ORACLE

MySQL

MySQL InnoDB ClusterSet

전양백

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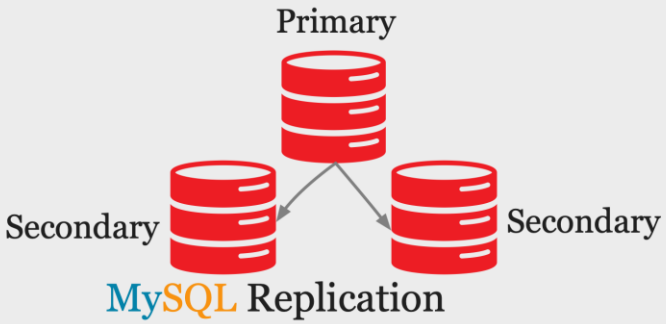
Past, Present & Future

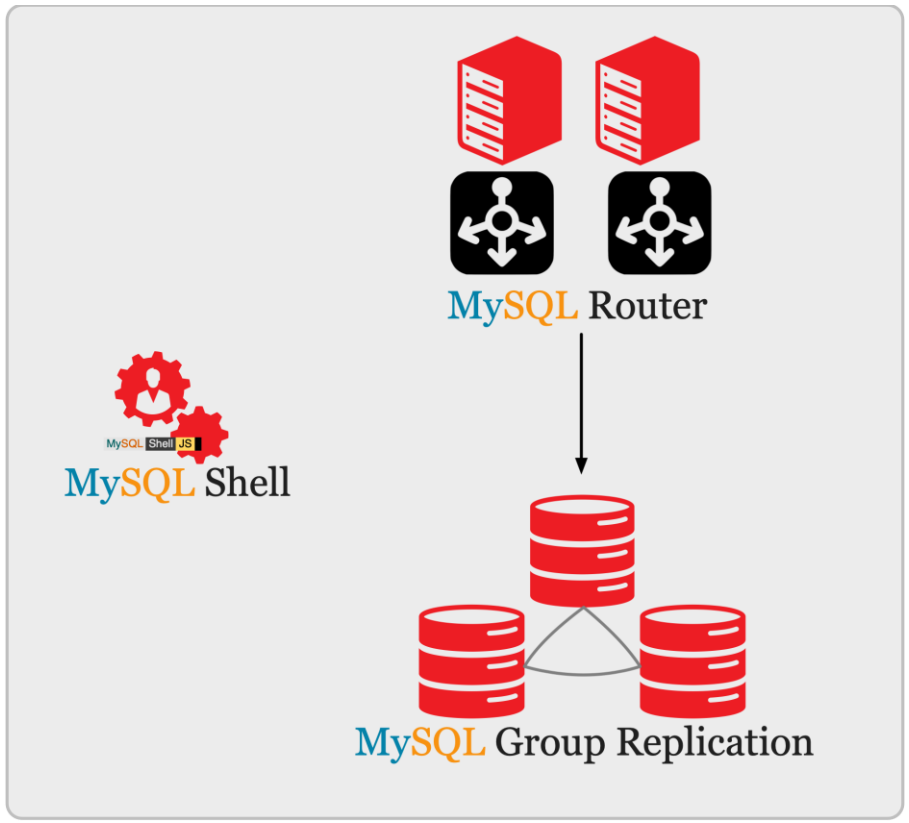
'Past' - Manual



MySQL Replication

- 기존의 복제 방식은 여러가지의 수동적인 스텝 필요
  - 복제 계정 생성, 소스로부터 백업 및 restore 절차 등
- 복제 방식
  - Async Replication
  - Semi-sync Replication
- Auto-Failover 미지원
  - Auto-failover를 위해서는 별도의 솔루션 필요
  - MMM, MHA, Orchestrator, OS layer HA solution..

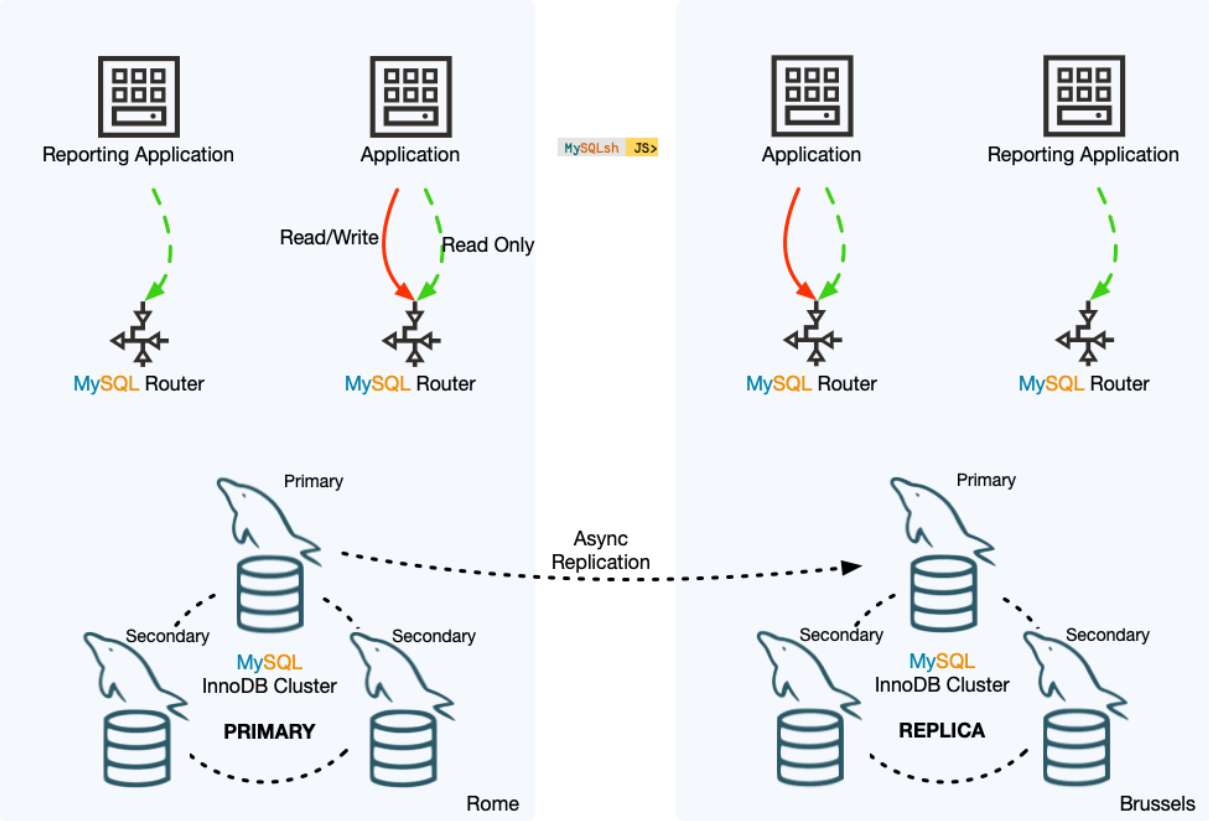
Present - Solutions!



MySQL InnoDB Cluster

- Group Replication
  - 멤버쉽 관리, 데이터 동기화, 네트워크 파티션 관리
- MySQL Shell
  - 파워풀한 인터페이스 제공
  - Java /python / sql 인터페이스
  - AdminAPI 제공 , 효율적인 DB 관리 툴
- MySQL Router
  - Read/Write 분산
  - Primary node의 auto detect

Present - Solutions!



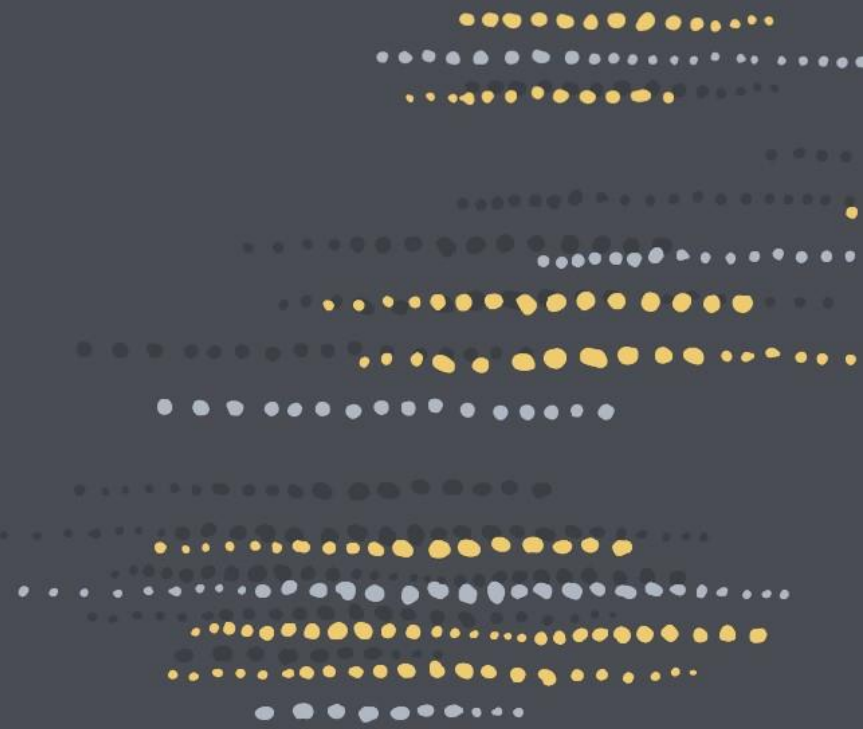
MySQL InnoDB ClusterSet (8.0.27 이후)

- For Multi-Region (c.g. 서울 DC ➡ 춘천 DC)

- Local Region : MySQL Router + InnoDB Cluster

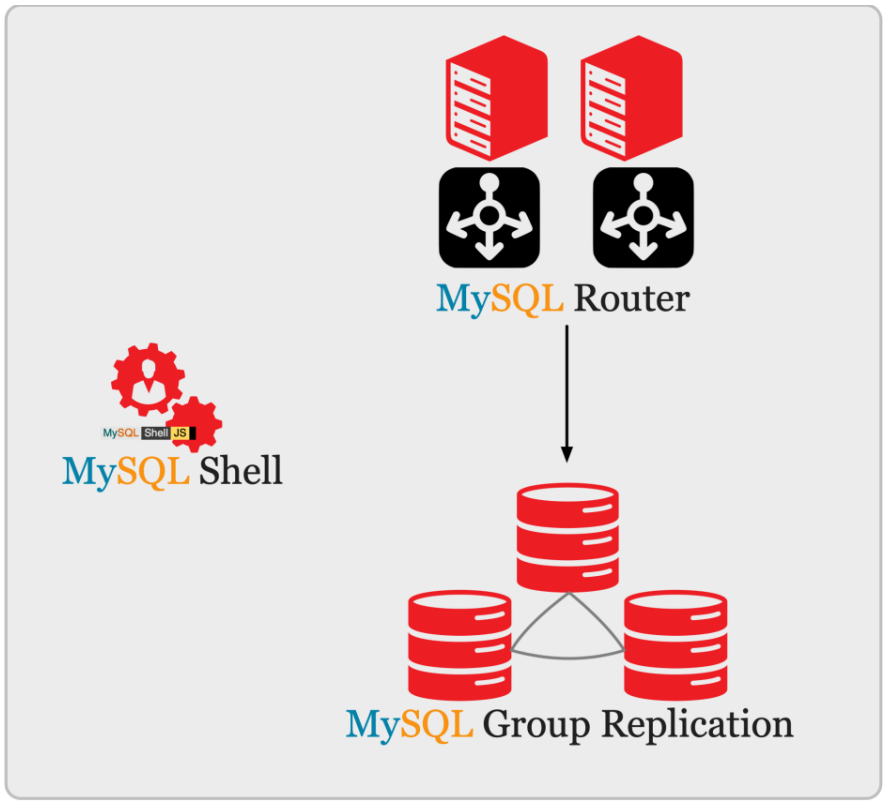
- WAN 구간 : 비동기식 방식으로 서울 데이터 센터 -> 춘천 데이터센터 간의 데이터 복제

MySQL InnoDB Cluster



MySQL InnoDB Cluster

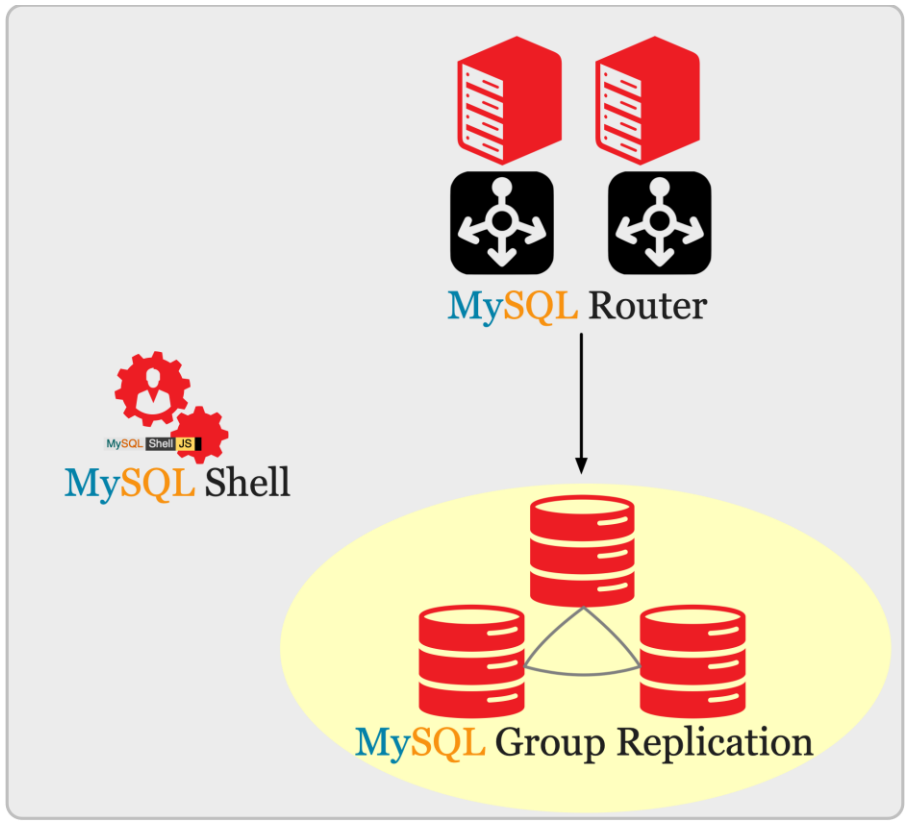
MySQL InnoDB Cluster는 MySQL DB에 대한 완벽한 HA 기능을 제공합니다.



InnoDB Cluster의 주요 컴포넌트

- MySQL Server
  - Group Replication
  - Clone Plugin
- MySQL Shell
- MySQL Router

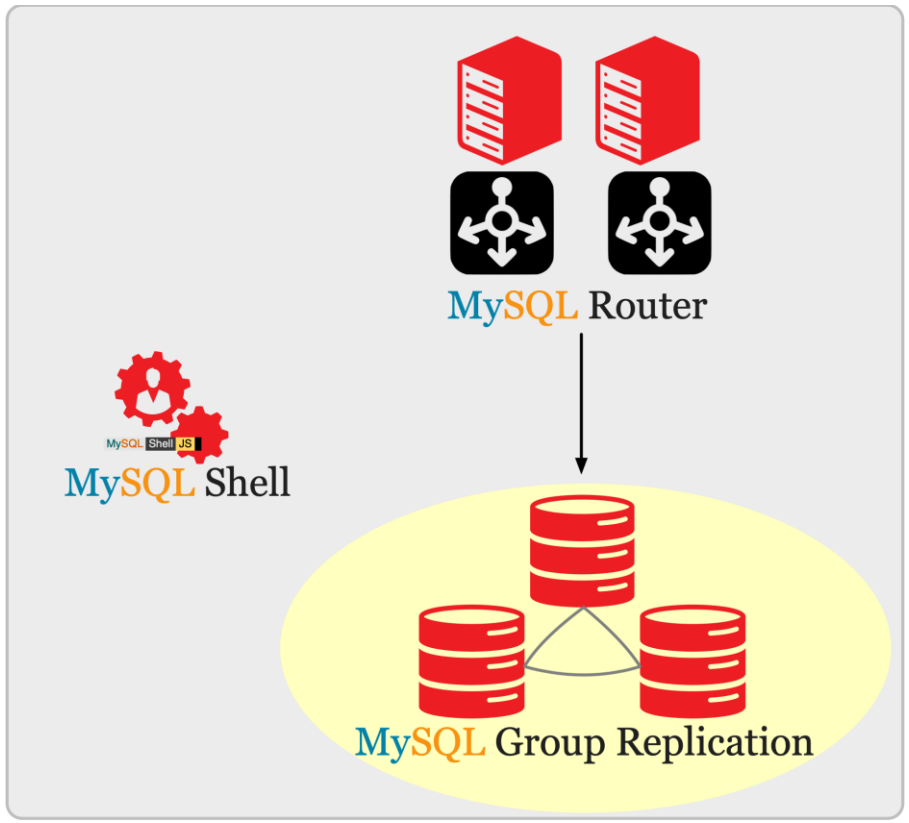
MySQL Group Replication



High Available Distributed MySQL DB

- Fault tolerance
- Confliction 감지 후 자동 Failover
- Single Primary (recommend), Multi Primary 선택
- Membership 관리의 자동화
- 온라인 노드 추가/삭제
- Split-brain 관리
- Transaction의 certification 을 통한 노드 별 데이터 일관성 유지
- 데이터 유실 예방

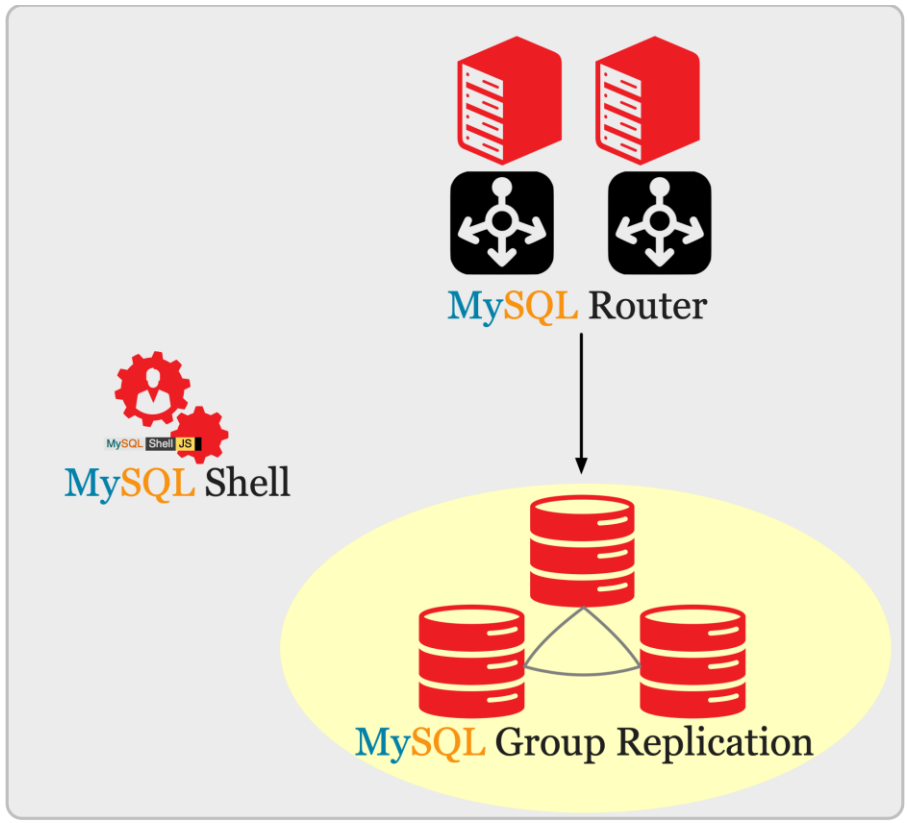
MySQL Shell



Console 기반의 개발 및 관리 기능을 제공하는 MySQL 클라이언트 툴

- JavaScript, Python 및 SQL 지원
- Document Store 및 관계형 모델 지원 (mysqlX protocol)
- AdminAPI를 통한 InnoDB Cluster 생성 및 관리
- MySQL 운영에 필요한 여러가지 utility 제공 (util.dump, util.load)
- 명령어, 배치 스크립트 지원

MySQL Router



어플리케이션과 GR을 구성한 MySQL 노드사이에서

투명한 클라이언트 라우팅을 담당하는

경량의 미들웨어 프로그램

- 애플리케이션 연결에 대한 Failover
- Read/Write에 대한 LoadBalancing
- InnoDB Cluster에 대한 metadata information 제공
- Stateless 디자인

MySQL InnoDB Cluster – Requirements / Limitations

Requirements

- InnoDB Storage Engines Only
- Primary Key
- Network Performance
- GTID / binlog_format=ROW
- Parallel Replication applier 사용

Limitations

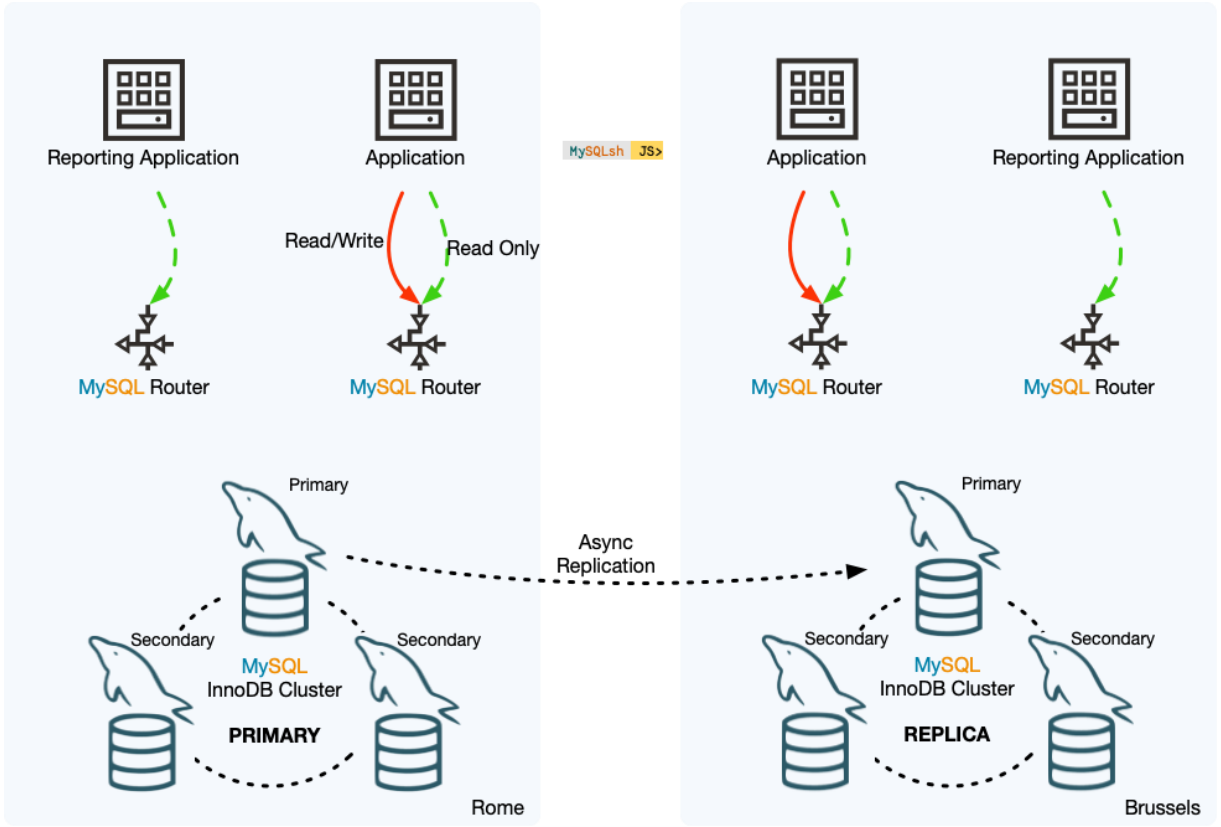
- **최대 노드 개수는 9**
- **대용량 트랜잭션**
- **READ-COMMITTED 권장 (Gap lock 지원불가)**
- **Multi-Primary node 제약**
  - Concurrent DDL/DML 지원 불가
  - FK 지원 불가
  - SELECT.. FOR UPDATE => Deadlock 발생

✓ https://dev.mysql.com/doc/mysql-shell/8.0/en/mysql-innodb-cluster-requirements.html
✓ https://dev.mysql.com/doc/mysql-shell/8.0/en/mysql-innodb-cluster-limitations.html

MySQL InnoDB ClusterSet

MySQL InnoDB ClusterSet

각 데이터 센터에 각각 InnoDB Cluster로 구성하며,
Primary Cluster와 Replica Cluster는 Async 방식으로 데이터 복제



High Availability (Failure within a Region)

- RPO=0
- RTO=seconds (automatic failover)

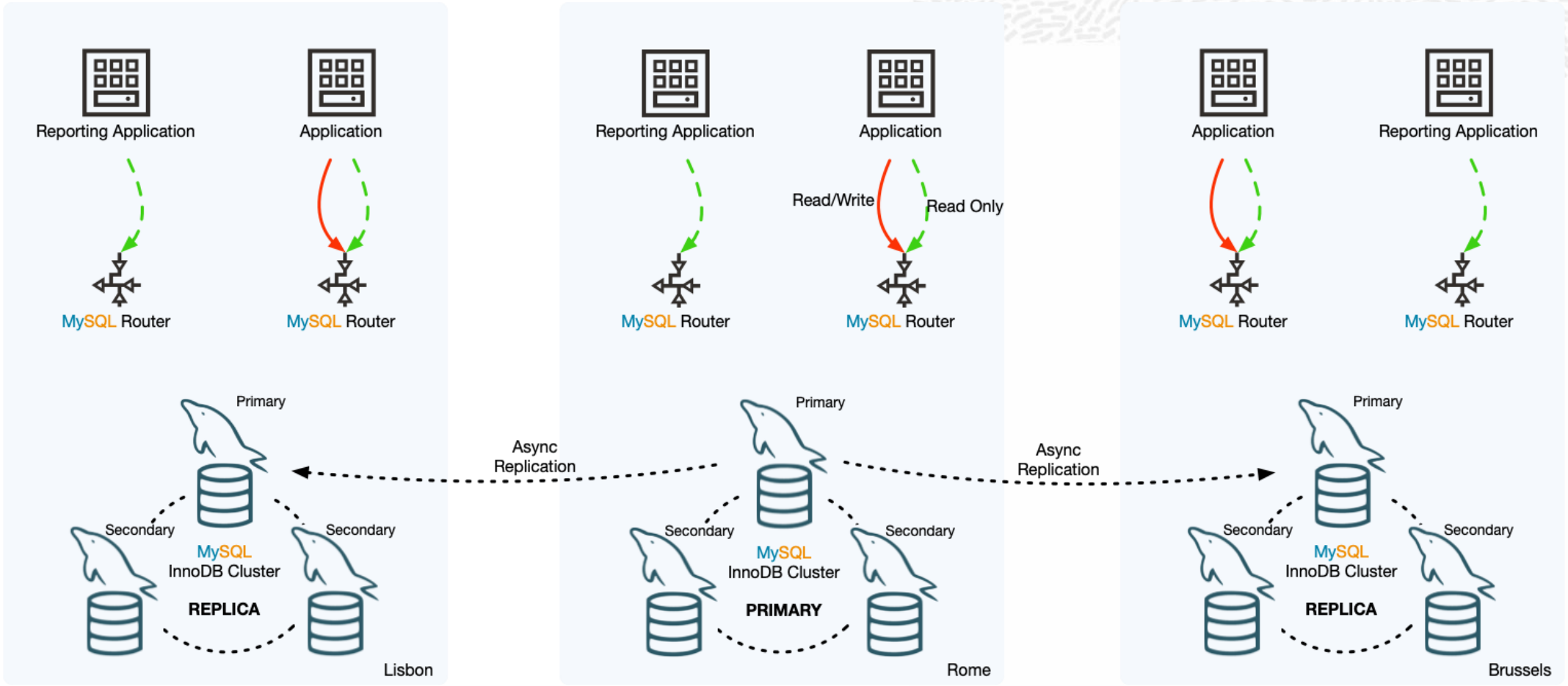
Disaster Recovery (Region Failure)

- RPO !=0
- RTO = mintues or more (manual failover)
- No write performance impact

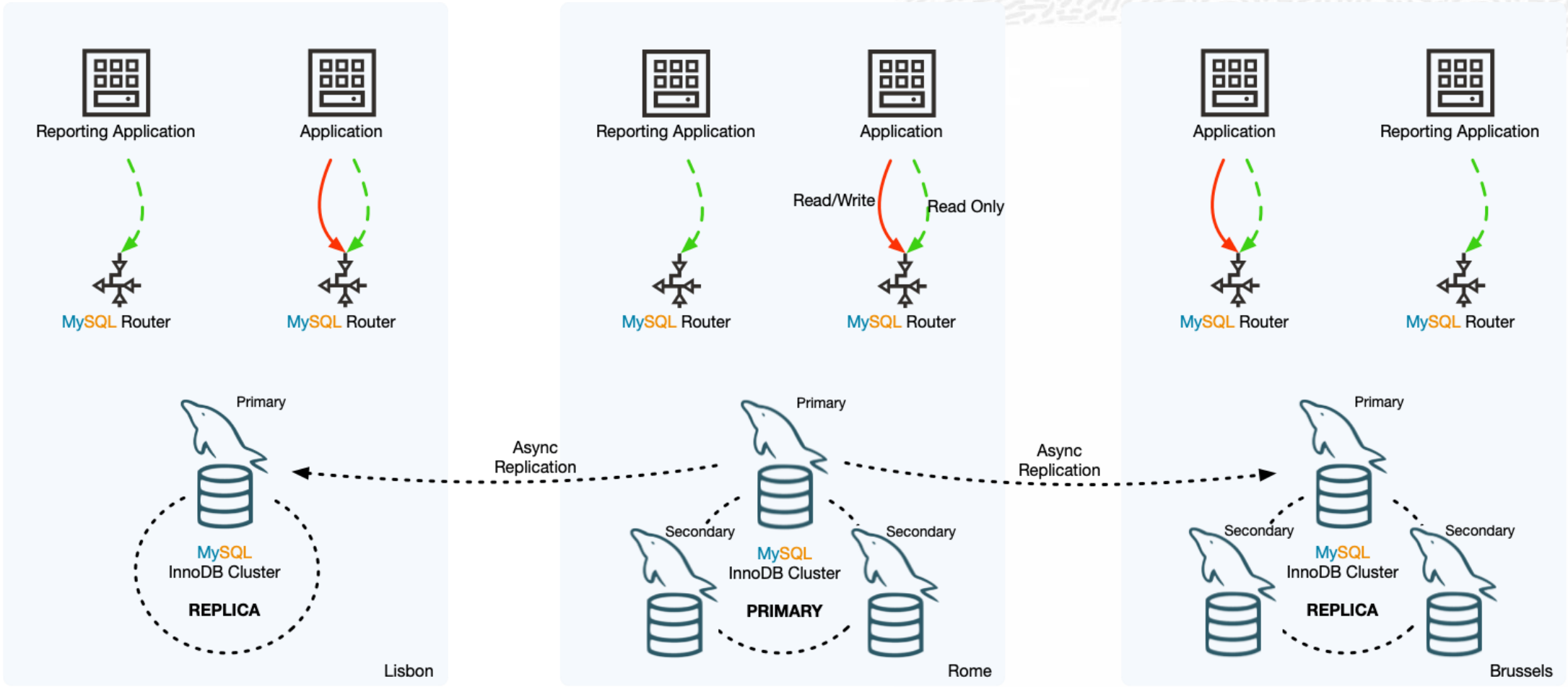
Features

- 사용 편리성
- 친숙한 환경 (mysqlsh, CLONE,…)
- Online 노드 추가/삭제
- Application 변경없이 Replica Cluster로 변경

MySQL InnoDB ClusterSet – 3 Data Centers



MySQL InnoDB ClusterSet – Not every Cluster has to be 3 nodes



Replication Enhancements

Features in replication that made ClusterSet possible:

- 8.0.22: Automatic connection failover for Async Replication Channels
- 8.0.23: Automatic connection failover for Async Replication Channels using Group Replication
- 8.0.24: Make skip-replica-start a global, persistable, read-only system variable.
- 8.0.26: Group Replication Member actions (configurable **`super_read_only`** on **`PRIMARY`** member)
- 8.0.26: Specify the UUID used to log **`View_change_log_event`**
- 8.0.27: Asynchronous Replication Channel conguration automatically follows the **`PRIMARY`** member

MySQL InnoDB ClusterSet – Requirements / Limitations

Requirements

- 모든 컴포넌트는 8.0.27 이상 버전 요구
- InnoDB Cluster의 메타버전이 2.1.0 이상
- Single-Primary 구성만 적용
- In-bound replication이 존재할 경우 구성 불가

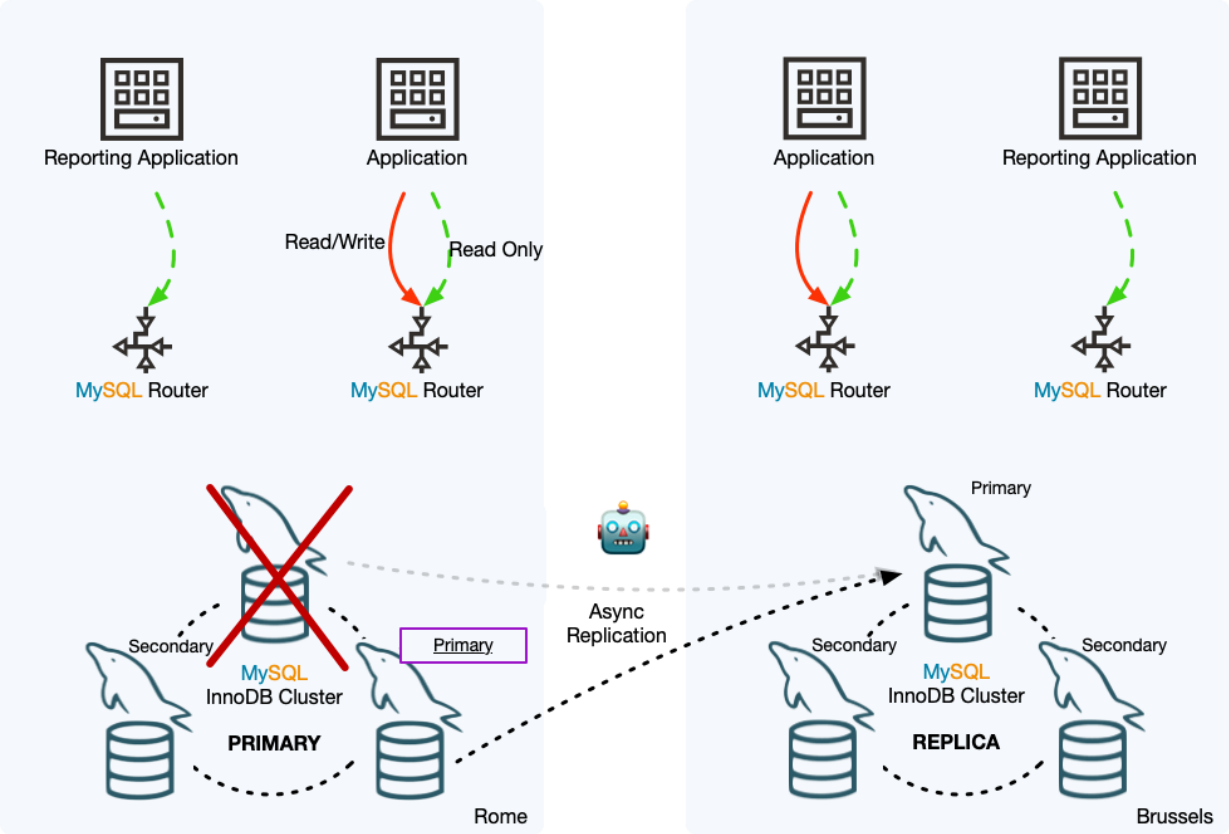
Limitations

- **일관성보다 가용성을 우선시하는 구성**
- **Failover 시에는 수동으로 실행**
- **Semi-sync 지원불가**

✓ https://dev.mysql.com/doc/mysql-shell/8.0/en/innodb-clusterset-requirements.html
✓ https://dev.mysql.com/doc/mysql-shell/8.0/en/innodb-clusterset-limitations.html

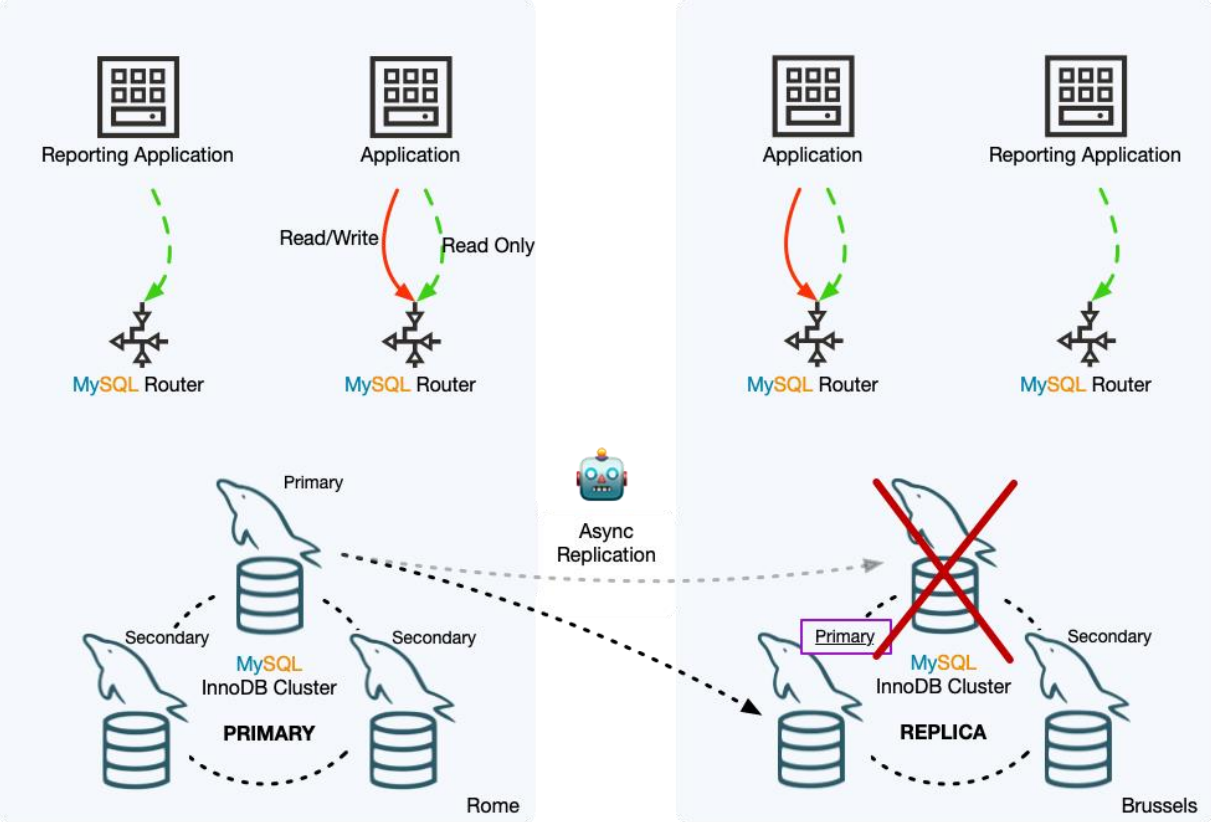
InnoDB ClusterSet 시나리오

PRIMARY Cluster PRIMARY member Crash/Partition - Automatic



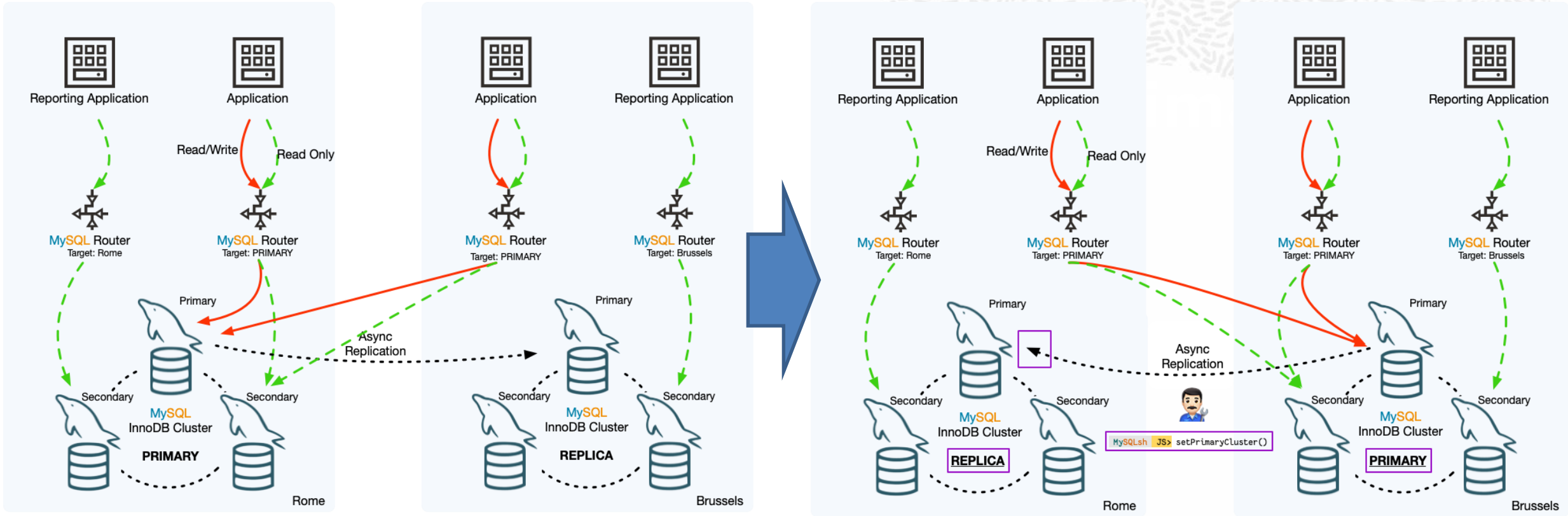
- Primary node 장애 시 Secondary node 중에서 To-Be Primary 노드를 자동 선출
- Replica Cluster에서는 Primary Cluster 에서 변경된 Primary node를 자동으로 인지하여 복제 연결

REPLICA Cluster PRIMARY member Crash/Partition - Automatic



- Replica Cluster 의 Primary node 장애 시 Secondary node 중에서 To-Be Primary 노드를 자동 선출
- Primary Cluster의 Primary node는 Replica Cluster의 변경된 Primary node를 자동으로 인지하여 복제 연결

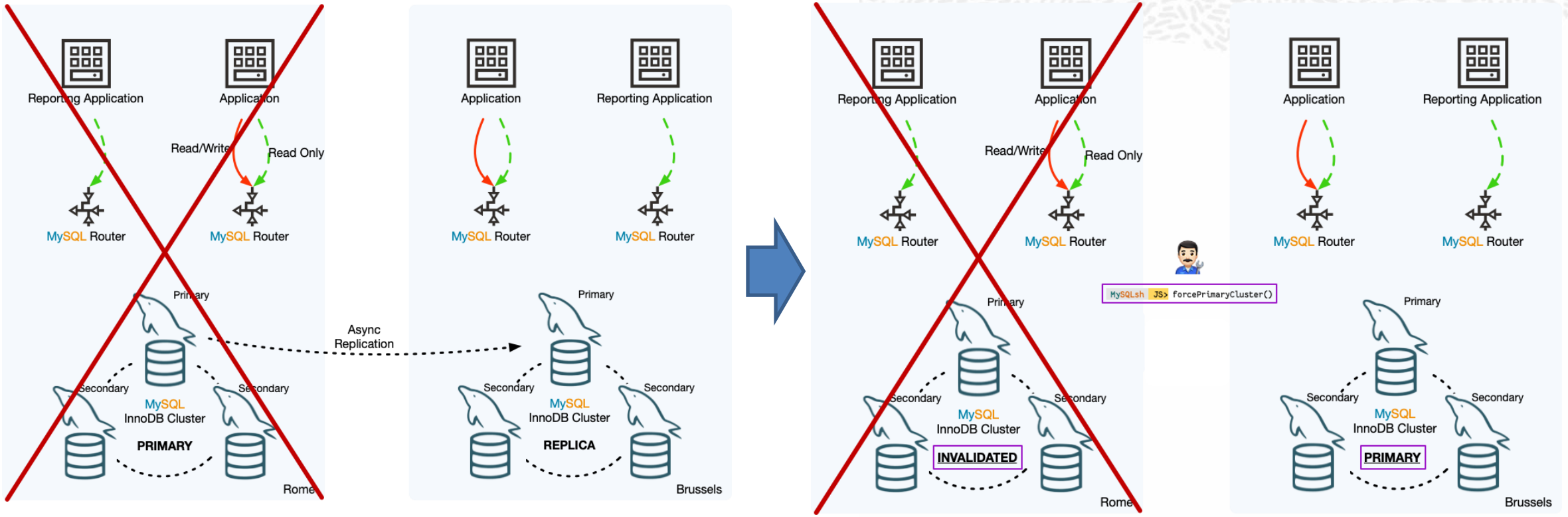
Changing Primary - Change Primary Cluster on Healthy System



Switchover

- **setPrimaryCluster()** : 이 명령어로 Replica Cluster를 Primary Cluster로 변경
- Async replicate channel은 자동 변경되며 데이터의 일관성을 보장
- 모든 mysql router의 라우팅 경로도 즉시 변경

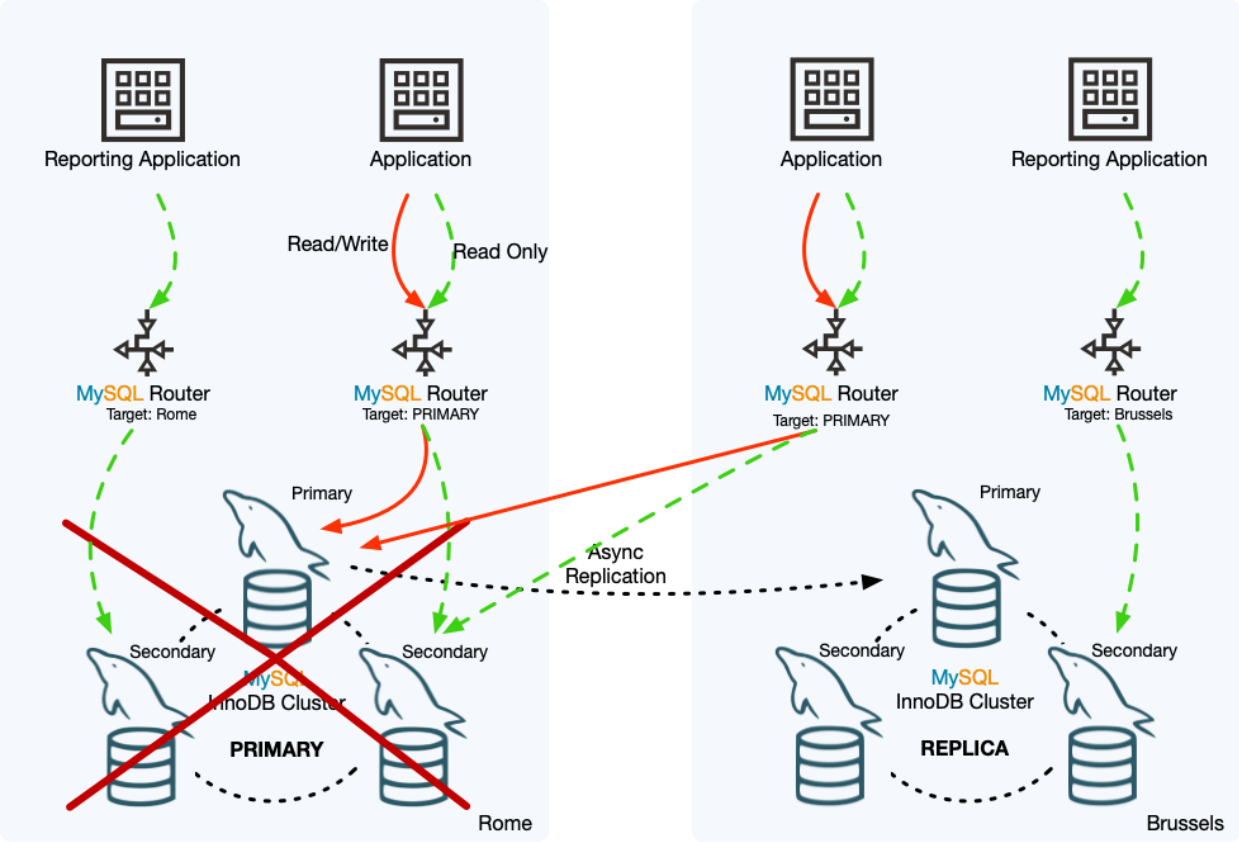
Datacenter Crash/Partition



Failover to another Cluster

- **forcePrimaryCluster()**
- Primary Cluster 그룹에 장애가 발생할 경우, 강제로 Primary Cluster를 Promote 하기 위한 명령어
- **Split-Brain 발생 가능성**

Group Replication Crash/Partition



Router Integration

When GR is offline:

- network partition
- no quorum
- full cluster lost (e.g. power outage)

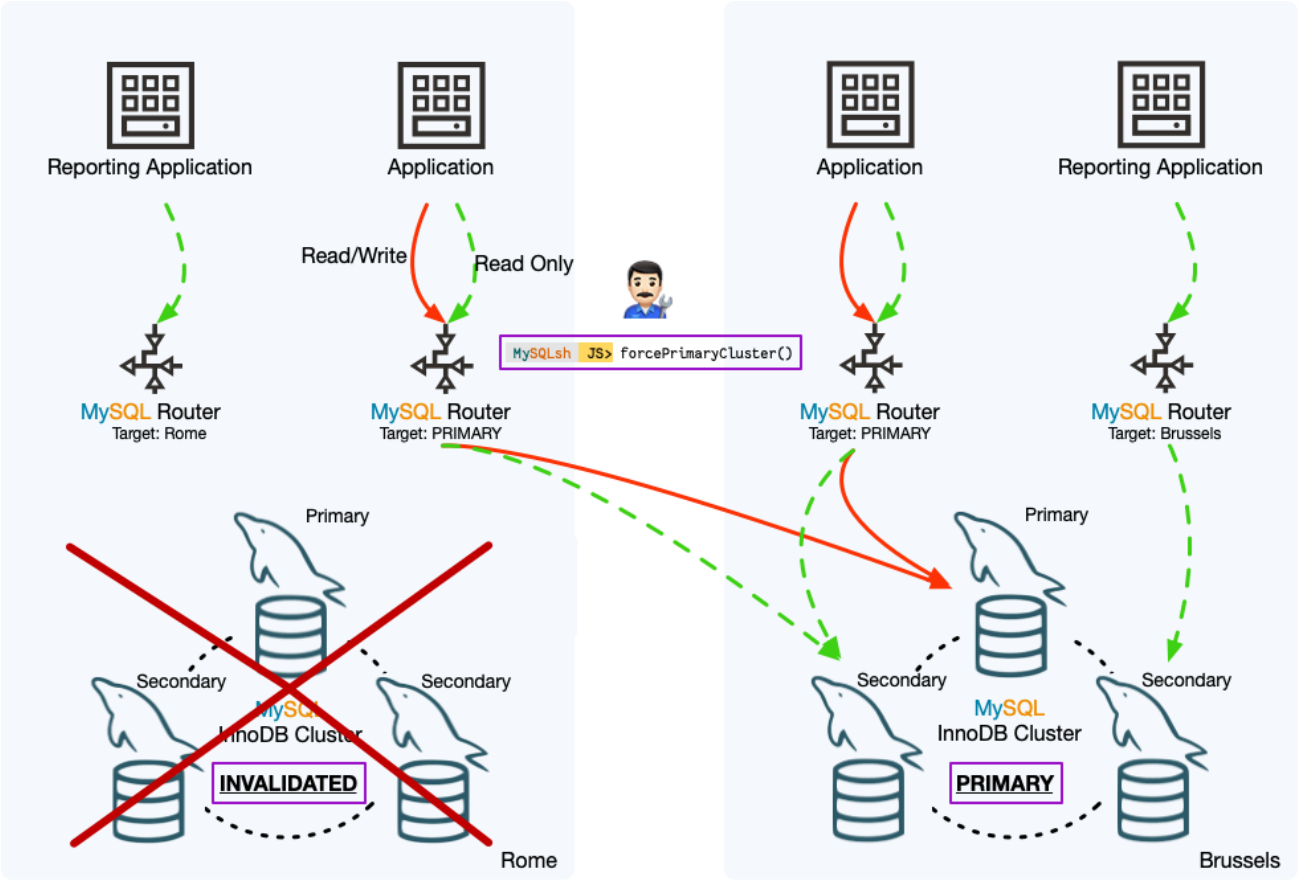
Failover to another Cluster

- **forcePrimaryCluster()**

  - 새로운 Primary Cluster로 강제 promotion

- Router 인스턴스들은 새로운 Primary Cluster로 트래픽 변경

Group Replication Crash/Partition - forcePrimaryCluster() & Router



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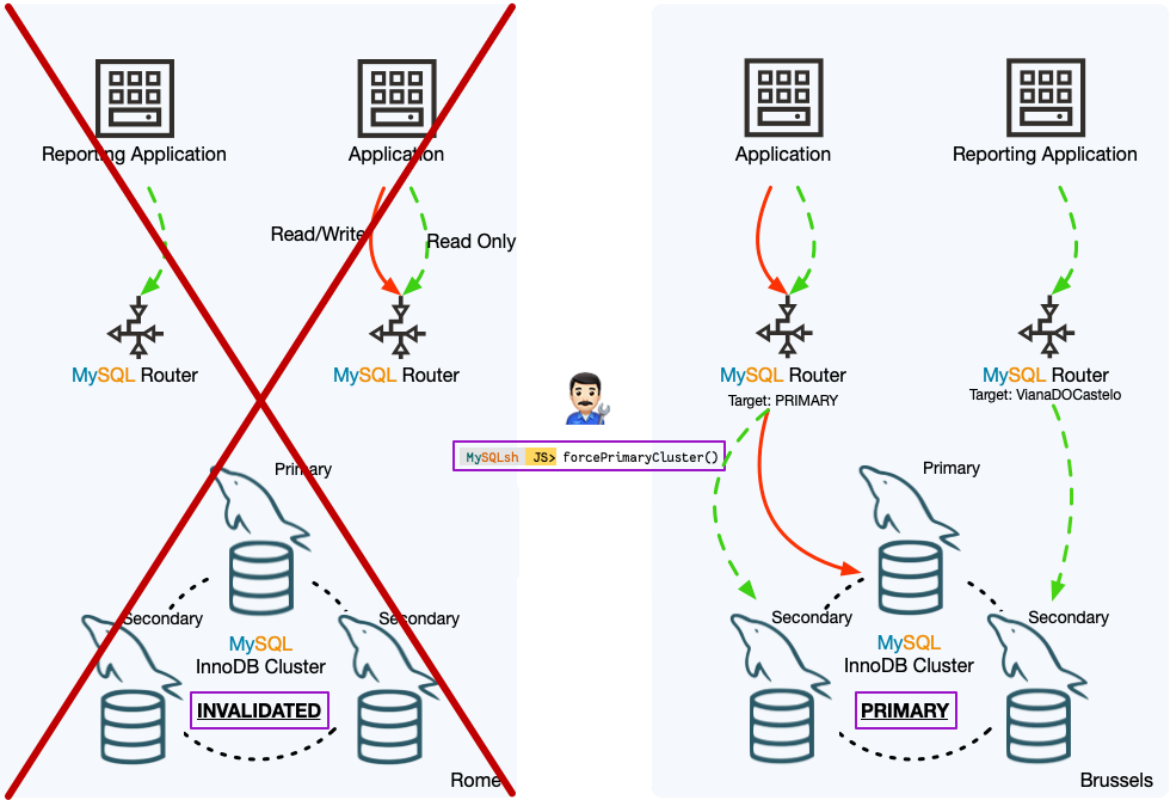
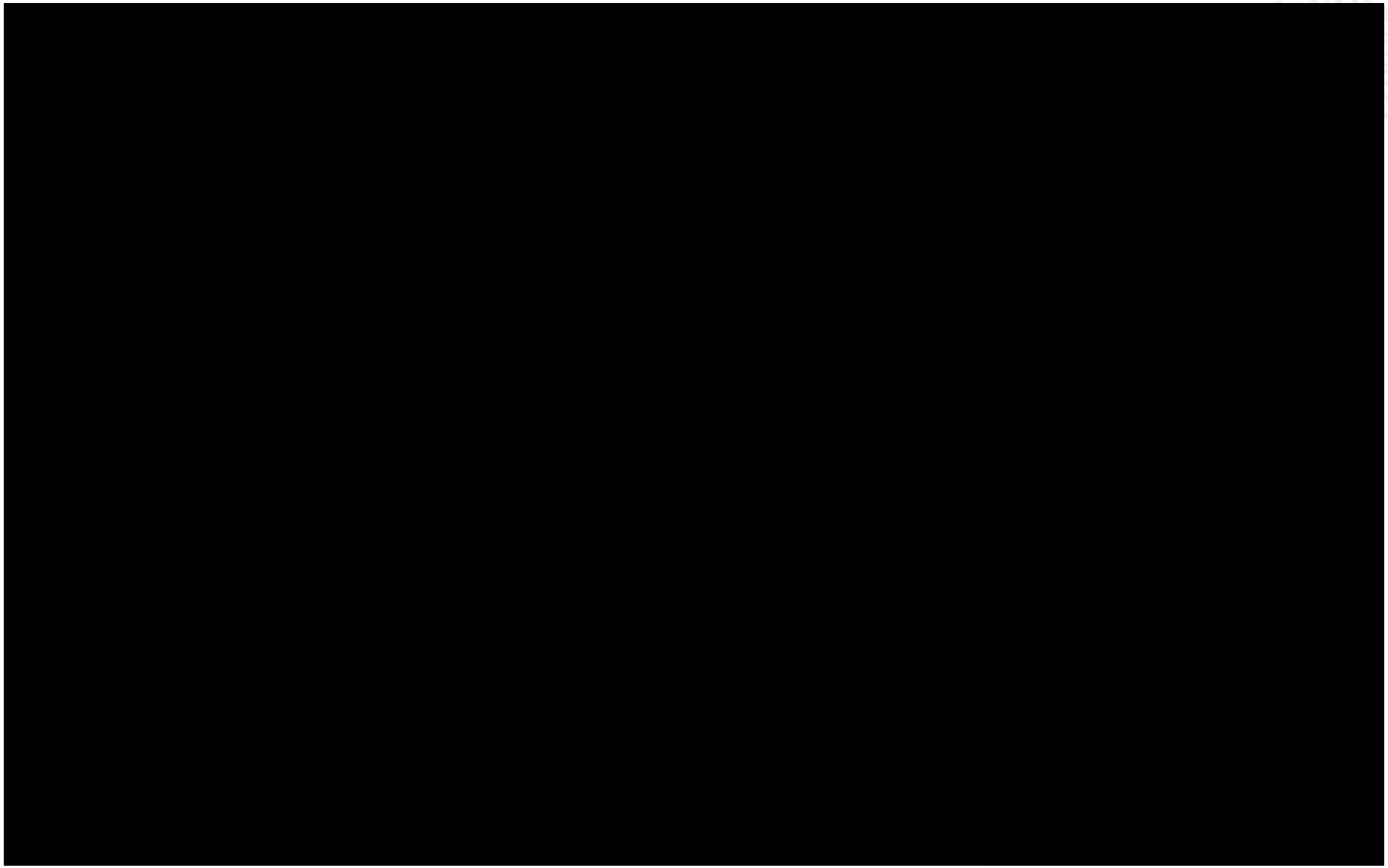
Datacenter Crash/Partition – Router Integration



Router Integration

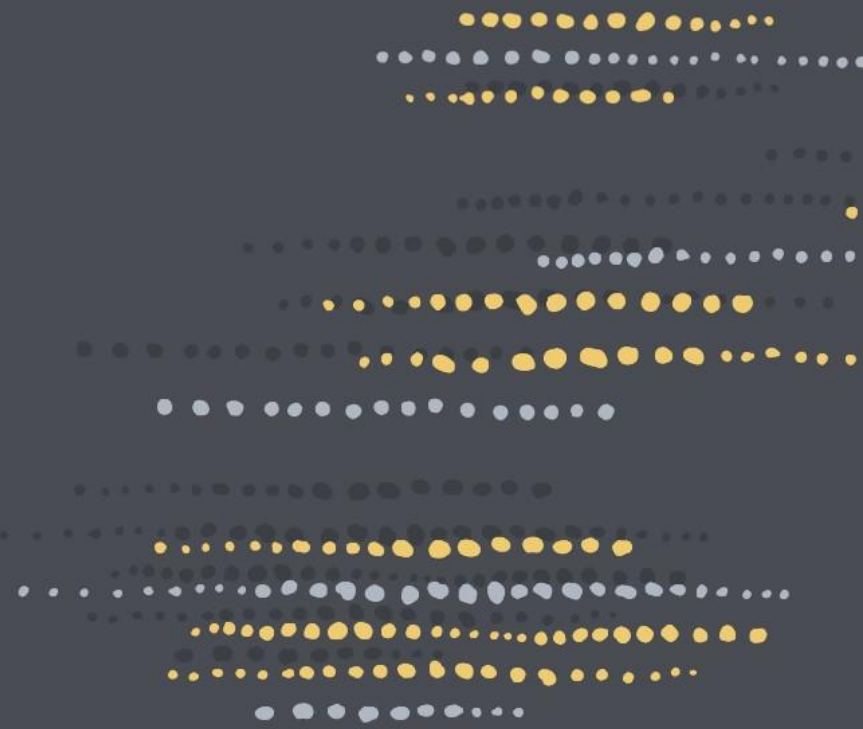
- MySQL Router는 새로운 토폴로지에 대해서 인지해야 하며, 트래픽을 redirect 해야 한다.
- Old Primary cluster를 라우팅했던 MySQL Router들은 old primary cluster에 대한 정보를 포기해야 하며 새로운 topology를 배워야 한다.

MySQL InnoDB ClusterSet Demo



MySQL Database Architectures

Summary



Business Requirements

RTO & RPO ?

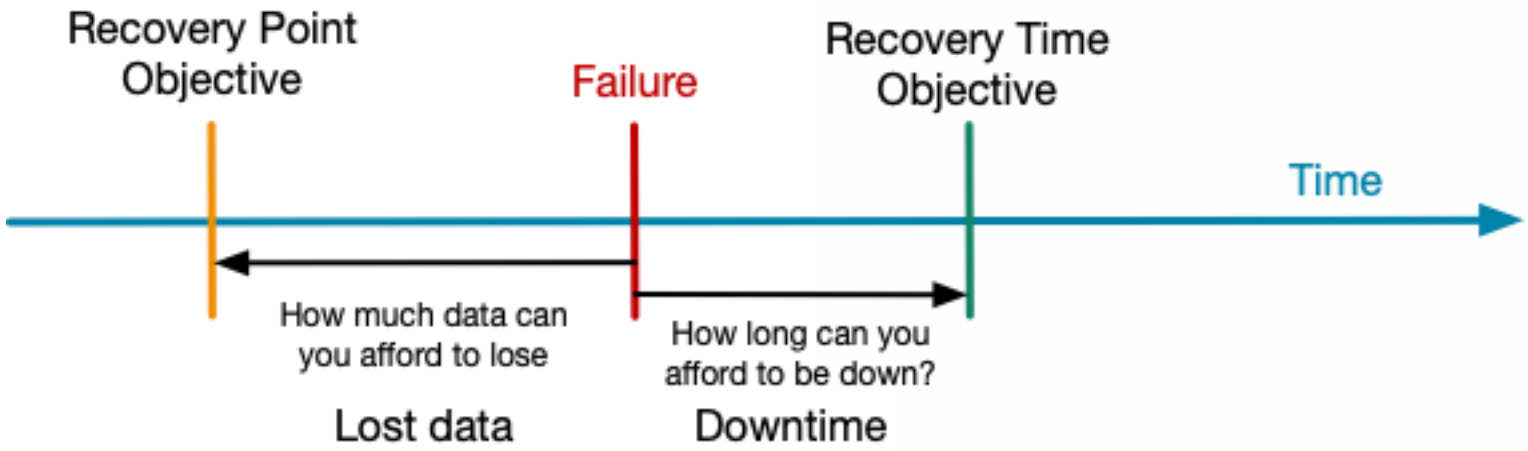
- RTO: Recovery Time Objective (= 복구 시간)
  How long does it take to recover from a single failure
- RPO: Recovery Point Objective (= 장애 시 데이터 유실)
  How much data can be lost when a failure occurs

Types of Failure

High Availability: Single Server Failure, Network Partition

Disaster Recovery: Full Region/Network Failure

Human Error: Little Bobby Tables



MySQL Database Architectures

Single Region

Requirement	Solution
RTO = hours, RPO = minutes	MySQL Server w. Backups & Binary Log Sync
RTO = hours, RPO = less than a second	MySQL Server w. Backups & Binary Log Stream
RTO = minutes, RPO = less than a second	MySQL InnoDB ReplicaSet
RTO = seconds, RPO = 0	MySQL InnoDB Cluster

Multi Region

Requirement	Solution
RTO = minutes, RPO = seconds	MySQL InnoDB Cluster w. asynchronous replica
RTO = seconds and/or RPO = 0	MySQL InnoDB ClusterSet

Q&A