Group Replication: A Journey to the Group Communication Core

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Program Agenda

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Program Agenda

1. Background
2. Group Communication Interface
3. Group Communication Engine
4. Performance
5. Conclusion

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1 Background

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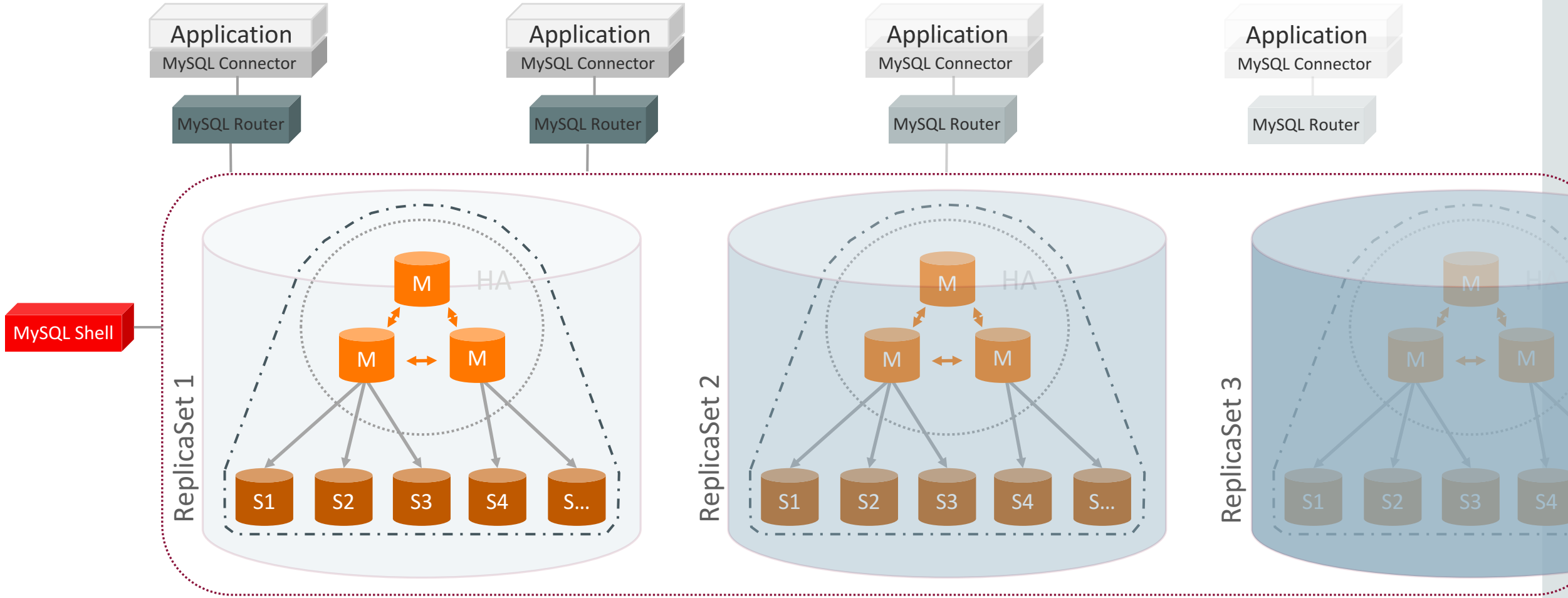
MySQL InnoDB Cluster



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MySQL Group Replication

- **What is MySQL Group Replication?**

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

- **What does the MySQL Group Replication plugin do for the user?**
  - Automates server failover in Single Primary
  - Provides fault tolerance
  - Enables update everywhere setups
  - Automates group reconfiguration (handling of crashes, failures, re-connects)
  - Provides a highly available replicated database

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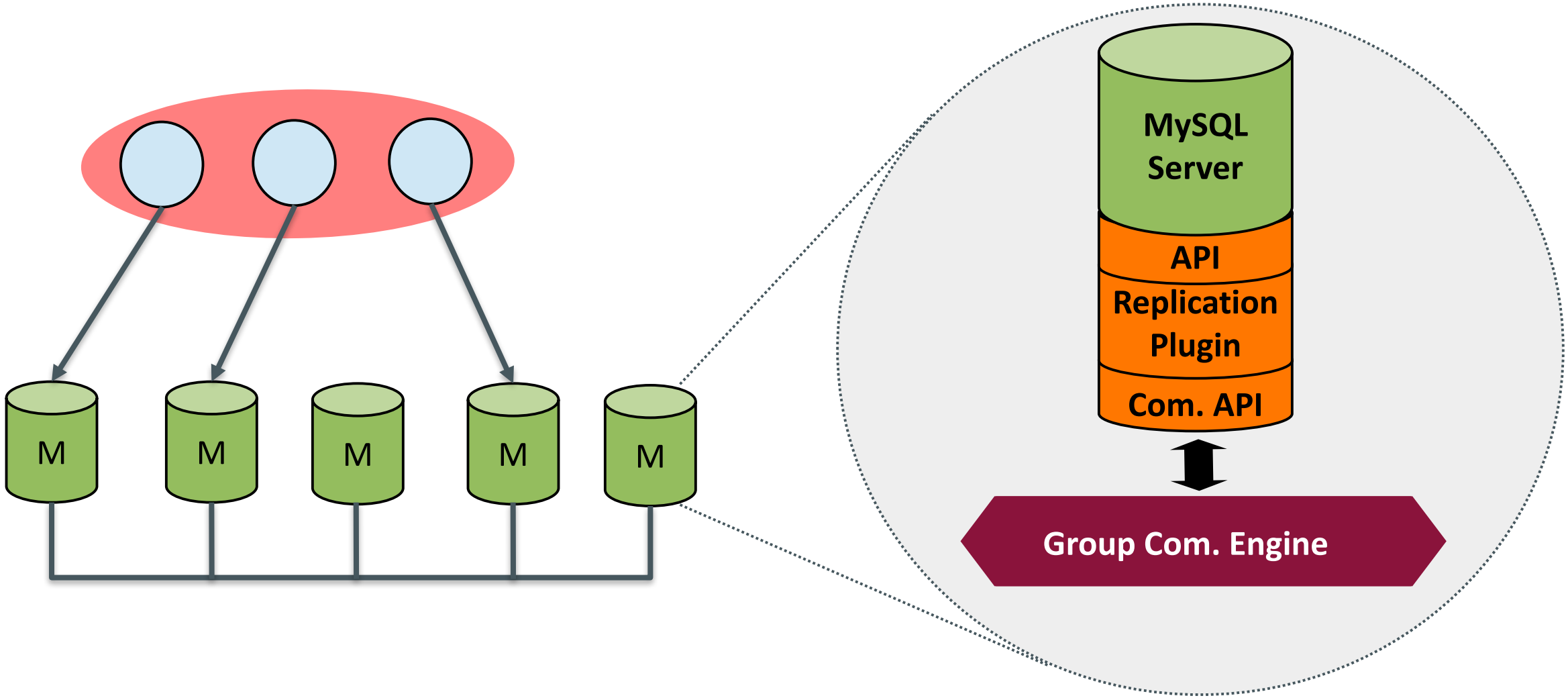
Major Building Blocks



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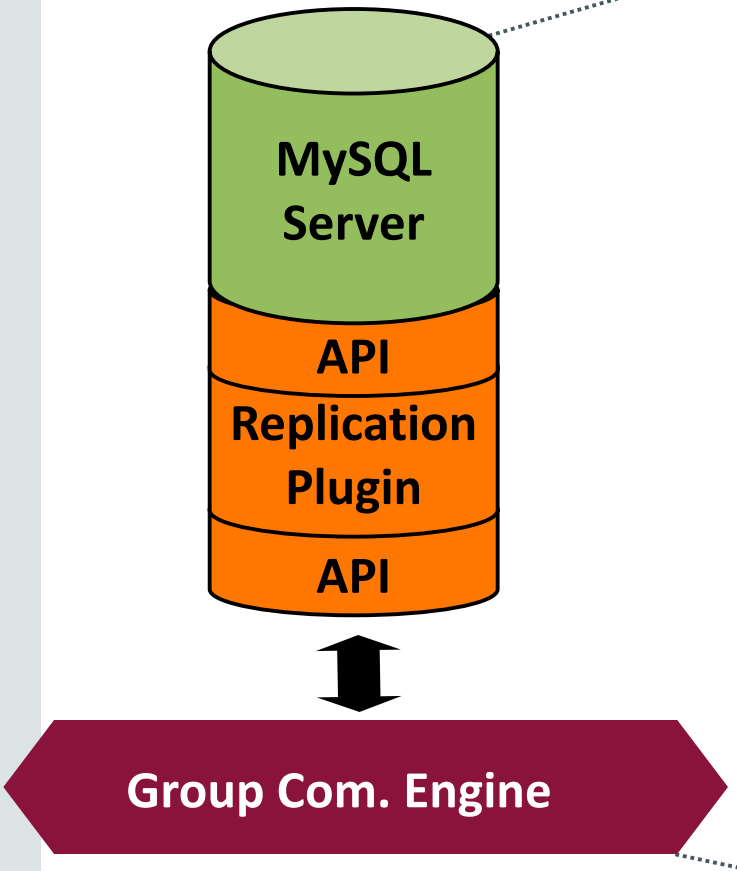
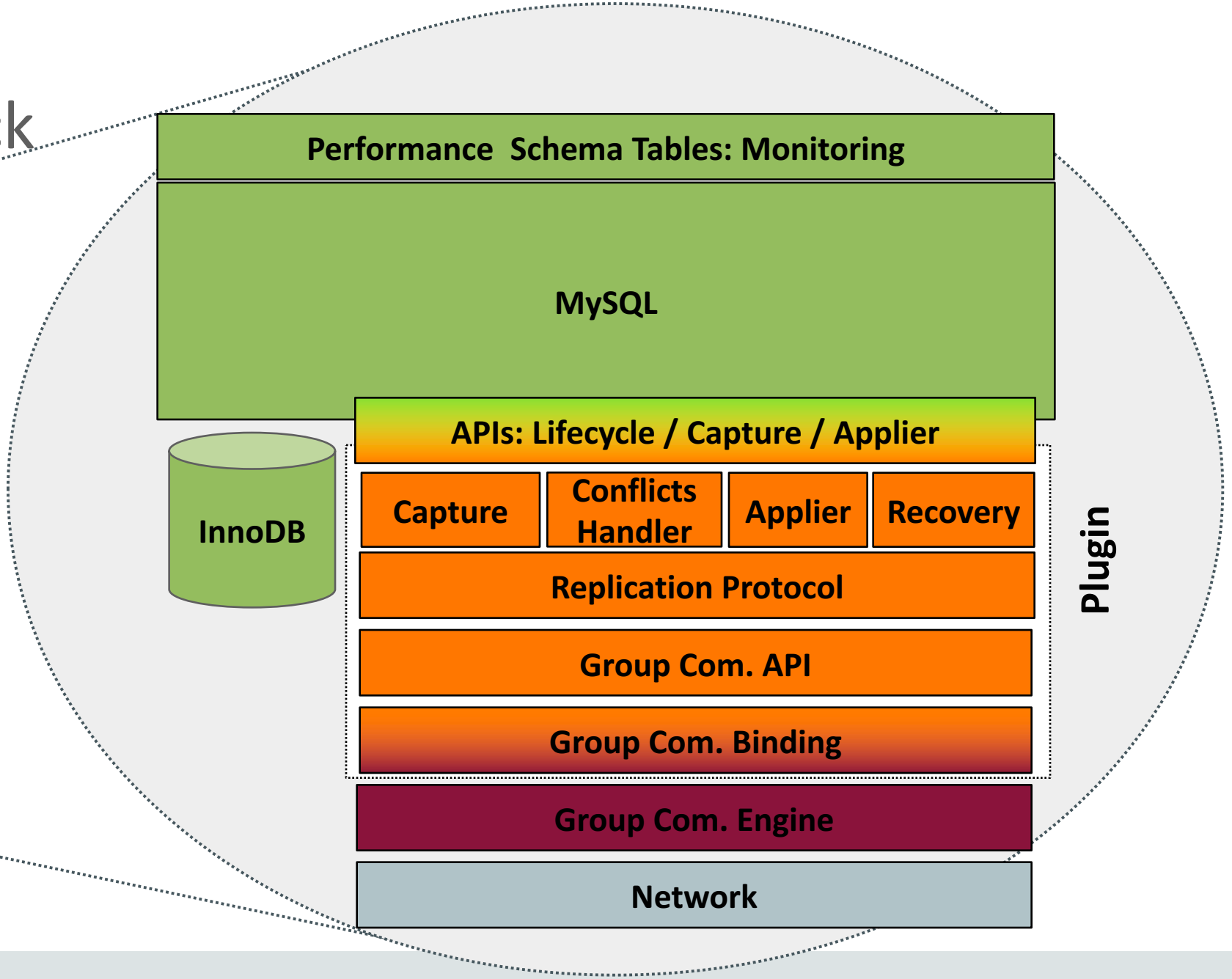
The Complete Stack





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2 Group Communication Interface

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Design

- Abstract interface to support different solutions
  - Reconfigure the group and get membership information
  - Send and receive messages
- Uses the observer pattern
  - MySQL Group Replication listens to events
- Different implementations per Communication Systems
- Made the transition from Corosync easy

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Semantics

- Closed Group
  - Only group members can send and receive messages
- Total Order
  - Messages are totally ordered among each other
- Safe Delivery
  - One cannot deliver a message if the majority can’t do so
- View Synchrony
  - Changes to membership are tolltaly ordered with messages

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3 Group Communication Engine

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Built-in Communication Engine

- Based on proven distributed systems algorithms (Paxos)
  - Compression, multi-platform, dynamic membership, SSL, IP whitelisting
- No third-party software required
- No network multicast support required
  - MySQL Group Replication can operate on cloud based installations where multicast is unsupported

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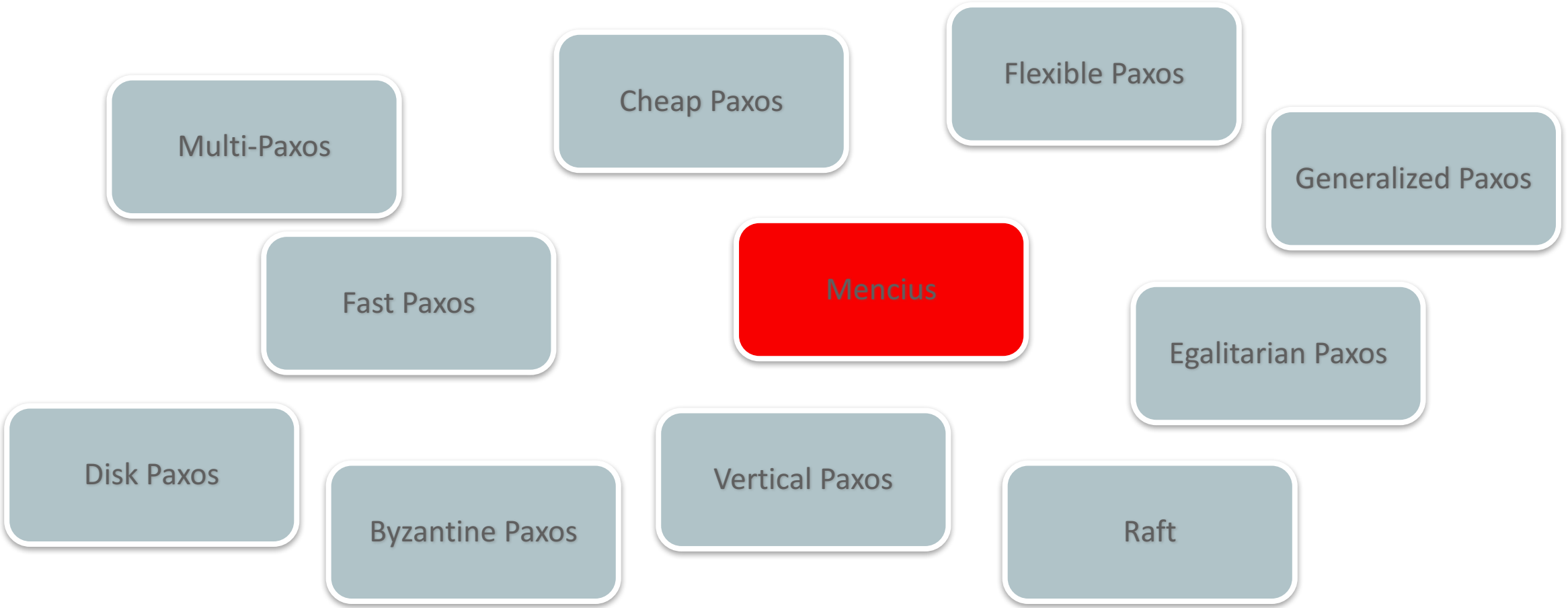
Paxos Family and Friends



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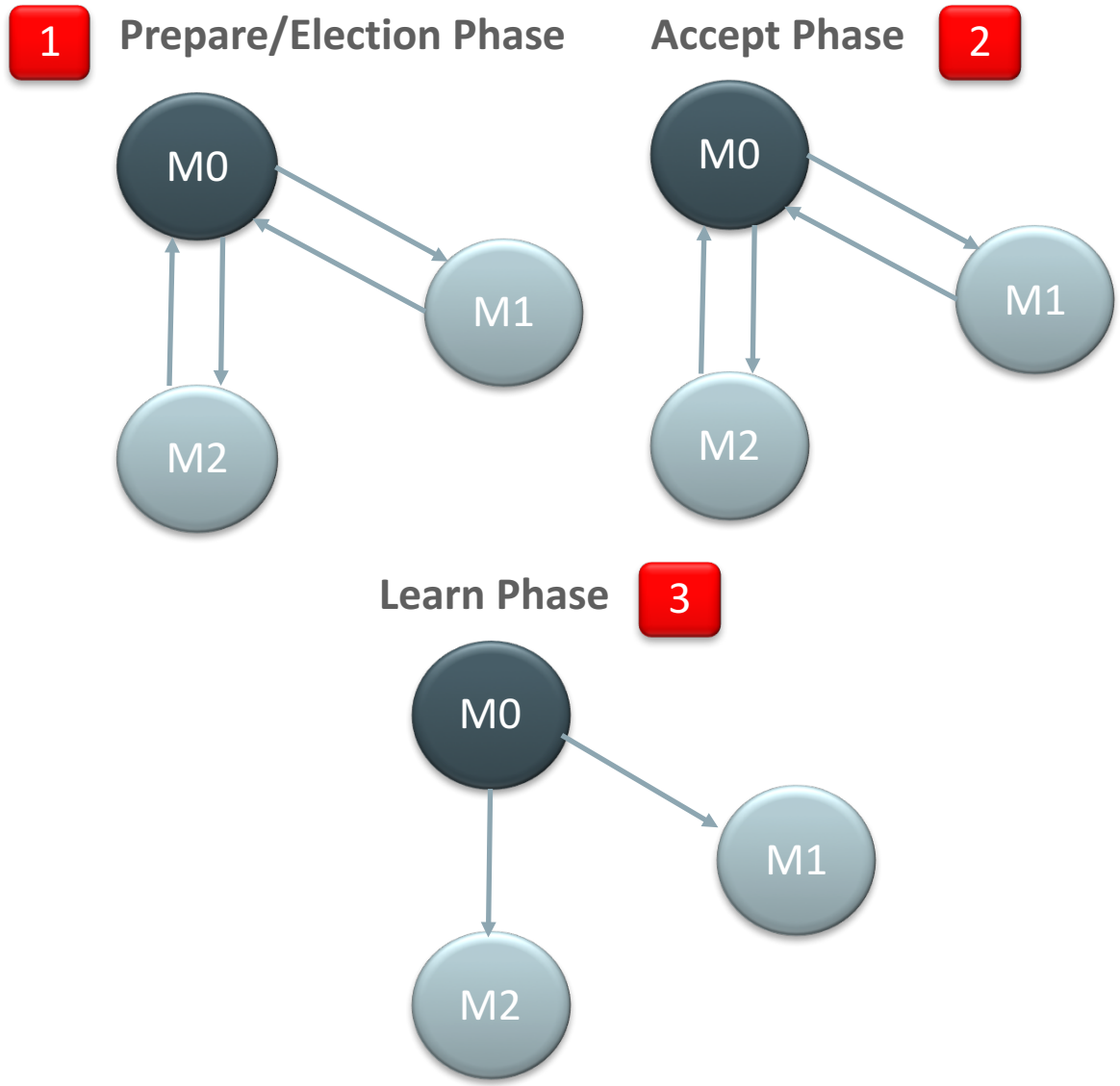
Basic Paxos

- Get agreement on a value:
  - Next message/transaction to be delivered
- Members may have different roles:
  - Usually all members are proposers, acceptors and learners
- Need a quorum to make progress
  - Usually a majority



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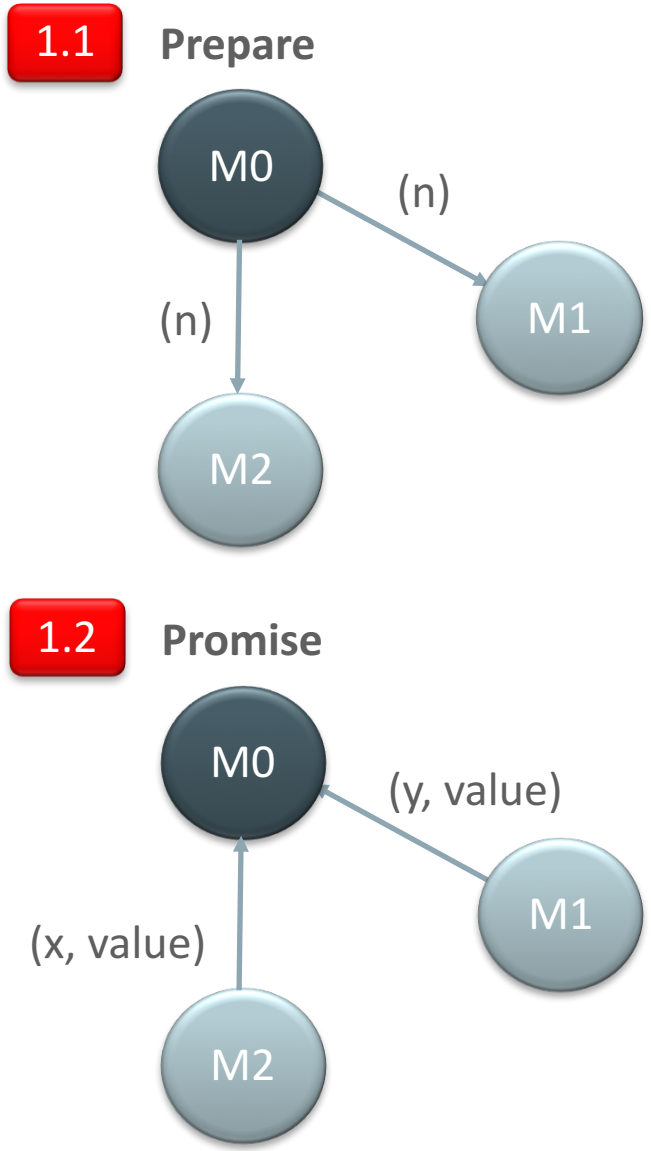
Prepare Phase

- Proposer sends a prepare request with number “n” to members (i.e. acceptors)
- If an acceptor has not received a request with a number greater than “n”, it will respond
- It will promise not to accept a request numbered less than “n”
- If the reply has a non-empty value, the leader will use that with the highest number



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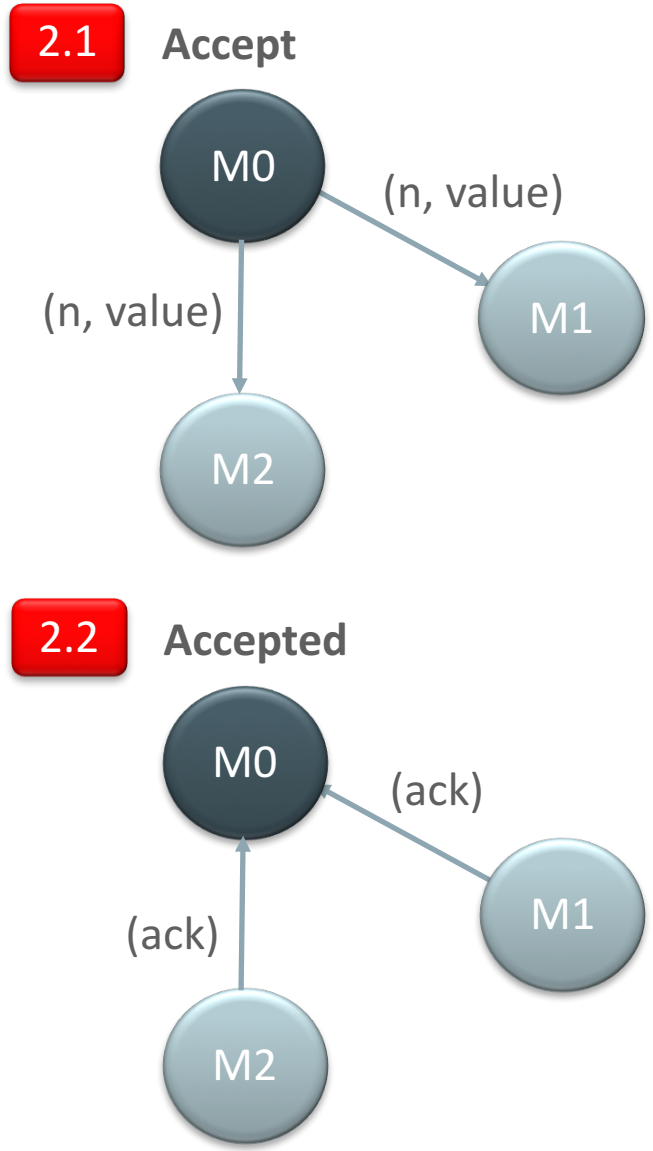
Accept Phase

- If the leader finds out that a non-empty value has been previously proposed, it will use it
- Otherwise, it will propose a new value
- Requires a network round-trip to get agreement



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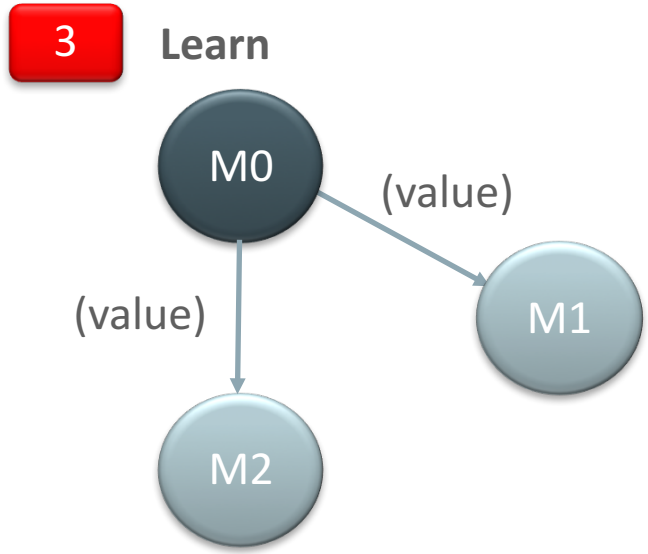
Learn Phase

- It will inform other members about the decision
- Only one learner is required to have progress
- If the member already has the value, an ack is enough



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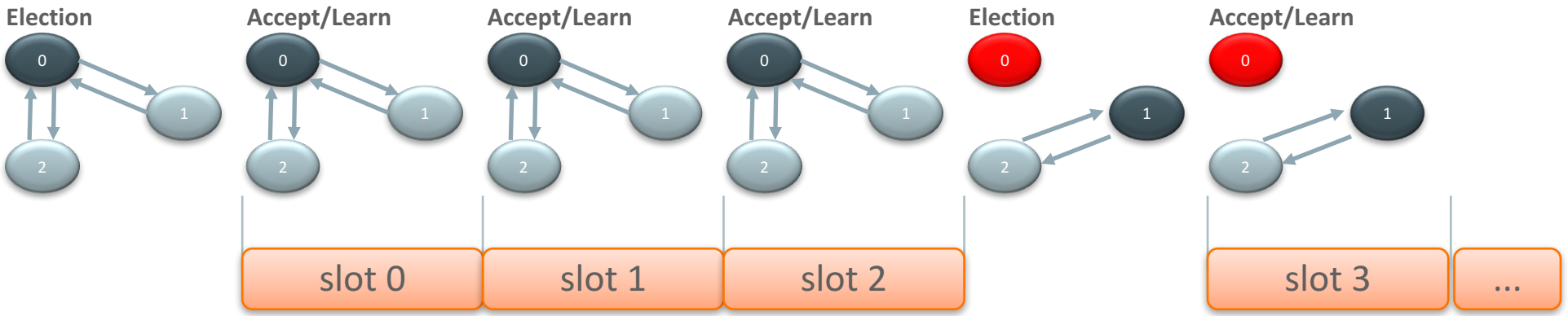
Multi-Paxos

- Consensus round to decide on each slot's content
- Replicated Log Stream



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So what?

- They can easily become a bottleneck
- Multiple leaders: eXtended COMmunications

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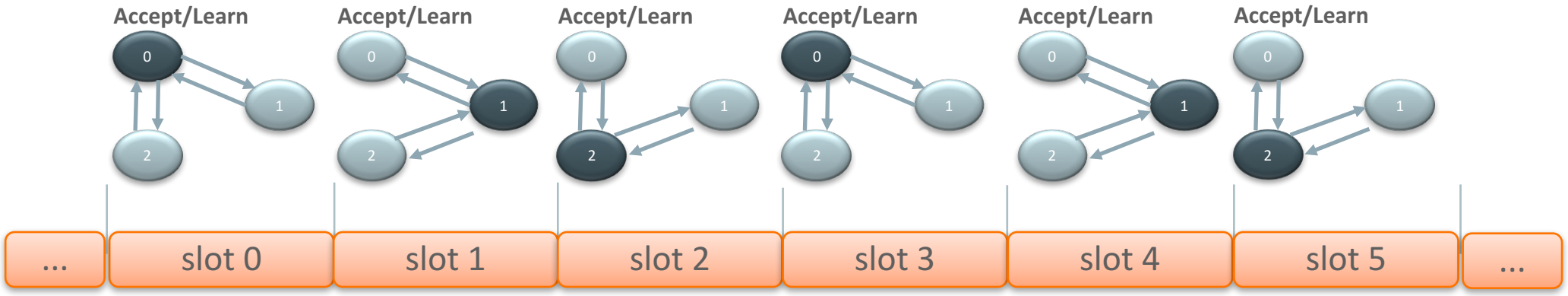
How does XCOM work?

- Every member is a leader so no leader election
- Every member owns a In-Memory Replicated Log



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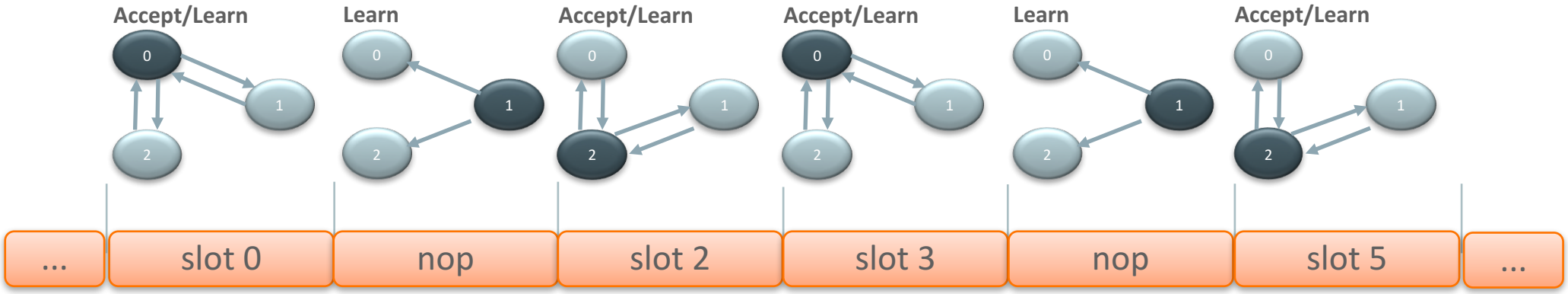
Nothing to Propose

- Only a learn message with a “nop” is enough



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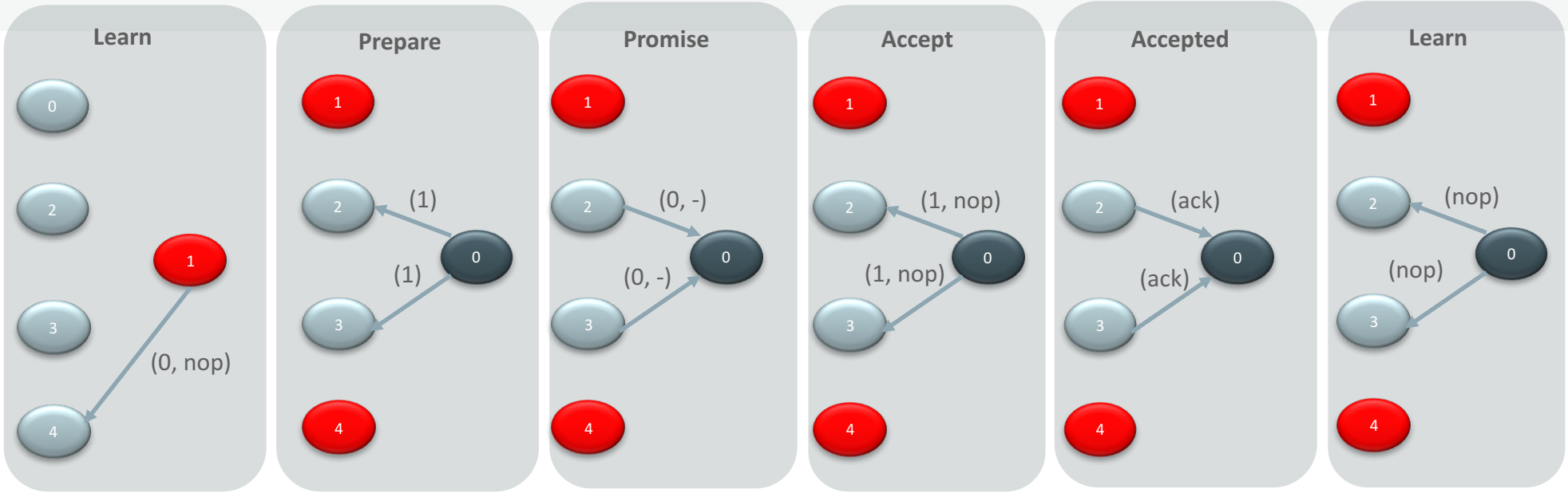
How is the optimization possible?

- Member “1” sends a learn message “(0, nop)” to member “4” and dies
- Non-leaders can only propose “nop”(s) on behalf of others
- They must go through all Paxos phases



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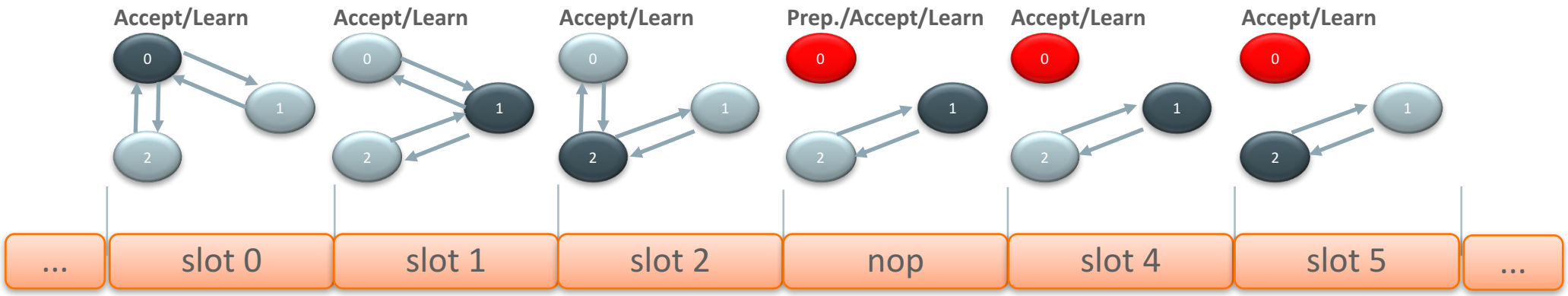
Handling Failures/Suspicions



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Implemented Optimizations in XCOM

- Pipeline
  - Proposes several “transactions” in parallel
  - Improves performance in high latency networks
  - Current value is “10”
- Batch
  - Improves CPU usage
  - Improves performance in high latency/low bandwidth networks
  - Current value is “5”

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Implemented Optimizations in Biding

- Compression
  - Reduces bandwith consumption
- Automatically reconfigure a group
  - Faulty members are expelled

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6 Performance

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Configuration

- Multipe writers – One per Server
- Single writer – Just one client
- Oracle Server X5-2L with two Intel Xeon E5-2660-V3 processors
  - 20 Cores
  - 40 Hardware Threads
- Oracle Enterprise Linux 7, kernel 3.8.13-118.13.3
- 10 Gbps ethernet
- Used “tc” to throttle network

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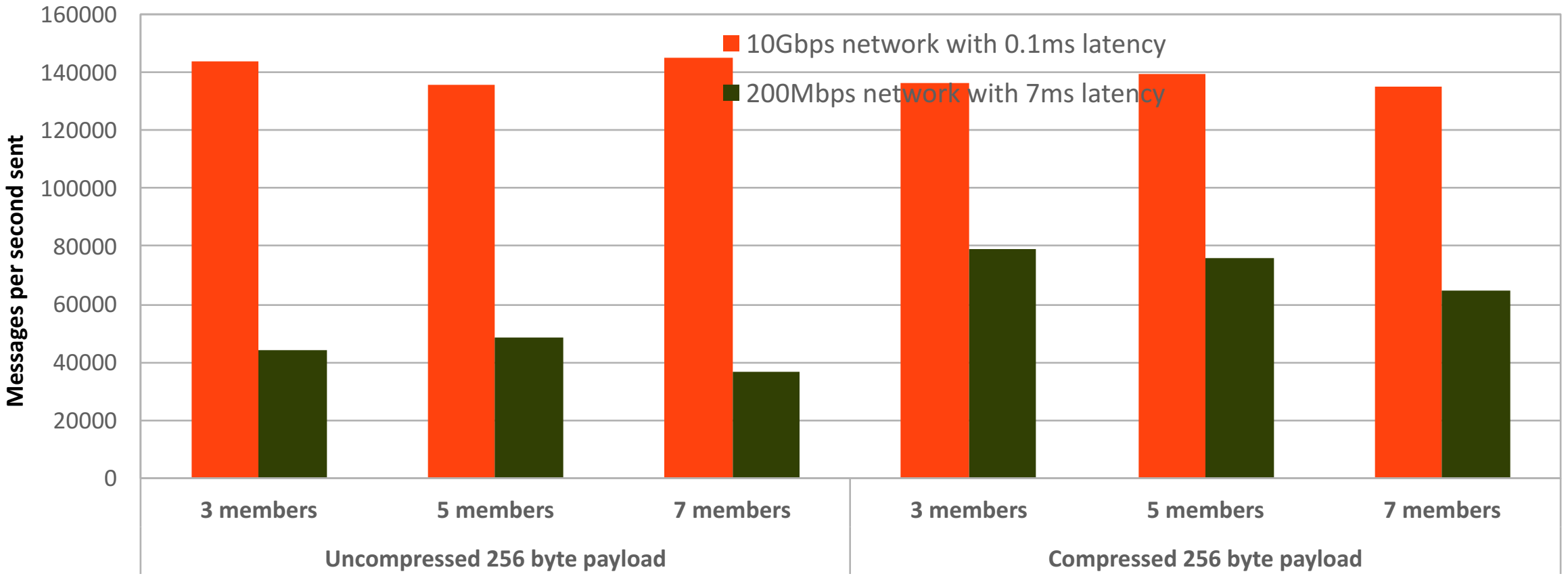
Multiple writers (256 Bytes)

- Compression improves performance in Metropolitan
- Headers are not compressed (~200 bytes) though



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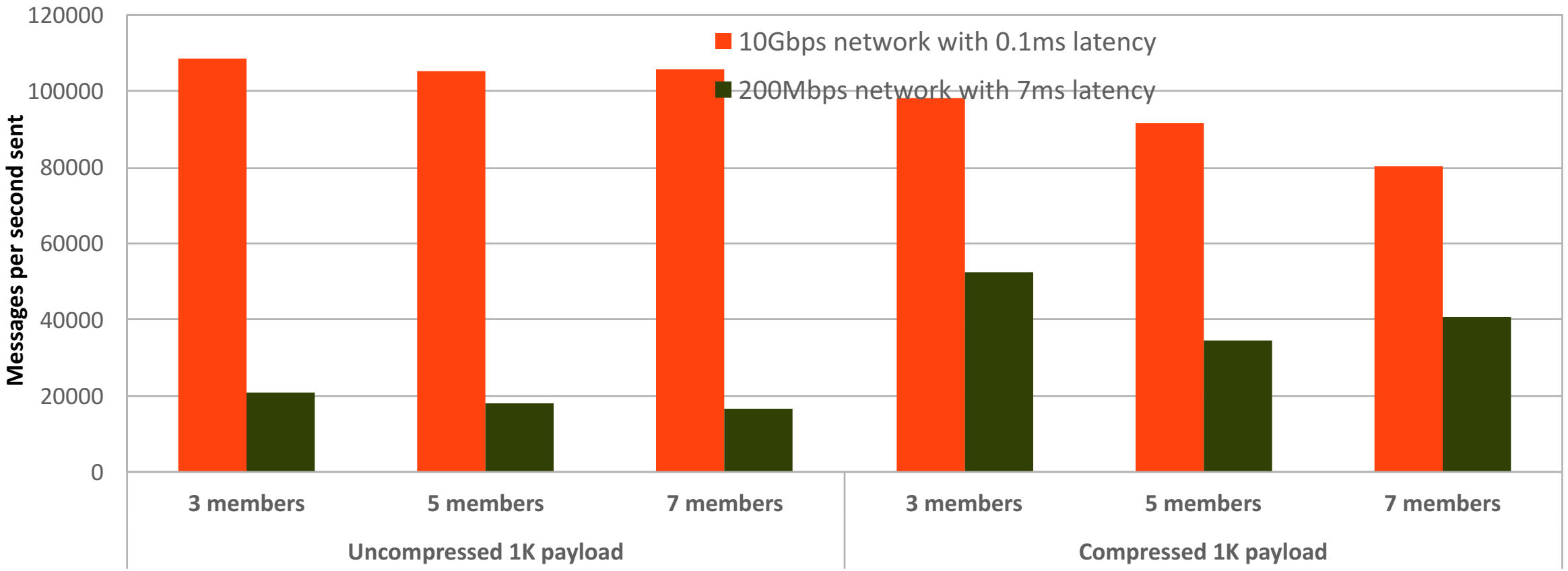
Multiple writers (1K Bytes)

- Check whether compression may help or not
- Usually helps when bandwidth is a problem



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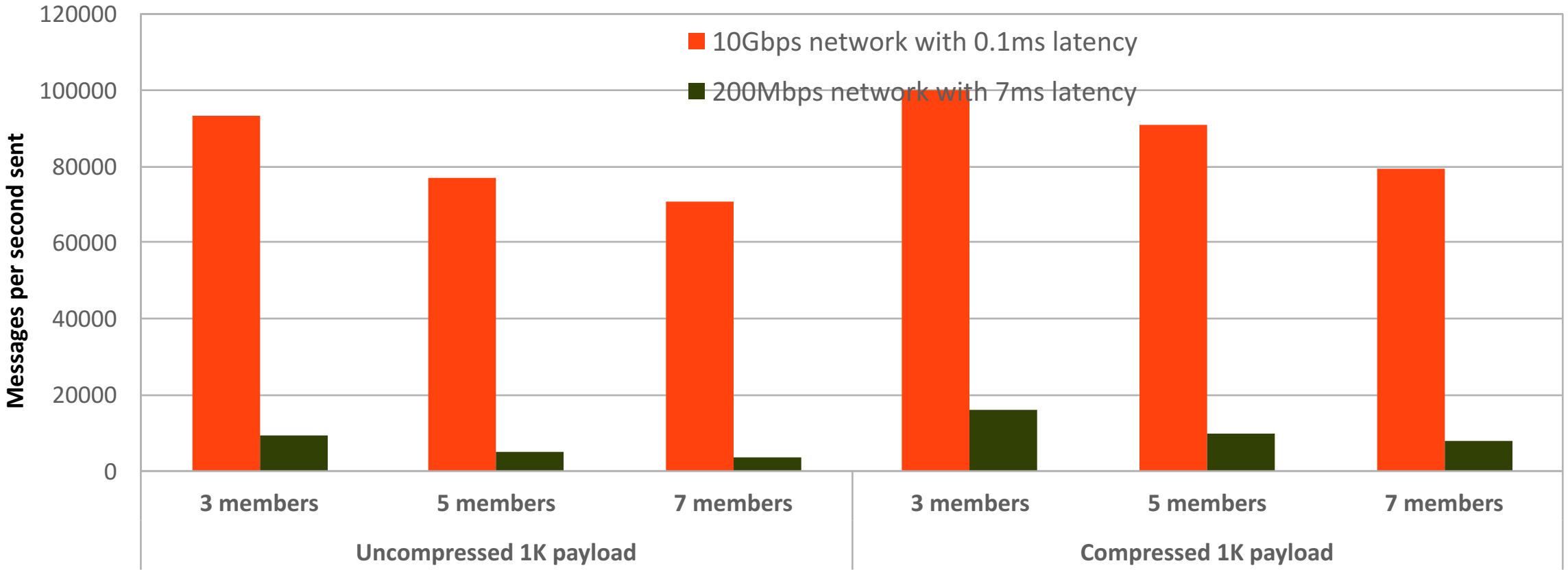
Single Writer (1K Bytes)

- The scale out effect with multiple writers is small
- Compression does not help here



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5 Conclusion

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Current Status

- Has made into MySQL 5.7.17 release
- GA in December 2016

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Future

- Configurable Paxos role(s)
  - Leader/Acceptor/Learner or Acceptor/Learner or Learner
- Multiple leaders only if needed:
  - Avoids the skip message
  - Improves CPU and network usage
- Not all members need to make messages network durable
  - Reduces resilience but improves performance

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Future

- Expose some configuration options:
  - Batch
  - Pipeline
- Compression at low level layers as well
- Write to network in parallel
- Overlay networks

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Where to go from here?

- Packages
  - http://www.mysql.com/downloads/
- Documentation
  - http://dev.mysql.com/doc/refman/5.7/en/group-replication.html
- Blogs from the Engineers (news, technical information, and much more)
  - http://mysqlhighavailability.com

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