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MySQL High Availability Solutions

Luca Olivari
MySQL Sales Consulting Manager, EMEA

Agenda

- Introduction to High Availability
- MySQL High Availability Solutions
- MySQL Cluster CGE
- Operational Best Practices
- Conclusion and Questions

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Why do I need High Availability?

- ## In the old days
  - Local time
  - Monday thru Friday
  - 8 am to 6 pm

- ## Current environment
  - Global
  - 365 x 24 x 7
  - No Downtime

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Eyjafjallajökull

http://en.wikipedia.org/wiki/2010_eruptions_of_Eyjafjallaj%C3%B6kull

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Why do we need to provide High Availability?
Remembering the ash cloud…

- Planned Downtime
  - Database backup/upgrade/patching
  - Operating system upgrade/patching
  - Hardware and Network maintenance
- Unplanned Downtime
  - Corruptions
    - Logical corruptions
    - Physical corruption
  - Human Errors
    - Accidentally drops a table …
  - Disasters
    - Volcanoes, terrorism, earthquakes …

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High Availability from Customers' Point of View
Hourly Costs of Downtime per Industry
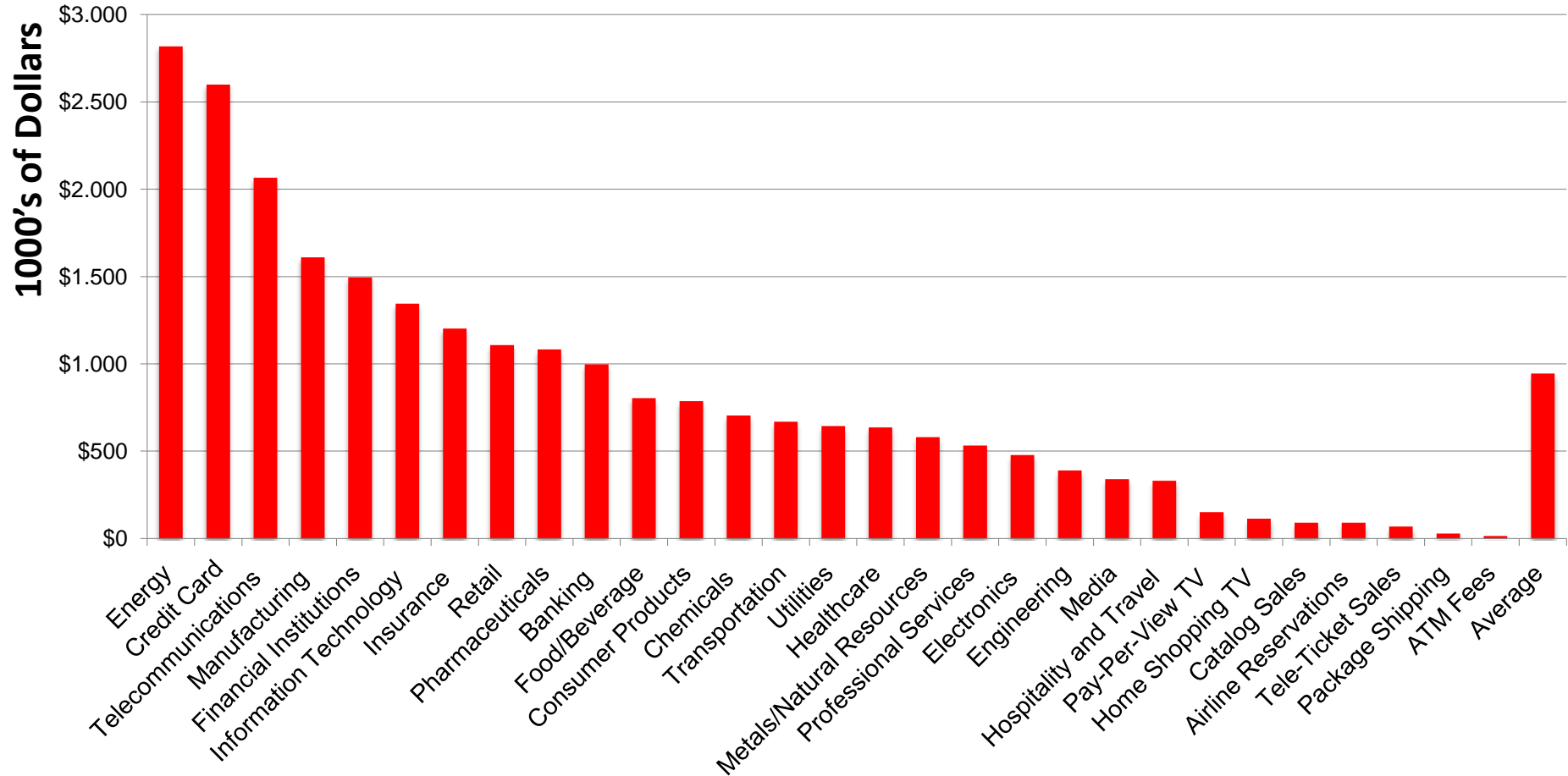
Sources: IT Performance Engineering and Measurement Strategies: Quantifying Performance and Loss, Meta Group, Oct. 2000;

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Reputation Matters
September 23, 2010 – Facebook is Down!

@alqaeda
Al-Qaeda

#facebook is down. Not sure if we did that, but we should claim credit anyway. Hitting the infidels where it hurts, etc.

19 hours ago via Tweetie for Mac ☆ Favorite ♺ Retweet ↩ Reply

@VladimirRS
Vladimir

BREAKING NEWS: Facebook down due to explosion in Farmville's manure composter. Five million people forced to work.
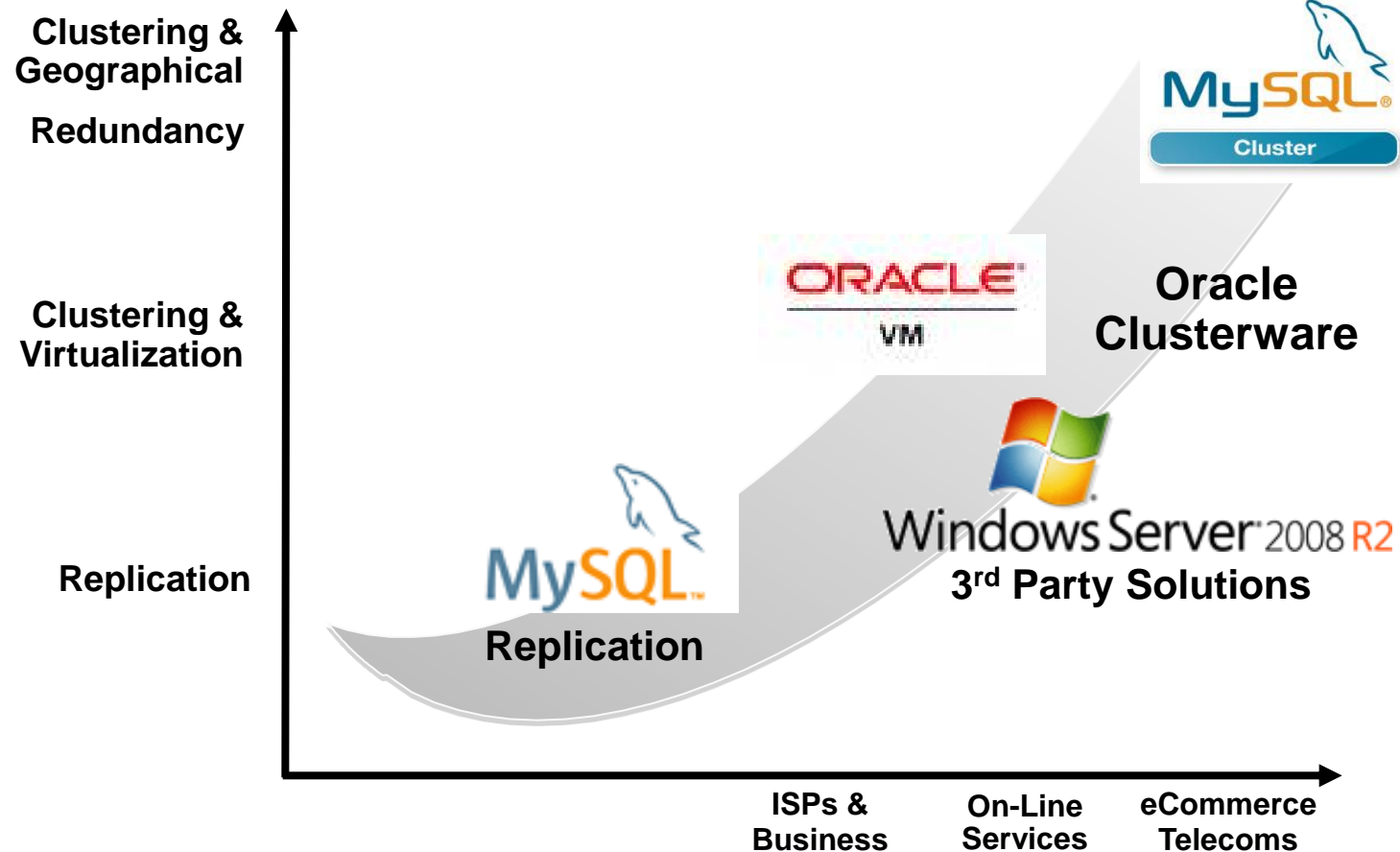
@RWW
ReadWriteWeb

Even Like buttons are down on Facebook. We can't live in a world where we can't arbitrarily like things. The end is nigh. #FacebookDown

7 hours ago via TweetDeck ☆ Favorite ♺ Retweet ↩ Reply

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Not Everything Needs 99.999% Uptime

- As increased availability needs more resources, be sure to adopt a tiered approach:
  - Tier 1, Mission-critical services
  - Tier 2, Business-critical services
  - Tier 3, Task-critical services
  - Tier 4, Non-critical services
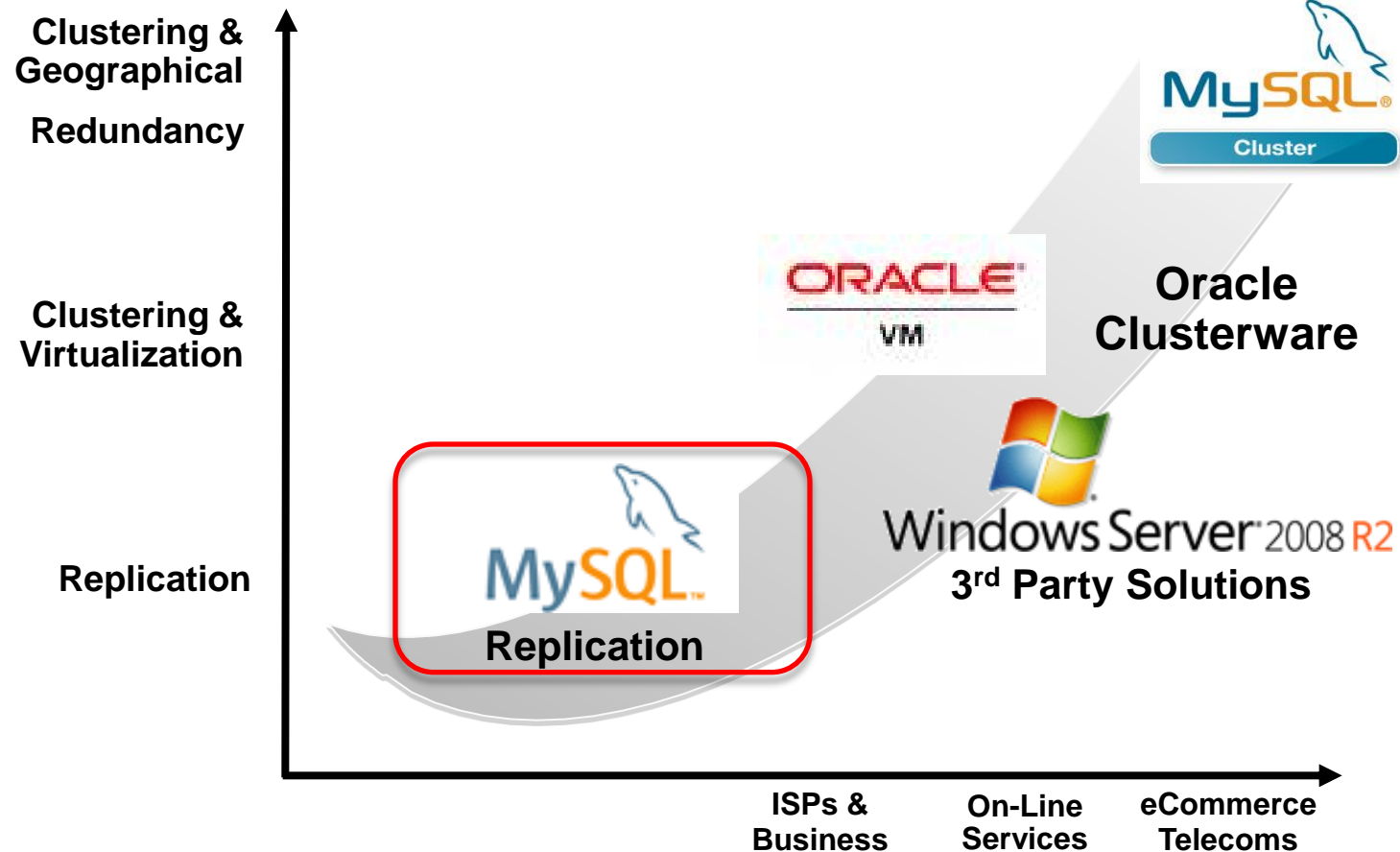
Mapping Architectures to Availability

9	9 .	9	9	9	%
35 days	4 days	8 hours	50 mins	5 mins	

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- Introduction to High Availability
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- MySQL Cluster CGE
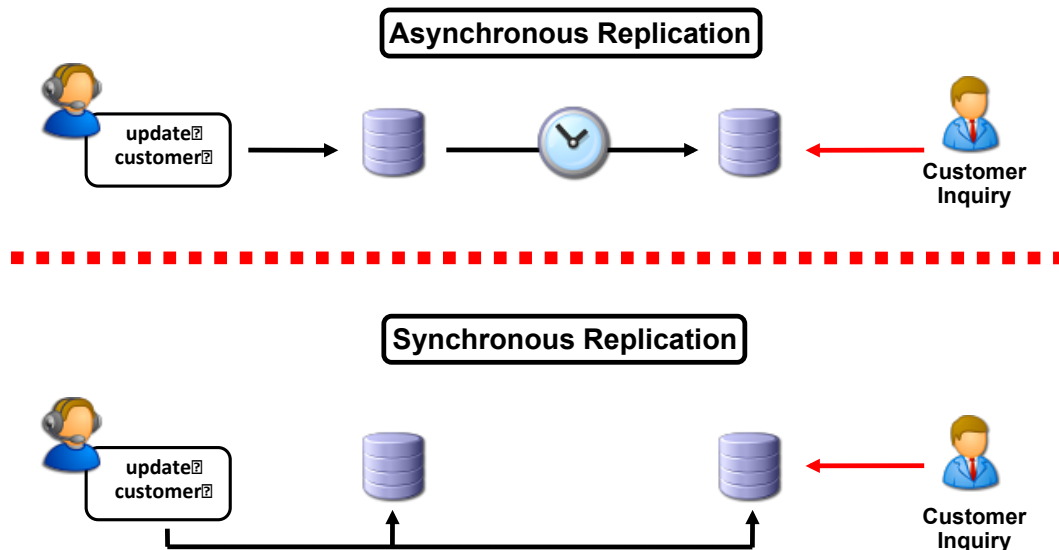- Operational Best Practices
- Conclusion and Questions
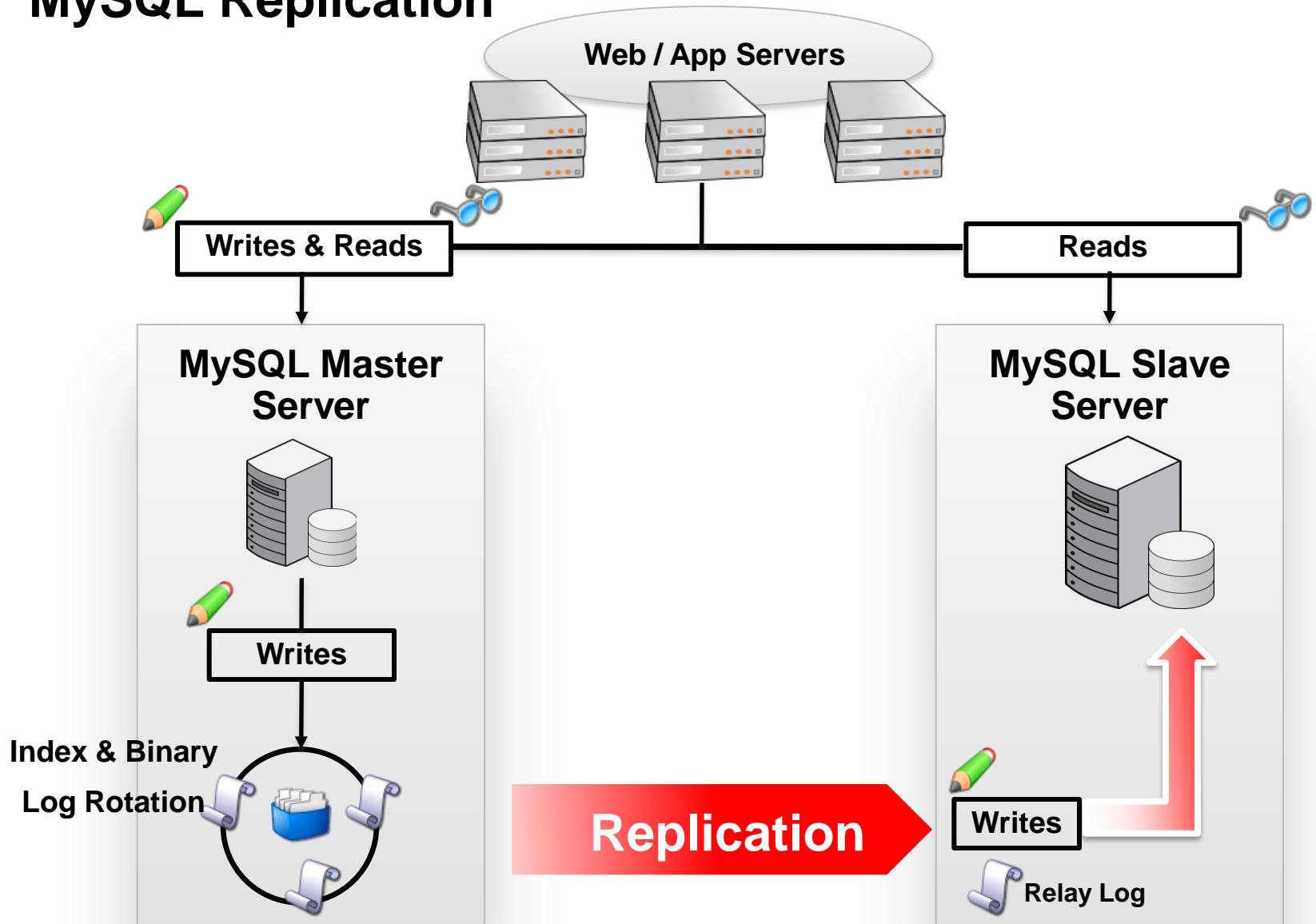
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Mapping Architectures to Availability

Clustering & Geographical Redundancy					
Clustering & Virtualization					
Replication					
	ISPs & Business	On-Line Services	eCommerce Telecoms		

9	9 .	9	9	9	%
35 days	4 days	8 hours	50 mins	5 mins	

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MySQL Replication

- Native to MySQL
- Duplicates updates from a "master" to a "slave"
- Most common solution for HA
  – Used to scale out as well
- Failover is either scripted or provided by additional middleware
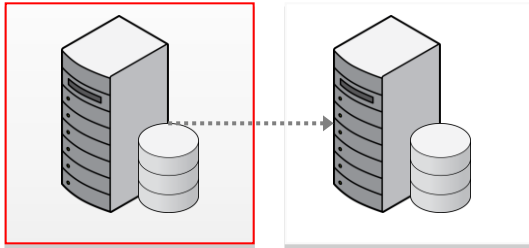- Supports Asynchronous and Semi-Synchronous replication

MySQL Replication

Web / App Servers

Writes & Reads

Reads

MySQL Master Server

MySQL Slave Server

Writes

Index & Binary

Log Rotation

Replication

Writes

Relay Log

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Replication Topologies
A Flexible Way to Scale

Single

Chain
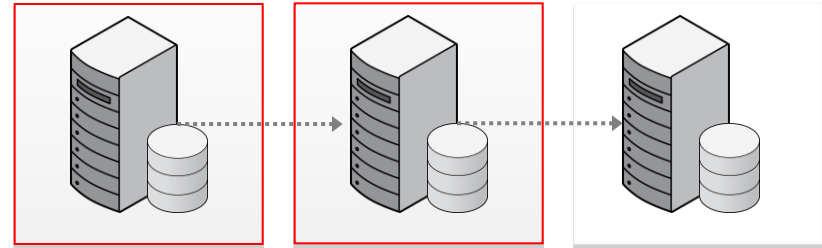
Multiple
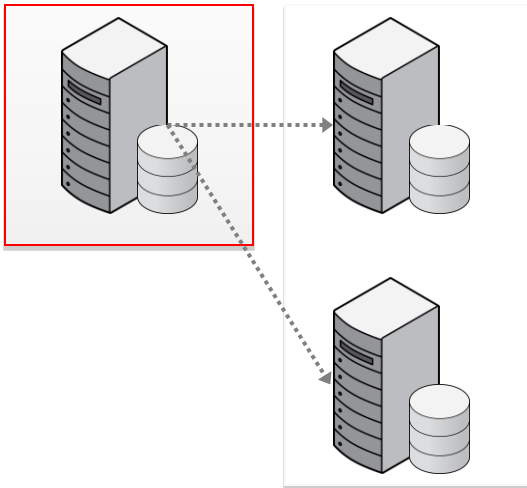
Circular
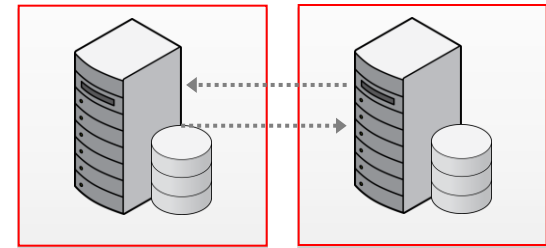
Master 🔴

Slave ⚪

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Scaling out with MySQL Replication

Read more: http://mysql.com/why-mysql/white-papers/mysql-wp-replication.php
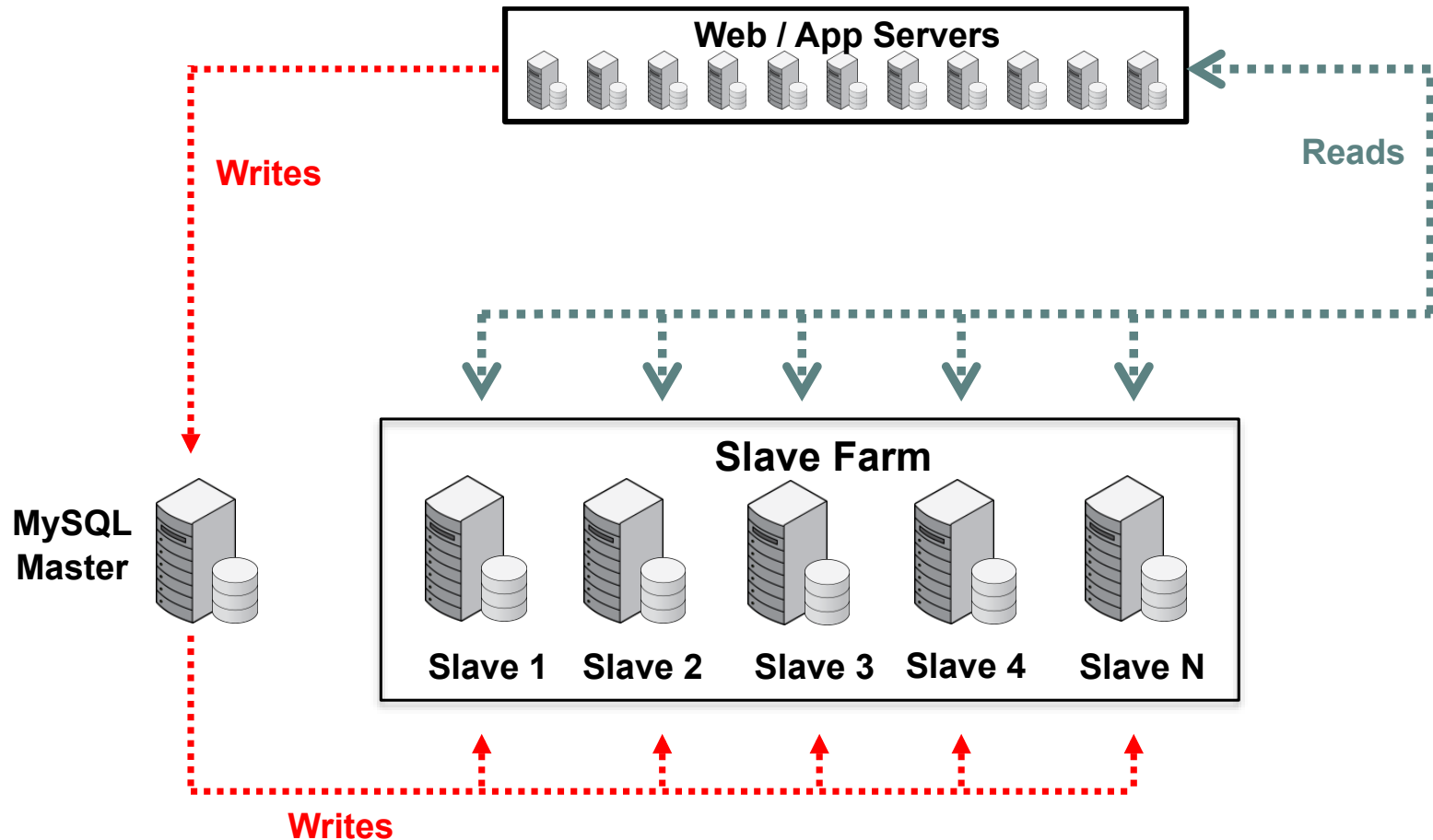
MySQL 5.5

InnoDB becomes default
- ACID Transactions, FKs, Crash Recovery

Improved Availability
- Semi-synchronous Replication
- Replication Heartbeat

Improved Usability
- SIGNAL/RESIGNAL
- More Partitioning Options
- PERFORMANCE_SCHEMA

Better Instrumentation/Diagnostics
- InnoDB stats in 5.5 PERFORMANCE_SCHEMA

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MySQL 5.5 - Semisynchronous Replication

- Semisynchronous replication ensures redundancy
  - At least one slave acknowledges relay logging the transaction
  - Master waits for slave acknowledgement before commit returns
  - On time-out, master temporarily switches to async replication
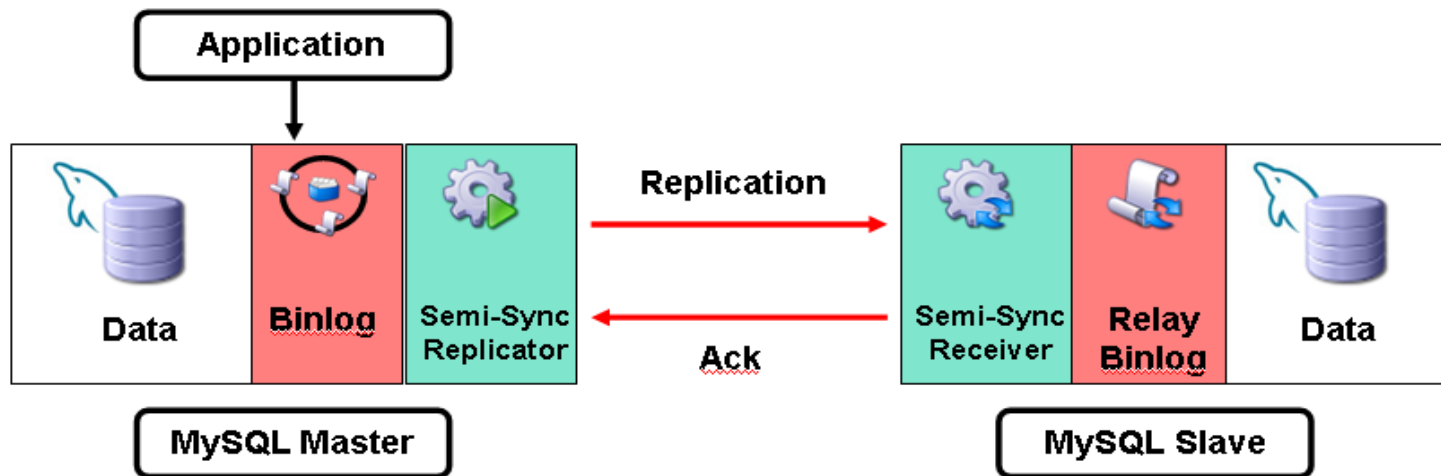
Enhancing HA in MySQL Replication
MySQL 5.6 DMR & Early Access Labs

MySQL Masters

Slave 6   Slave 7   Slave 8   Slave 9   Slave 10

Slave 1   Slave 2   Slave 3   Slave 4   Slave 5
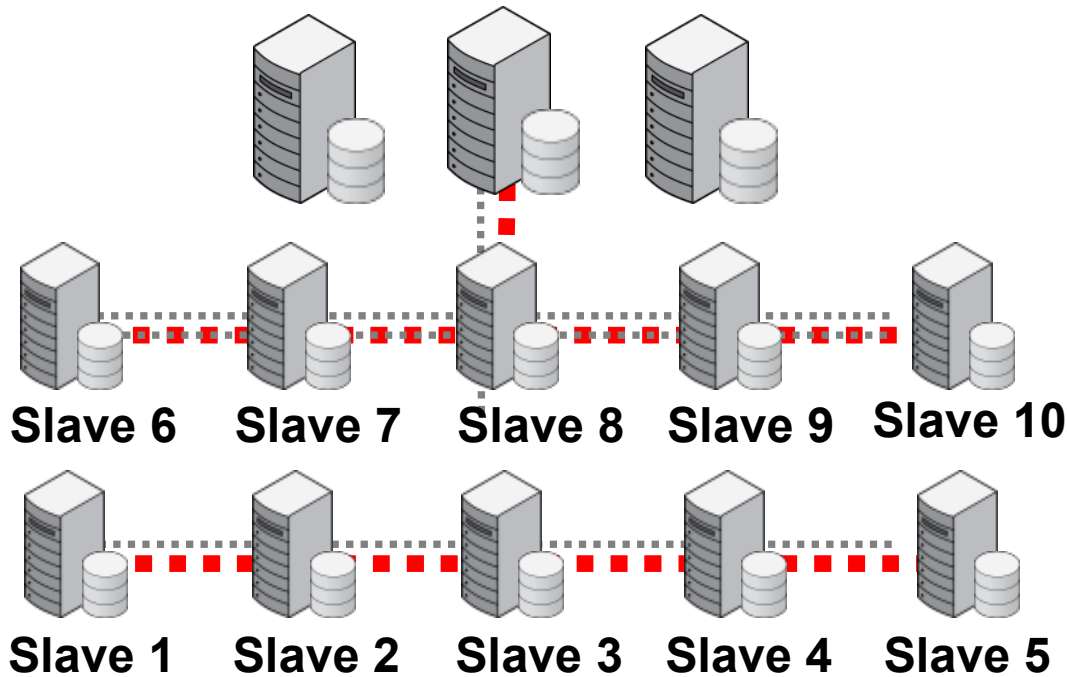
- Global Transaction IDs
- Crash-Safe Slaves
- Multi-Threaded Slaves
- Group Commit
- Replication Checksums
- Binlog API

Global Transaction IDs: http://bit.ly/pqdkPZ

General Replication Enhancements: http://bit.ly/q3ZNga

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Automated Replication Monitor
MySQL Enterprise Monitor

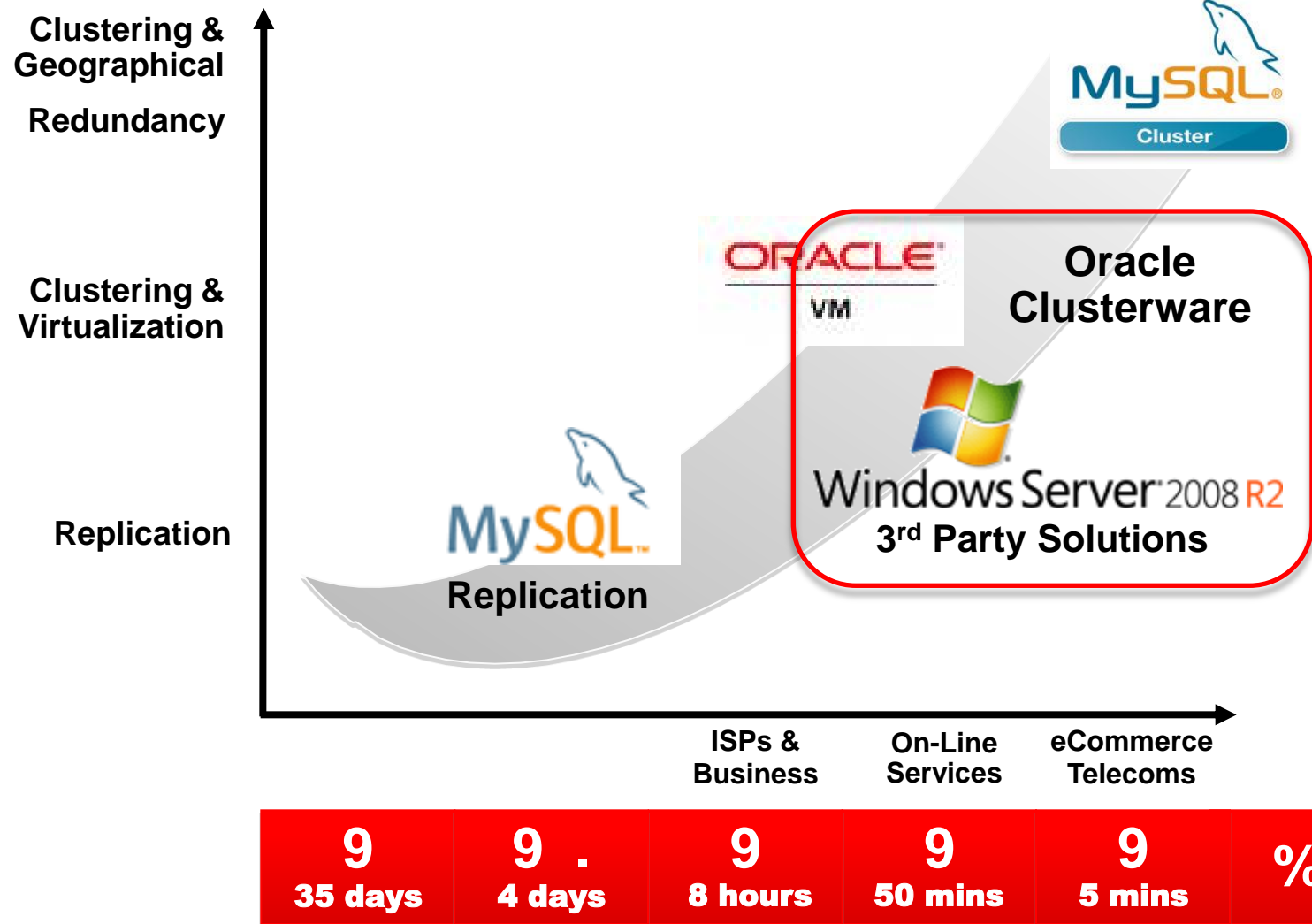- Auto-detects, groups/maintains Master/Slave topologies
- Consolidated, real time status/synch check
- Notifications on Synch Issues
- Proactive vs reactive

Saves you time **monitoring and collecting replication status/synch data from MySQL command line.**

Servers	Type	Slave IO	Slave SQL	Seconds Behind
Basic (2)	TREE	Running	Running	
master:10101	master			
slave:10100	slave	Running	Running	00:00:00
Ringlet (2)	RING	Running	Running	
Yang:10120	master/slave	Running	Running	00:00:00
Yin:10121	master/slave	Running	Running	00:00:00
RingSpoke (4)	MIXED	Running	Running	
ring1:10183	master/slave	Running	Running	00:00:00
ring2:10182	master/slave	Running	Running	00:00:00
ring3:10181	master/slave	Running	Running	00:00:00
ring3slave:10180	slave	Running	Running	00:00:00
Tree 3 (5)	TREE	Running	Running	
master:10153	master			
slave1:10150	slave	Running	Running	00:00:00
slave2master:10152	master/slave	Running	Running	00:00:00
slave2slave:10151	slave	Running	Running	00:00:00
slave3:10154	slave	Running	Running	00:00:00

Monitor   Advisors   Events   Graphs   Replication

Replication Monitoring

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Mapping Architectures to Availability

Clustering & Geographical Redundancy

Clustering & Virtualization

Replication

Oracle Clusterware

MySQL Cluster

ORACLE VM

Windows Server 2008 R2
3rd Party Solutions

MySQL
Replication

ISPs & Business

On-Line Services

eCommerce Telecoms

| 9	9 .	9	9	9	%
35 days	4 days	8 hours	50 mins	5 mins	

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Clustering Overview

- Tightly coupled clusters of servers/storage providing service to an application
  - Use heartbeating and management software to monitor hardware, OS, database and network
  - Heartbeat between nodes detects failures and automatically failover to redundant systems
  - Implements Virtual IP (VIP) so failover is transparent to the application
- Couple with Virtualization for higher agility
  - Migrate between servers with load balancing

Windows Server Failover Clustering

- Native Windows HA clustering with MySQL

- Failures & Planned Maintenance

- Quorum (3rd vote), data (InnoDB + schema) & binaries (optional) stored in shared storage (iSCSI & FCAL)

- Loss of service = couple of seconds + InnoDB recovery time
  - App sees temporary loss of connection and reconnects on same IP address
  - Replication slave recovers automatically

- Cluster managed through MS Failover Cluster Management snap-in GUI

- No new software/scripts required

Download the Guide: **http://bit.ly/w3rSoP**
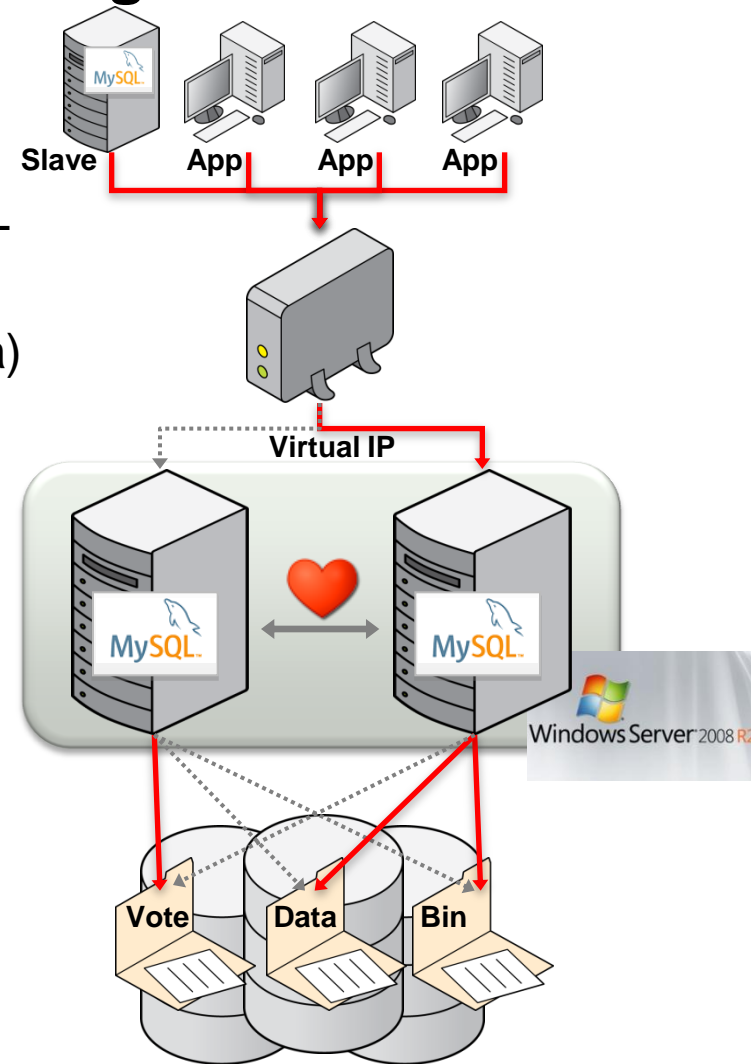
** **Technical support for Windows Server Failover Clustering must be sourced from Microsoft.**
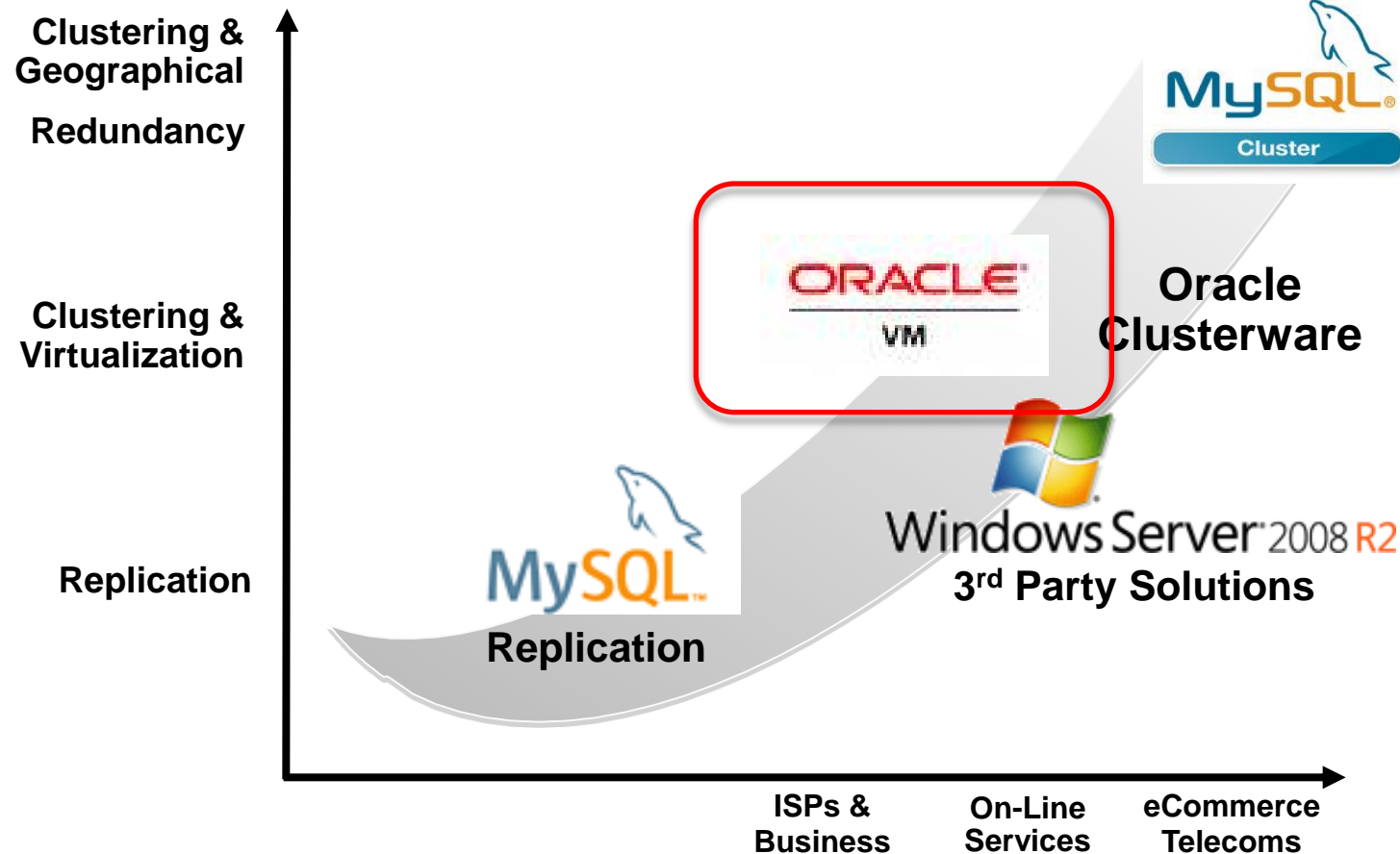
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Solaris Clustering
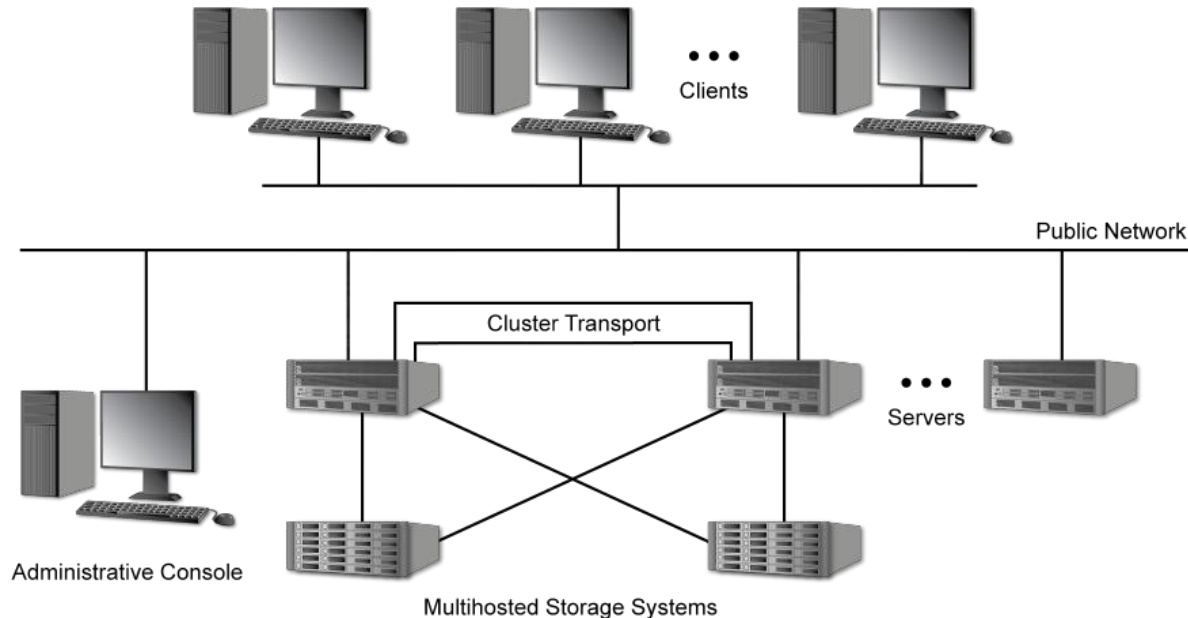
- Kernel based heartbeating and monitoring
- MySQL agent used to integrate with Solaris Clustering
  - Monitor MySQL Replication
- Learn more: http://www.oracle.com/technetwork/server-storage/solaris-cluster/overview/index.html

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3rd Party HA Solutions

- Oracle supports MySQL on community / commercial HA technologies
  - Support for HA mechanisms from respective vendors
- Linux Heartbeat / Corosync with Pacemaker
  - Kernel level block replication using DRBD
- Symantec Veritas Cluster
- Red Hat Cluster Suite

Mapping Architectures to Availability

Clustering & Geographical Redundancy		MySQL Cluster
Clustering & Virtualization	ORACLE VM	Oracle Clusterware
Replication	MySQL Replication	Windows Server 2008 R2 — 3rd Party Solutions

| | ISPs & Business | On-Line Services | eCommerce Telecoms |

9	9 .	9	9	9	%
35 days	4 days	8 hours	50 mins	5 mins	

MySQL Enterprise High Availability
OVM Template for MySQL

- Oracle Linux with the Unbreakable Enterprise Kernel
- Oracle VM
- Oracle VM Manager
- Oracle Cluster File System 2 (OCFS2)
- MySQL Database (Enterprise Edition)

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

**Oracle VM Manager**

Oracle VM   Automatic Fault Detection & Recovery   **Oracle VM**

MySQL Unbreakable Linux

Secure Live Migration (SSL)

MySQL Unbreakable Linux

Oracle VM Server Pool

Oracle VM Servers

ocfs2

SAN / iSCSI

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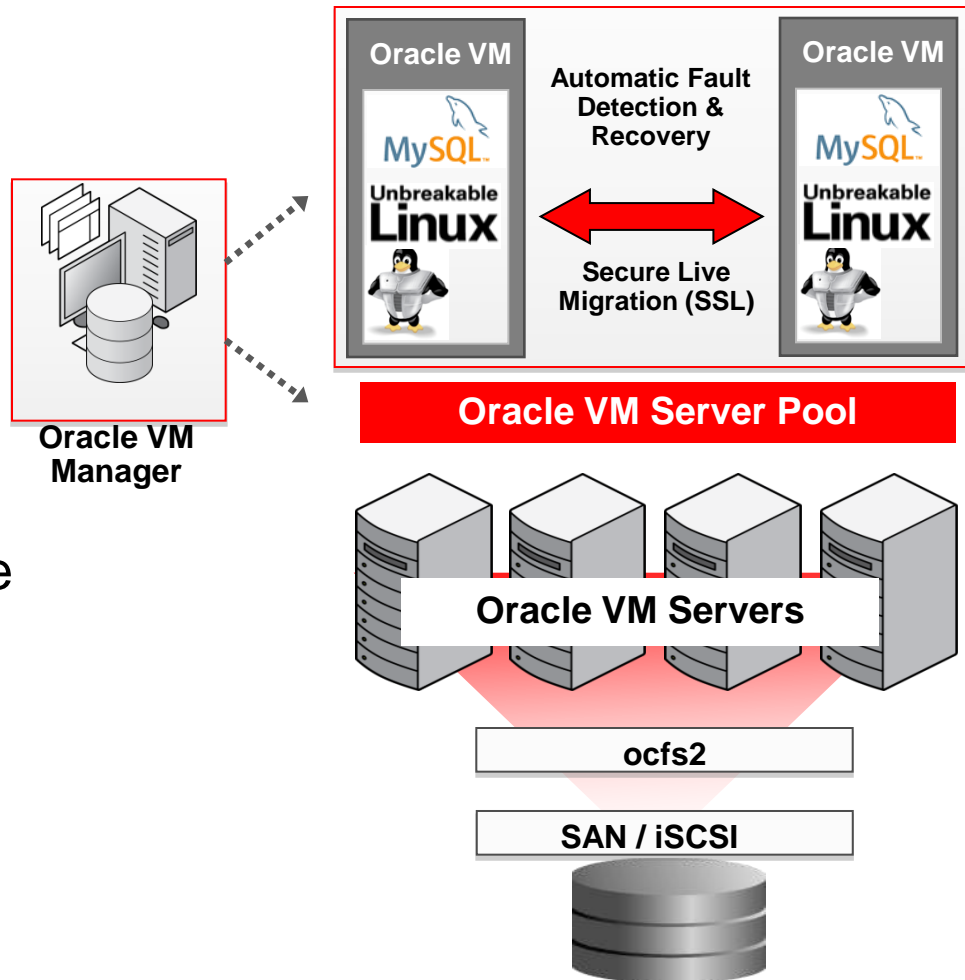
MySQL High Availability
Protecting Against Planned and Unplanned Downtime

Planned Events:

• **Maintenance or upgrades**

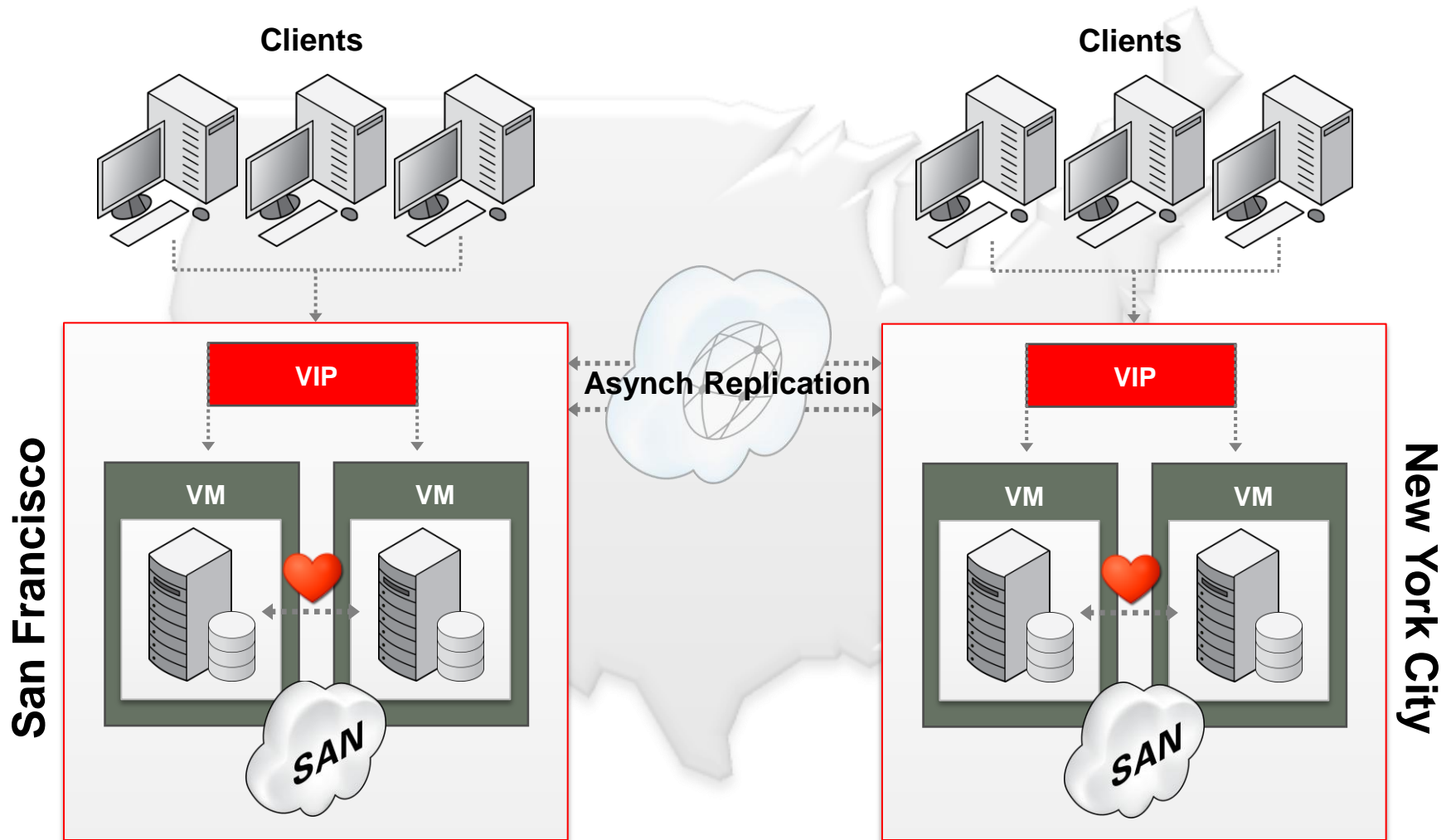• **Secure Live Migration**

• **Zero interruption**

VM **VM** **VM** **VM**

VM Server Pool

SSL Migration

Browser

VM Server Pool
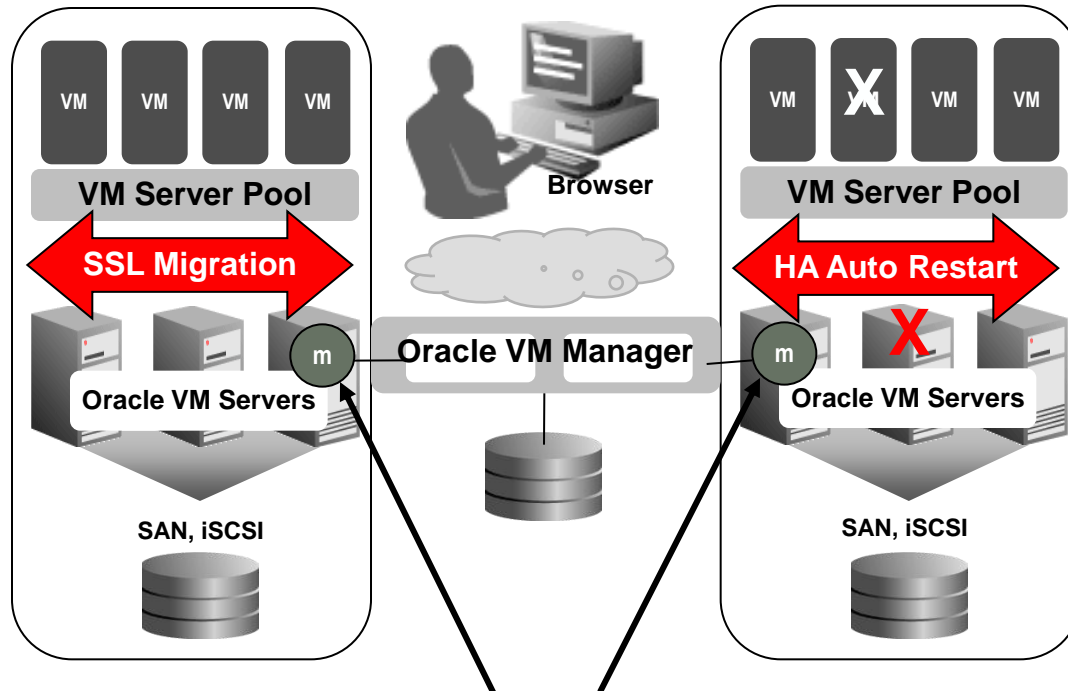
HA Auto Restart

Failures

• **Server, VM or database failure**

• **HA Auto-restart in pool**

• **Automatic failure detection & recovery**

m **Oracle VM Manager** **m**

Oracle VM Servers **Oracle VM Servers**

SAN, iSCSI **SAN, iSCSI**

Pool Masters assure

Secure Migration or HA restarts complete

in the event of a Manager outage

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Disaster Recovery

- *"Disaster recovery is the process, policies and procedures related to preparing for recovery or continuation of technology infrastructure critical to an organization after a natural or human-induced disaster."*

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Disaster Recovery with MySQL Replication

Clients

Clients

VIP

Asynch Replication

VIP

VM

VM

VM

VM

San Francisco

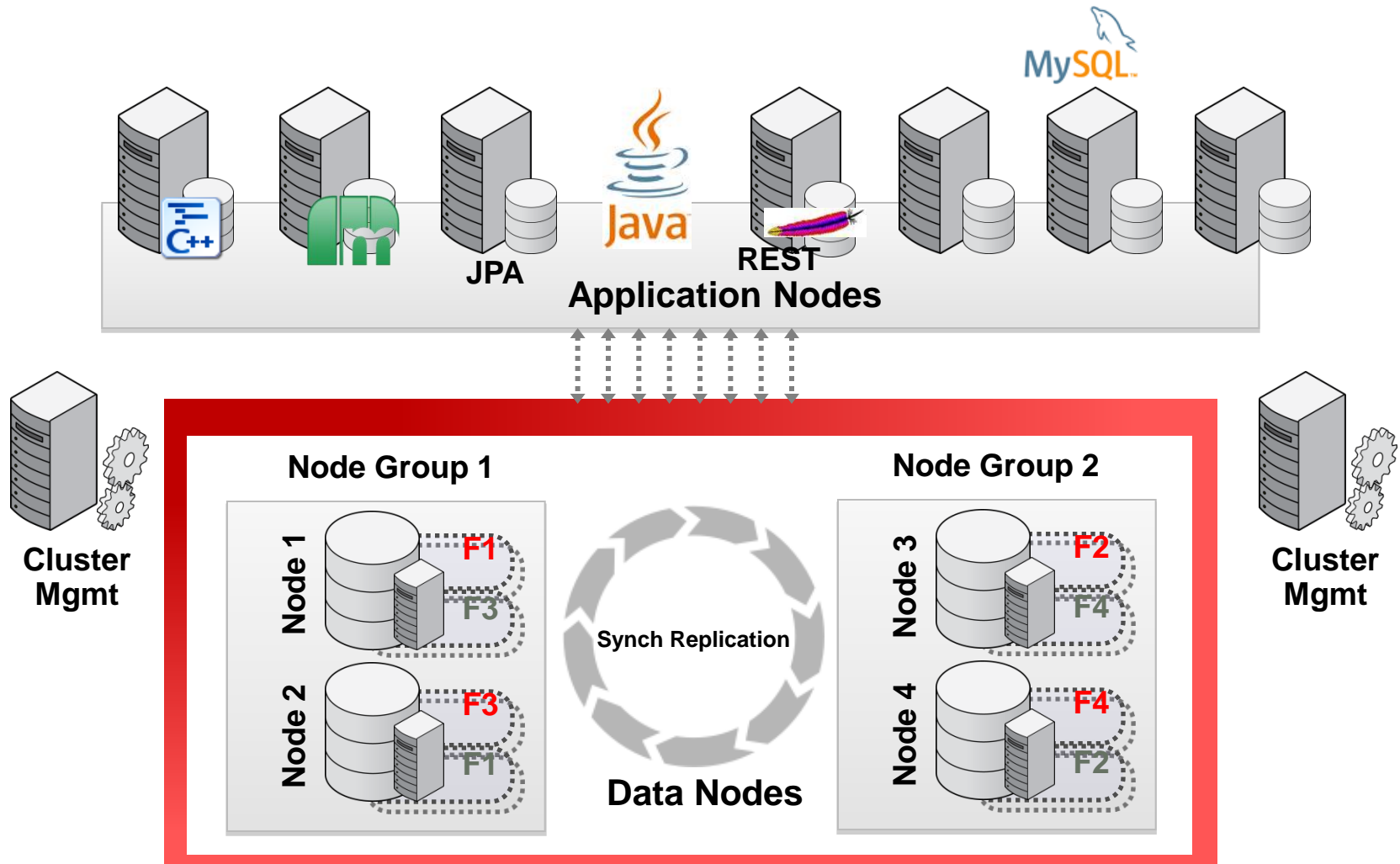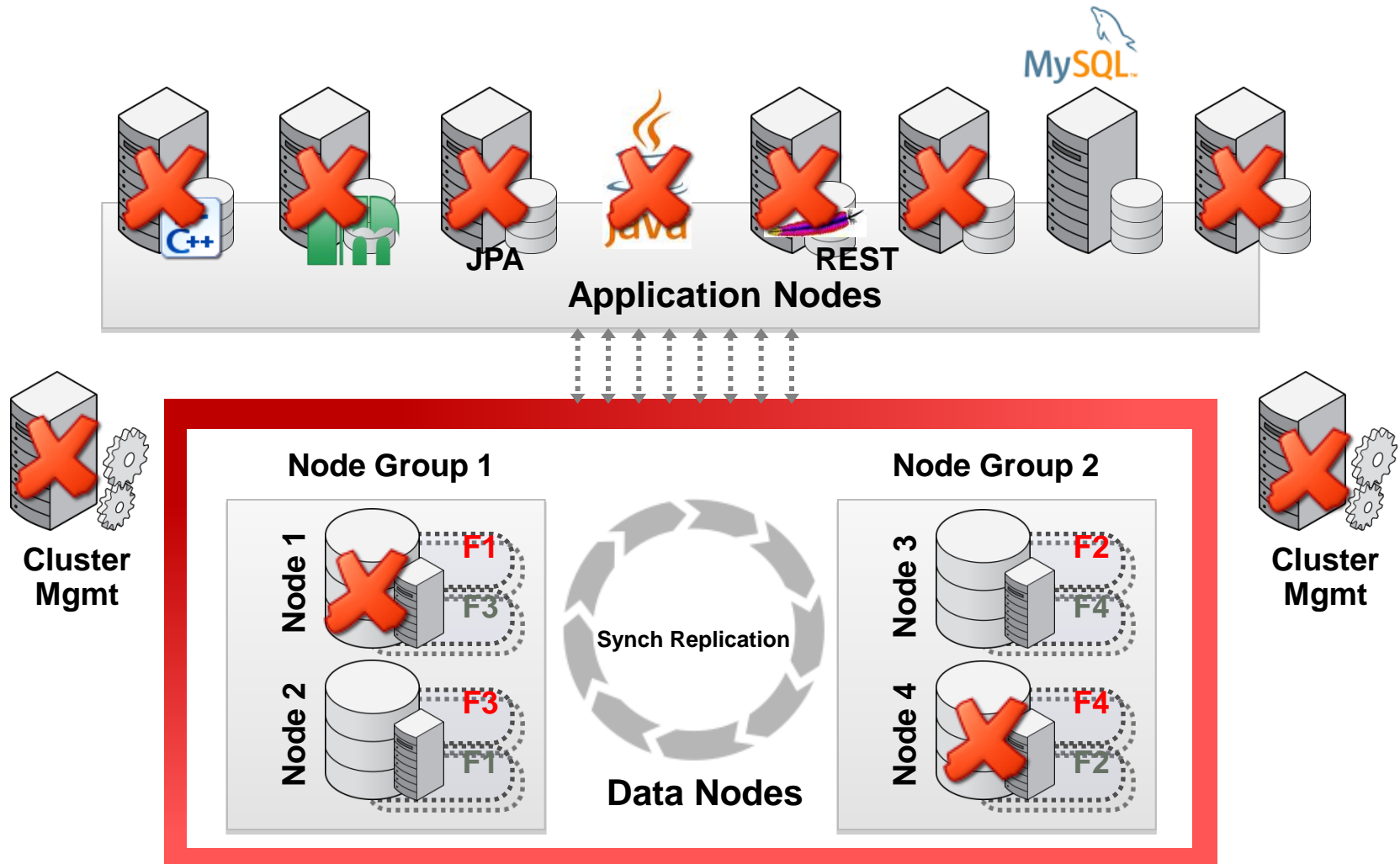**New York City**

SAN

SAN

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MySQL Cluster Architecture

MySQL Cluster - Extreme Resilience

Handling Scheduled Maintenance
On-Line Operations

- Scale the cluster (add & remove nodes on-line)
- Repartition tables
- Upgrade / patch servers & OS
- Upgrade / patch MySQL Cluster
- Back-Up
- Evolve the schema on-line, in real-time
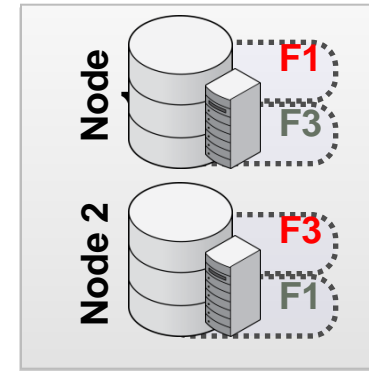
Automatic Data Sharding
4 Data Nodes and 2 Replicas

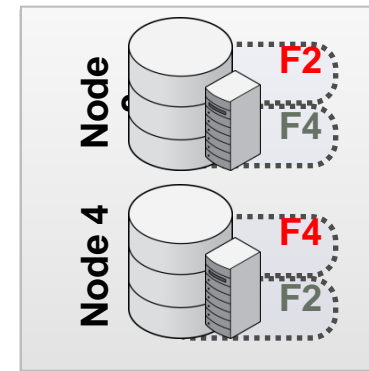| IDCol	Col1	Col2	Col3	Col4	…	
1						
2						**F1**
3						
4						**F2**
5						
6						**F3**
7						
8						**F4**

Fn   **Primary Replica**
Fn   **Secondary Replica**

Node Group 1

Node : F1 / F3

Node 2 : F3 / F1

Node Group 2

Node : F2 / F4

Node 4 : F4 / F2

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Servicing the Most Performance-Intensive Workloads

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MySQL Cluster 7.2 GA

Enabling Next Generation Web Services

- 70x Faster Complex Queries: Adaptive Query Localization
- Native Memcached API
- MySQL 5.5 Server Integration
- Multithreaded Data Node Extensions
- VM Support

Enhancing Cross Data Center Scalability

- Multi-Site Clustering
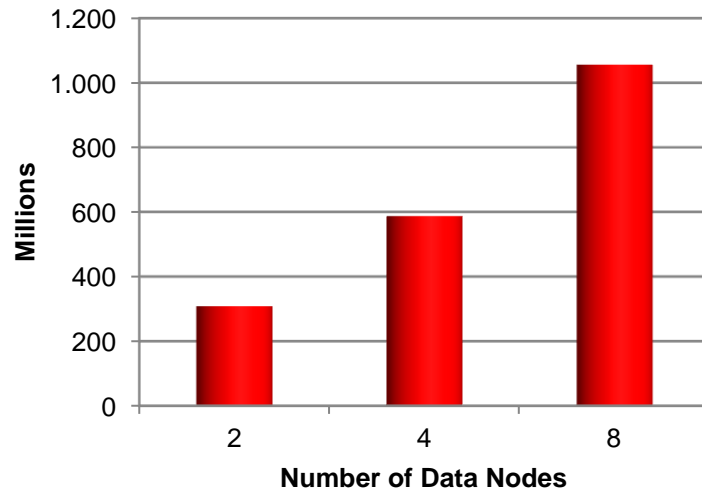- Simplified Active / Active Replication

Ease of Use

- MySQL Cluster Manager 1.1.4
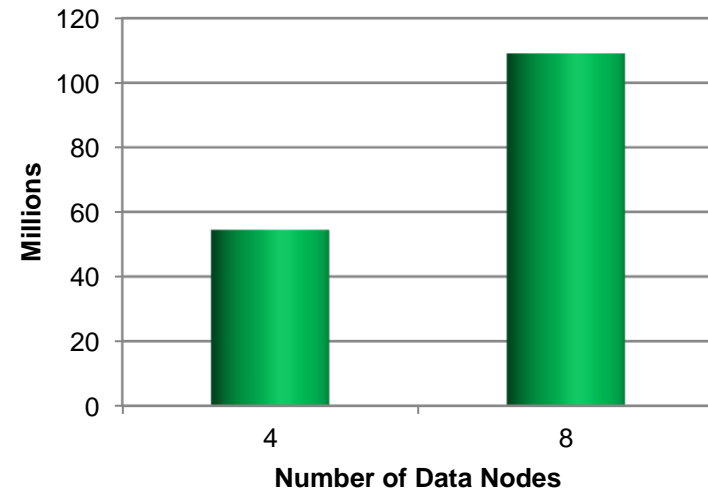- Consolidated Privileges

http://clusterdb.com/u/72wp

MySQL Cluster 7.2 – 1 Billion Queries per Minute

SELECT Queries per Minute

UPDATE Queries per Minute

8 x Commodity Intel Servers

2 x 6-core processors

2.93GHz x5670 processors (24 threads)

48GB RAM

Linux OS

Infiniband networking

flexAsynch benchmark

C++ NoSQL API (NDB API)

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Paggo
Customer Success Profile

COMPANY OVERVIEW

- Paggo has built an innovative payment solution making it easier for customers and merchants to buy and sell products and services using their mobile phones
- Enables buyers and sellers to conduct transactions using text messaging

CHALLENGES/OPPORTUNITIES

- Building a highly reliable system that delivers 24x7 availability
- Lost data results in lost business
- Build a system that could scale and perform as new merchants and buyers joined the network and transaction volumes increased

SOLUTIONS

- Oracle MySQL
- Java

KEY BUSINESS BENEFIT

- Since its launch with Oi, Brazil's largest GSM operator one year ago, MySQL Cluster Carrier Grade Edition has enabled Paggo to quickly add 40,000 merchants and 1.2 million subscribers to its network and handle over 750,000 financial transactions per month.

SUPPORTING QUOTE

"Paggo would not have been possible without MySQL Cluster. No other product would have give us the ability to start small, scale quickly and provide 24 x7 availability for our financial payment system."

Cicero Toreli
Founder - Paggo

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Operational Best Practices

Training

Consulting

24 x 7 x 365 Global Support

Database Management & Monitoring

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MySQL Enterprise Monitor

- Global view of MySQL environment

- Automated, rules-based monitoring and alerts (SMTP, SNMP enabled)

- Query capture, monitoring, analysis and tuning, correlated with Monitor graphs

- Visual monitoring of "hot" applications and servers

- Real-time Replication Monitor with auto-discovery of master-slave topologies

- Integrated with MySQL Support
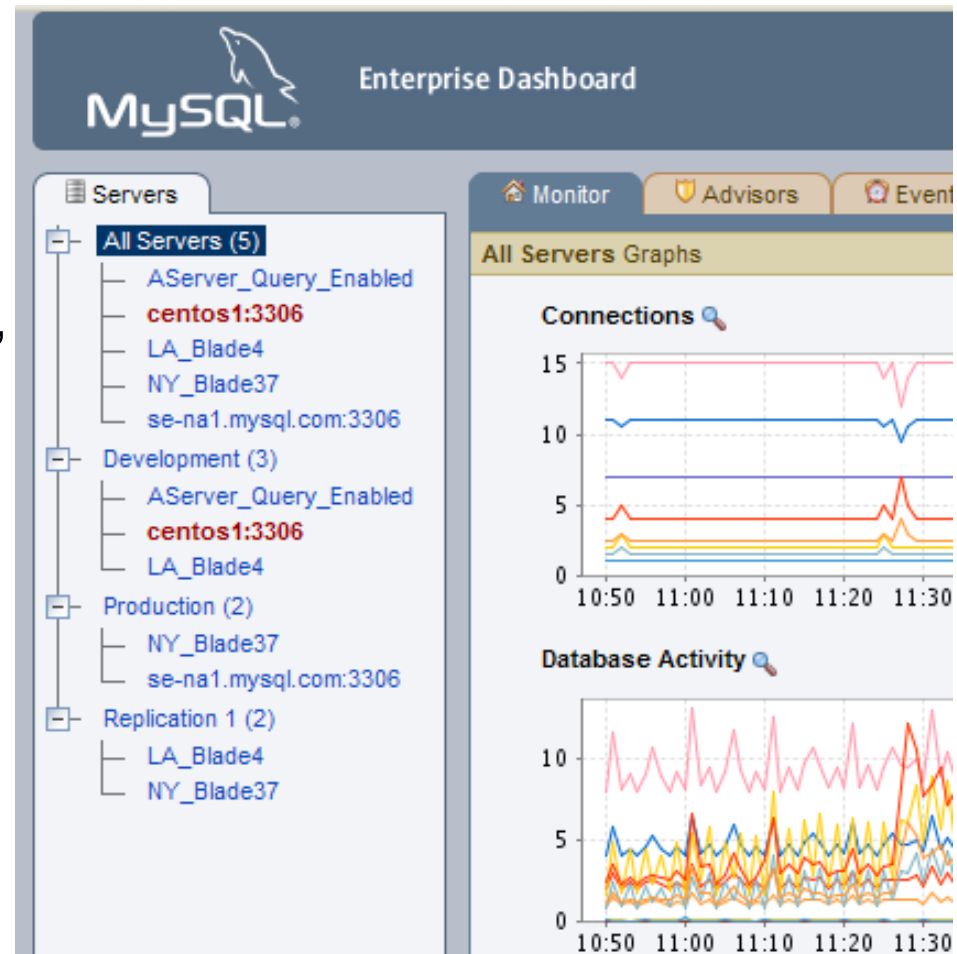
A Virtual MySQL Tuning Assistant!

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MySQL Expert Advisors

MySQL Cluster
- Monitors and Advises on status/ performance of MySQL Cluster Data Nodes.

Administration
- Monitors and Advises on Optimal Configuration

Performance
- Monitors and Advises on Optimal Performance Variable Settings

Custom
- Built by DBA to Enforce Organization specific best practices.

Upgrade
- Monitors and Advises on Bugs/Upgrades that affect current installation

Replication
- Monitors and Advises on Master/Slave Latency.

Security
- Monitors and Advises on Unplanned Security Changes/Loopholes

Schema
- Monitors and Advises on Unplanned Schema Change

Memory Usage
- Monitors and advises on optimal memory/cache settings

140+ Rules, 40+ MySQL, OS specific Graphs

Save you time writing, deploying, versioning, maintaining custom scripts. Find problems and tuning opportunities you cannot find yourself.
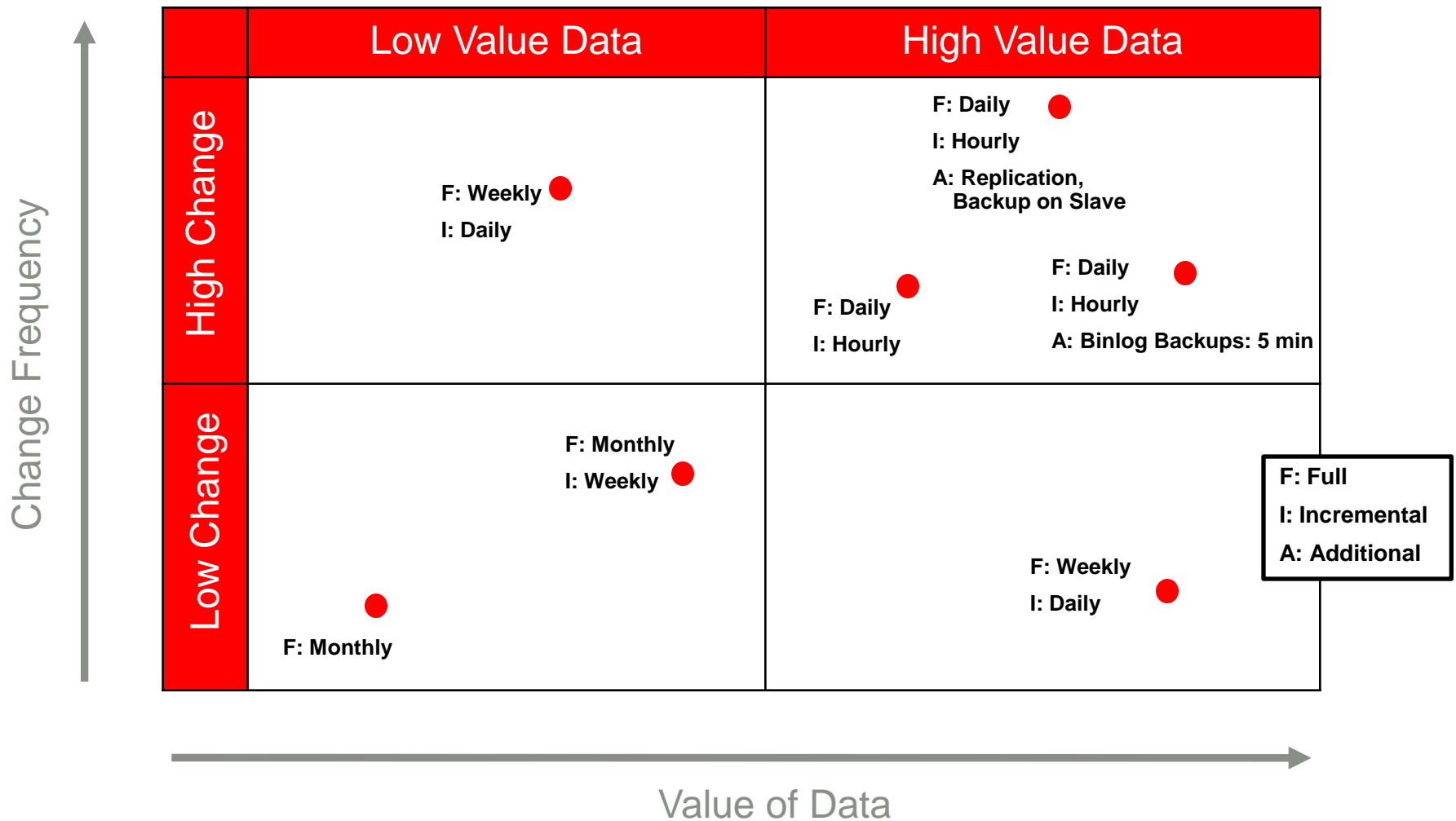
MySQL Enterprise Backup

- Online Backup for InnoDB

- Full, Incremental, Partial Backups (scriptable interface)

- Compression

- Point in Time, Full, Partial Recovery options

- Metadata on status, progress, history

- Unlimited Database Size

- Cross-Platform
  - Windows, Linux, Unix

- Certified with Oracle Secure Backup

mysqlbackup

MEB Backup Files

MySQL Database Files

Ensures <u>quick, online backup and recovery</u> of your MySQL apps.

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Determining Backup Strategy

Change Frequency

	Low Value Data	High Value Data
High Change	F: Weekly I: Daily	F: Daily I: Hourly A: Replication, Backup on Slave F: Daily I: Hourly F: Daily I: Hourly A: Binlog Backups: 5 min
Low Change	F: Monthly I: Weekly F: Monthly	F: Weekly I: Daily

F: Full

I: Incremental

A: Additional

Value of Data

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Backup Strategies Comparison

Method	Backup Factors	Recovery Factors
Method 1: Full Backups	• Longest Backup Times • Largest Storage Space • Save space with compression	• Easy to Recover • Fastest Restore Times
Method 2: Full + Incremental Backup	• Shortest Backup Time • Reduced Storage Requirements • Requires 1X production storage for copy	• Finer-grained Recovery • Slower Restore Times • First Restore Full Backup • Then Restore Incrementals
Method 3: Full + Incremental + Log Backup	• Added Storage Requirements • Requires more than 1X production storage for copy	• Finest-grained Recovery • Slowest Restore Times • First Restore Full Backup • Then Restore Incrementals • Then Apply Logs
Method 4: Offload Backups Slave Replication	• Used with 1 of the above • Frees Master for more workload • Requires 1X production hardware and storage for standby database	• Fast failover to standby • Backups are last resort, in event of double site failure or need to perform PITR

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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
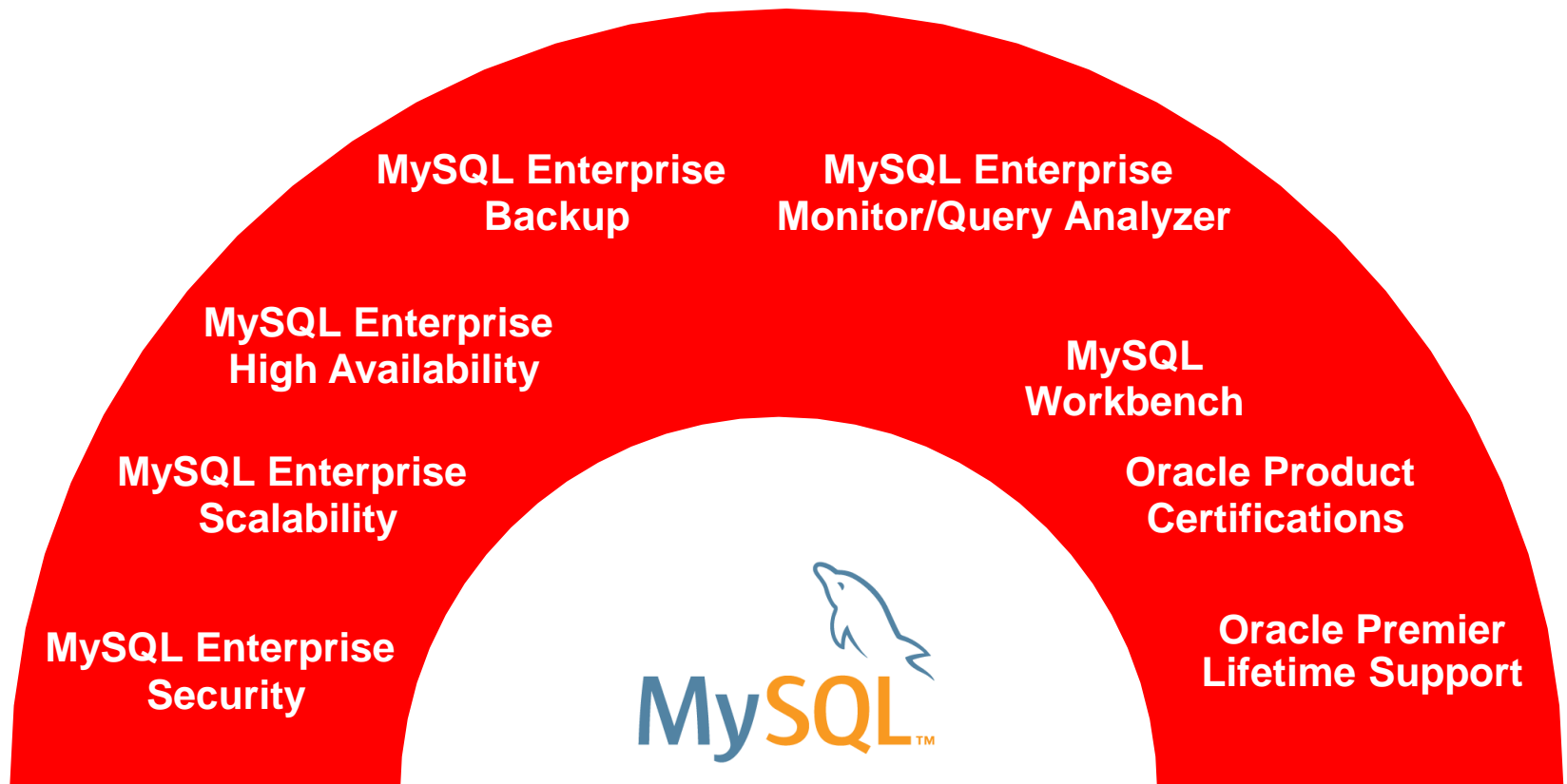- Knowledge Base
- MySQL Consultative Support

Only From Oracle

"The rep that assisted me was simply outstanding. He immediately recognized the cause of my problem and provided the resolution."
-- (July 27, 2011)

mysql.com/support/quotes

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MySQL Enterprise Edition

Management & Monitoring Tools & Commercial Extensions, backed by Oracle Premier Lifetime Support

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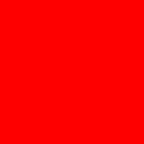- Operational Best Practices
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Mapping Applications to HA Technology

Applications	Database Replication	Clustered / Virtualized	Shared-Nothing, Geo-Replicated Cluster
E-Commerce / Trading	◉ (1)	◉	◉
Session Management	◉ (1)	◉	◉
User Authentication / Accounting	◉ (1)	◉	◉
Feeds, Blogs, Wikis	◉		
OLTP	◉ (1)	◉	◉
Data Warehouse/BI	◉	◉	◉
Content Management	◉	◉	
CRM	◉	◉	
Collaboration	◉	◉	
Packaged Software	◉	◉	
Network Infrastructure	◉	◉	
Core Telco Apps (HLR/HSS/SDP…)			◉

1: Replication used in combination with cluster or virtualization – based HA

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