Discussion of Time Sync Redundancy

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Motivation for Redundant Time Sync

- GM and path redundancy provides:
  - Fault tolerance
  - Integrity
  - Security
- Industries
  - Industrial control
  - Automotive
  - Financial
  - …

Proposed Road Map

1. Define and agree on assumptions
2. Create a new PAR
   - Assumption: Not addressed in 802.1AS rev
3. Specify technical details for the PAR

- This presentation is the beginning of step 1

Review Modes of Failure

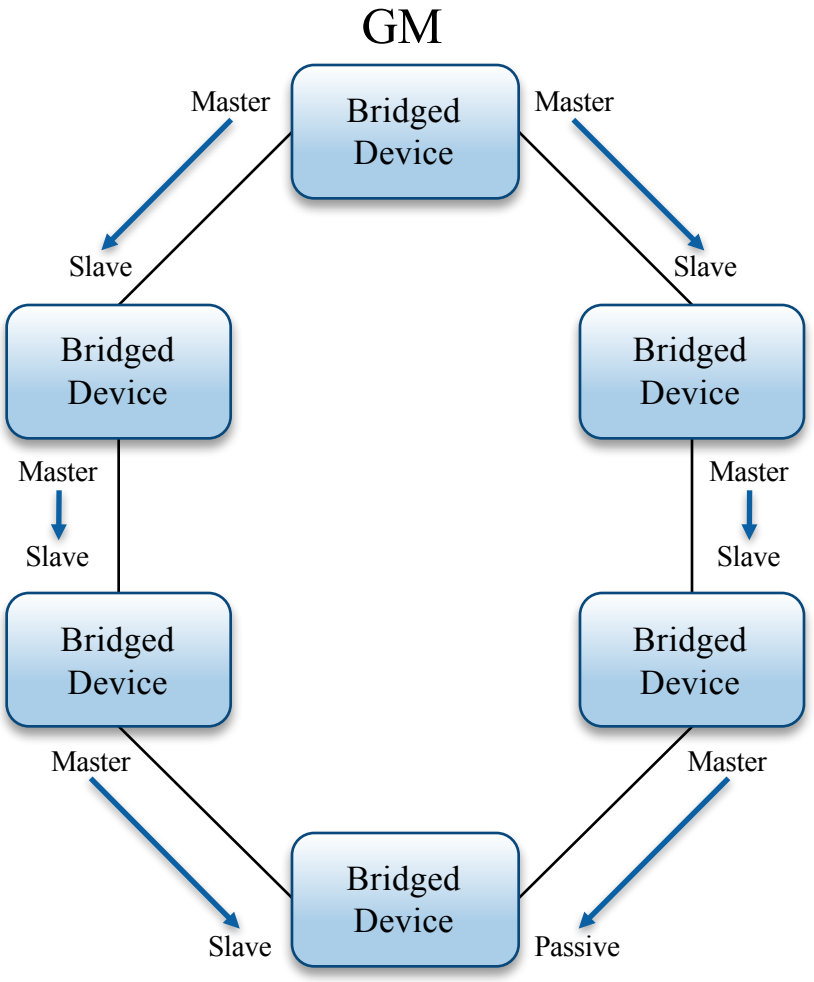
Failure Concepts

- Single-failure: At most one device
  - Device = End station, bridge/router, or link between
    - Including GM clock failure
- Dual-failure: At most two devices
- Failure modes: How
  - Fail-silent: Device stops transferring time
  - Fail-consistent: Send faulty time, but same to all receivers
  - Fail-inconsistent: Different time to each receiver (byzantine)
    - NASA – Real System Failures
- Failure modes: When
  - Permanent: Device unable to recover (i.e. offline until replaced)
  - Transient: Fault comes and goes (e.g. omit some frames)
- Multipath synchronization: Provides failover of time synchronization through redundant physical paths
- Multi-clocks: Provides failover of time synchronization through redundant GM's

Redundancy Examples using Ring Topology

Redundancy using BMCA

- Advantages:
  - Already in standard
  - Addresses path failures
  - Addresses ‘fail-silent’



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- Advantages:
  - Already in standard
  - Addresses path failures
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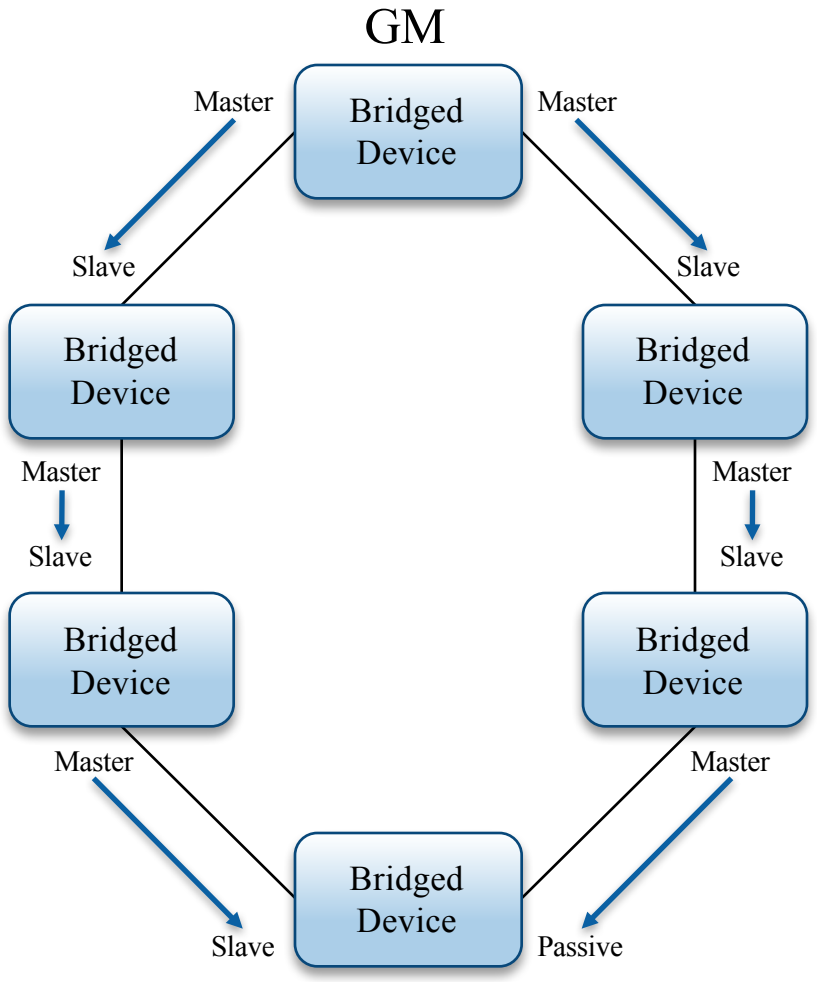
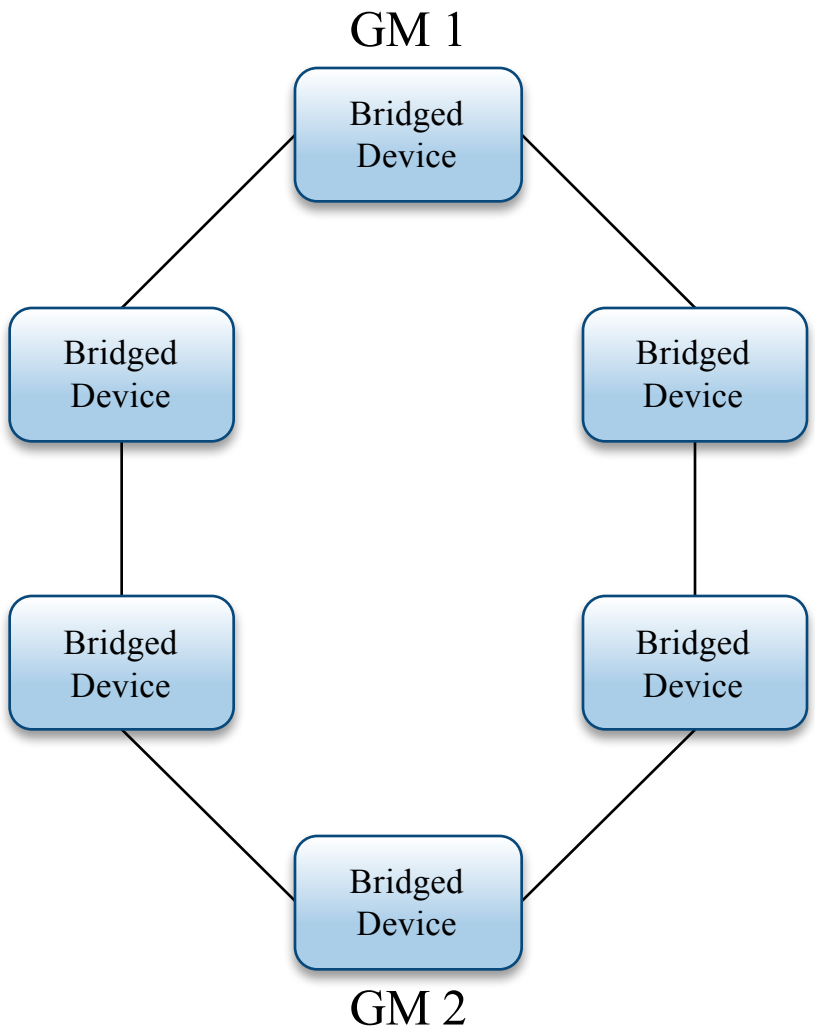
- Disadvantages:
  - Does not address engineered networks
  - Path failures and ‘fail-silent’ are not seamless
    - Some applications may require holdover or increased traffic
  - Does not address ‘fail-consistent’
  - Does not address ‘fail-inconsistent (byzantine)’



Redundancy with 2 GM's

- Observations:
  - Requires 4 domains
    - Seamless path failure requires at least 2 domains per GM (multipath)



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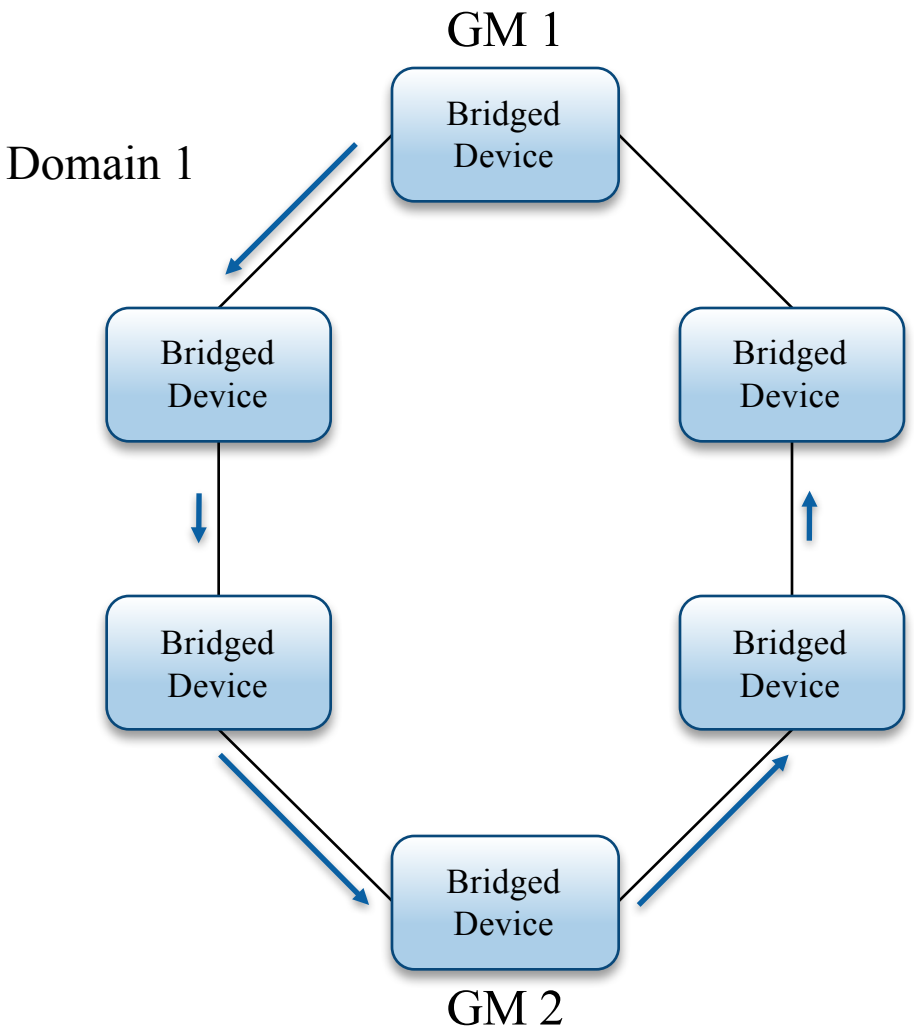

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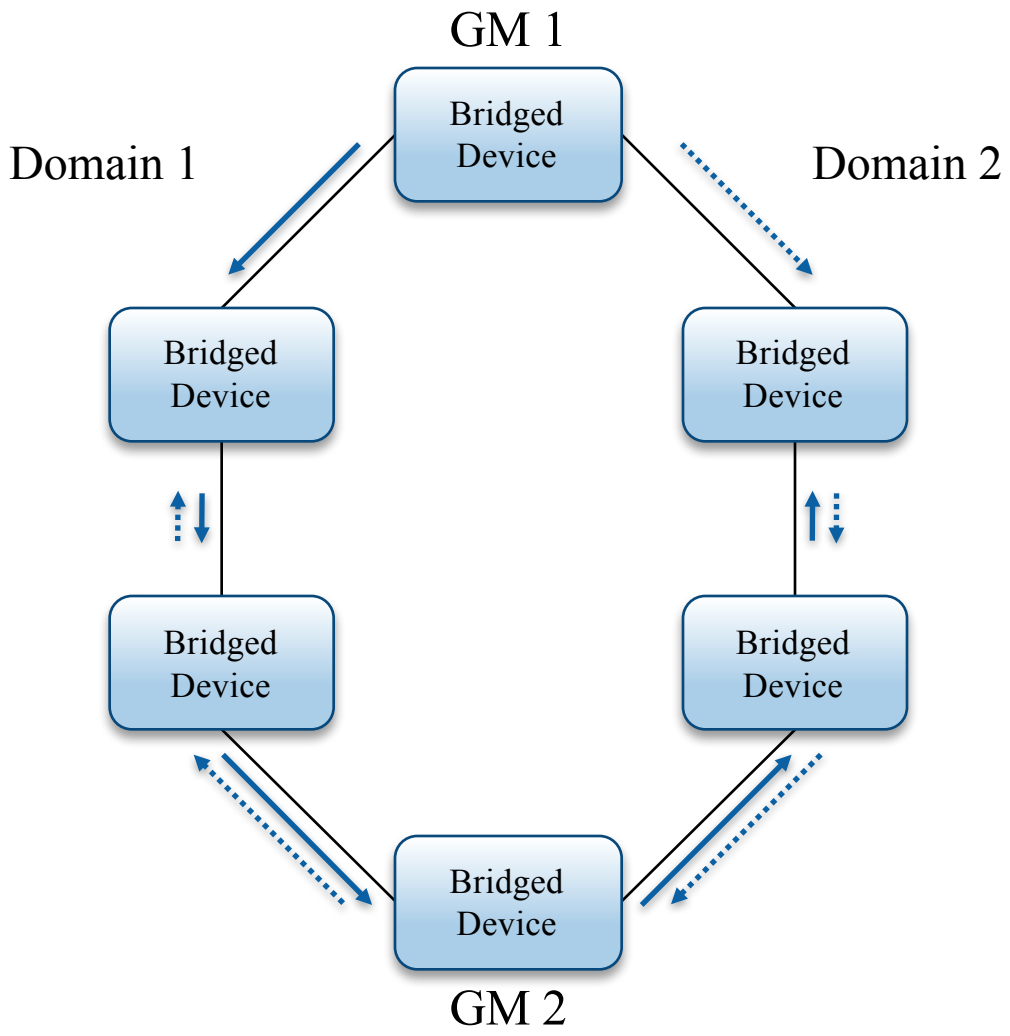

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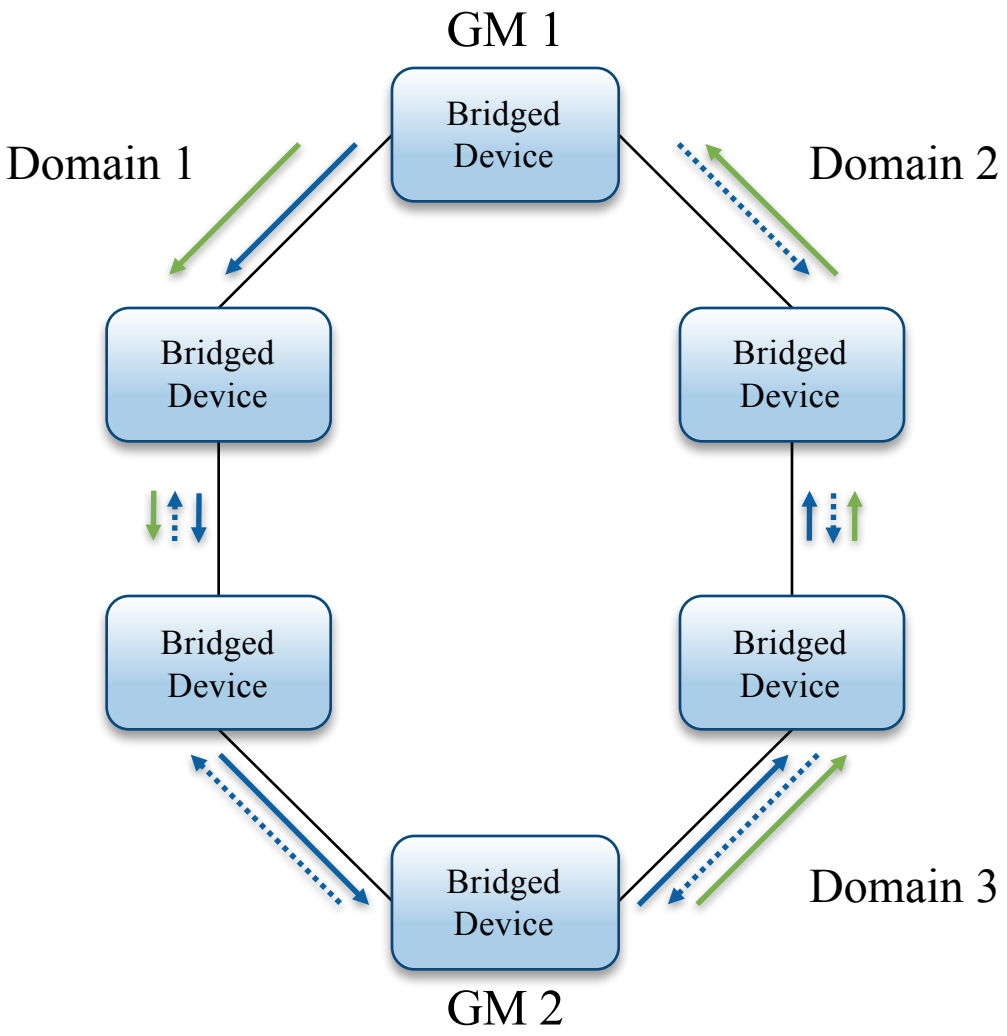

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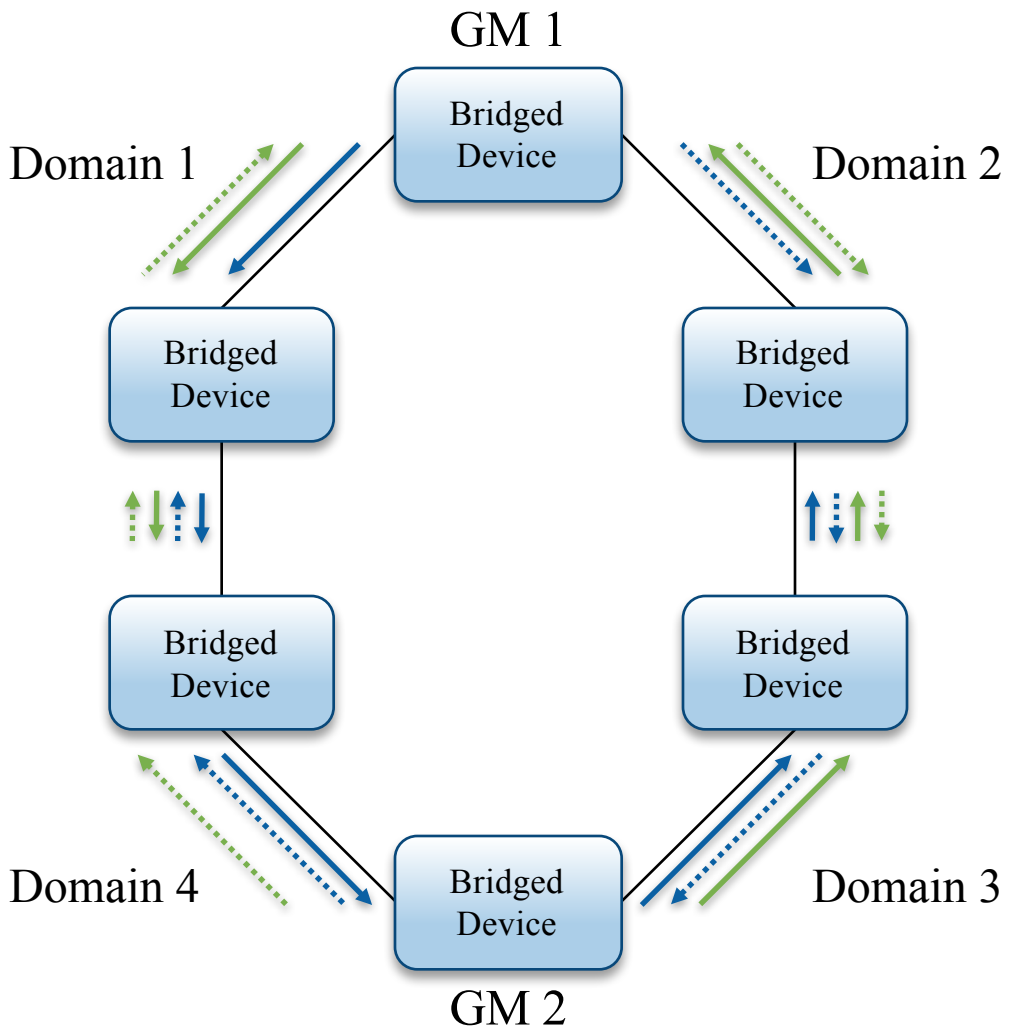

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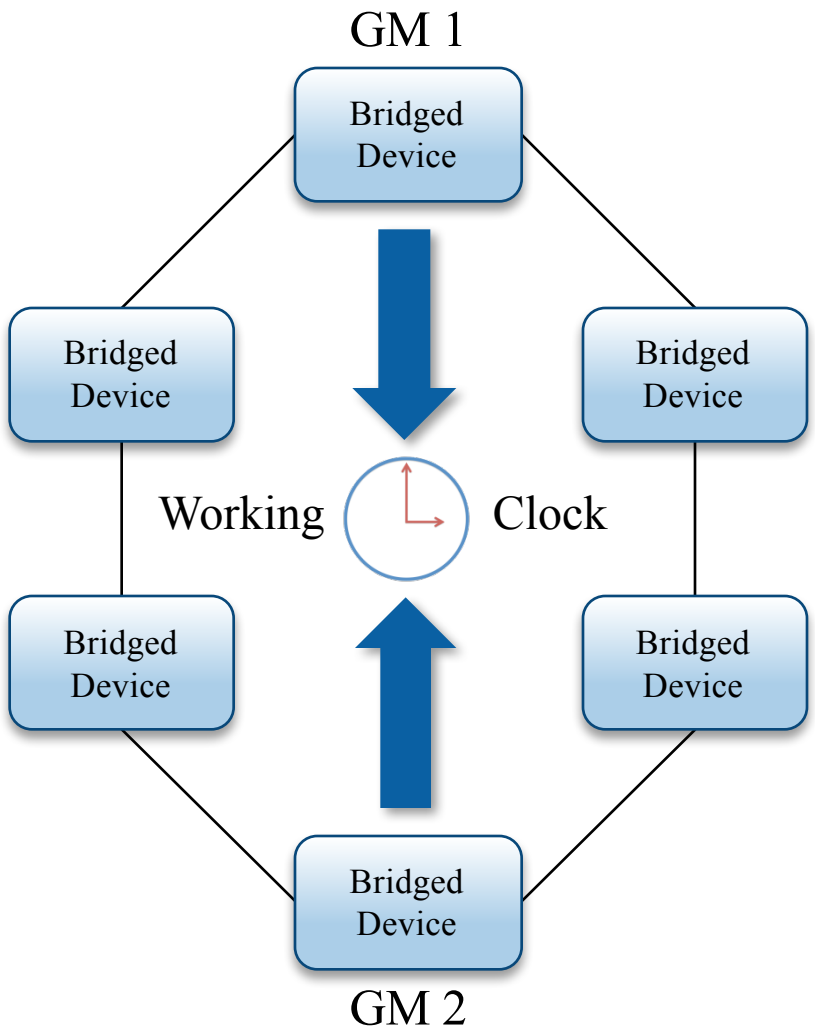

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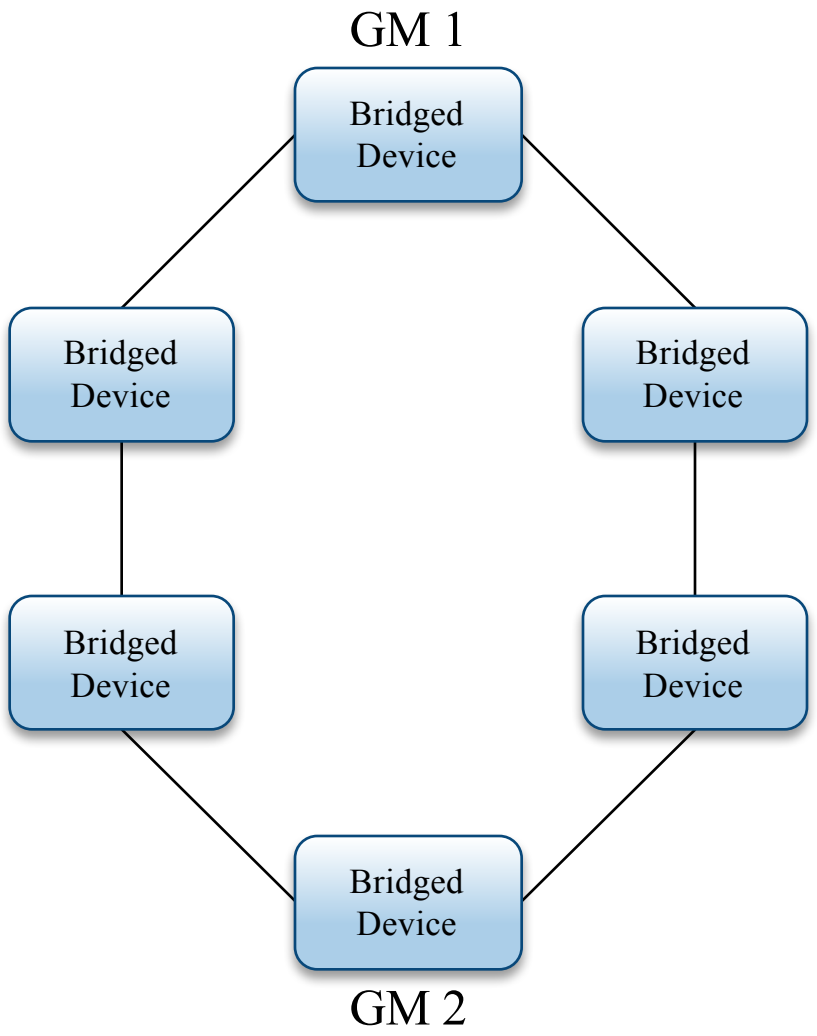

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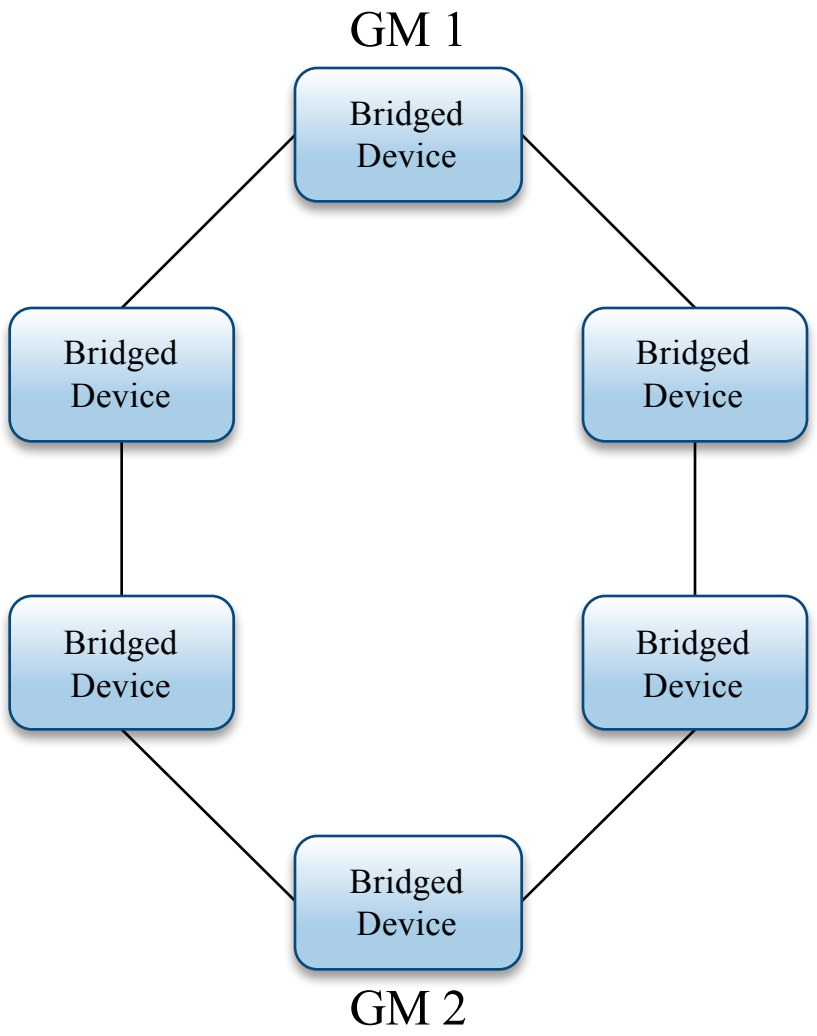

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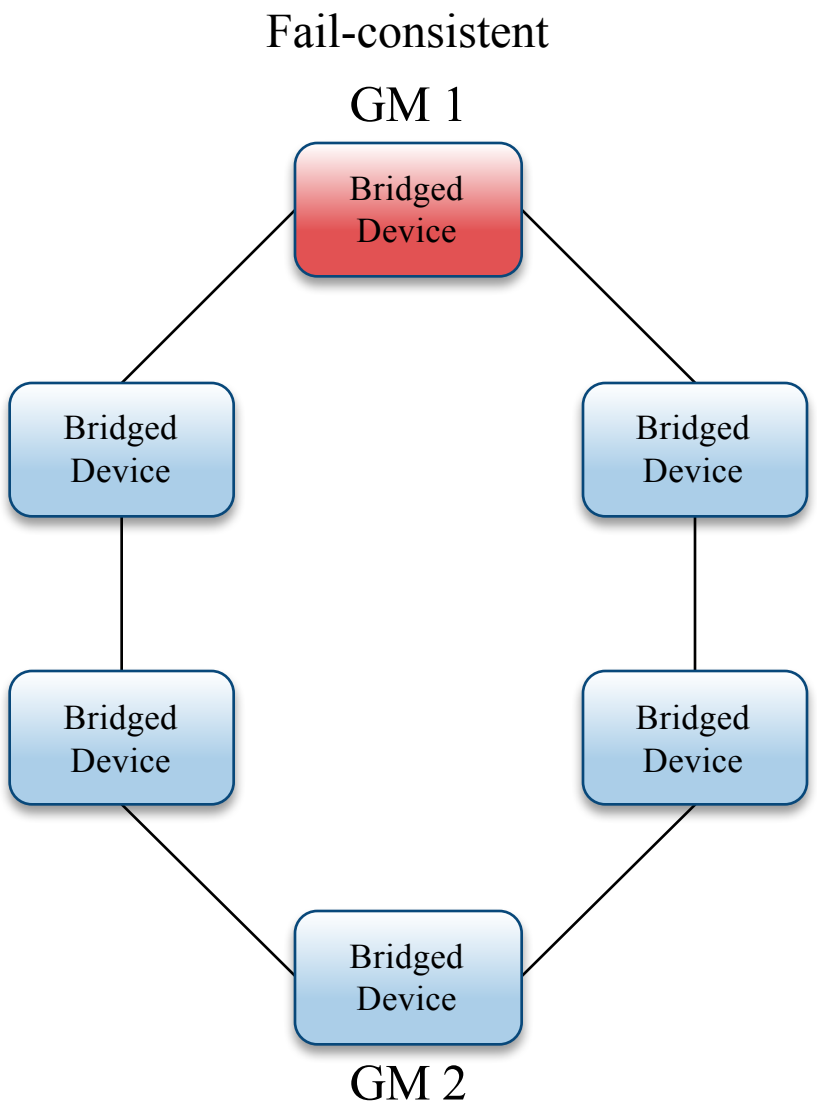

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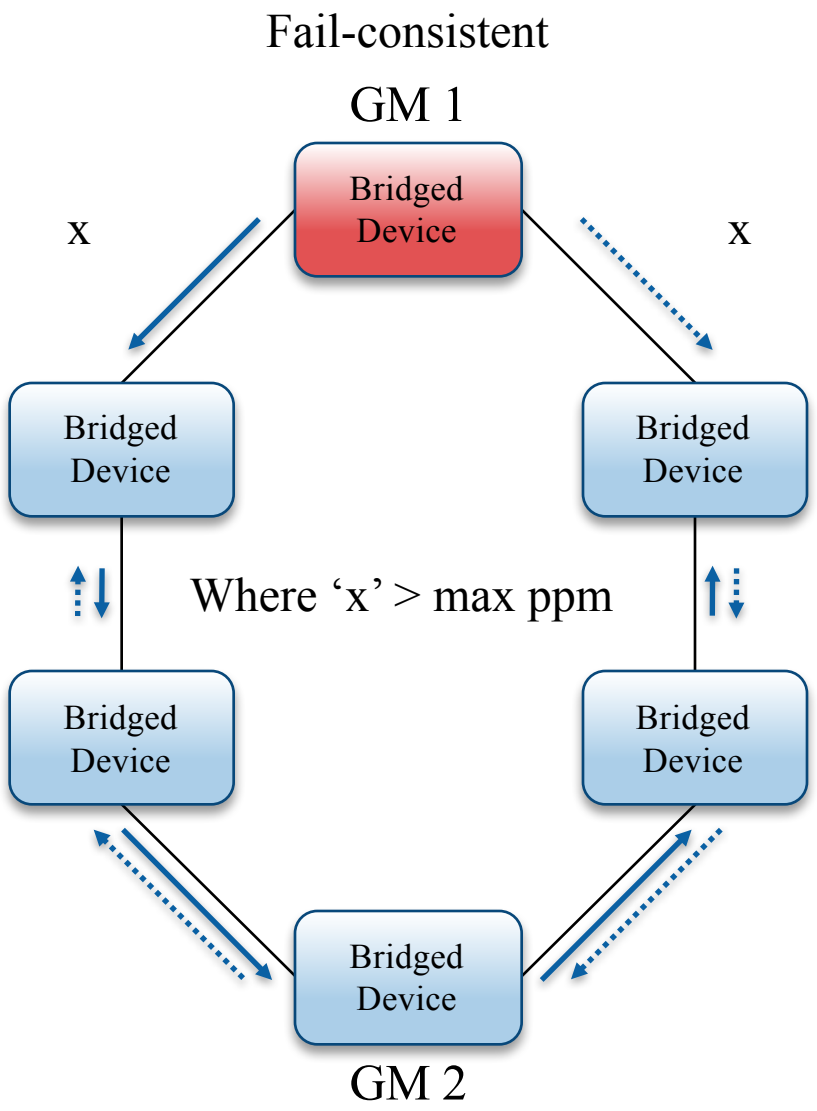

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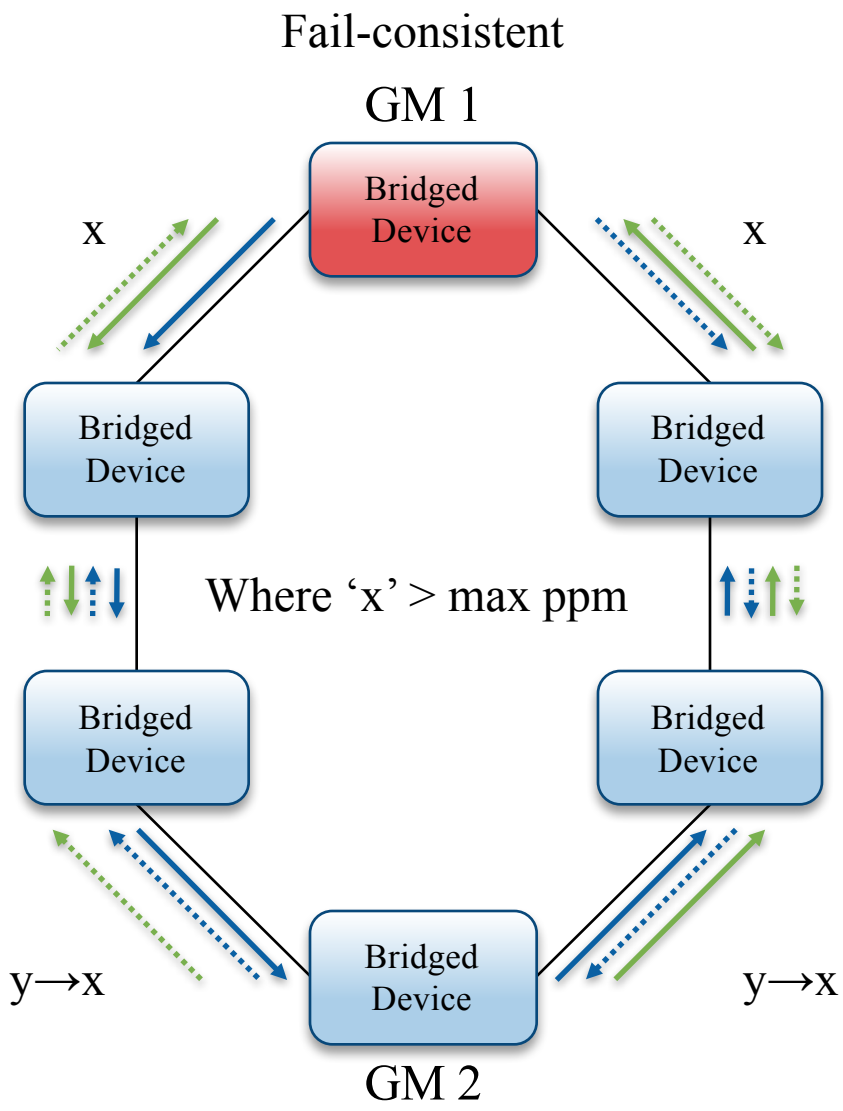

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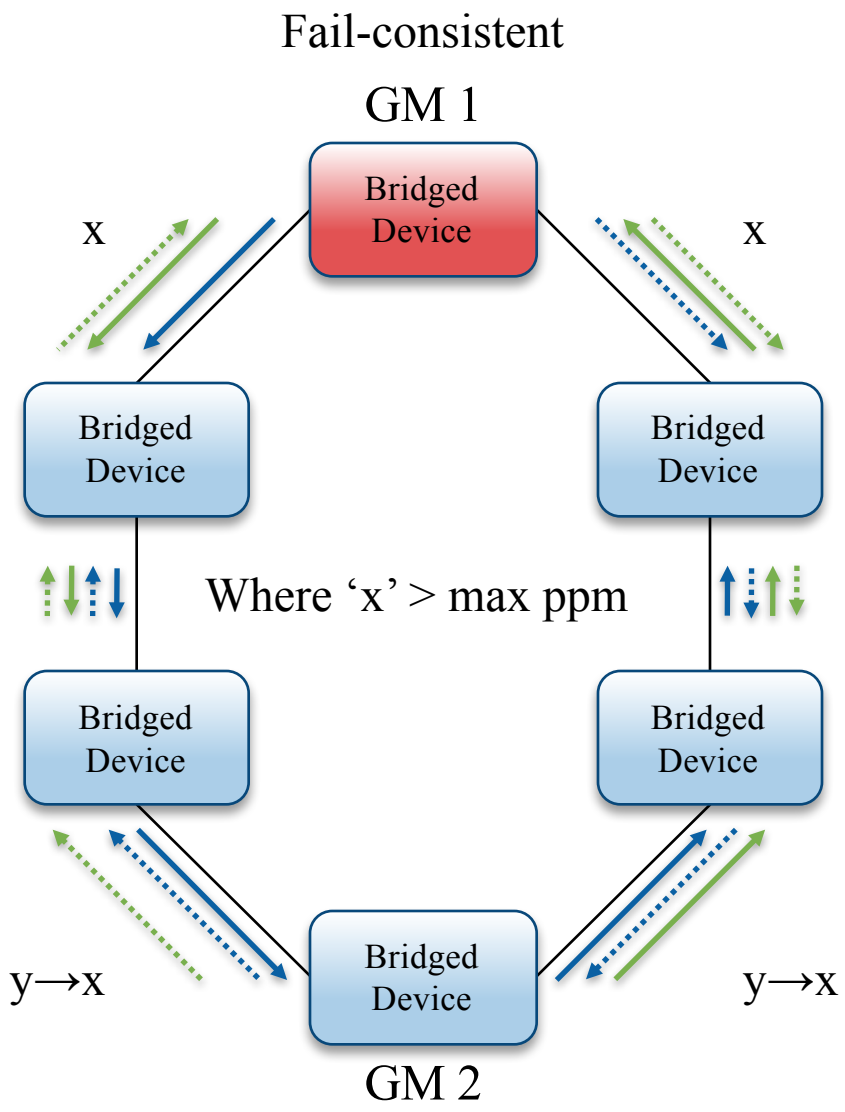

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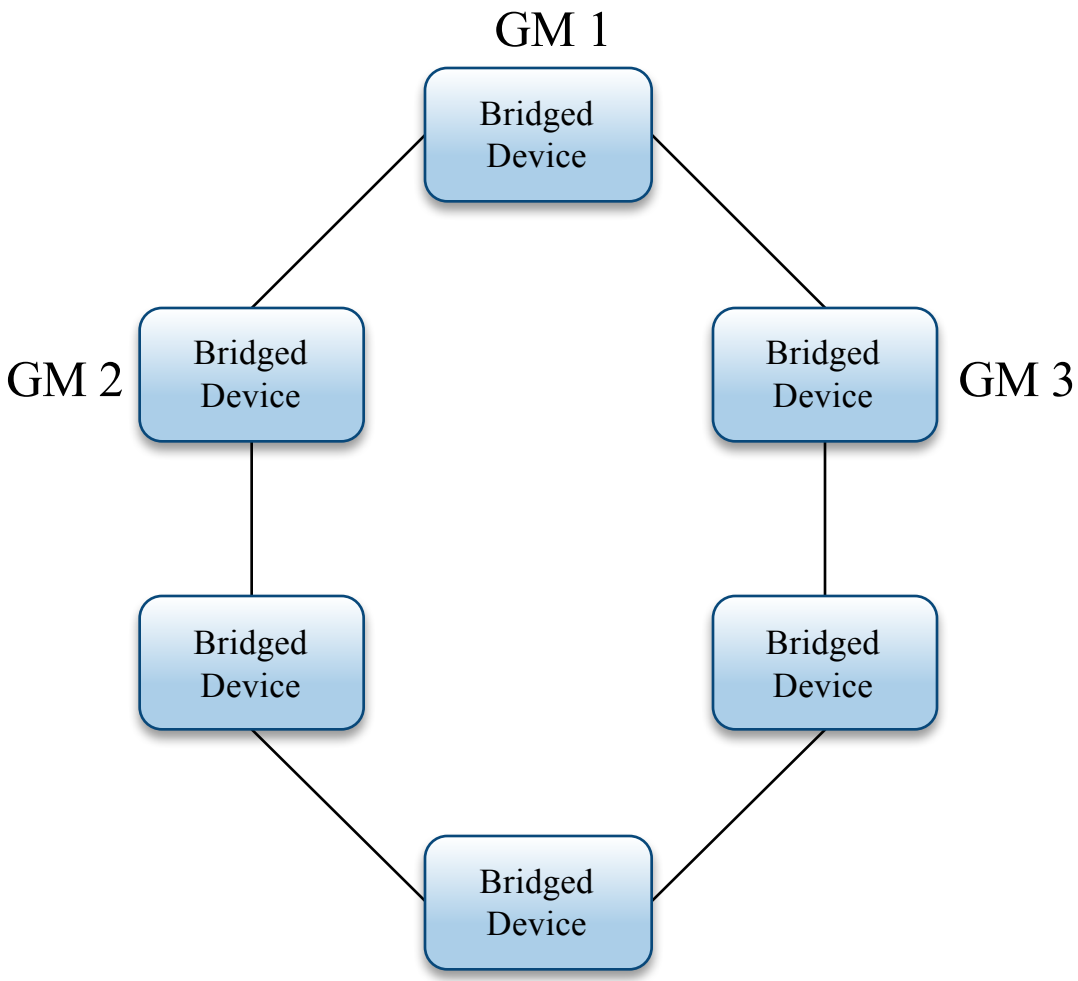

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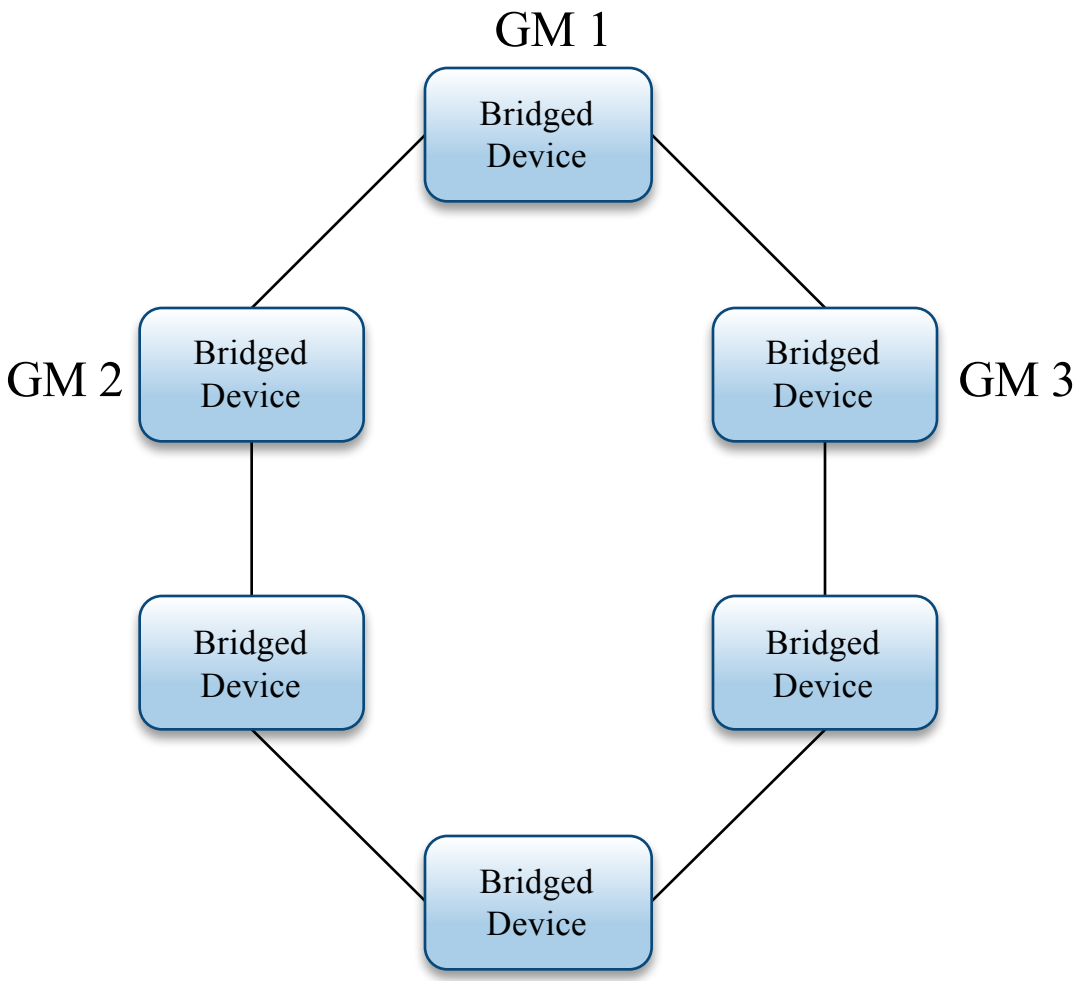

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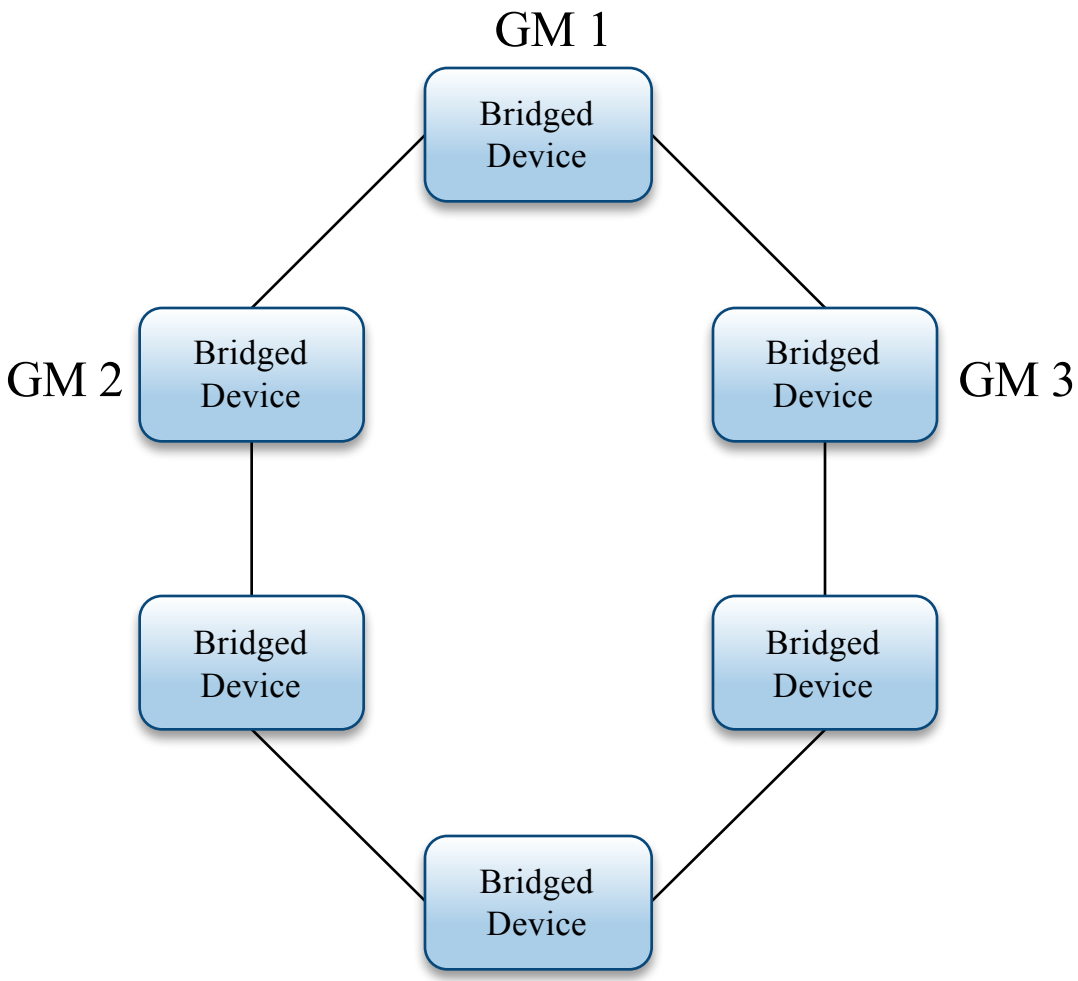

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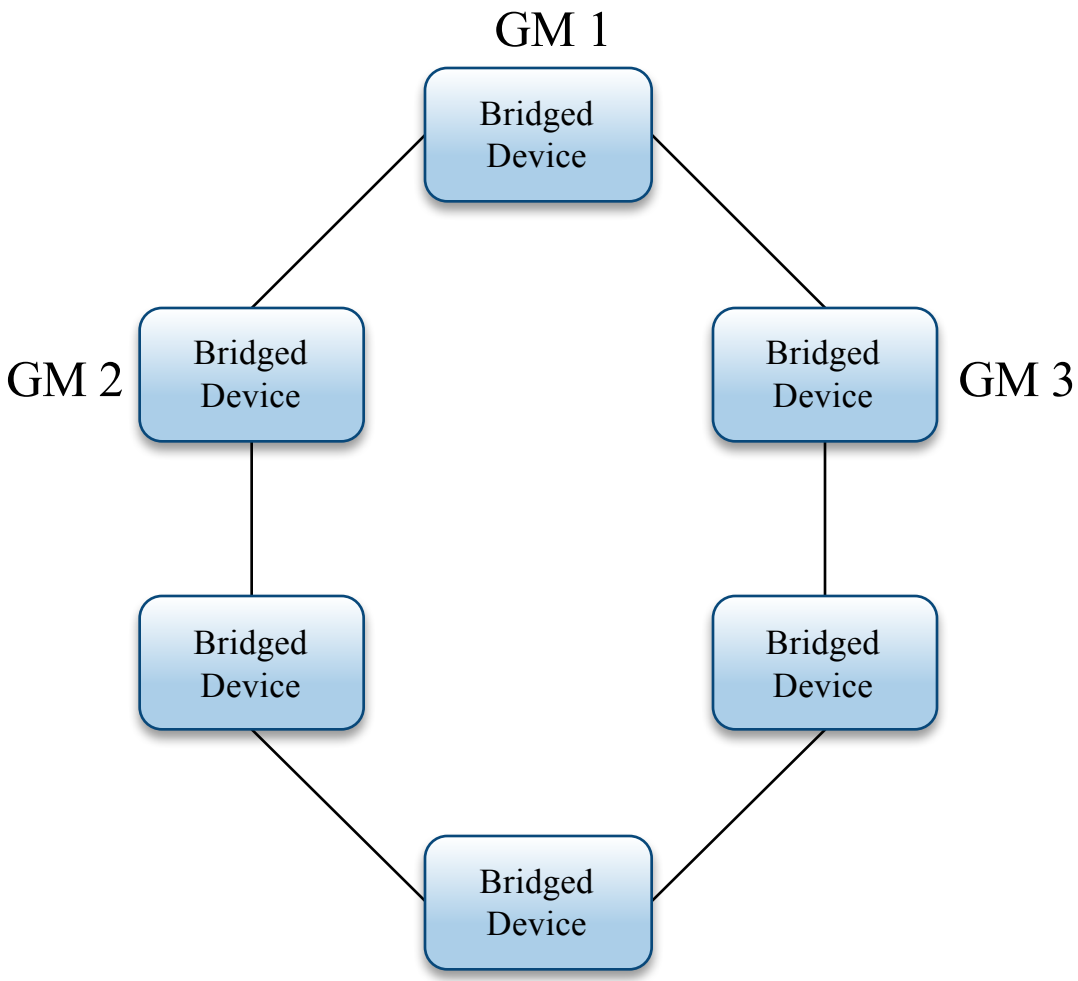

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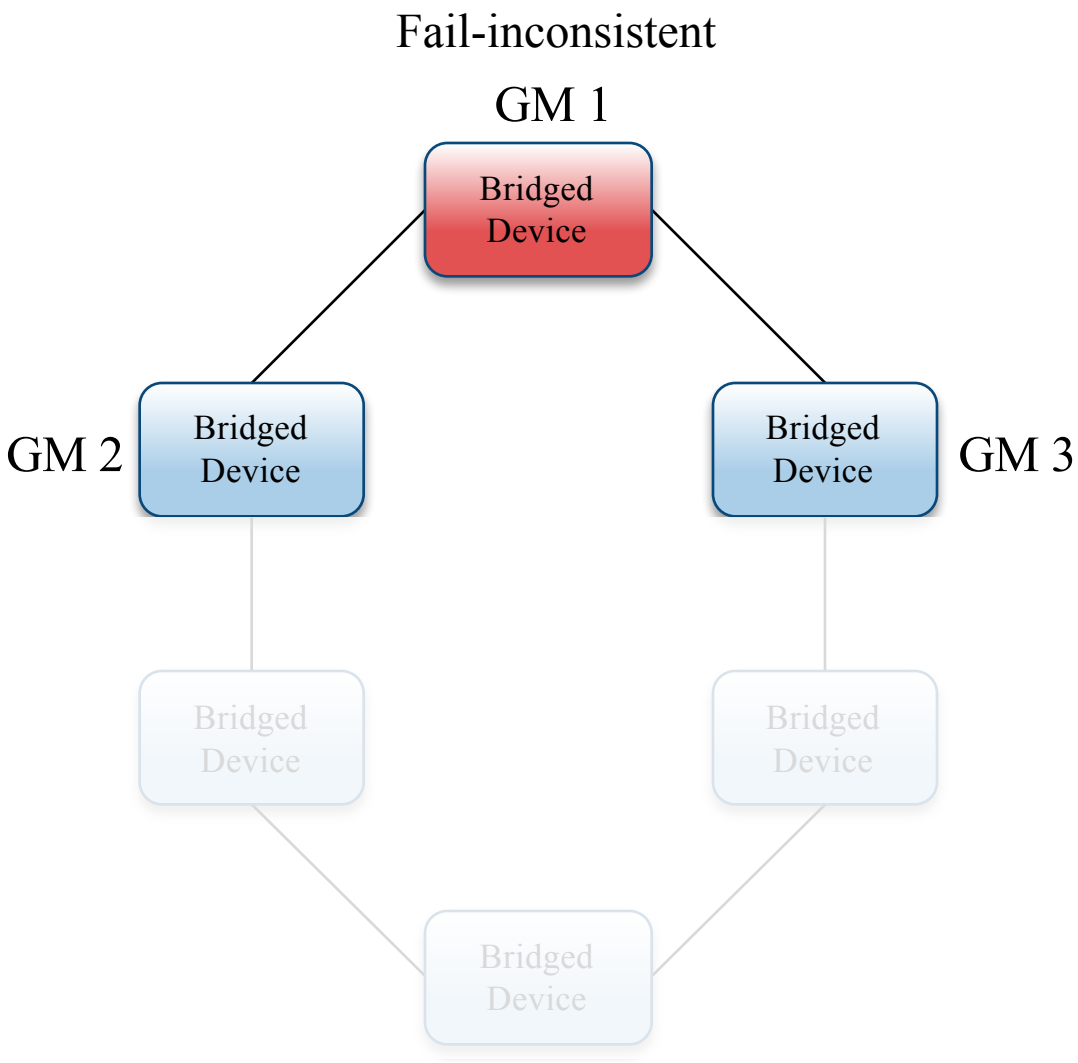

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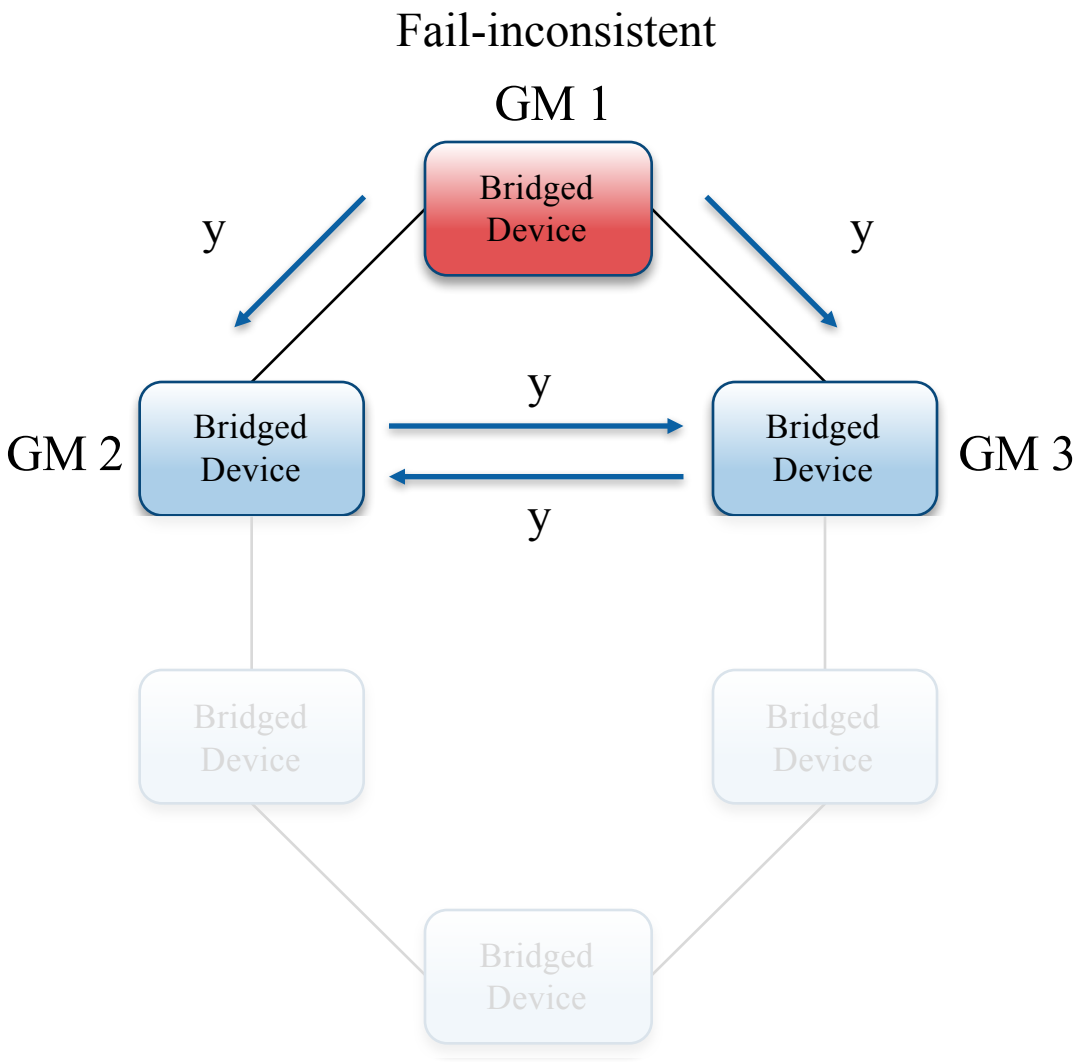

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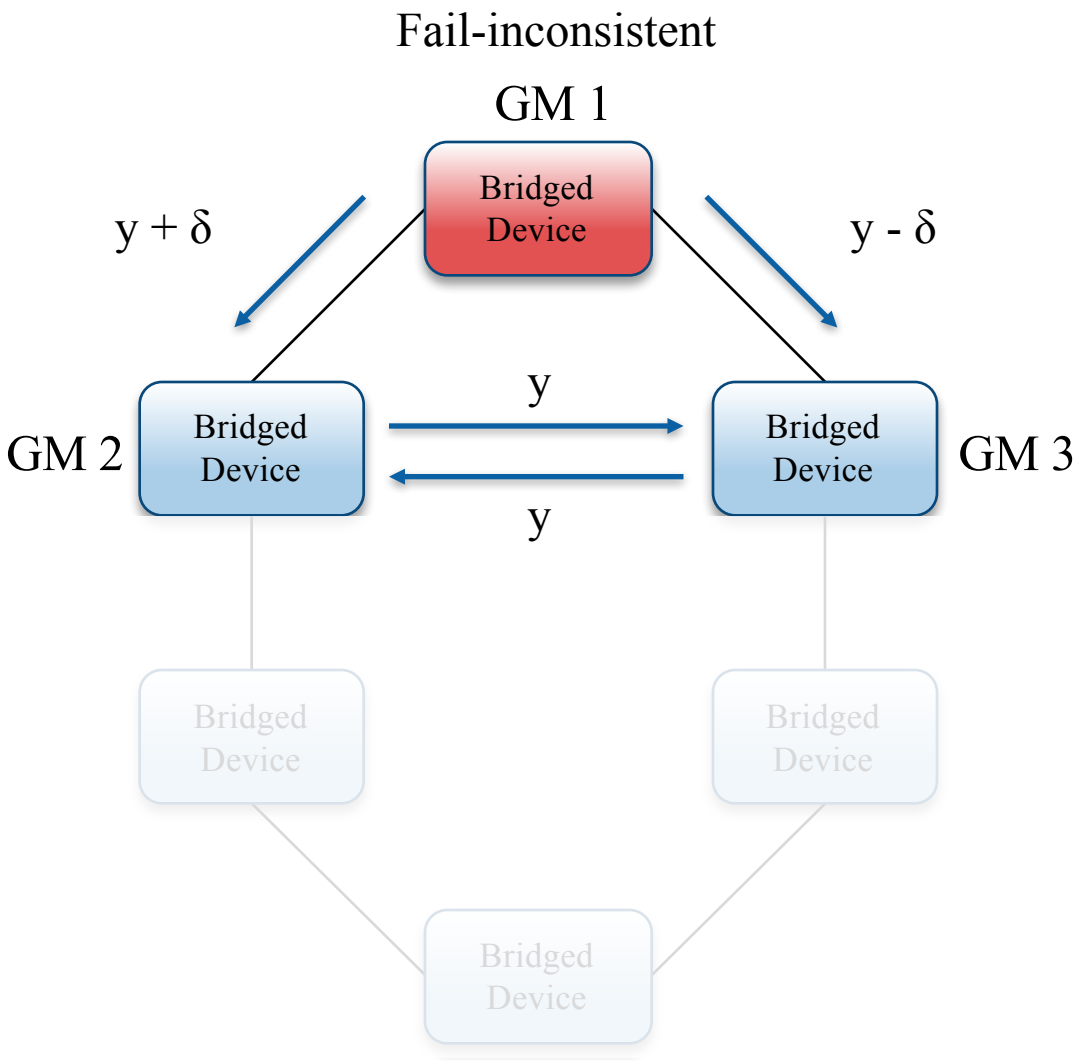

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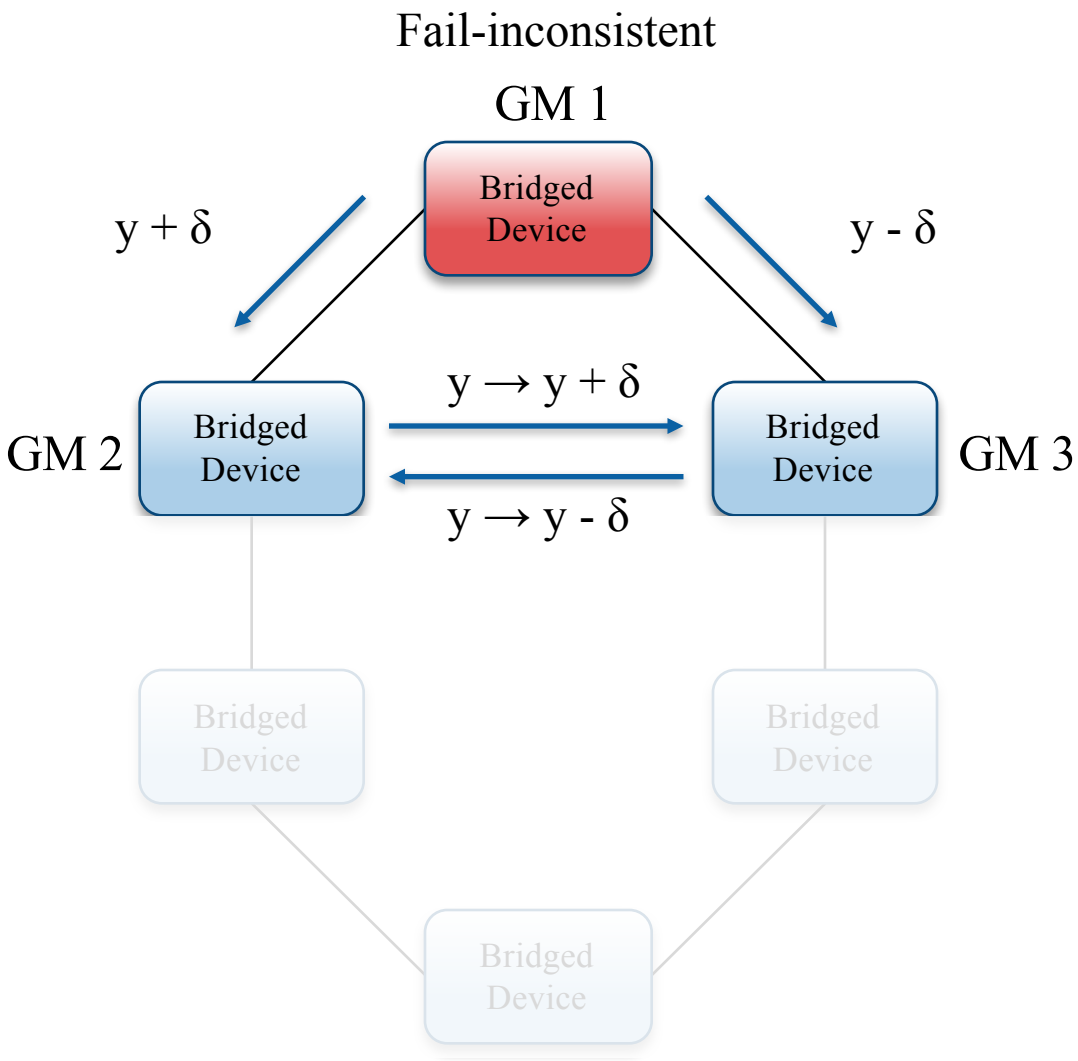

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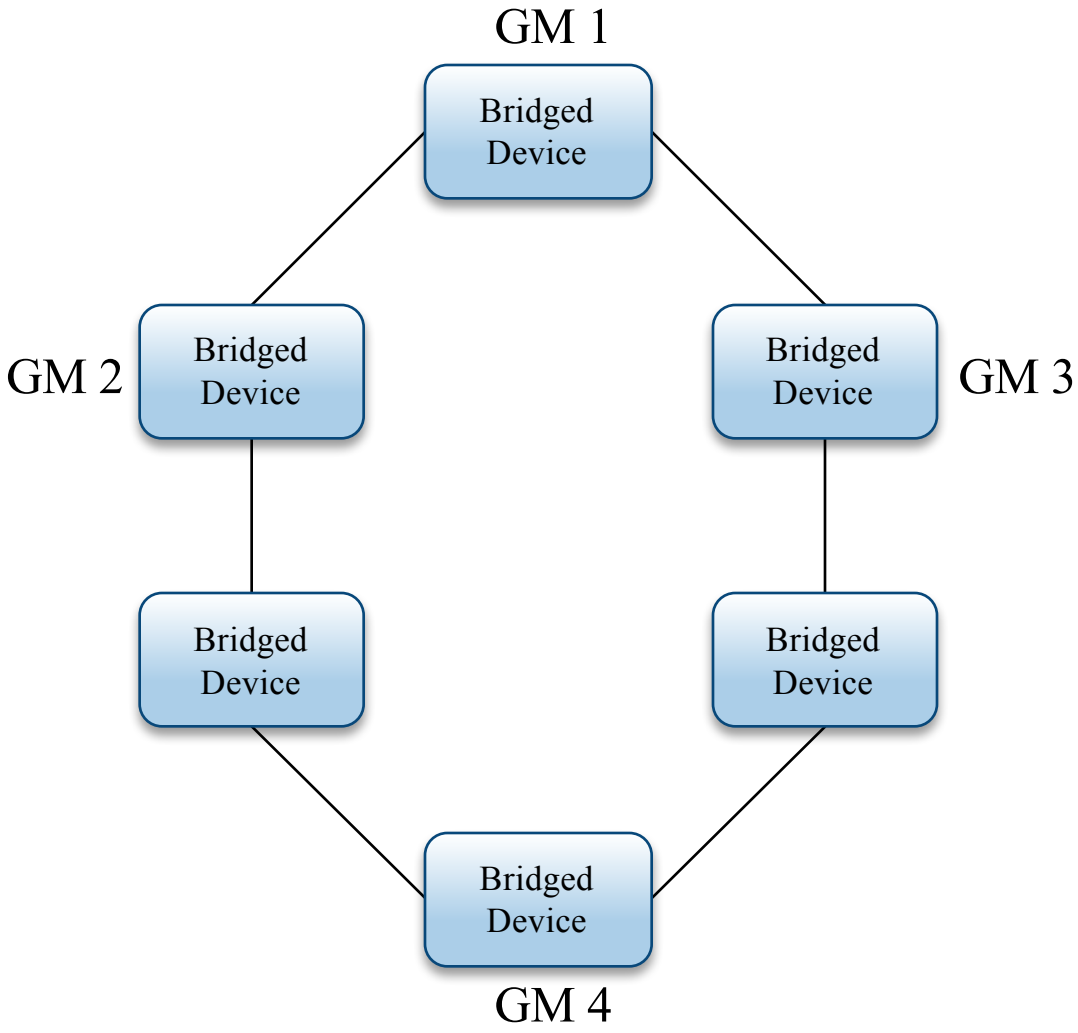

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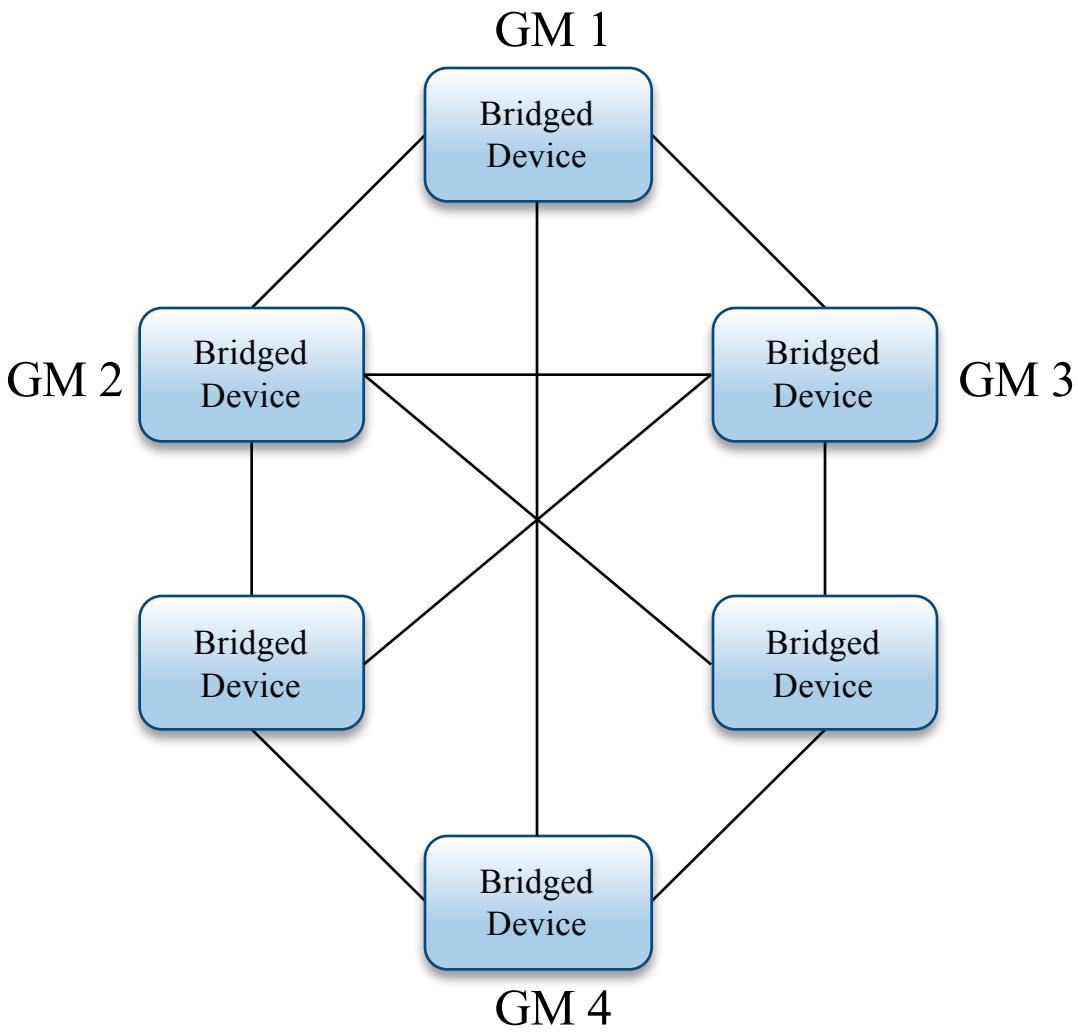

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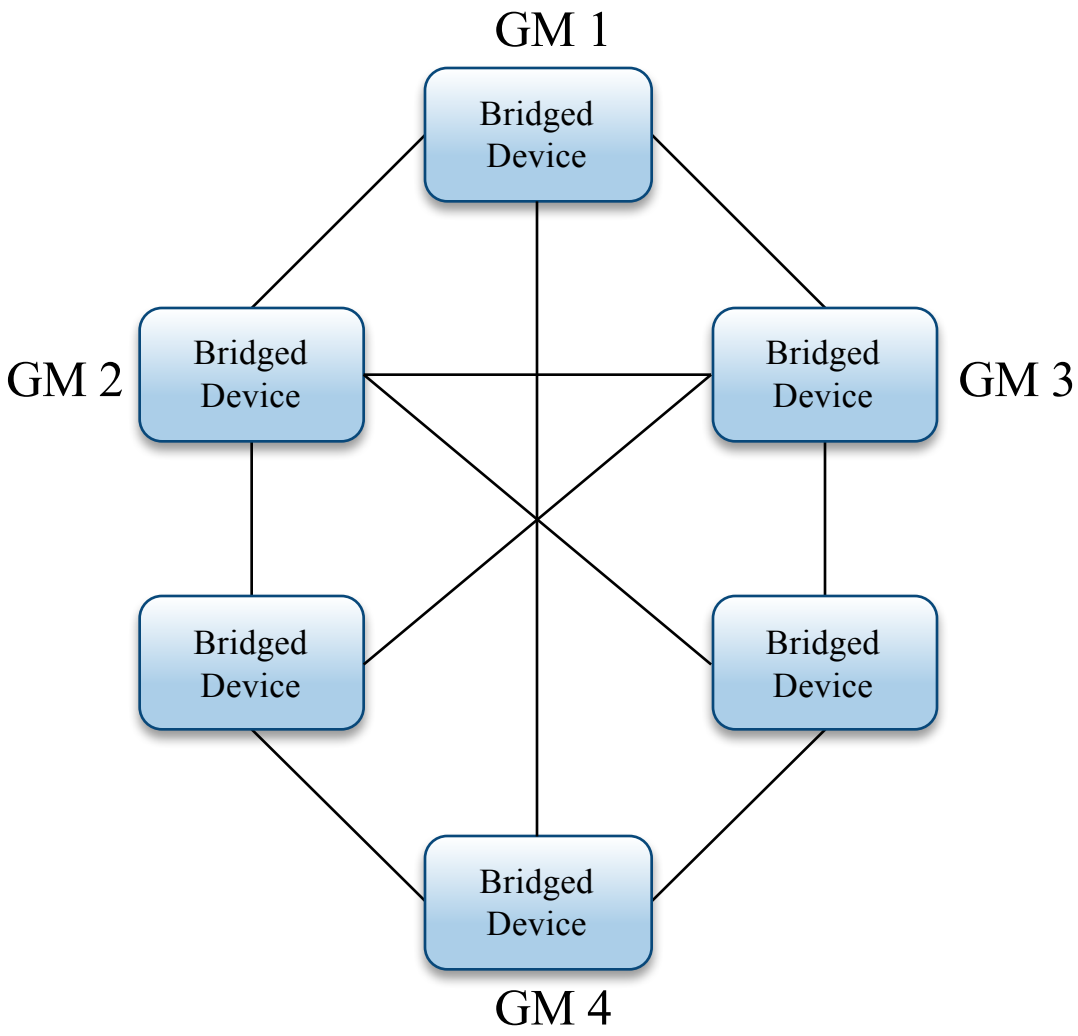

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Proposed Assumptions

- One solution that is scalable
  - Fail-silent to fail-inconsistent
  - One device failure to N device failures

- .1AS redundancy can specify a single algorithm as the default.
  - Cover a wide variety of applications