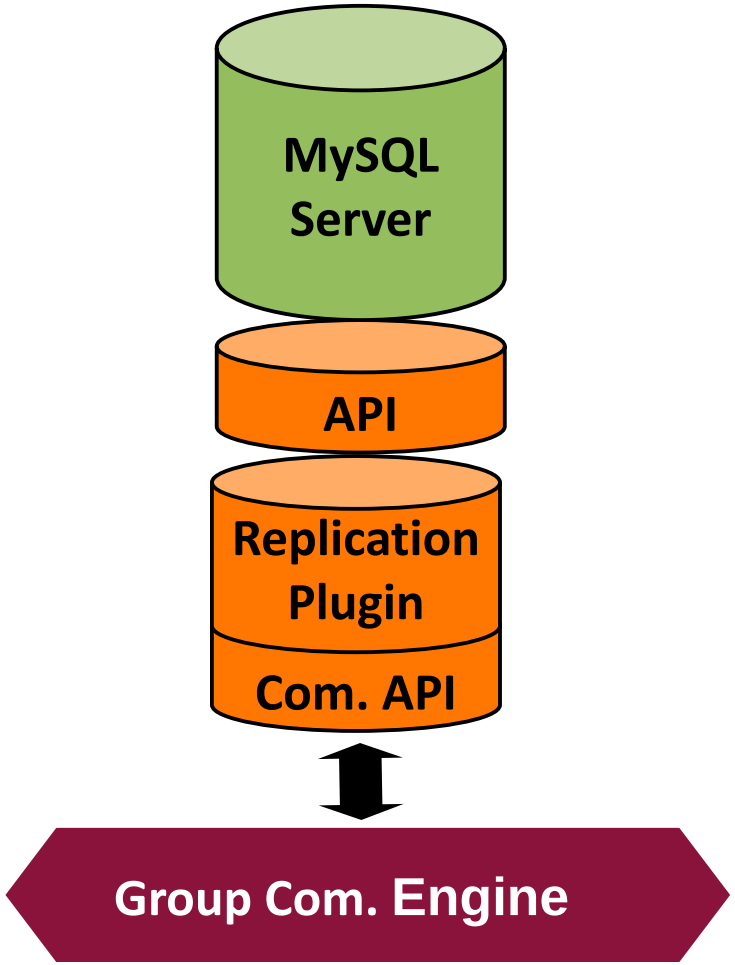
3.1 Introduction

3.2 Major Building Blocks

Major Building Blocks (1)

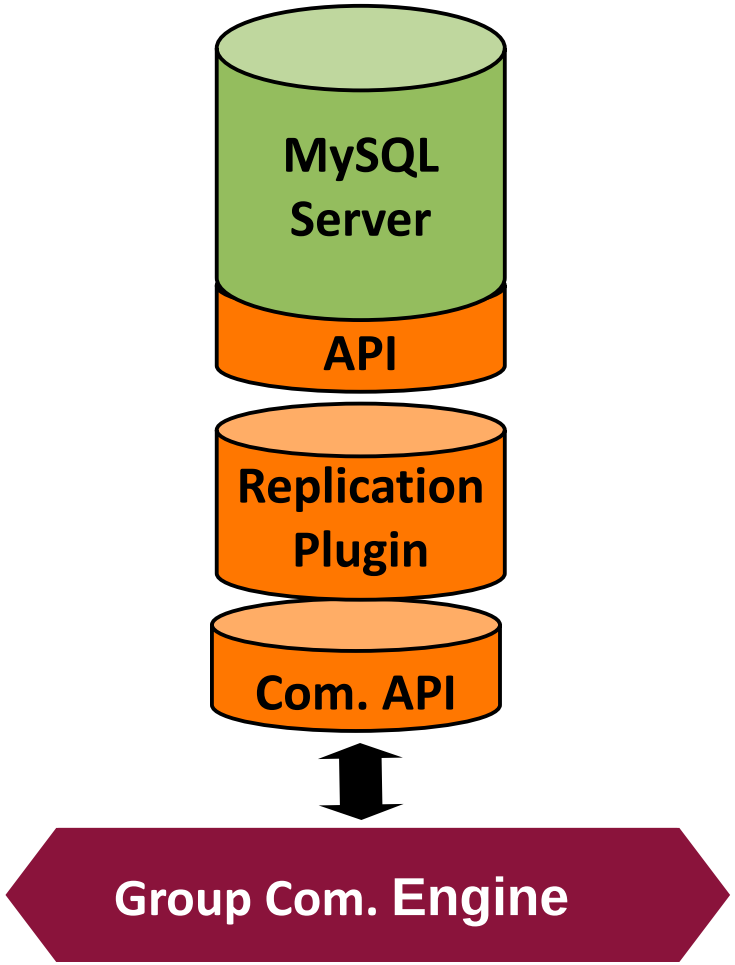


Major Building Blocks (2)



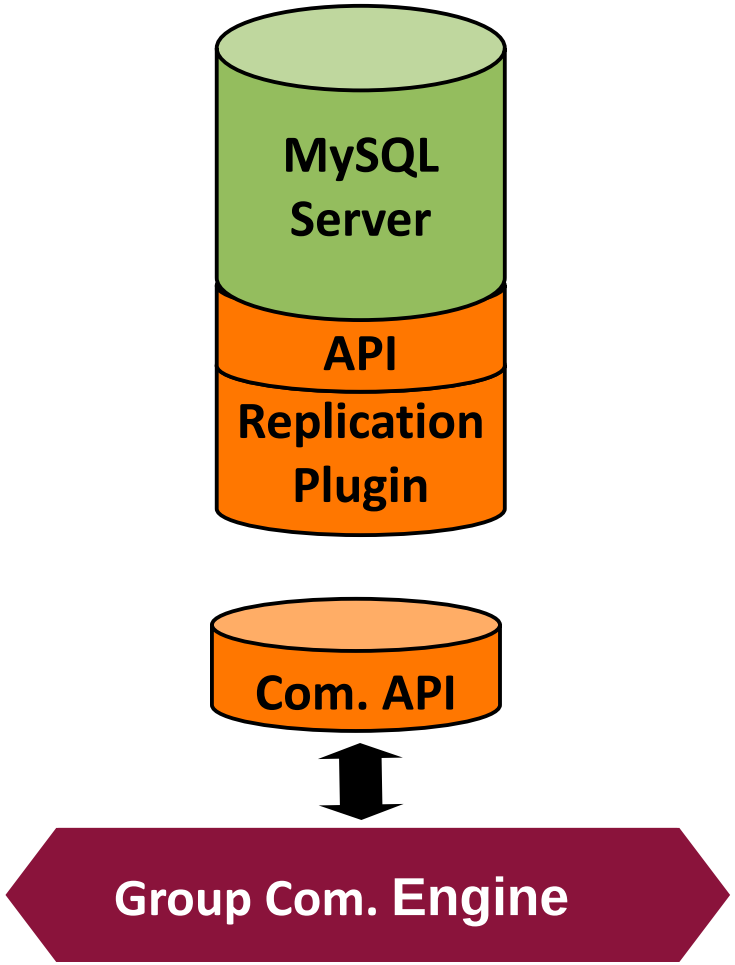
- Server calls into the plugin through a generic interface
  - (Most of server) internals are hidden from the plugin.
  - Some of the semi-sync interfaces were reused. Others were deployed.
- Plugin interacts with the server through a generic interface
  - Replication plugin determines the fate of the commit operation through a well defined server interface.
  - The plugin makes use of the relay log infrastructure to inject changes in the receiving server.

Major Building Blocks (3)



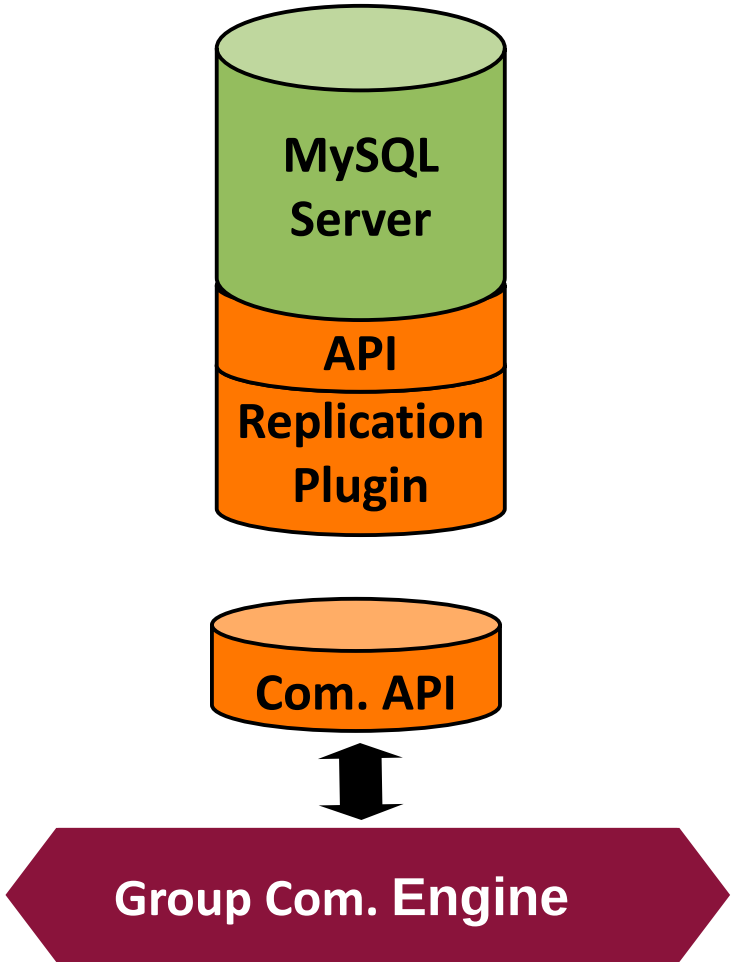
- The plugin is responsible for
  - Maintaining distributed execution context.
  - Detecting conflicts.
  - Handling distributed recovery:
    - Detect membership changes;
    - Donate state if needed;
    - Collect state if needed.
  - Receiving and handling transactions from other members.
  - Deciding the fate of on-going transactions.

Major Building Blocks (4)



- The communication API (and bindings) is responsible for:
  - Abstracting the underlaying communication engine from the plugin itself.
  - Maping the interface to a specific communication engine.

Major Building Blocks (5)



- The communication engine:
  - Variant of Paxos developed at MySQL.
  - Building block to provide distributed agreement between servers.

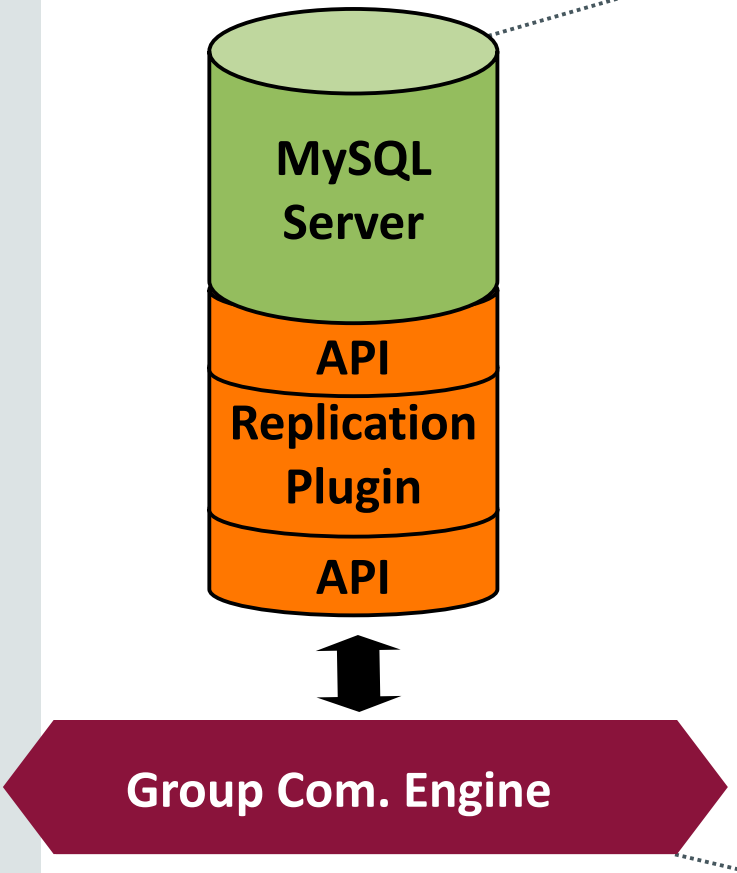
3 Architecture

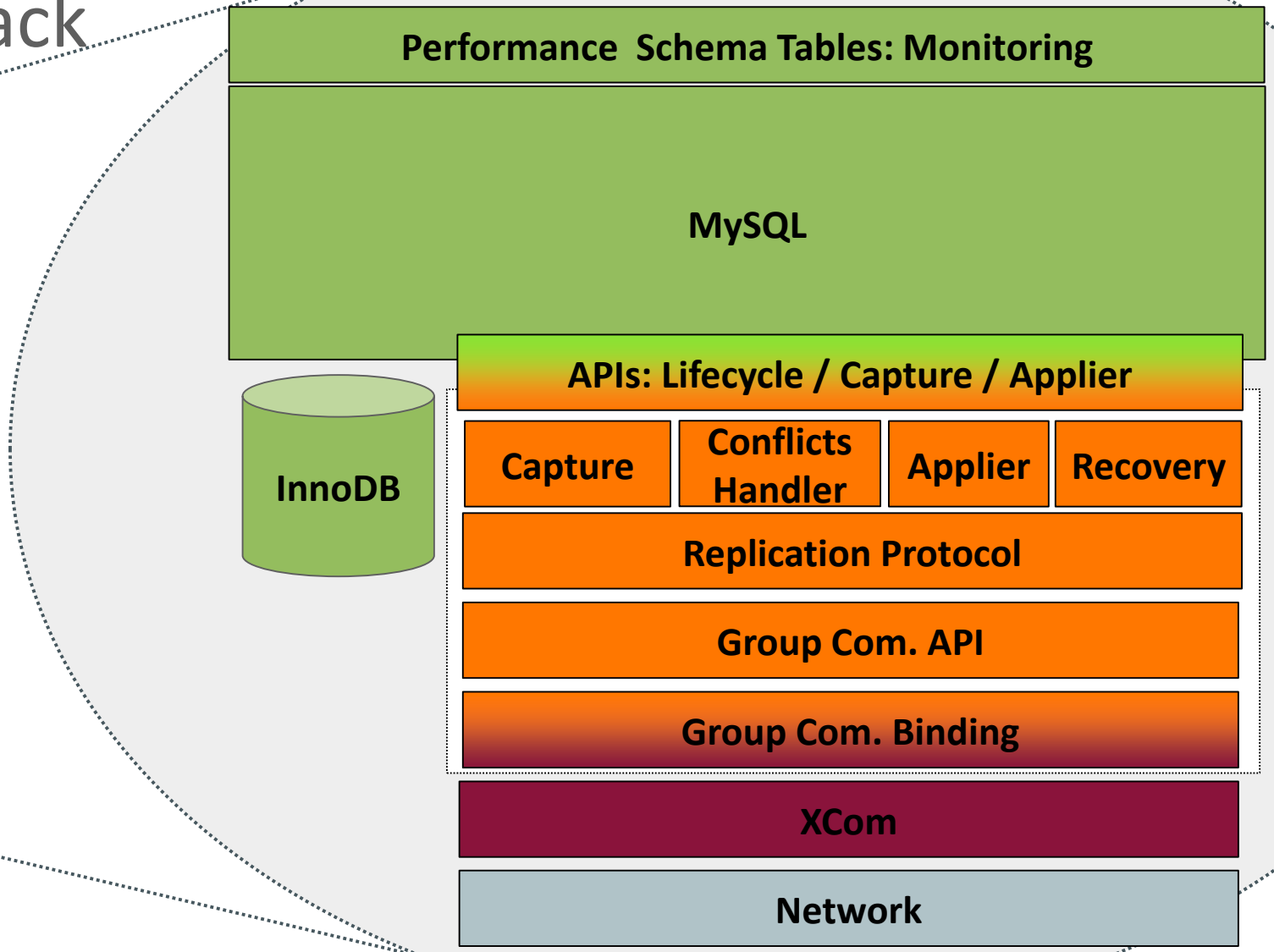
3.1 Introduction

3.2 Major Building Blocks

3.3 The Complete Stack

The Complete Stack





4 Use cases

4.1 Use cases

Use Cases

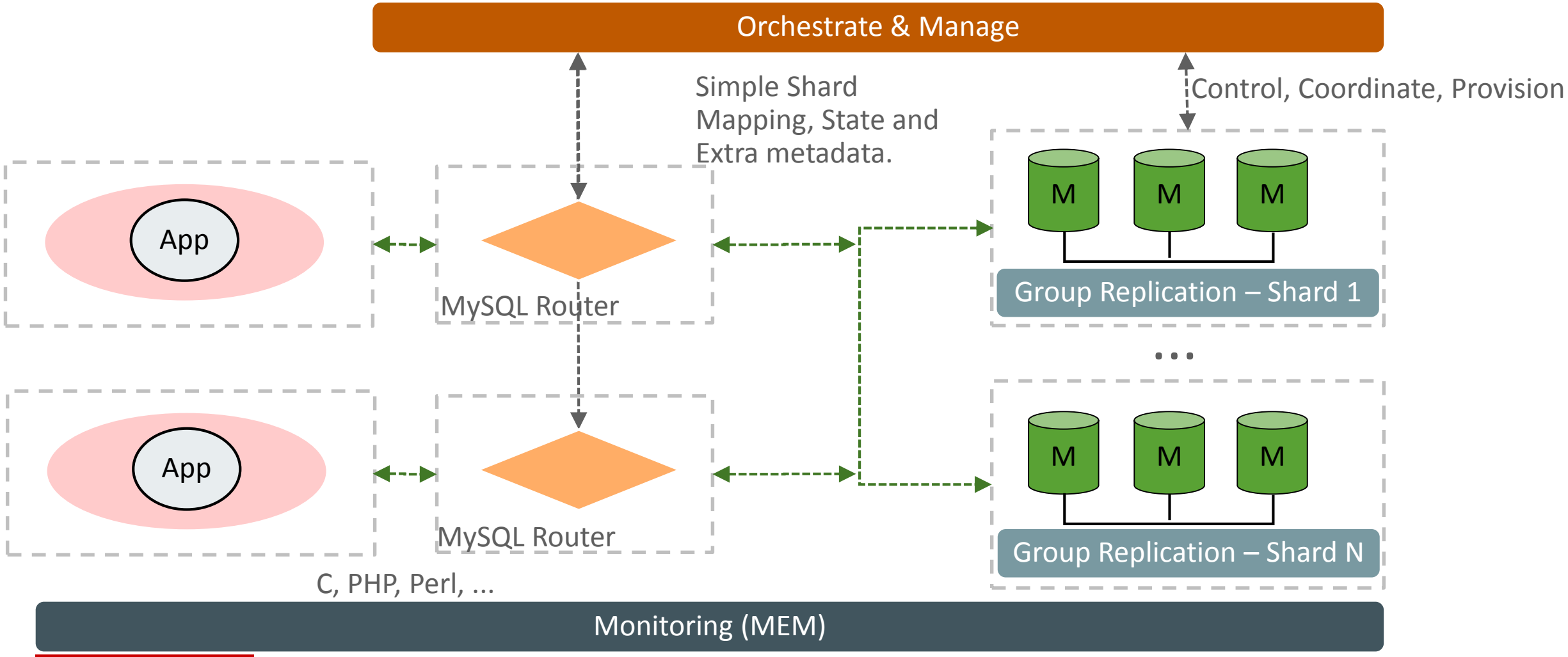
- **Elastic Replication**
  - Environments that require a very fluid replication infrastructure, where the number of servers has to grow or shrink dynamically and with as little pain as possible.
- **Highly Available Shards**
  - Sharding is a popular approach to achieve write scale-out. Users can use MySQL Group Replication to implement highly available shards. Each shard can map into a Replication Group.
- **Alternative to Master-Slave replication**
  - It may be that a single master server makes it a single point of contention. Writing to an entire group may prove more scalable under certain circumstances.

4 Use cases

4.1 Use cases

4.2 Big Picture

Dependable and Scalable MySQL Setups



5 Conclusion

Summary

- **Cloud Friendly**
  - Great techonology for deployments where elasticity is a requirement, such as cloud based infrastructures.
- **Integrated**
  - With server core through a well defined API.
  - With GTIDs, row based replication, performance schema tables.
- **Autonomic and Operations Friendly**
  - It is self-healing: no admin overhead for handling server fail-overs.
  - Provides fault-tolerance, enables multi-master update everywhere and a dependable MySQL service.

Where to go from here?

- Packages
  - http://labs.mysql.com

- Blogs from the Engineers (news, technical information, and much more)
  - http://mysqlhighavailability.com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