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Raft in Theory and Practice

Building a Distributed Consistent Database

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About me

- Tang Liu
- Chief Architect of PingCAP
- TiDB/TiKV
- Open sources: LedisDB, go-mysql, etc...

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Agenda

- Why Raft
- What is Raft
- The optimization
- Multi-Raft

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Why

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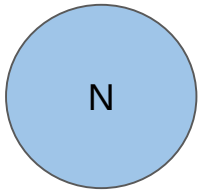
One Node



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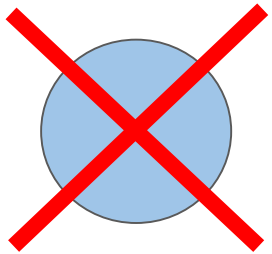
One Node



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Replication

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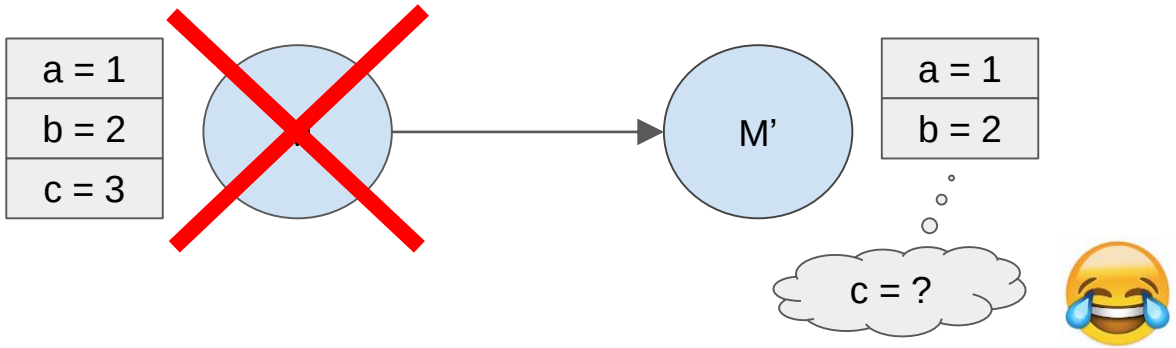
Async Replication



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Sync Replication

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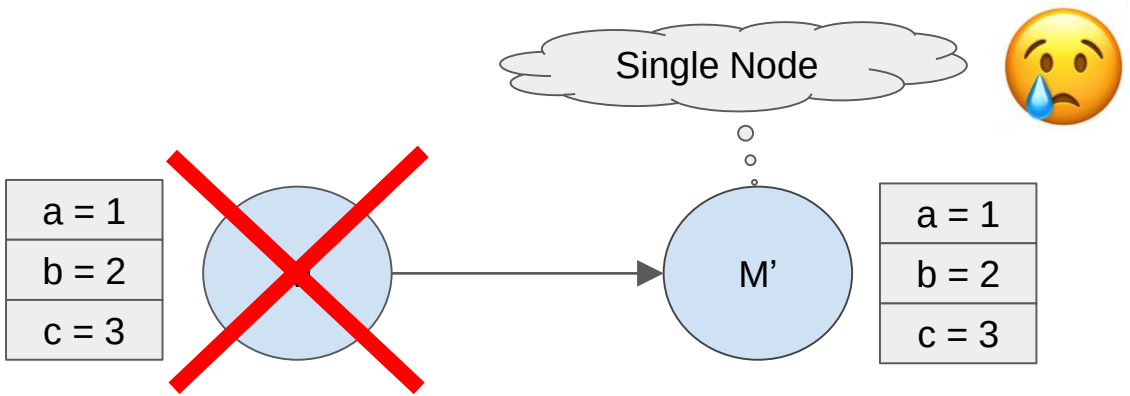
Sync Replication



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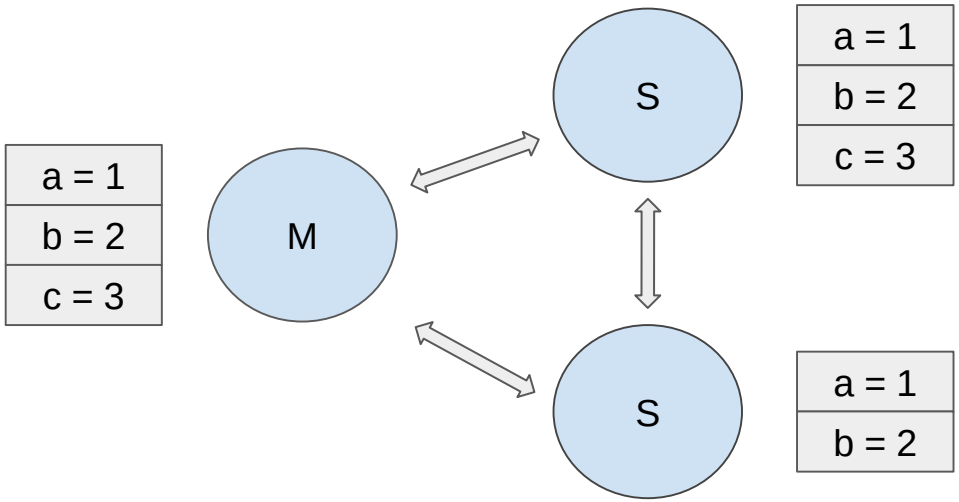
Quorum , 2 N + 1



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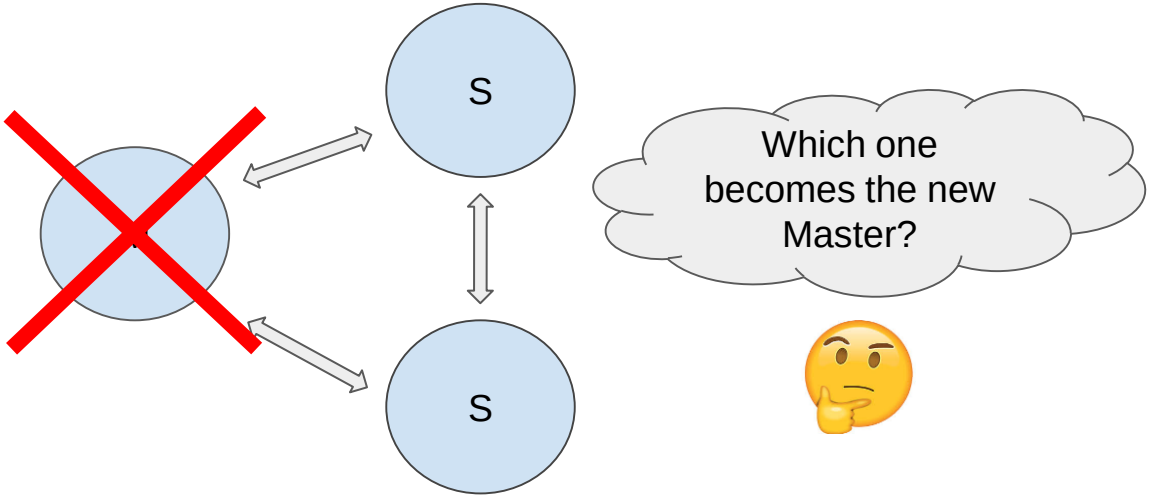
Failover



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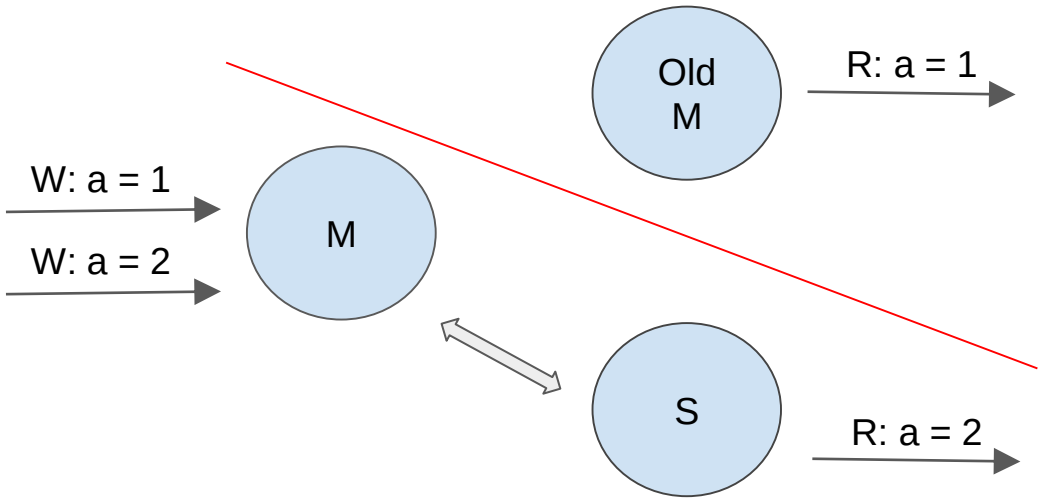
Brain Split



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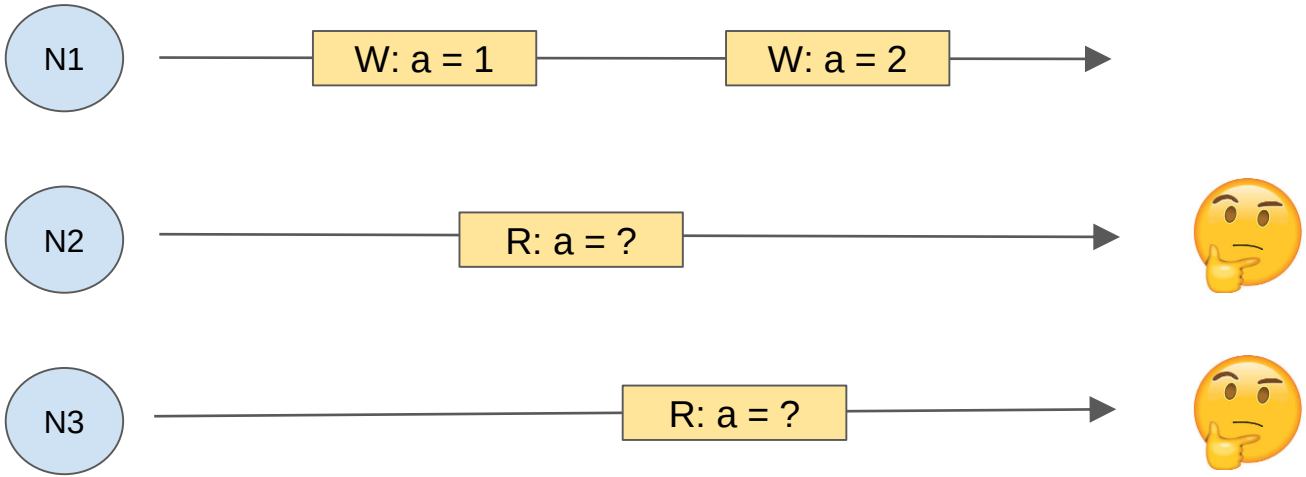
Linearizability



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Consensus Algorithm

- Agreement on shared state
- Recovery from server failures autonomously
  - Minority failure: no problem
  - Majority failure: lose availability, retain consistency
- Strong consistency (linearizability)

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Raft

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Keypoint

- Replicated Log for replicated state machine
- Leader, Follower and Candidate
- Term and Leader election
- Log Replication
- Membership Change

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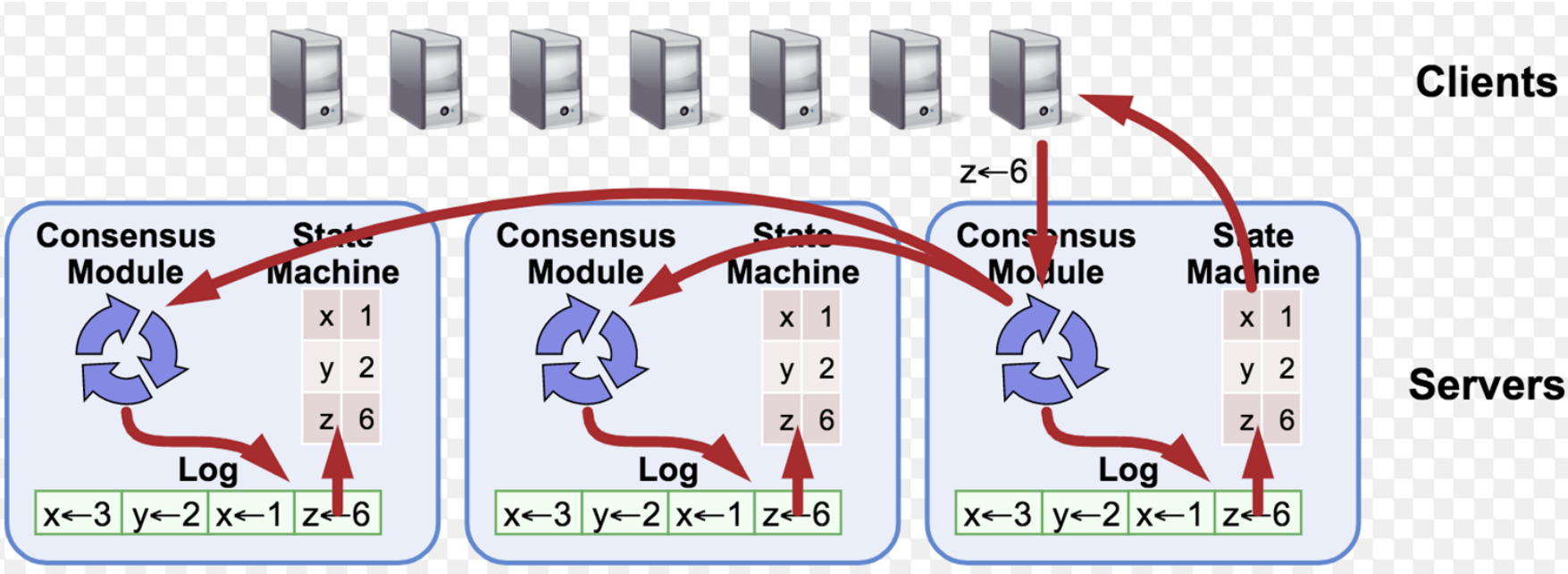
Replicated State Machine



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State

- Leader
  - Only one Leader
  - Elected by the majority of the peers
  - Handles all the client requests
- Follower
  - Receives Replicated Logs from the Leader
- Candidate
  - For campaign

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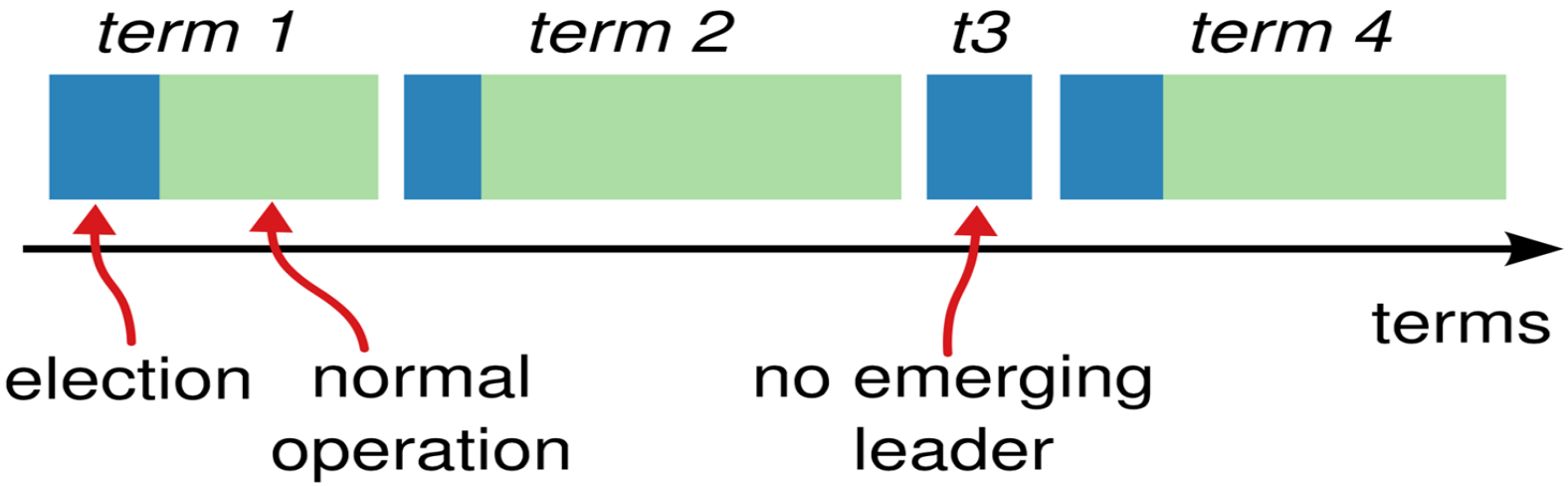
Term



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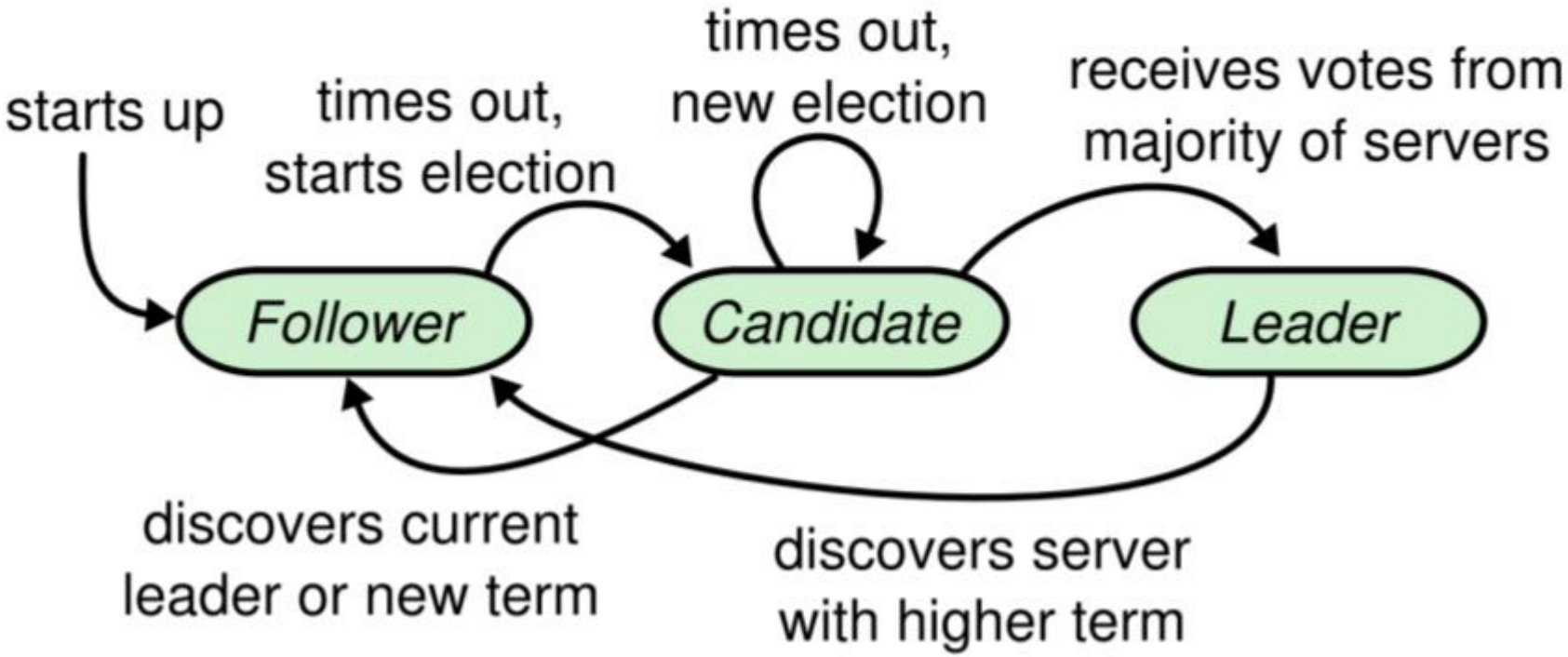
Election



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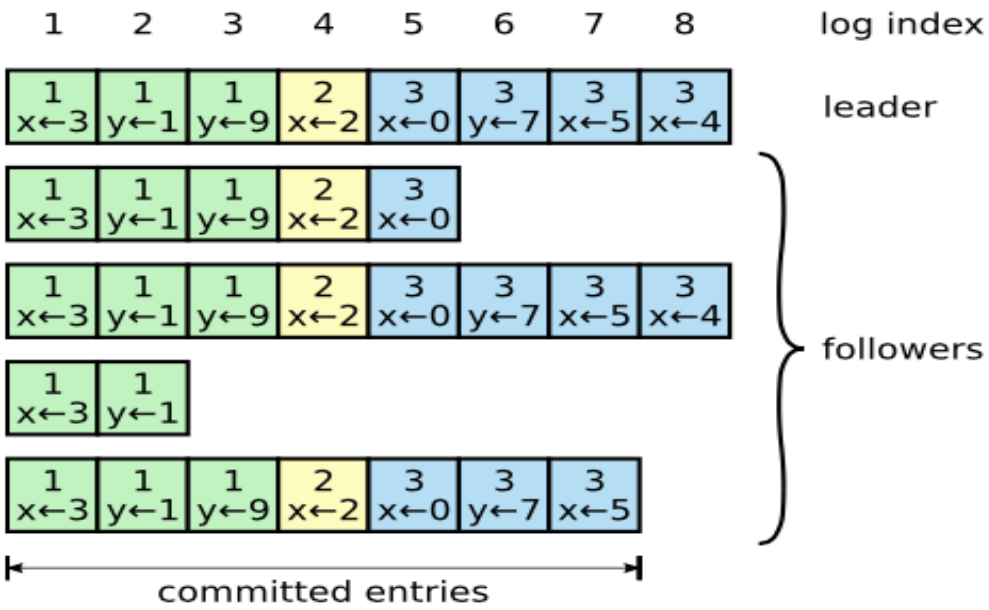
Log Replication



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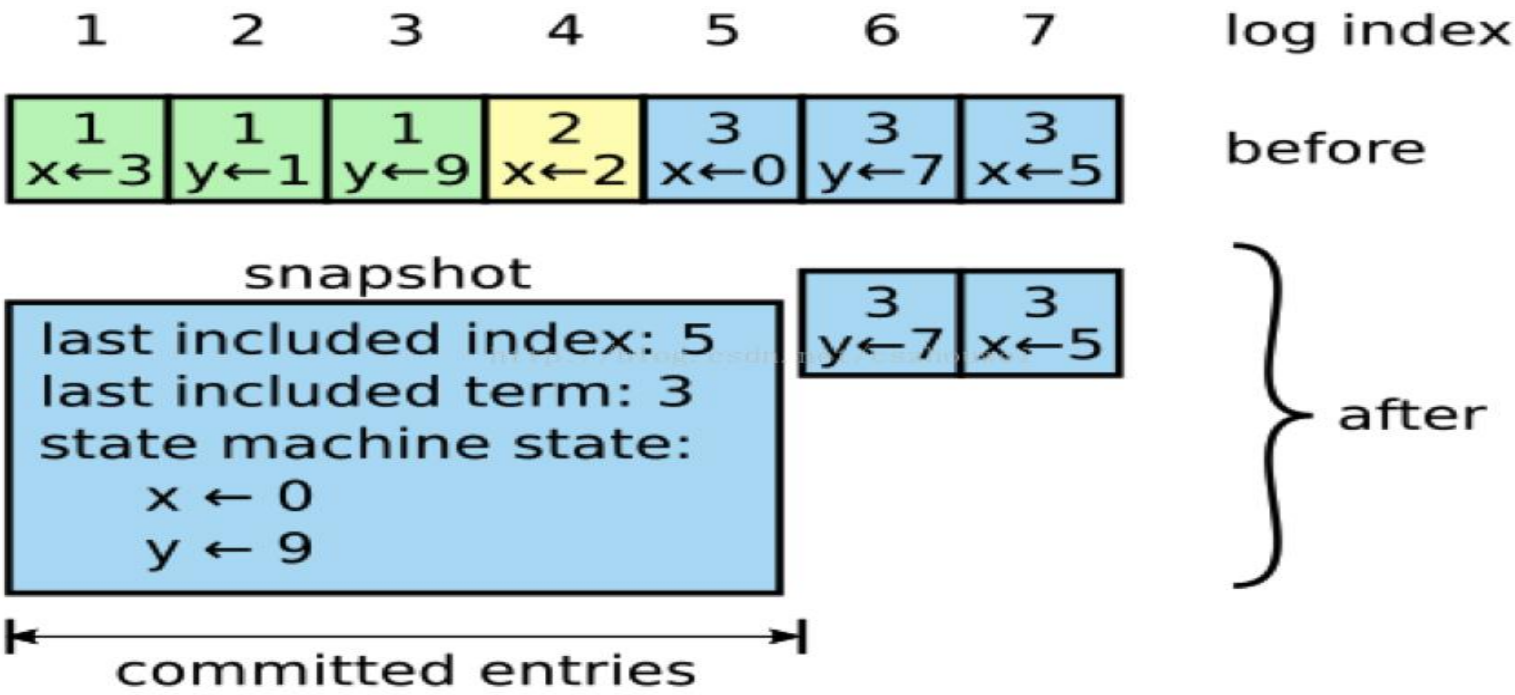
Snapshot



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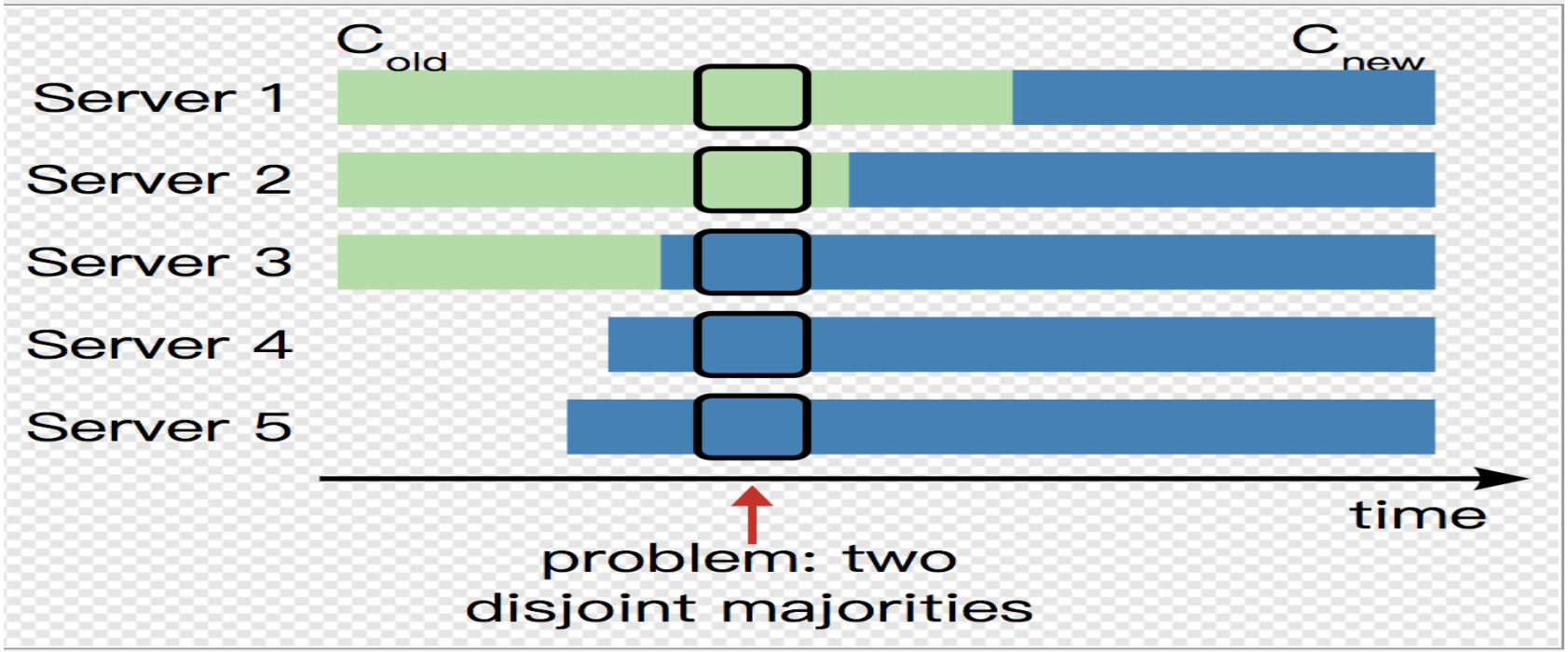
Membership Change



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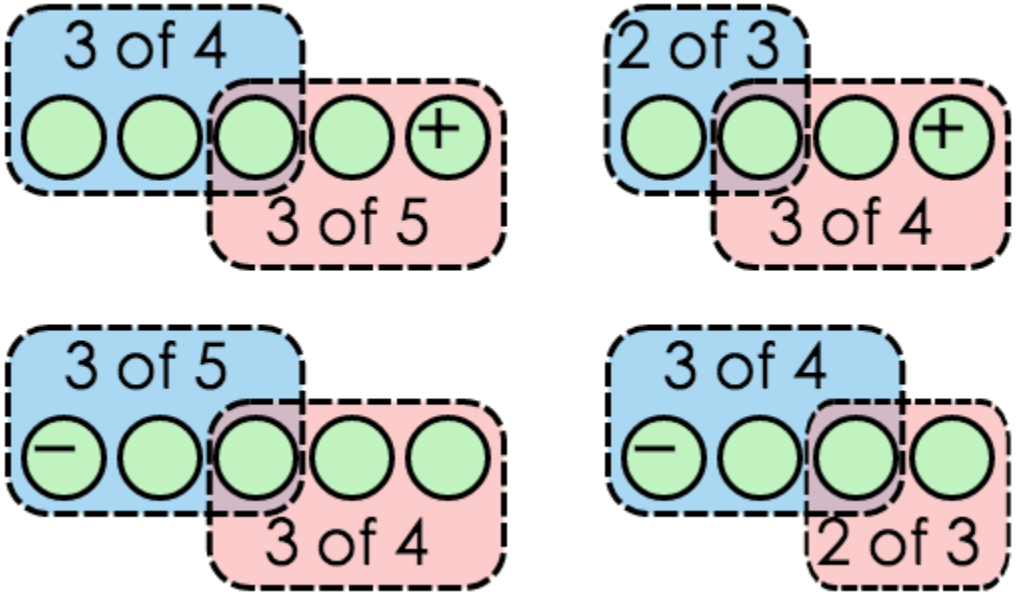
Membership Change



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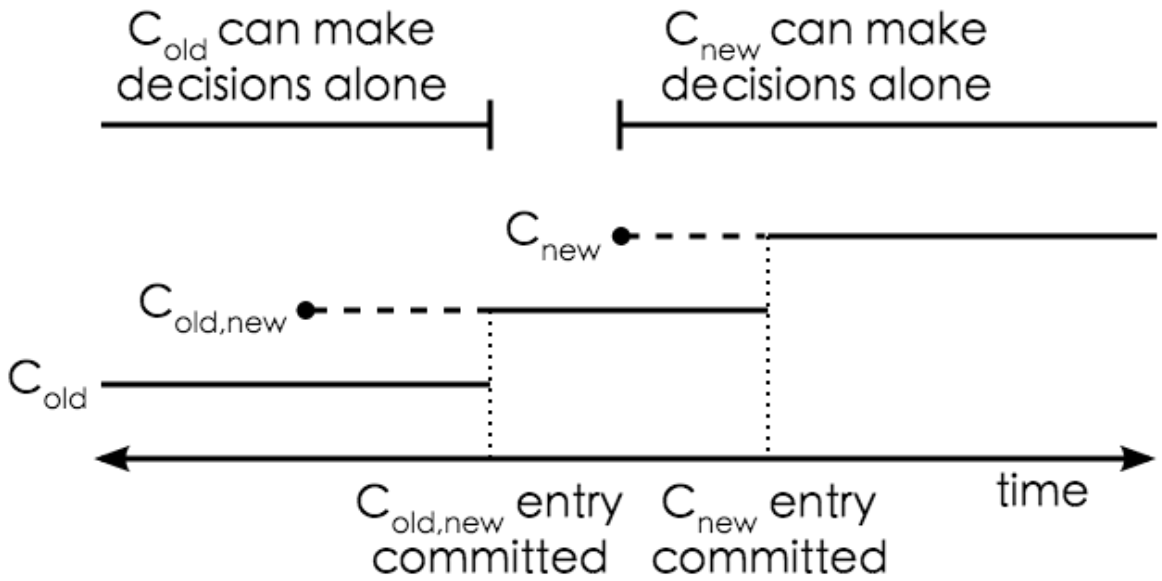
Membership Change



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Optimization

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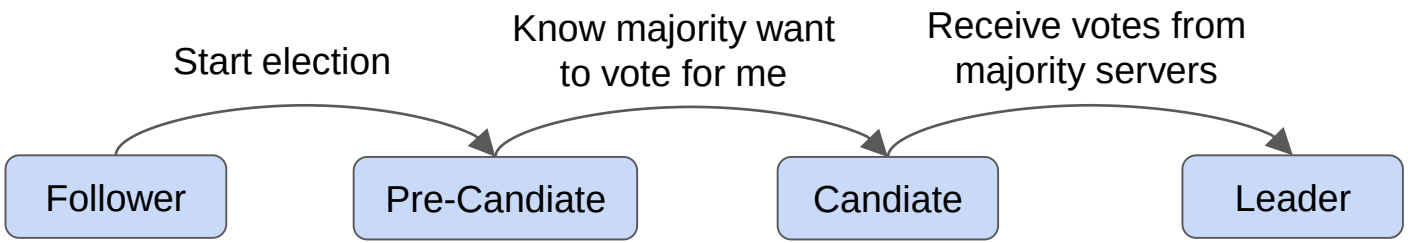
Pre-Vote



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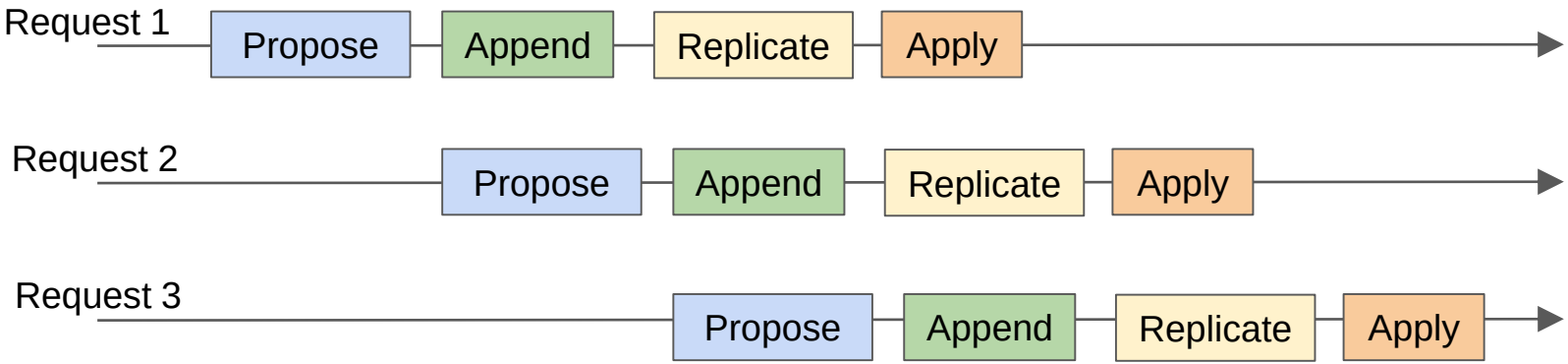
Pipeline



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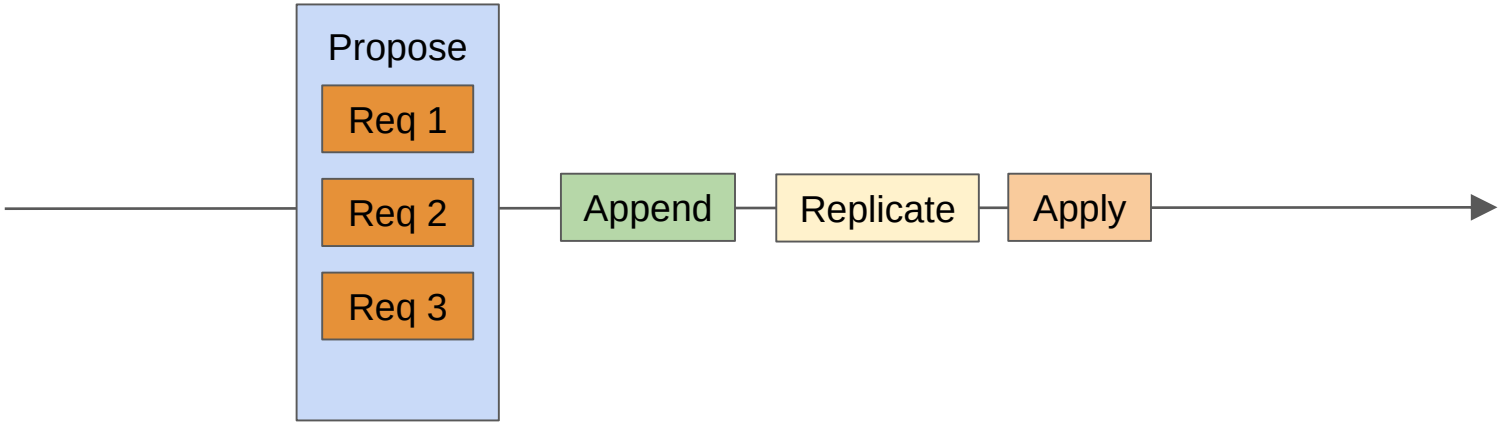
Batch



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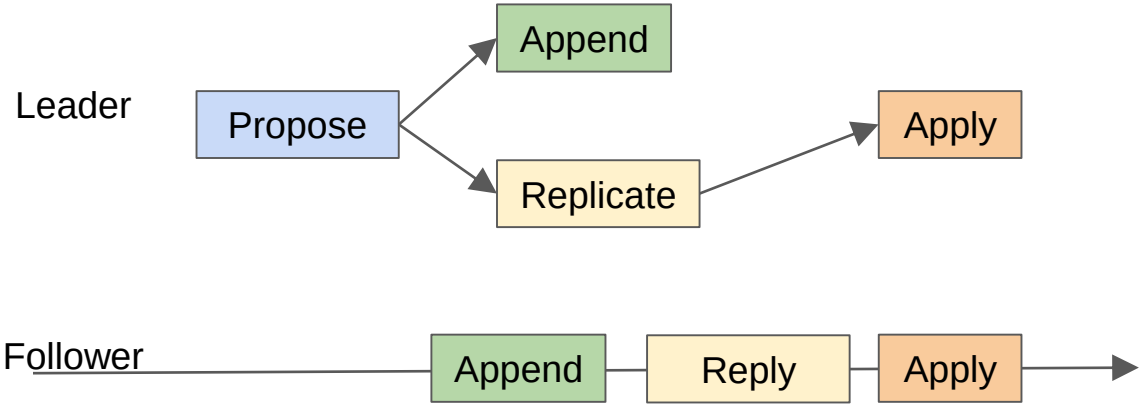
Writing to the Leader in parallel



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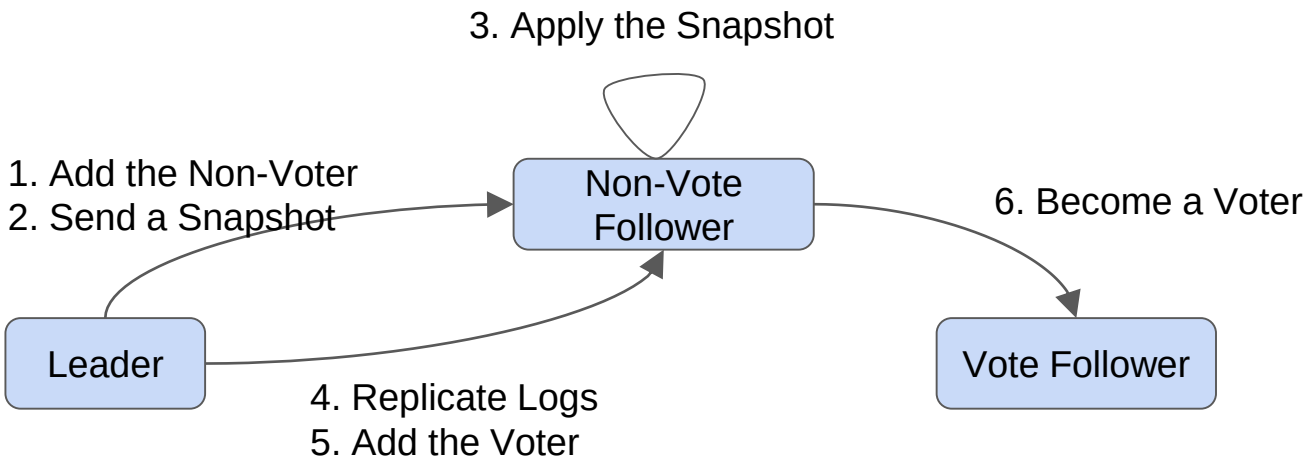
Non-Voter



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Multi-Raft

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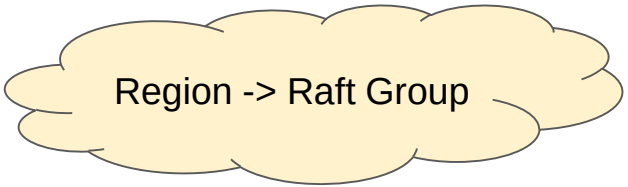
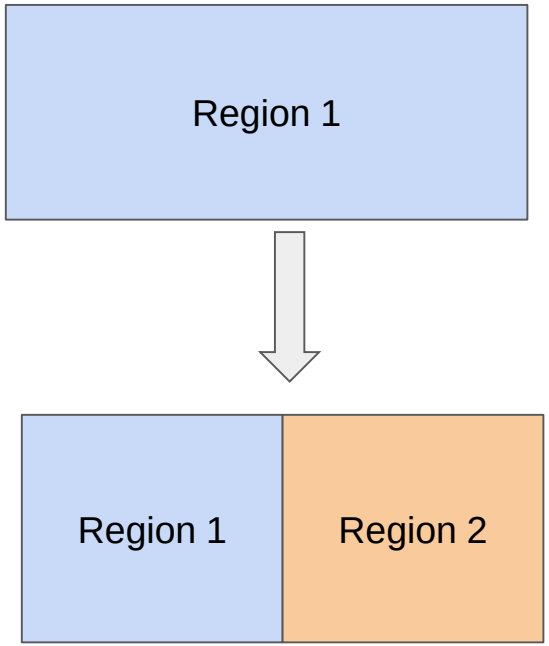
How to scale?

- **Logical split**
- Just Split && Move





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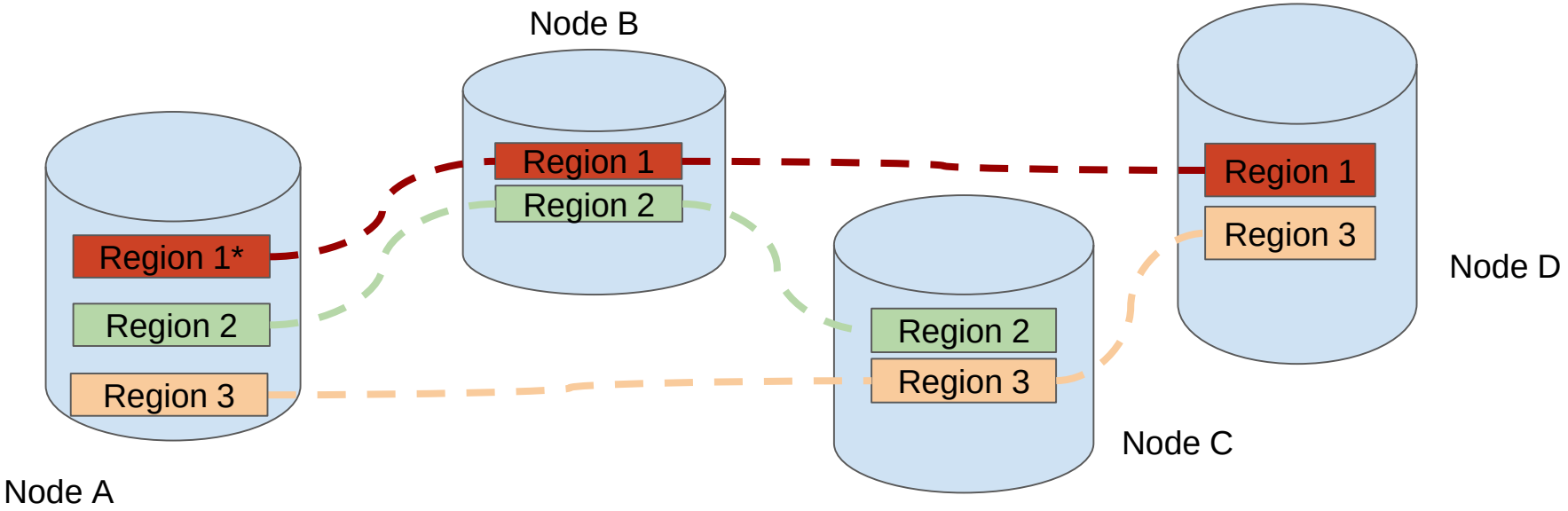
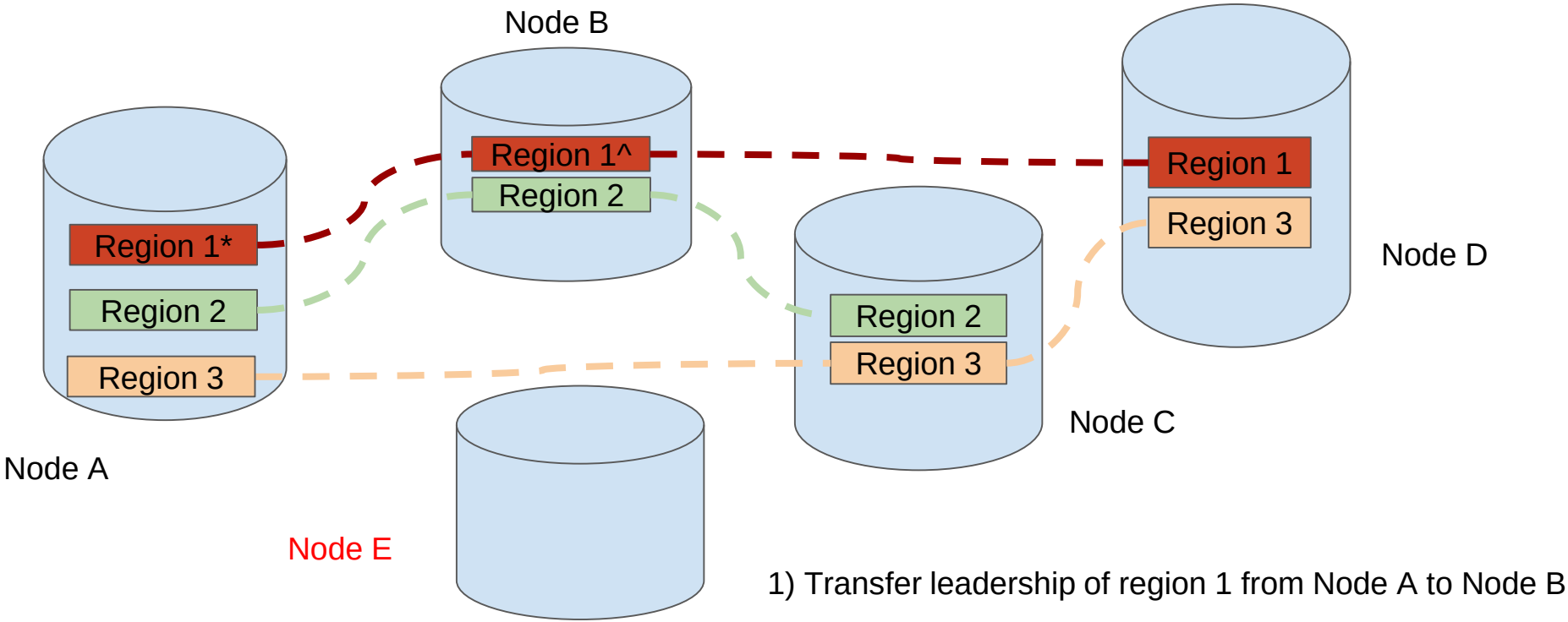
Scale-out (initial state)



Scale-out (add new node)



1) Transfer leadership of region 1 from Node A to Node B

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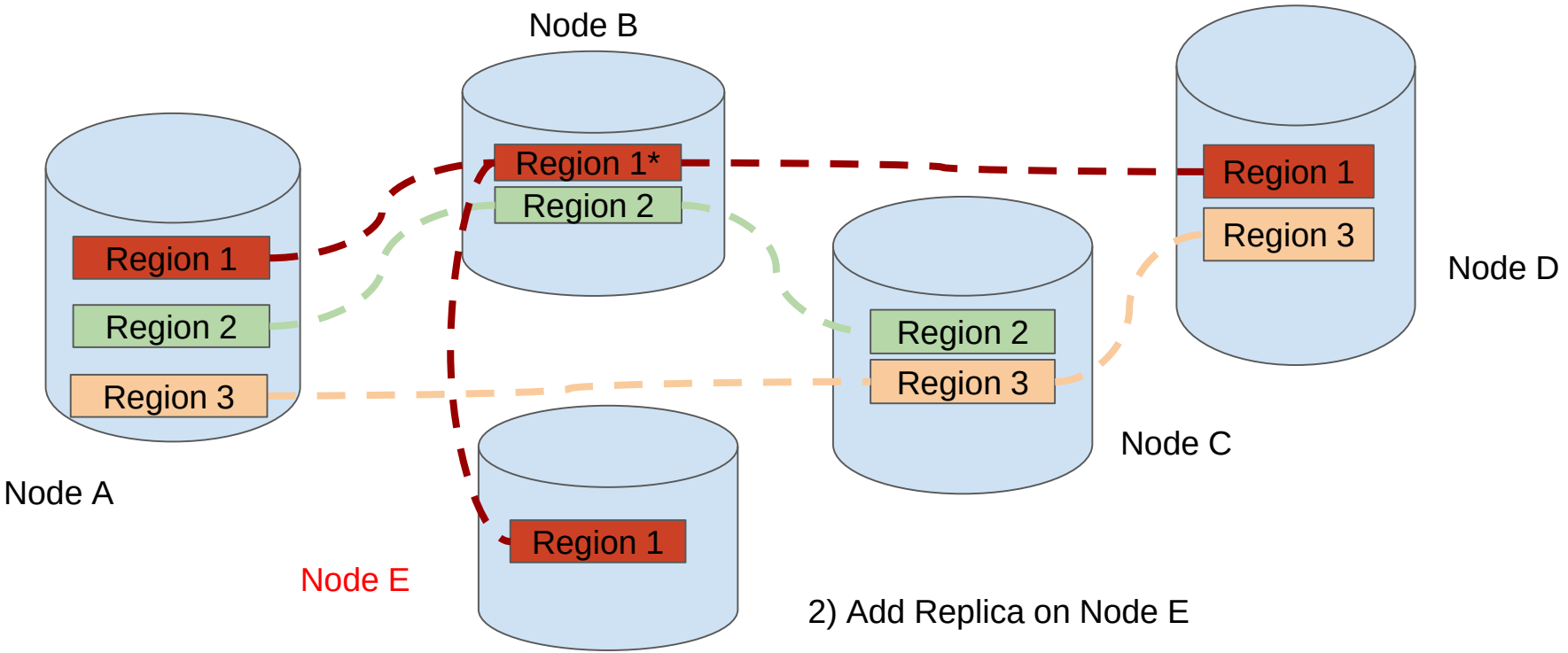
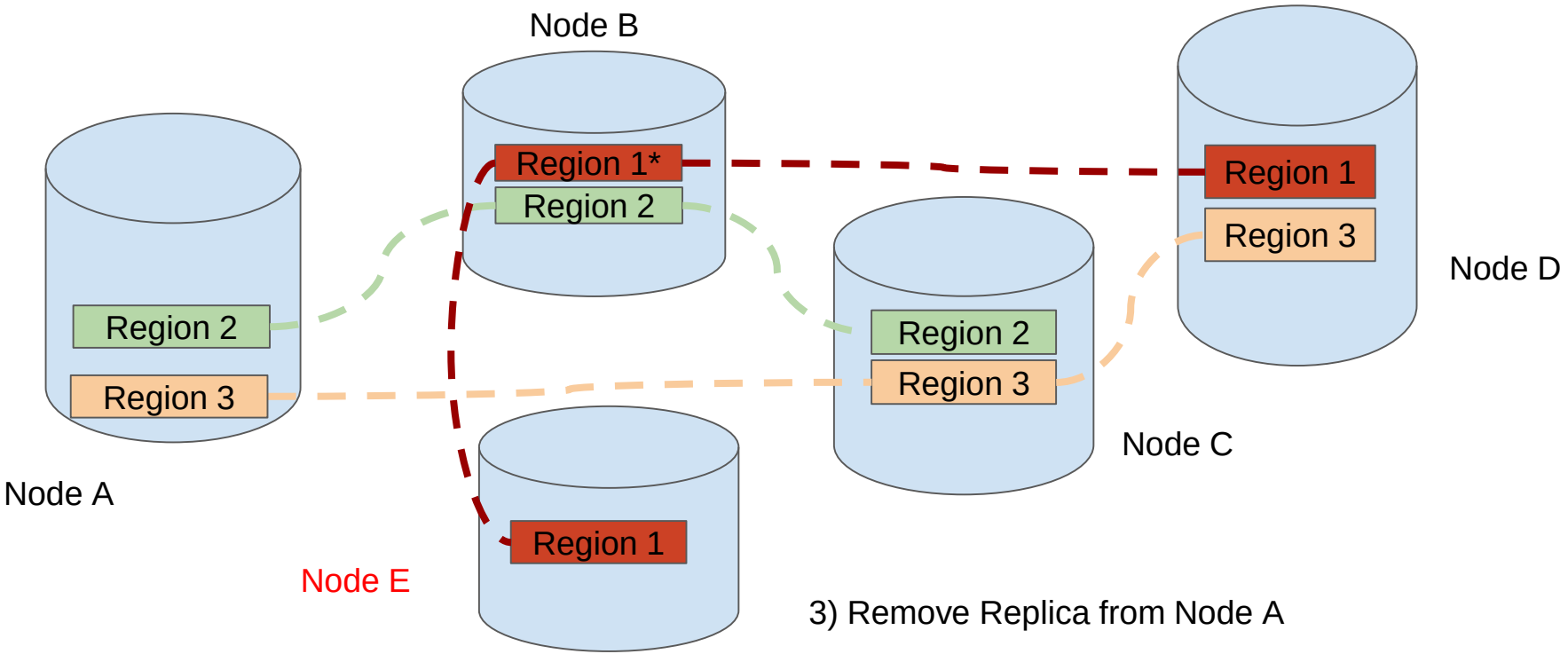
Scale-out (balancing)



Scale-out (balancing)



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Questions?