

MySQL HA Solutions

Selecting the best approach to protect access to your data

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clusterdb.com

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Safe Harbor Statement

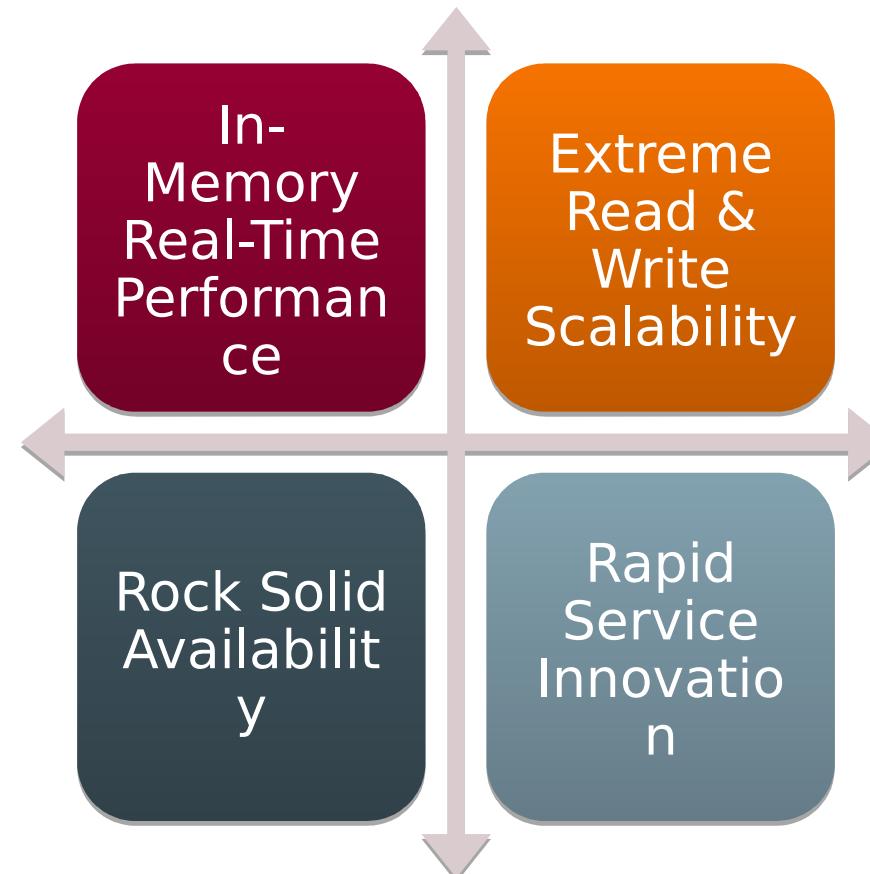
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Industry Leaders Rely on MySQL



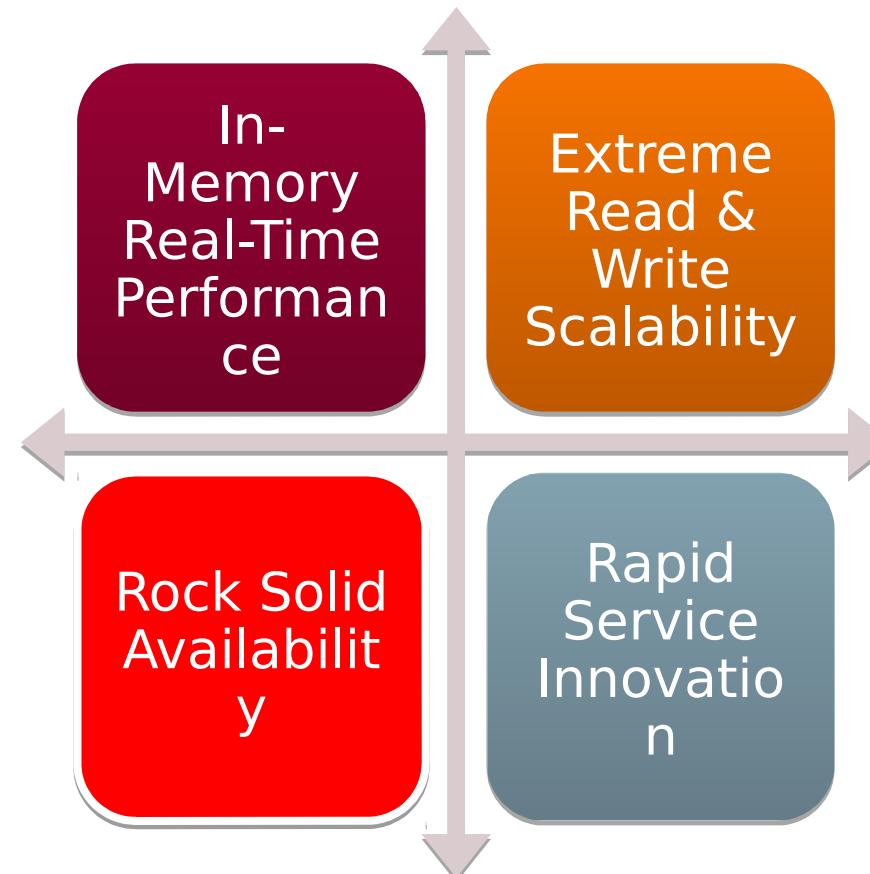
Driving new Database Requirements

Focus on driving the business rather than on infrastructure



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Focus on driving the business rather than on infrastructure



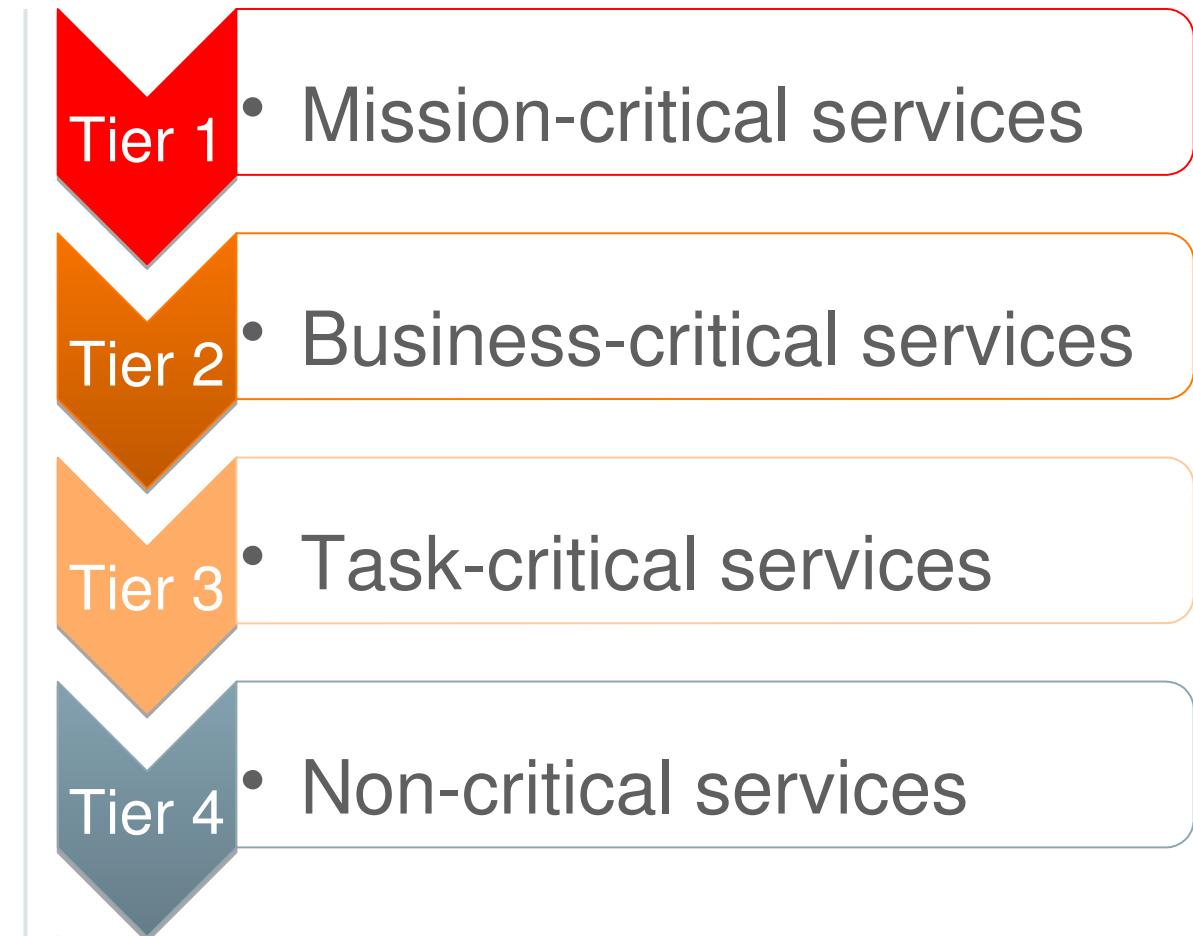
HA Considerations

- SLA requirements to support business objectives
- Operational capabilities
- Service agility & time to market
- Budgetary constraints

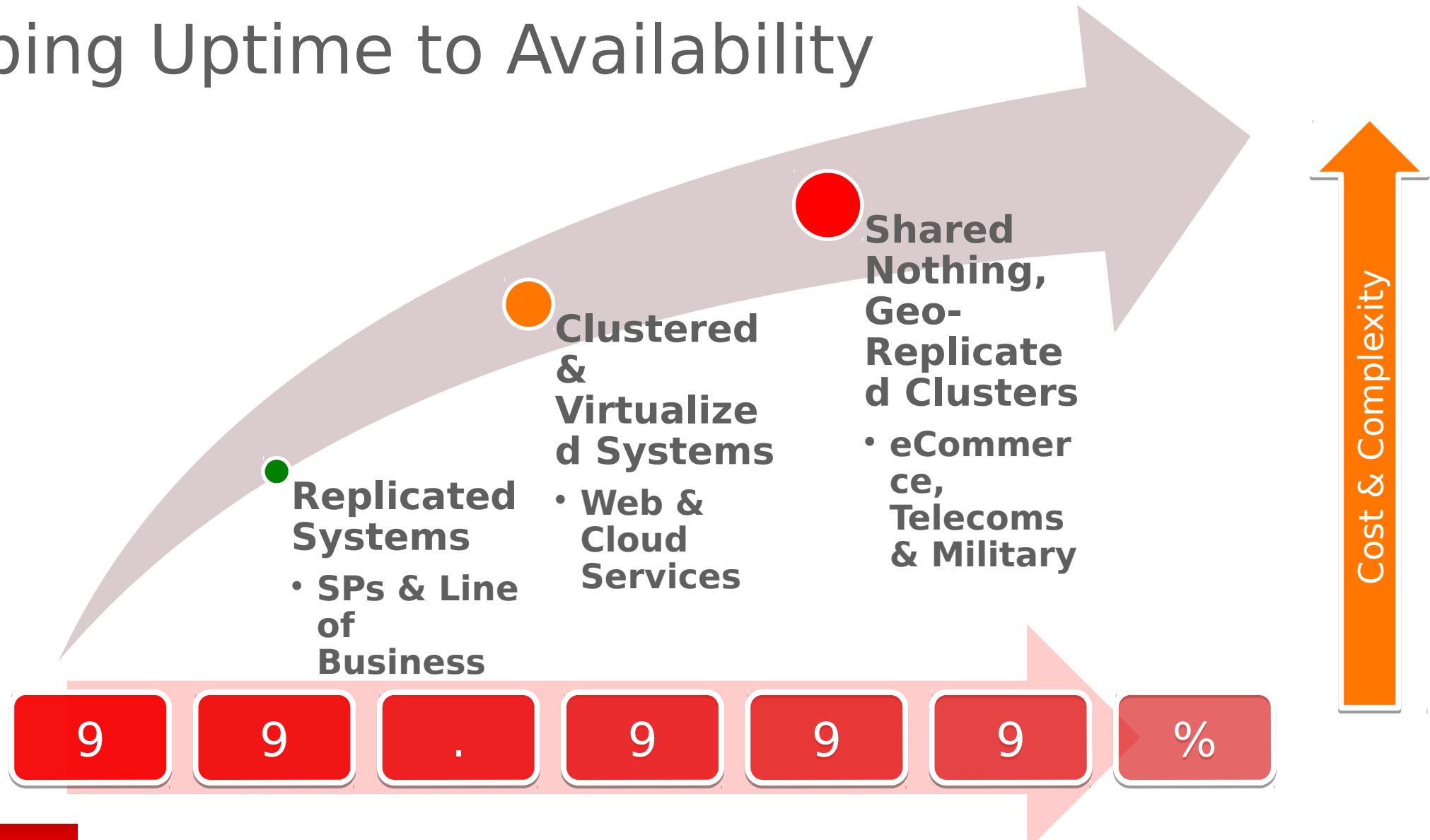


Don't assume 99.999% HA needed for all apps

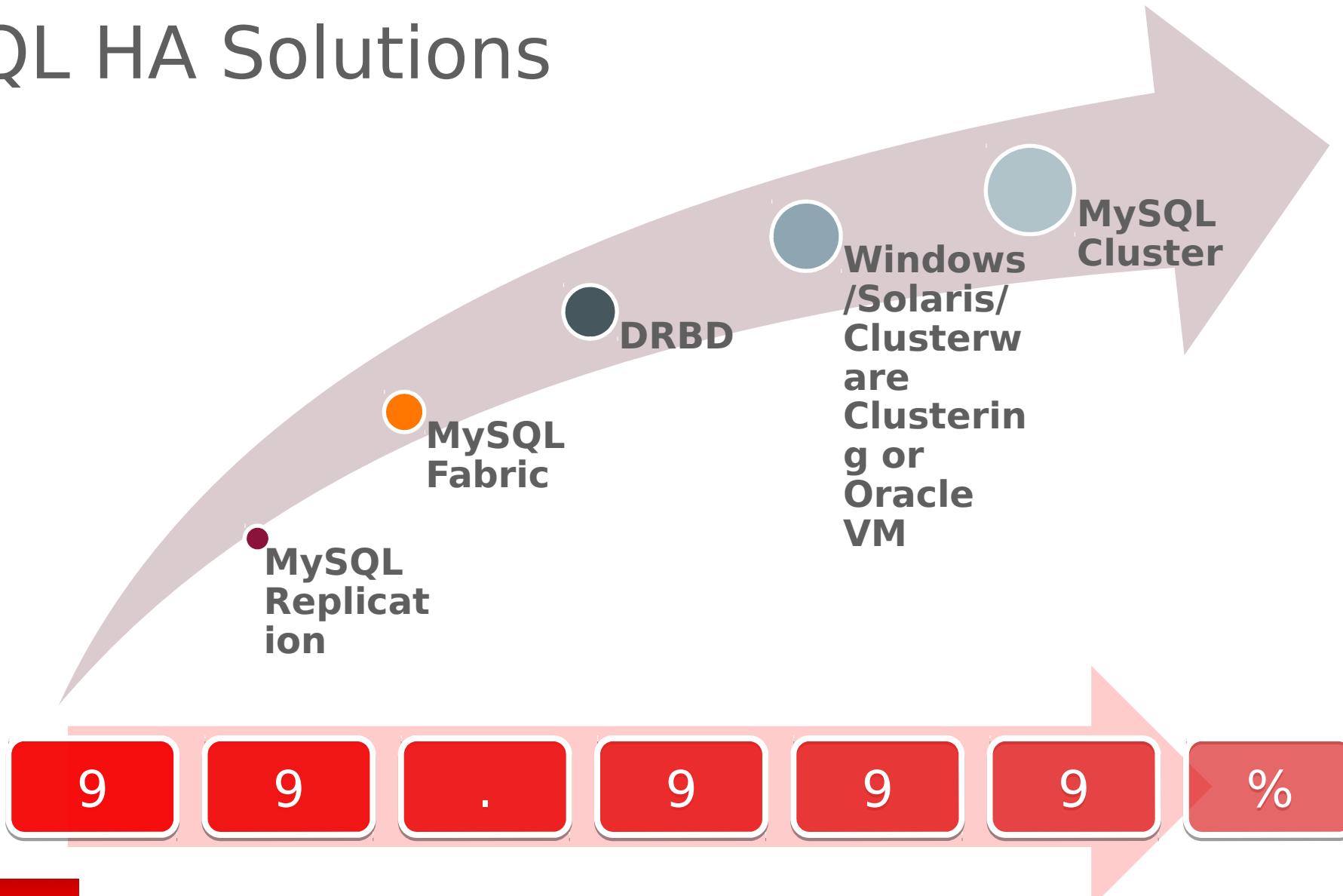
- Recovery Time Objective
 - Maximum length of downtime before there is break in “business continuity”
- Recovery Point Objective
 - Point in time to which data must be recovered when service is re-established



Mapping Uptime to Availability

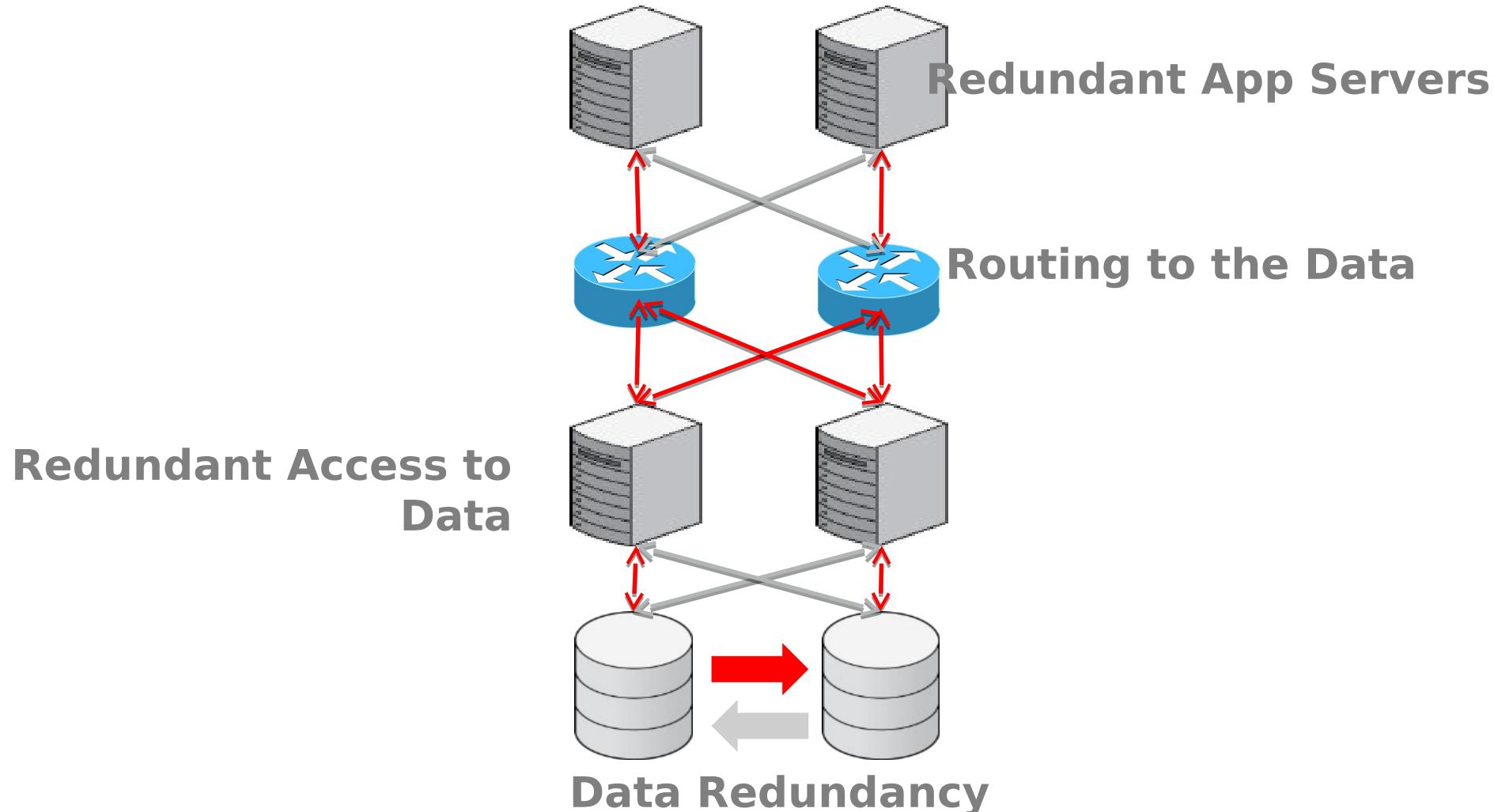


MySQL HA Solutions



Layers of HA

It's not just reliably storing the data

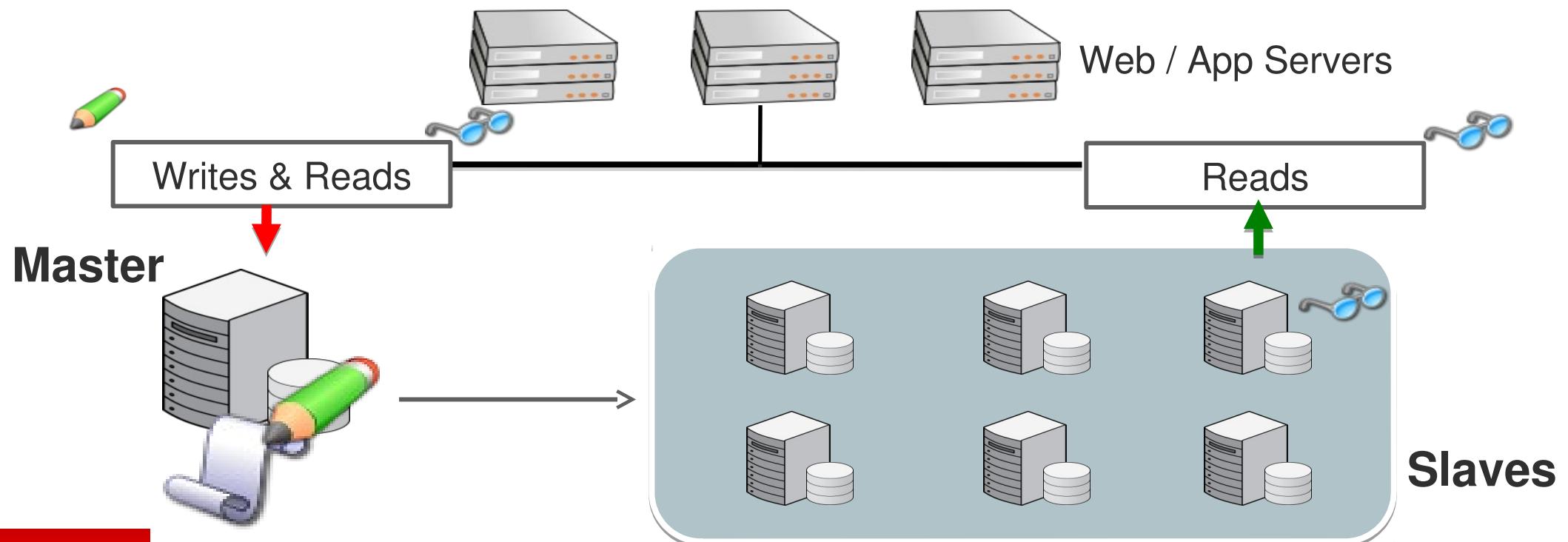


Oracle MySQL HA & Scaling Solutions

	MySQL Replication	MySQL Fabric	Oracle VM Template	Oracle Clusterware	Solaris Cluster	Windows Cluster	DRBD	MySQL Cluster
App Auto-Failover	✗	✓	✓	✓	✓	✓	✓	✓
Data Layer Auto-Failover	✗	✓	✓	✓	✓	✓	✓	✓
Zero Data Loss	MySQL 5.7	MySQL 5.7	✓	✓	✓	✓	✓	✓
Platform Support	All	All	Linux	Linux	Solaris	Windows	Linux	All
Clustering Mode	Master + Slaves	Master + Slaves	Active/Passive	Active/Passive	Active/Passive	Active/Passive	Active/Passive	Multi-Master
Failover Time	N/A	Secs	Secs +	Secs +	Secs +	Secs +	Secs +	< 1 Sec
Scale-out	Reads	✓	✗	✗	✗	✗	✗	✓
Cross-shard operations	N/A	✗	N/A	N/A	N/A	N/A	N/A	✓
Transparent routing	✗	For HA	✓	✓	✓	✓	✓	✓
Shared Nothing	✓	✓	✗	✗	✗	✗	✓	✓
Storage Engine	InnoDB	InnoDB	InnoDB	InnoDB	InnoDB	InnoDB	InnoDB	NDB

Why Replicate?

- Duplicates database from a “master” to a “slave”
 - Redundant copies of the data provide foundation for High Availability
 - Scale out by distributing queries across the replication farm



Twitter



Company Overview

Twitter's mission: To give everyone the power to create and share ideas and information instantly, without barriers.

Application

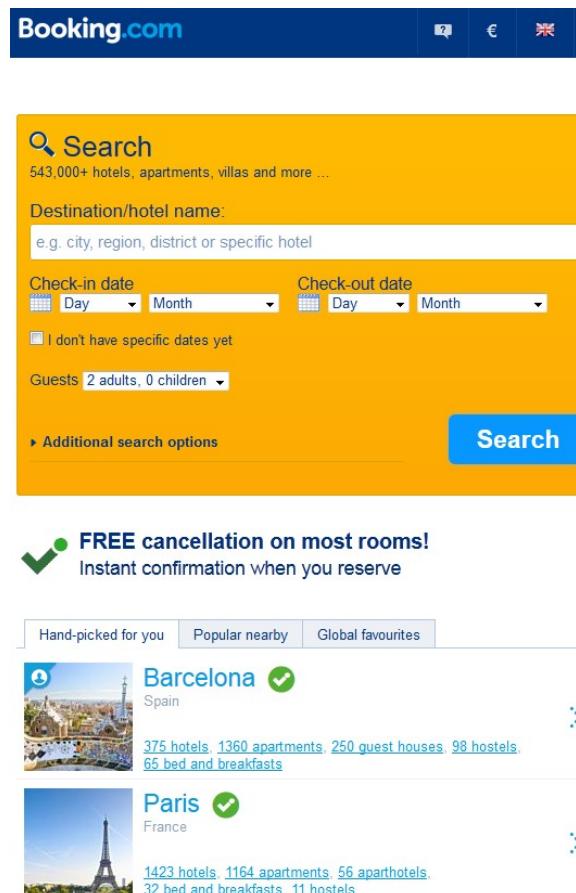
A typical day sees over 500 million tweets, which means about 5,700 per second with MySQL. Twitter achieved in August 2013 a new World record of 143,199 Tweets Per Second (TPS).

Why MySQL 5.6?

“Performance, replication, compression improvements, transportable tablespaces, better monitoring & diagnostics.” Calvin Sun, Senior Engineering Manager, Twitter

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Booking.com



Company Overview

Each day, over 700,000 room nights are reserved on Booking.com. Part of the Priceline Group.

Application

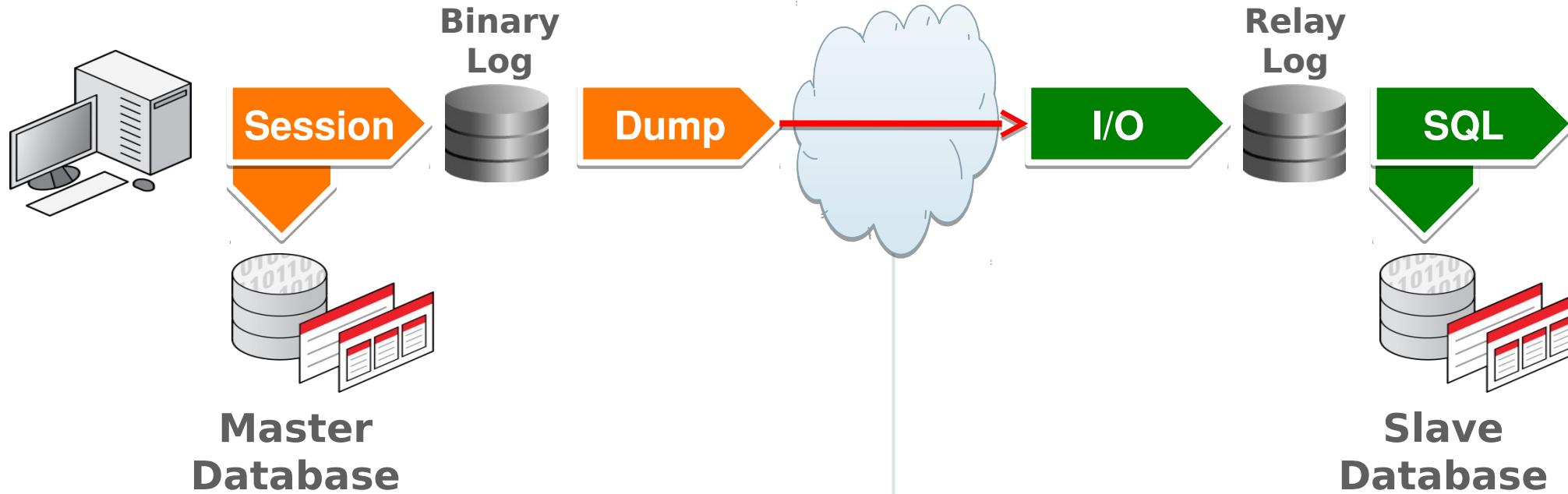
Booking has relied on MySQL since 2003. Supporting 60-70% annual growth and an agile development model.

Why MySQL?

Performance and scalability to manage a very large event volume:

- 60 MByte/sec Event data rate
- 2 Billion Events per day
- 15 TB in MySQL for Events, lookups, monitoring
- 150 TB MySQL Event archive

MySQL Replication Workflow



- Session thread: processes queries from the application – writes data to master database & associated events to binary log
- Dump thread: reads events from binary log and sends them to a slave

- I/O thread: receives replication events and stores them in slave's relay log
- SQL thread: reads replication events from slave's relay log and applies them to slave database

Asynchronous vs. Synchronous Replication

- Asynchronous
 - MySQL Default
 - In **parallel**: Master acks to app and sends transaction to slave
 - Fast
 - Risk of lost changes if master dies

Synchronous

- MySQL 5.5+ - Enhanced in MySQL 5.7
- **Serially**: Master waits for change to be received by slave then In **parallel** ack to app and apply changes on slave
 - Intermediate latency
 - Lossless (MySQL 5.7)

- Synchronous
 - Only available with MySQL Cluster
 - **Serially**: Master waits for change to be applied on all slaves before ack to app
 - Higher latency
 - If Active/Active, best suited to small transactions
 - Lossless

MySQL 5.6 Replication

Performance and Scalability

- 5x Higher slave throughput with MTS (multiple schemas)
- Reduced master impact – Binlog Group Commit

Simplicity

- Global Transaction IDs

Automation

- MySQL Replication Utilities (including auto-failover)

Robustness

- Crash safety
- Replication checksums

Insurance

- Time Delayed Replication

MySQL 5.7 Replication – **Pre-GA**

Performance and Scalability

- Intra-schema Multi-Threaded Slave
- Faster Master

Monitoring

- Performance Schema

Operational Simplicity

- Dynamic slave filters
- On-line CHANGE MASTER

Resilience

- Lossless Semi-Synchronous Replication
- Multiple Semi-Synchronous Acks

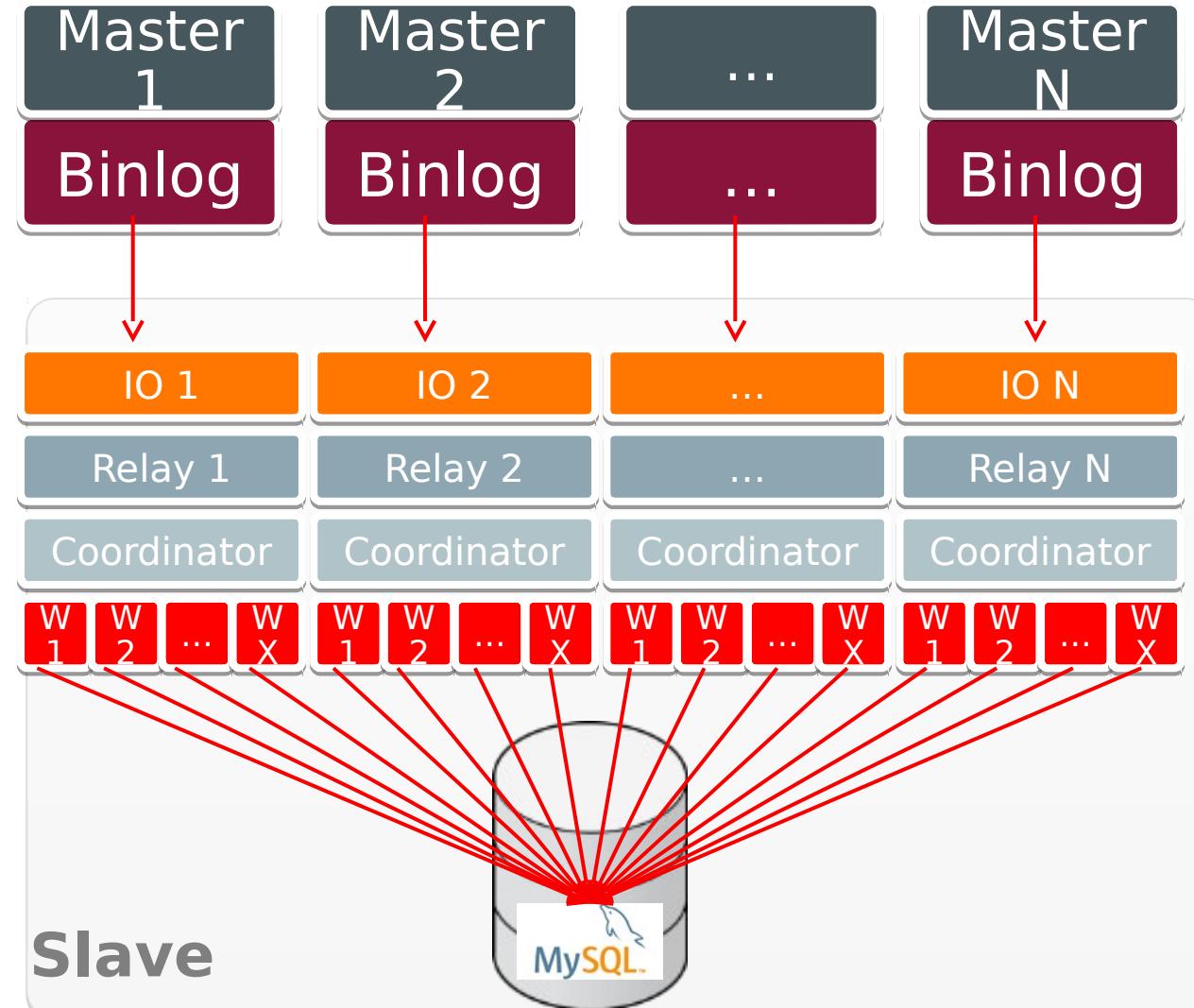
MORE Resilience

- GTIDs stored in transactional tables
- Automatic slave retries

Multi-Source Replication

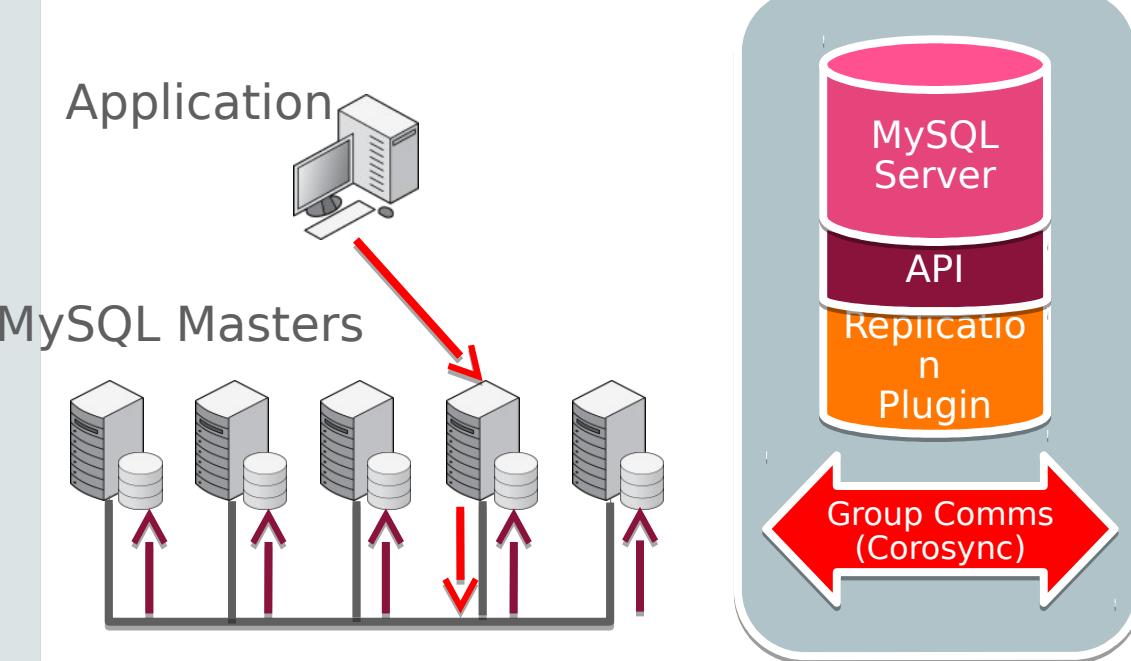
labs.mysql.co
m

- Consolidate updates from multiple Masters into one Slave
 - Consolidated view of all shards
 - More flexible topologies
 - Centralized point for backups
- Compatible with Semi-Sync Replication & enhanced MTS
- Master-specific slave filters



MySQL Group Replication

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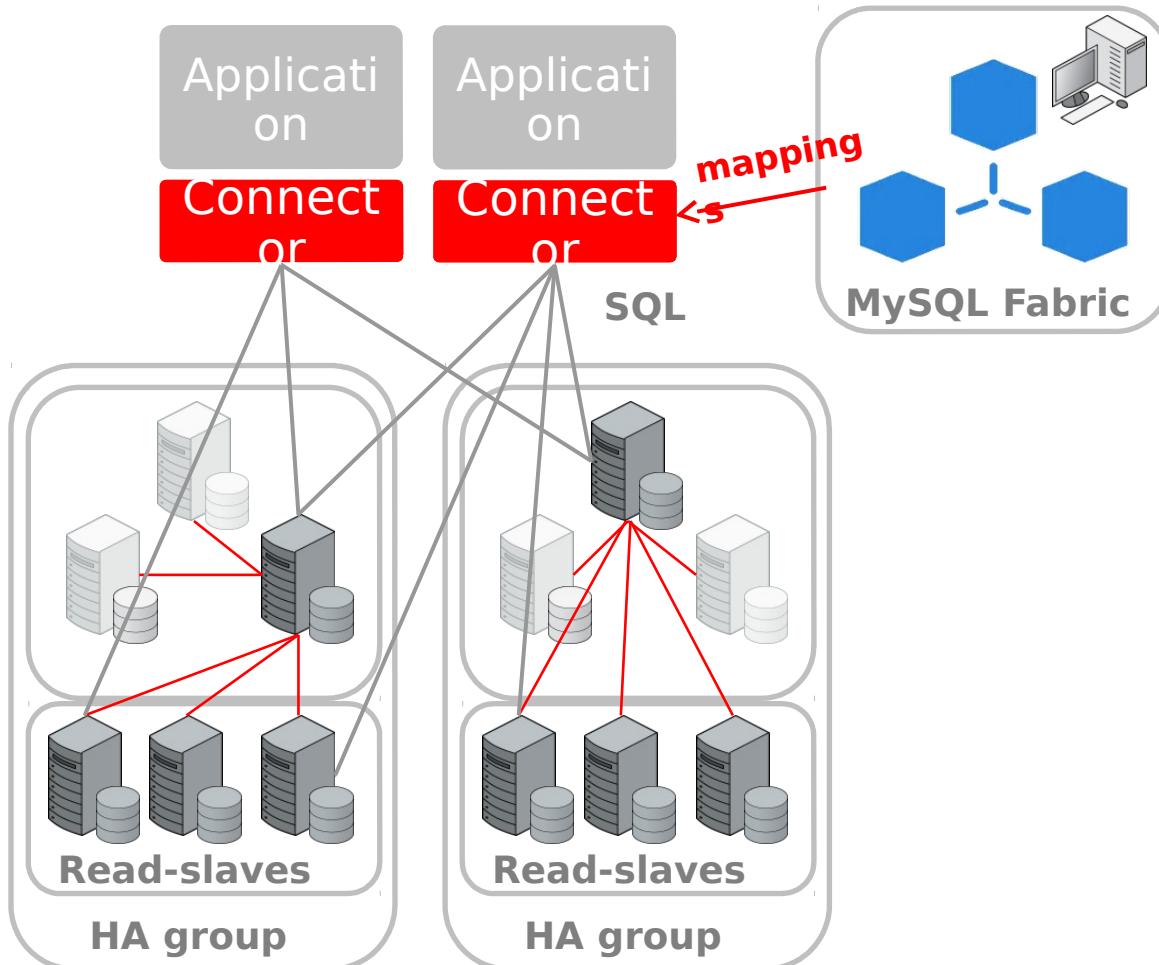
- Shared-nothing virtually synchronous database system
- Multi-master update anywhere
 - Conflict detection and resolution (transaction rollback)
 - Optimistic State Machine Replication
- Automatic group membership management and failure detection
 - No need for server fail-over
 - Elastic scale out/in
 - No single point of failure
 - Automatic reconfiguration
- Well integrated
 - InnoDB
 - GTID-based replication
 - PERFORMANCE_SCHEMA

MySQL Fabric
Anyextensible and
easy-to-use
framework for
managing a farm of
MySQL server
supporting high-
availability and
sharding



MySQL Fabric 1.5

High Availability + Sharding-Based Scale-out



- High Availability
 - Server monitoring with auto-promotion and transparent application failover
- Optionally scale-out through sharding
 - Application provides shard key
 - Range or Hash
 - Tools for resharding
 - Global updates & tables
- Fabric-aware connectors rather than proxy: Python, Java, PHP, .NET, C (labs)
 - Lower latency, bottleneck-free

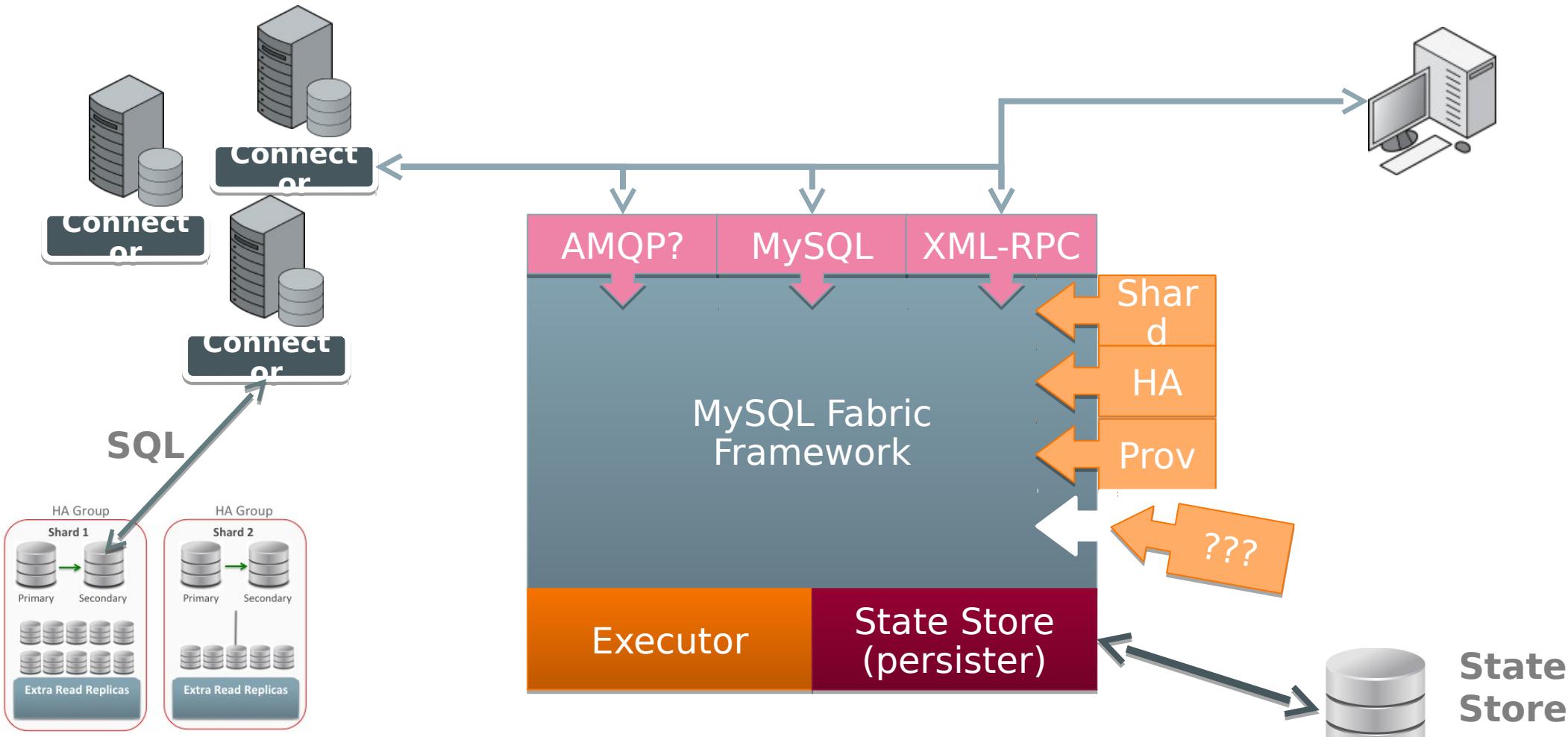
MySQL Replication & MySQL Fabric HA

How this effects failover

- MySQL Replication is the initial implementation used in HA Groups
 - **PRIMARY** = Replication Master & receives all writes
 - **SECONDARY** = Replication Slave & receives share of reads
- Failover
 - MySQL Fabric detects failure of PRIMARY/Master
 - Selects a SECONDARY/Slave and promotes it
 - Updates State Store
 - Updated state fetched by Fabric-aware connectors

MySQL Fabric Node

Extensible Architecture



X ACTIVE



TAKE
OVER



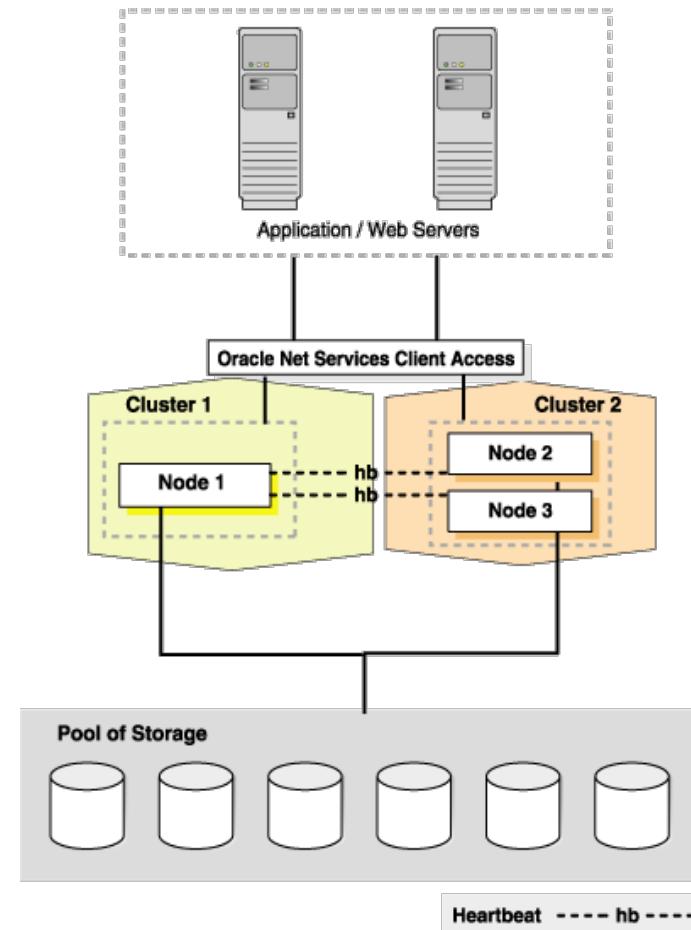
SHARED
STORAGE



OPASSIVE

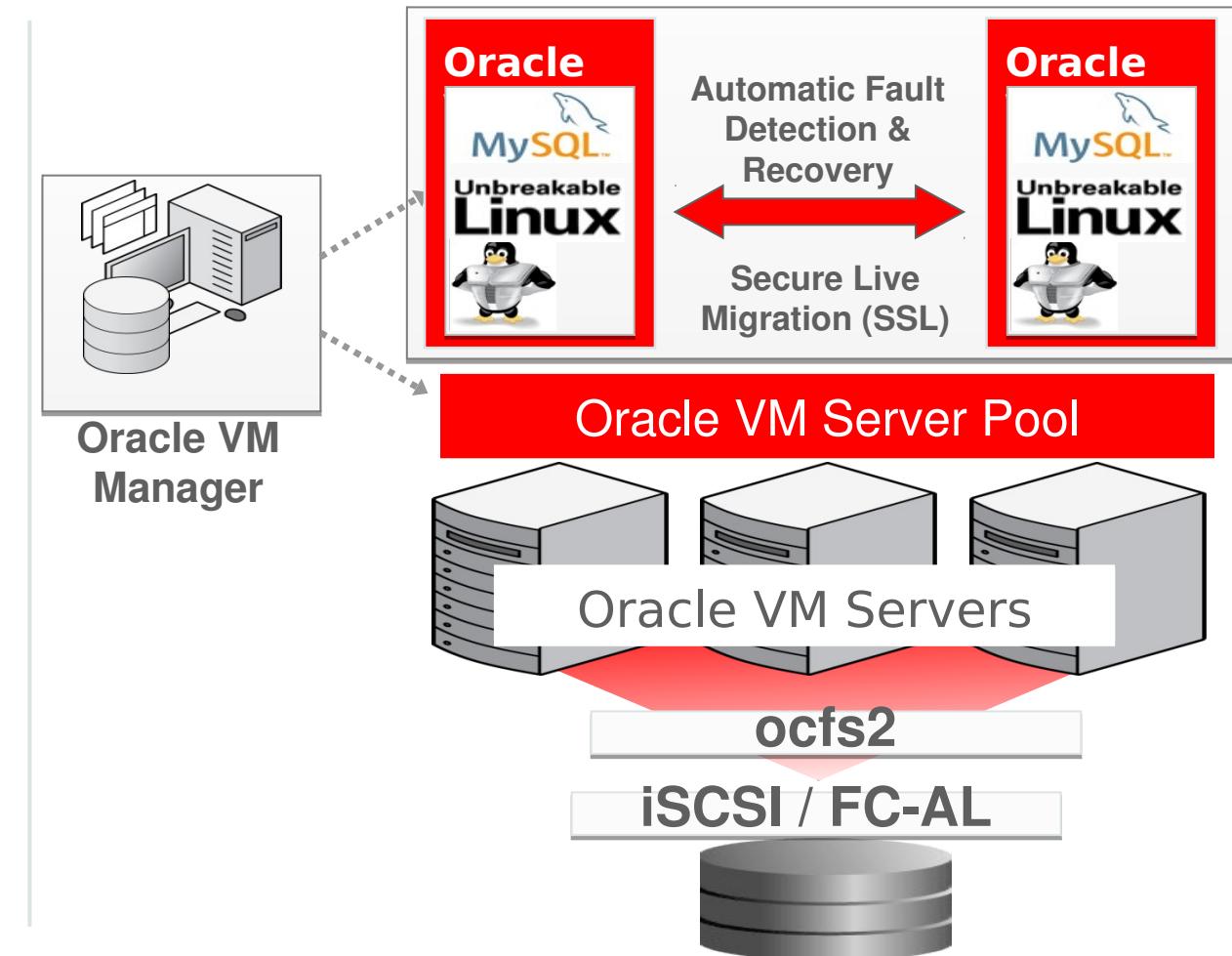
MySQL on Oracle Clusterware

- Oracle Clusterware unifies servers in a server farm to form a cluster
 - At the core of Oracle RAC
- Oracle Cluster 12c includes MySQL Server 5.6 agent
- Planned migration and failover of MySQL database
 - Hidden from the application



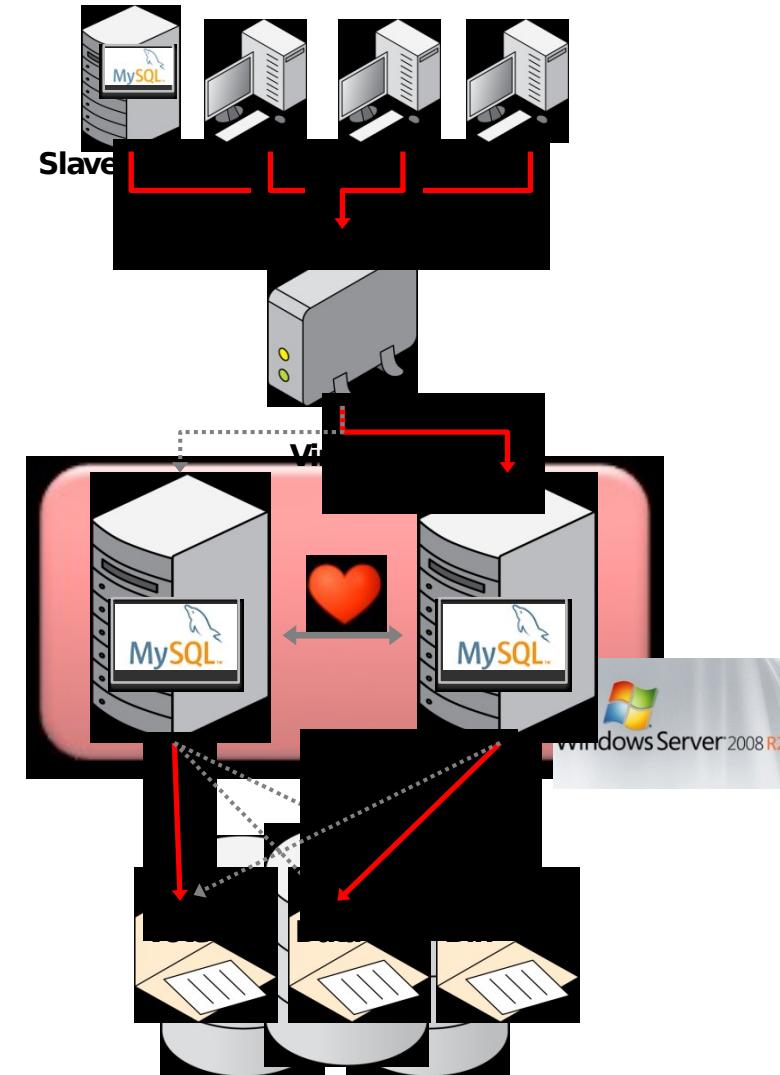
Oracle VM Template for MySQL

- Pre-Installed & Pre-Configured
- Full Integration & QA Testing
- Single Point of Support



Windows Server Failover Clustering

- Native Windows HA clustering with MySQL
- Quorum (3rd vote), data (InnoDB + schema) & binaries (optional) stored in shared storage (iSCSI & FCAL)
- Loss of service = couple of seconds + InnoDB recovery time
- Cluster managed through **ORACLE MS Failover Cluster**



Oracle Solaris Clustering

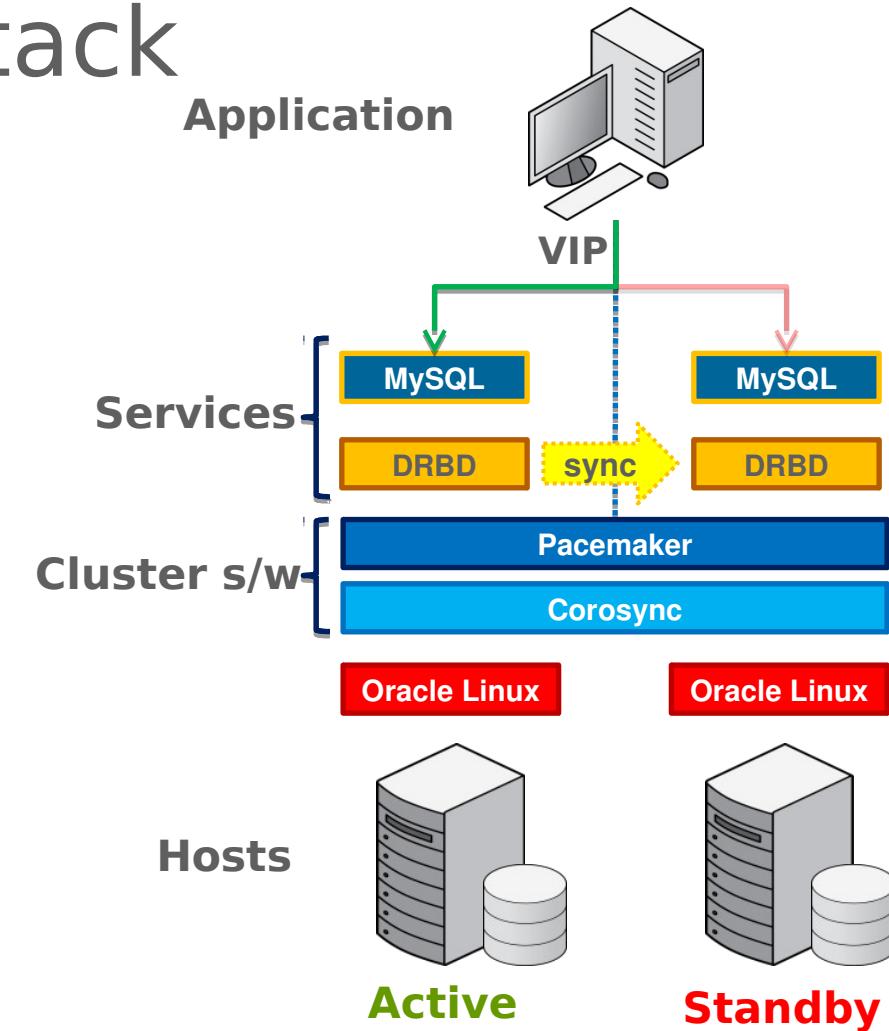
- Kernel based heartbeating and monitoring
- SPARC and x86. Solaris Virtualization-aware
- MySQL agent included with Oracle Solaris Cluster
- Learn more:

<http://www.oracle.com/technetwork/server-storage/solaris-cluster/overview/index.html>



Oracle Linux and DRBD Stack

- Based on distributed storage
 - NOT physical shared storage
- Synchronous replication at block device level eliminates risk of data loss
- Open source, mature & proven
- Certified and supported by Oracle



MySQL Cluster Overview

REAL-TIME

- Memory optimized tables with durability
- Predictable Low-Latency, Bounded Access Time

HIGH SCALE, READS + WRITES

- Auto-Sharding, Multi-Master
- ACID Compliant, OLTP + Real-Time Analytics

99.999% AVAILABILITY

- Shared nothing, no Single Point of Failure
- Self Healing + On-Line Operations

SQL + NoSQL

- Key/Value + Complex, Relational Queries
- SQL + Memcached + JavaScript + Java + HTTP/REST & C++

LOW TCO

- Open Source + Commercial Editions
- Commodity hardware + Management, Monitoring Tools

Who's Using MySQL Cluster?



ORACLE®



PayPal



Company Overview

PayPal allows any business or individual with an email address to securely, conveniently and cost-effectively send and receive payments online.

Application

PayPal built a cloud-based globally-distributed database with 100 TB of user-related data based on MySQL Cluster. “Must NOT lose data” system, delivering 99,999% availability, transactional, with data available WW anywhere in < 1 Sec.

Why MySQL Cluster?

“You can achieve high performance and availability without giving up relational models and read consistency.” Daniel Austin, Chief Architect, PayPal

Alcatel-Lucent



Company Overview

Global telecommunications equipment company, focuses on fixed, mobile, and converged networking hardware, IP technologies, software, and services.

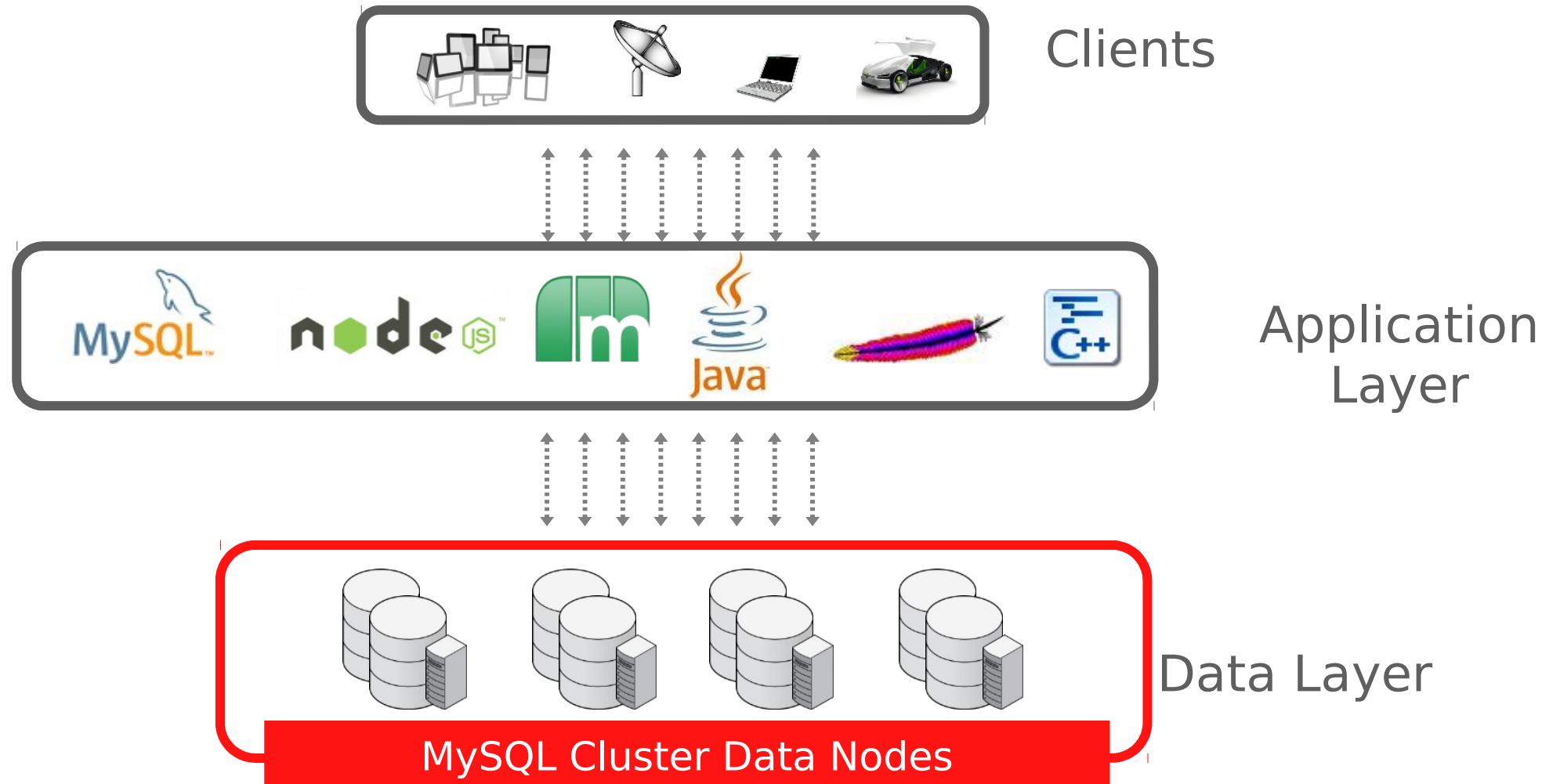
Application

MySQL Cluster CGE is at the heart of Alcatel-Lucent's Subscriber Data Manager to deliver converged IMS services to mobile and fixed line users.

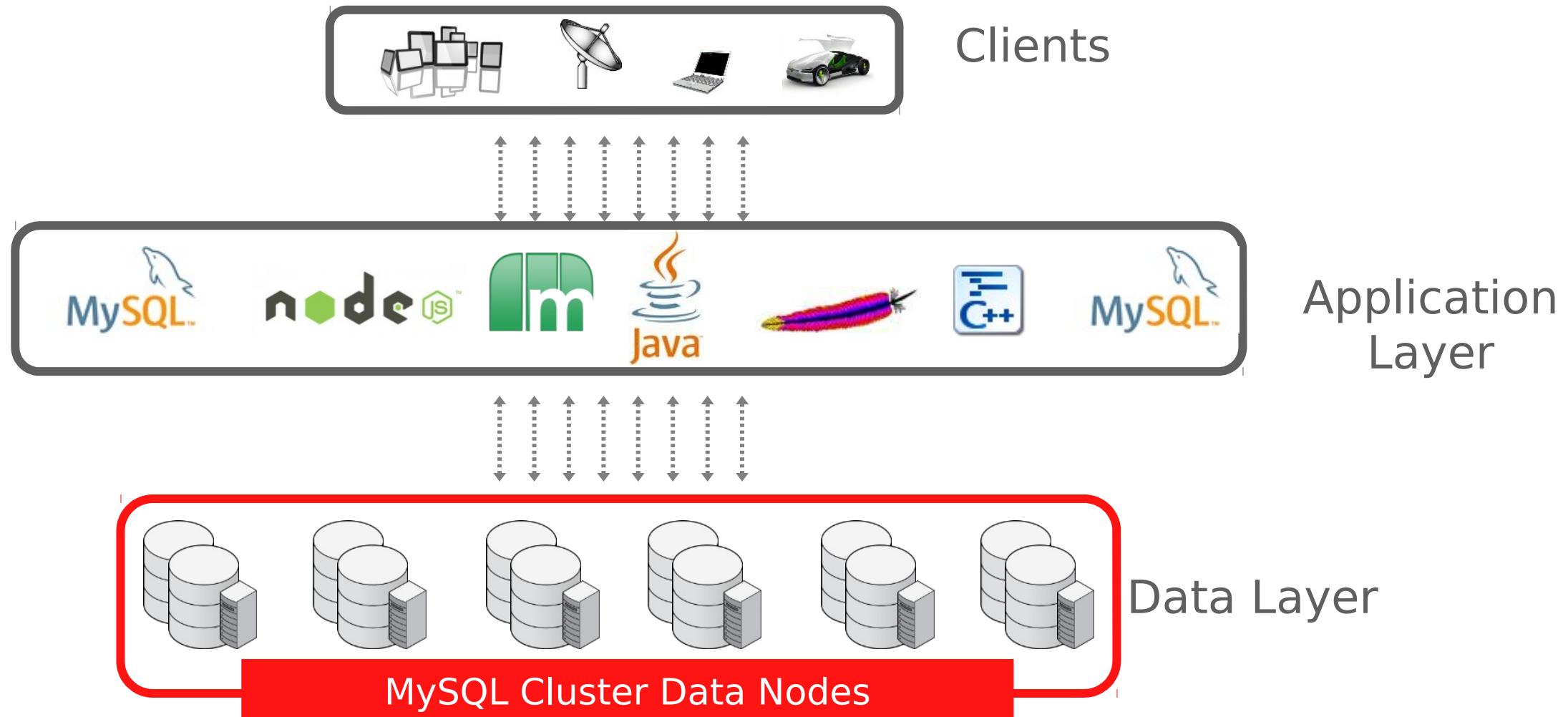
Why MySQL Cluster CGE?

- Delivers the performance, scalability and availability required by this mission critical real-time application
- Real-time read & write access for tens of millions of subscribers in a single system
- Always-on service: no offline maintenance window for services users depend on (voice, SMS, email, Web, social media...)

MySQL Cluster Architecture

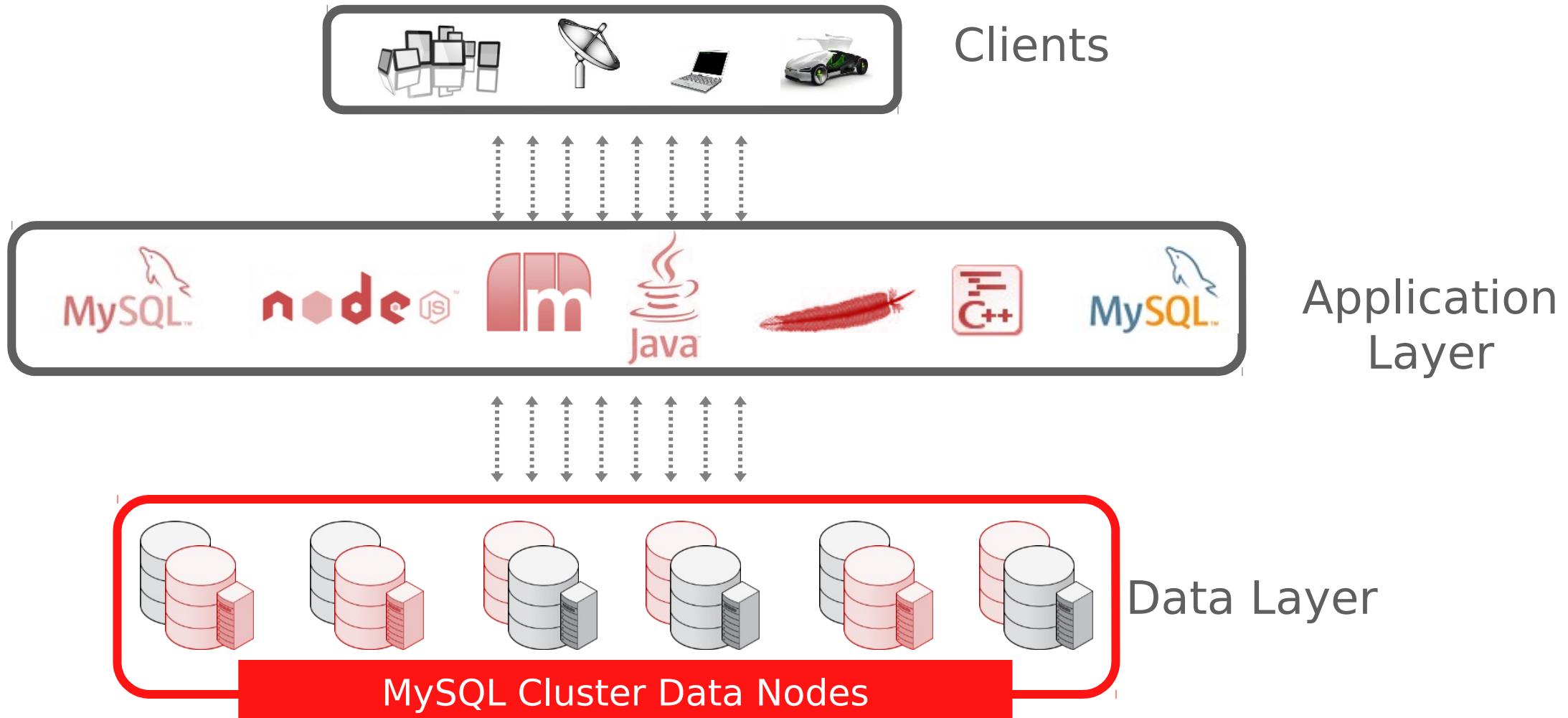


MySQL Cluster Scaling



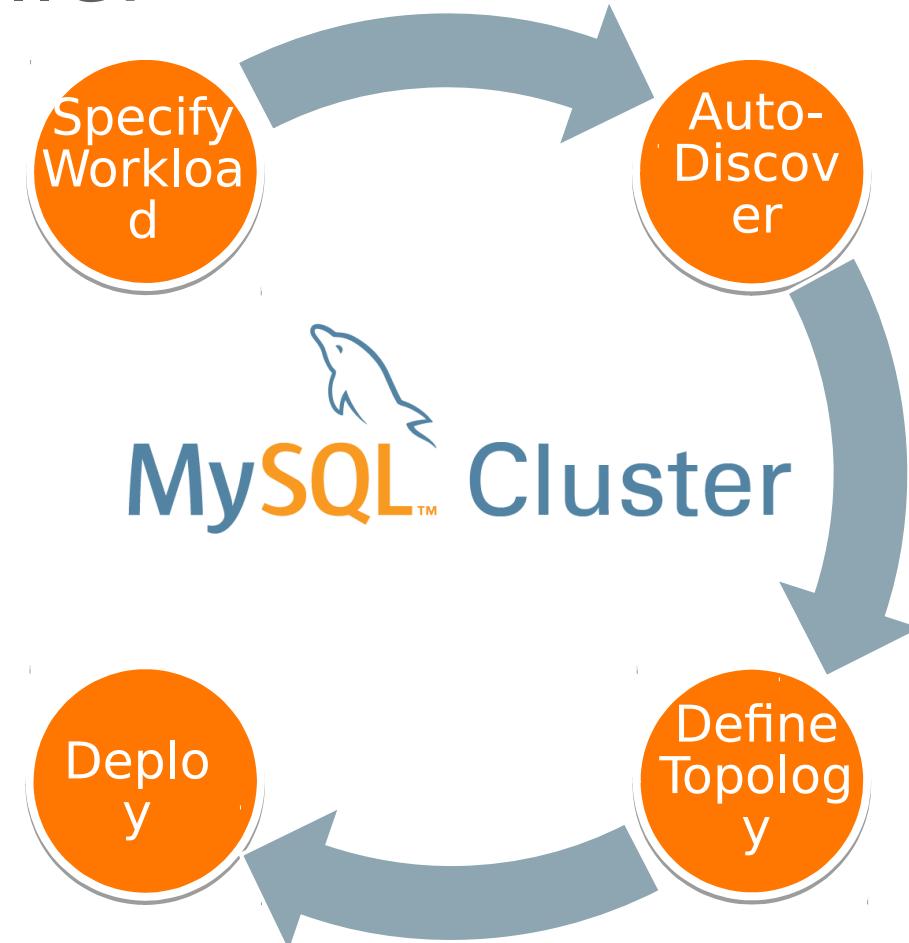


MySQL Cluster HA



MySQL Cluster Auto-Installer

- Fast configuration
- Auto-discovery
- Workload optimized
- Repeatable best practices



Active-Active Geo-Replication

- Asynchronous replication between MySQL Clusters



- Active-Active
 - Update anywhere
 - Conflict detection
 - Application notified through exception tables
 - Can opt to have conflicts resolved automatically
 - Auto-conflict-resolution
 - Conflicting transaction and dependent ones are rolled-back (MySQL Cluster 7.4 – **pre GA**)
- No changes to application schema

When to Consider MySQL Cluster

- Scalability demands
 - Sharding for write performance?
- Latency demands
 - Cost of each millisecond?
- Uptime requirements
 - Cost per minute of downtime?
 - Failure versus maintenance?
- Application agility
 - Developer languages and frameworks?
 - SQL or NoSQL?



MySQL Enterprise Edition



Advanced Features

- Scalability
- High Availability
- Security
- Audit



Management Tools

- Monitoring
- Backup
- Development
- Administration
- Migration



Support

- Technical Support
- Consultative Support
- Oracle Certifications





MySQL Enterprise Monitor



Application

Big Fish Games is a global leader in the online games industry and distributes more games worldwide than any other online site.

Key Business Benefit

MySQL Query Analyzer provides a consolidated view of query activities and execution details, and has enabled Big Fish Games to quickly identify poorly running queries and tackle the root causes directly in the SQL code.

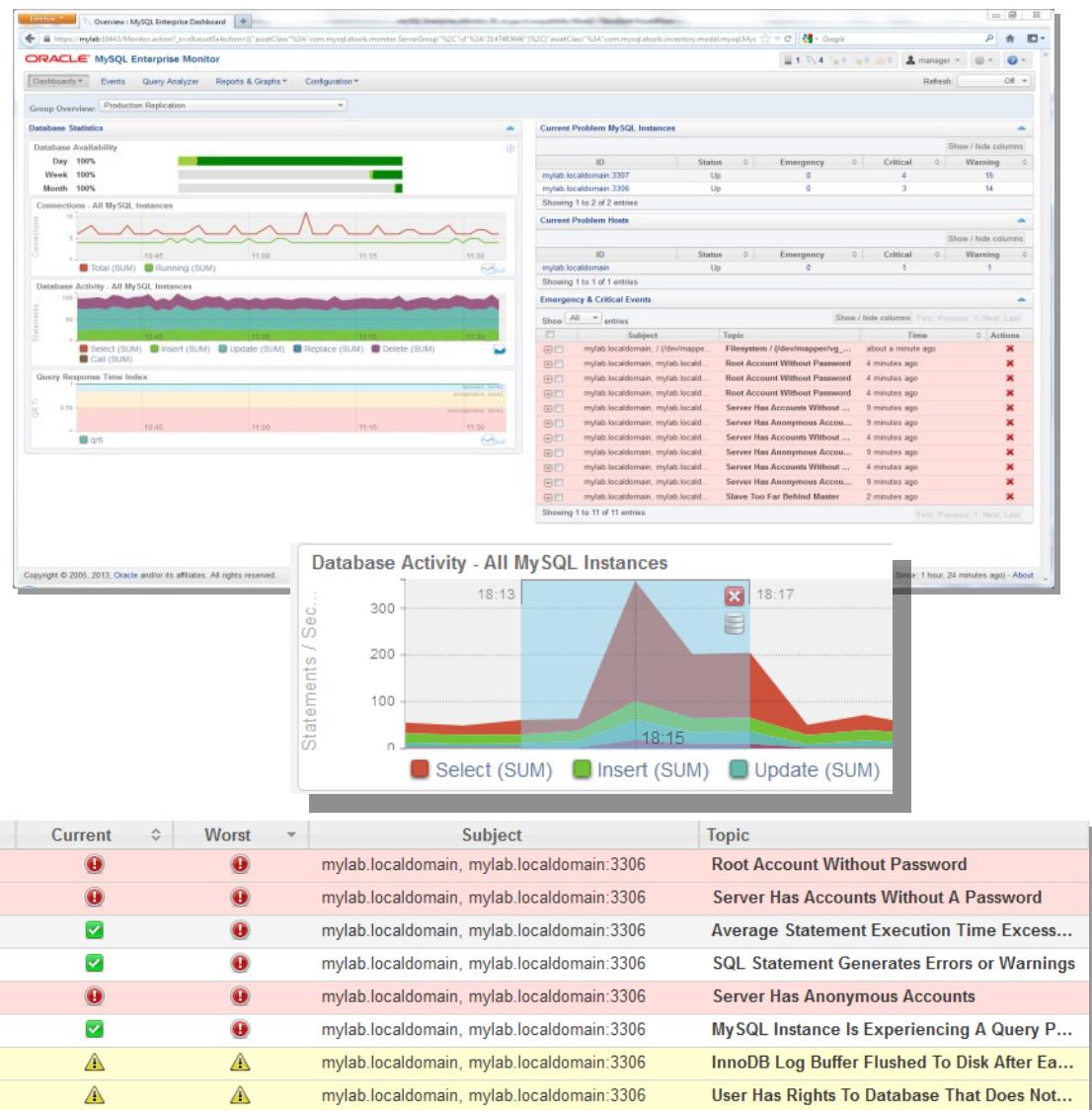
Why MySQL?

"With the MySQL Query Analyzer, we were able to identify and analyze problematic SQL code, and triple our database performance. More importantly, we were able to accomplish this in three days, rather than taking weeks."

Keith Souhrada, Software Development Engineer, Big Fish Games

MySQL Enterprise Monitor

- Start monitoring MySQL in 10 minutes
- Real-time MySQL performance and availability monitoring
- Visually find & fix problem queries
- Disk monitoring for capacity planning
- Cloud friendly architecture
 - No agents required
- **Optional agent option provides advanced Host/OS monitoring**



Enterprise Replication Monitor

- Auto-discovers replication topology
- Master/Slave performance monitoring
- Replication advisor
- Best practice replication

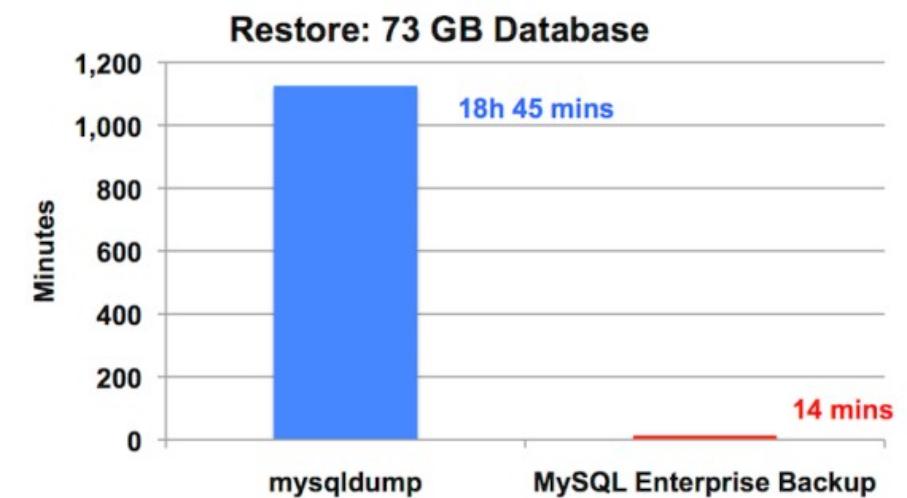
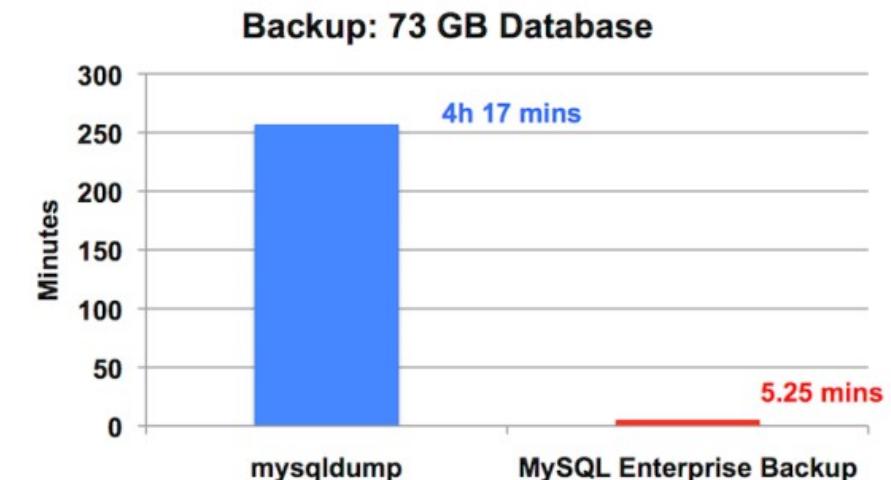
"I use the MySQL Enterprise Monitor every day to monitor and keep tabs on our MySQL databases. Quick one stop shopping for keeping tabs on them."

-Wes Homer
 Sr System and Network Administrator

Replication Monitoring												
Servers	Type	Threads		Time Behind	Binary Logs		Master Position		Log Space			
		IO	SQL		Current File	Position	Binary Log	Position	Binary Logs	Relay Logs		
Replication 1 (4)	MIXED											
mylab.localdomain:3306	master/slave			00:00:00	mylab-bin.000001	791	mylab-bin.000001	791	791 B	1.1 KB		
mylab.localdomain:3307	master/slave			00:00:00	mylab-bin.000001	791	mylab-bin.000001	791	791 B	1.1 KB		
mylab.localdomain:3308	master/slave			00:00:00	mylab-bin.000001	986	mylab-bin.000001	791	0.96 KB	1.1 KB		
MLORD-PC:3306	slave			00:00:00			mylab-bin.000001	986		1.29 KB		

MySQL Enterprise Backup

- Online, non-locking backup and recovery
 - Complete MySQL instance backup (data and config)
 - Partial backup and restore
- Direct Cloud storage backups (S3, etc.)
- Incremental backups
- Point-in-time recovery
- Advanced compressed and encryption
- Backup to tape (SBT)
- Backup validation



MySQL Enterprise Monitor + Backup

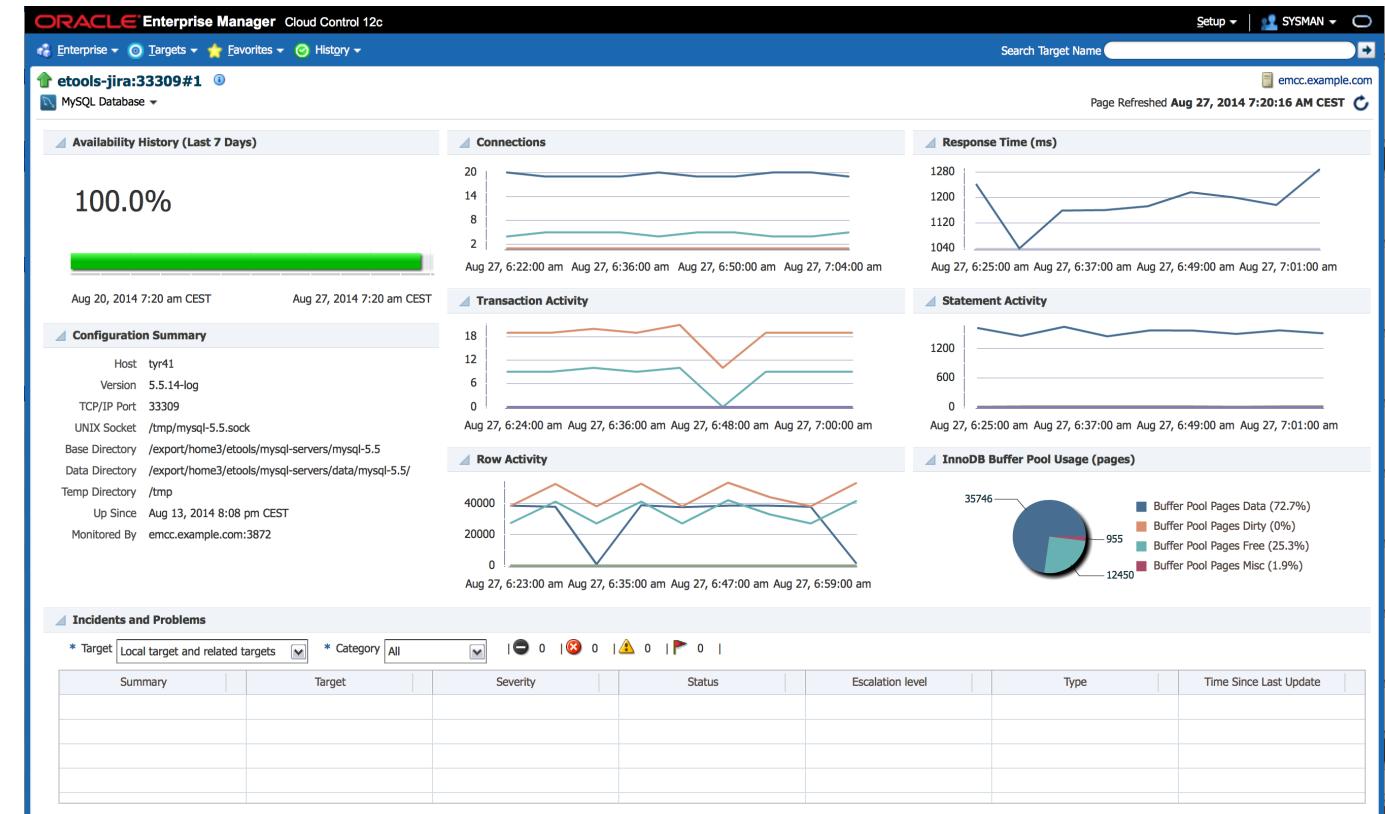
- Monitor backup results
- Monitor backup performance
- Ensure backups are up ^{to} date

The screenshot shows the MySQL Enterprise Monitor interface with the title "ORACLE MySQL Enterprise Monitor". The main area is titled "Advisors" and displays a list of configured items under four categories: Administration, Agent, Availability, and Backup. The "Backup" category is selected, showing five items:

Item	Info	Coverage	Schedule	Event Handling	Status
MySQL Enterprise Backup Failed	100% (1/1)	5m	0 0 0	0 0 0	FAILURE
MySQL Enterprise Backup Succeeded	100% (1/1)	5m	1 0 0	0 0 0	SUCCESS
Last Full MySQL Enterprise Backup Too Old	100% (1/1)	6h	1 0 0	0 0 0	7
Incremental MySQL Enterprise Backups Not Enabled	100% (1/1)	6h	1 0 0	0 0 0	0
MySQL Enterprise Backup Lock Time Excessive	100% (1/1)	5m	0 0 0	0 0 0	10 60

Oracle Enterprise Manager for MySQL

- Availability monitoring
- Performance monitoring
- Configuration monitoring
- All available metrics collected
 - Allowing for custom threshold based incident reports
- MySQL auto-detection



ORACLE®
ENTERPRISE MANAGER

Oracle Premier Support for MySQL

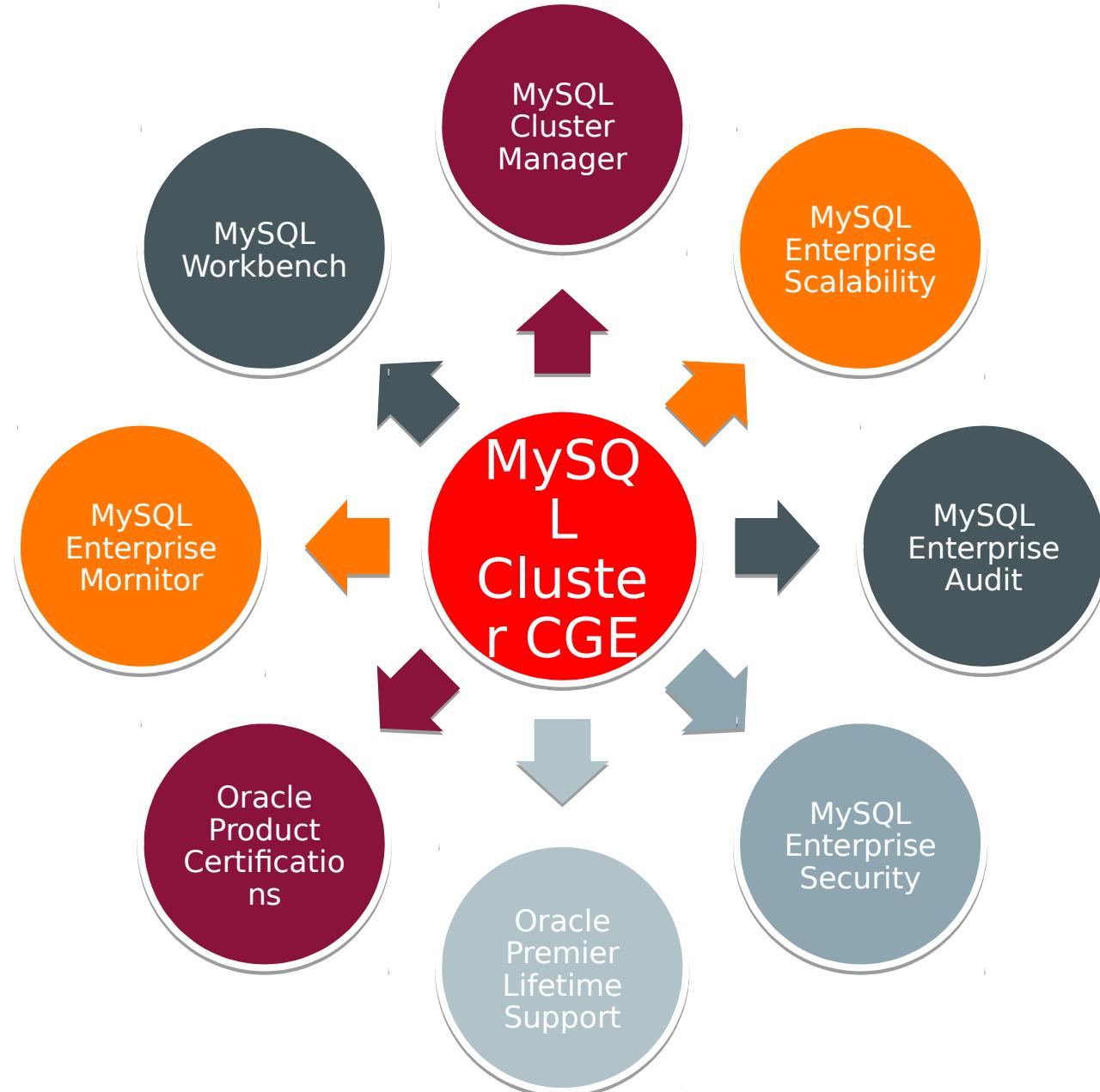
Rely on The Experts - Get Unique Benefits

- Straight from the Source
- Largest Team of MySQL Experts
- Backed by MySQL Developers
- Forward Compatible Hot Fixes
- MySQL Maintenance Releases
- MySQL Support in 29 Languages
- 24/7/365
- Unlimited Incidents
- Knowledge Base
- MySQL Consultative Support

Only From
Oracle

"The MySQL support service has been essential in helping us with troubleshooting and providing recommendations for the production cluster, Thanks."

-- Carlos Morales -
Playfulplay.com



Enhancing DevOps Agility, Reducing Downtime



Automated Management

- Start / Stop node or whole cluster
- On-Line Scaling
- On-Line Reconfiguration
- On-Line Upgrades
- On-Line Backup & Restore
- Import Running Cluster

Self-Healing

- Node monitoring
- Auto-recovery extended to SQL + mgmt nodes

HA Operations

- Cluster-wide configuration consistency
- Persistent configurations
- HA Agents

Software Upgrade – example of benefits of MCM?

Without MySQL Cluster Manager

- Preliminary check of cluster state
- 8 x ssh commands per server
- 8 x per-process stop commands
- 4 x scp of config files (2 x mgmd & 2 x mysqld)
- 8 x per-process start commands
- 8 x checks for started and re-joined processes
- 8 x process completion verifications
- 1 x verify completion of the whole cluster.
- Excludes manual editing of each configuration file.
- Total: 46 commands

ORACLE

2.5 hours of attended operation

February 2015

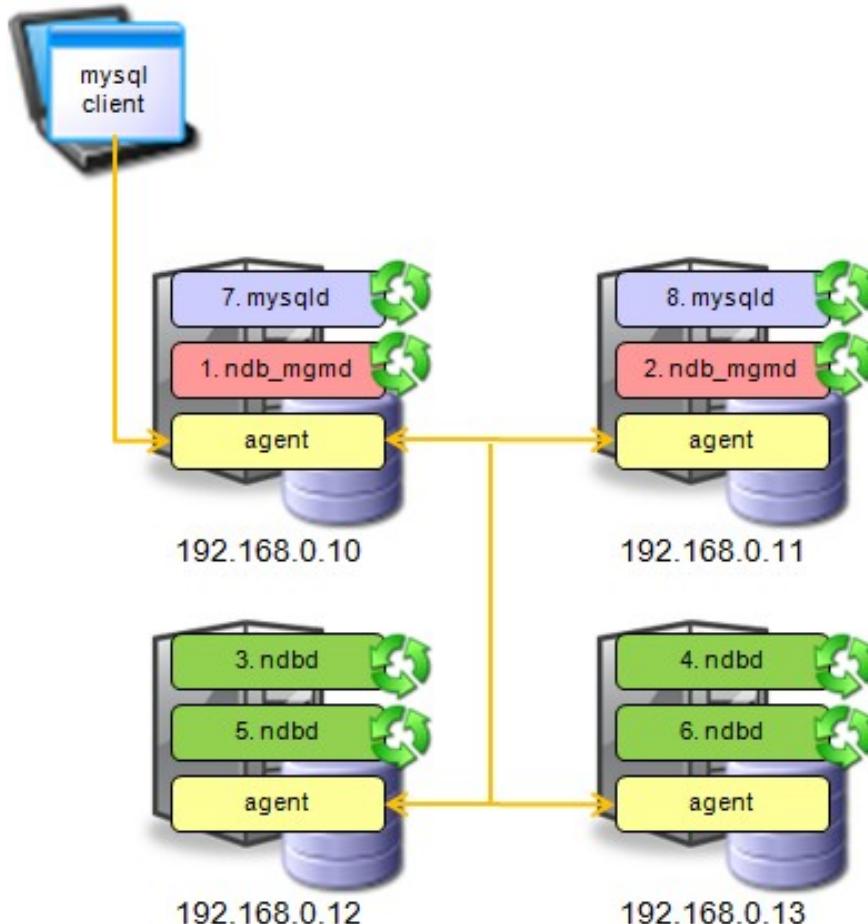
With MySQL Cluster Manager



```
mcm> upgrade cluster  
---package=7.4 mycluster;
```

- Total: 1 Command -
 - Unattended Operation

MCM: Upgrade Cluster



```
mcm> upgrade cluster  
--package=7.3 mycluster;
```

Oracle University MySQL Training Services

Prepare Your Organization to Enable Reliable and High-Performance Web-Based Database Applications

RECENTLY RELEASED !!ALL NEW!!

MySQL Cluster Training

To Register your interest to influence the schedule on this newly released course – go to

education.oracle.com/mysql and click on the **MySQL Cluster Course**

"Training and team skills have the most significant impact on overall performance of technology and success of technology projects." - IDC, 2013

Premier Support customers eligible to save 20% on learning credits.

Benefits

- Expert-led training to support your MySQL learning needs
- Flexibility to train in the classroom or online
- Hands-on experience to gain real world experience
- Key skills needed for database administrators and developers

Top Courses for Administrators and Developers

- MySQL for Beginners
- MySQL for Database Administrators
- MySQL Performance Tuning
- MySQL Cluster – **NEW - Register Your Interest!**
- MySQL and PHP - Developing Dynamic Web Applications
- MySQL for Developers
- MySQL Developer Techniques

Top Certifications

- MySQL 5.6 Database Administrator
- MySQL 5.6 Developer

To find out more about available MySQL Training & Certification offerings, go to: education.oracle.com/mysql

White Papers & Webinar Replays

High Availability

- <http://www.mysql.com/why-mysql/white-papers/#en-22-16>
- <http://www.mysql.com/news-and-events/on-demand-webinars/#e>

MySQL Replication

- <http://www.mysql.com/why-mysql/white-papers/#en-22-38>
- <http://www.mysql.com/news-and-events/on-demand-webinars/#e>

MySQL Cluster

- <http://www.mysql.com/why-mysql/white-papers/#en-22-28>
- <http://www.mysql.com/news-and-events/on-demand-webinars/#e>