MySQL High Availability Solutions

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Agenda

- High Availability: Concepts & Considerations
- MySQL Replication
- DRBD / Heartbeat
- MySQL Cluster
- Other HA tools/applications
- Links

What Is HA Clustering?

- Redundancy
- One service goes down → others take over
- IP address takeover, service takeover
- Failover vs. failback vs. switchover
- **Not designed** for high-performance
- **Not designed** for high troughput (load balancing)

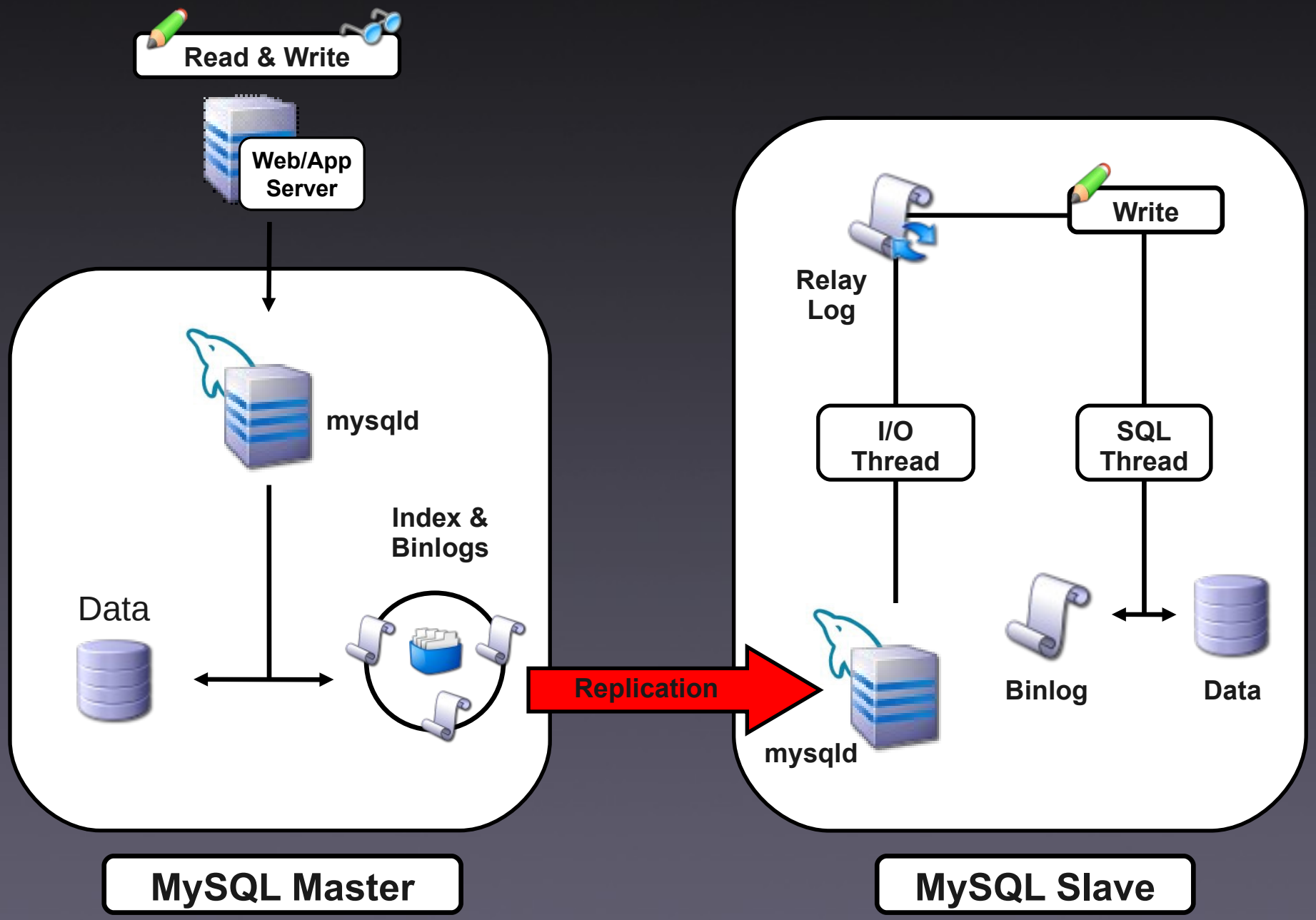
Replication vs. Shared Storage

- Shared storage resource can become SPOF
- Split brain situations can lead to mayhem (e.g. mounting file systems concurrently)
- SAN/NAS read I/O overhead
- Consistency of replicated data
- Synchronous vs. asynchronous replication

MySQL Replication

- One-way, statement- or row-based
- One Master, many Slaves
- Asynchronous – Slaves can lag
- Master maintains binary logs & index
- ✔ Easy to use and set up
- ✔ Built into MySQL
- ✗ Replication is single-threaded
- ✗ No automated fail-over
- ✗ No heartbeat, no monitoring

MySQL Replication Overview



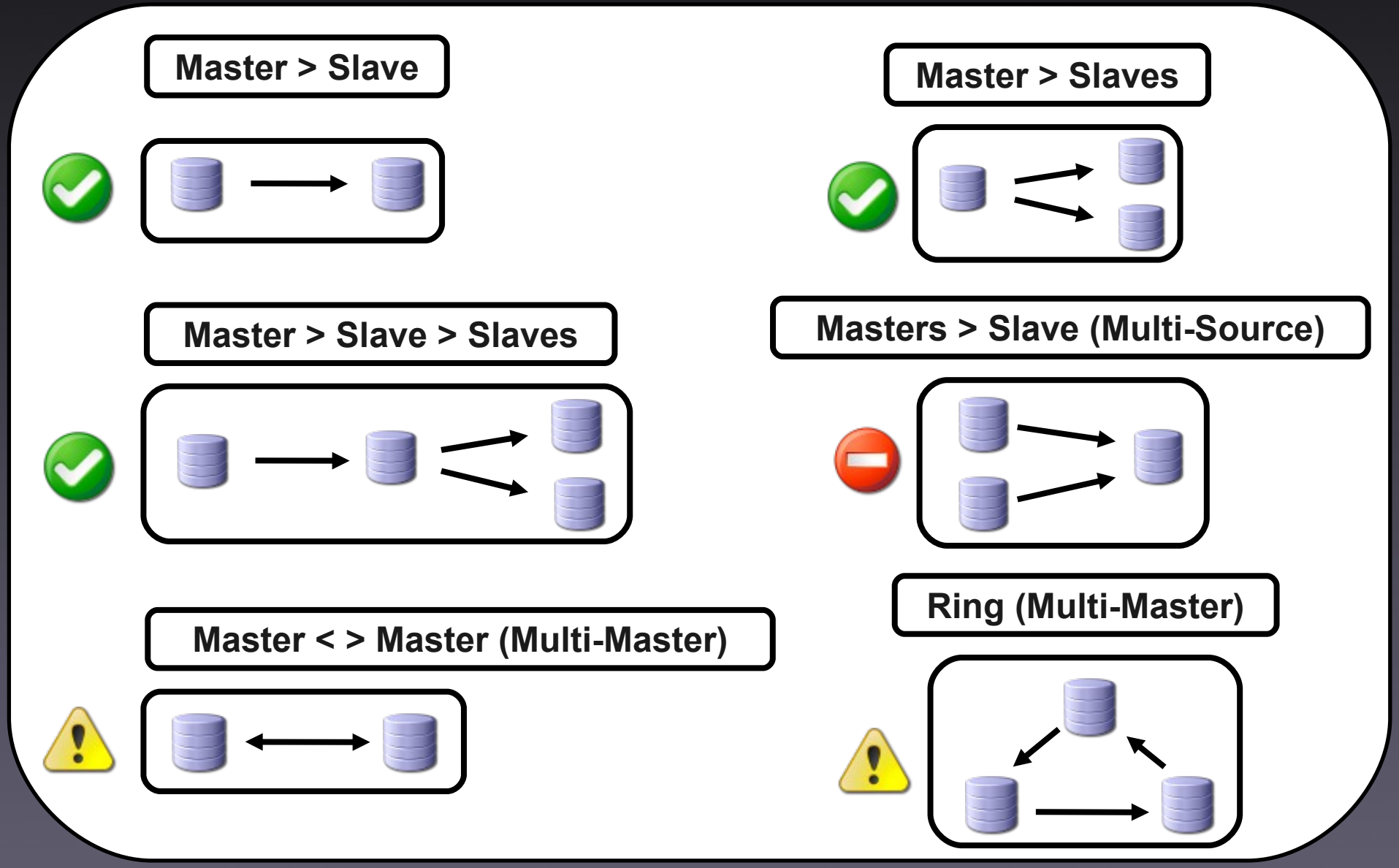
Statement-based replication

- Pro
  - ✔ Proven (around since MySQL 3.23)
  - ✔ Smaller log files
  - ✔ Auditing of actual SQL statements
  - ✔ No primary key requirement for replicated tables
- Con
  - ✗ Non-deterministic functions and UDFs
  - ✗ LOAD_FILE(), UUID(), USER(), FOUND_ROWS()
    (but RAND() and NOW() work)

Row-based replication

- Pro
  - ✔ All changes can be replicated
  - ✔ Similar technology used by other RDBMSes
  - ✔ Fewer locks required for some INSERT, UPDATE or DELETE statements
- Con
  - ✗ More data to be logged
  - ✗ Log file size increases (backup/restore implications)
  - ✗ Replicated tables require explicit primary keys
  - ✗ Possible different result sets on bulk INSERTs

Replication Topologies



Master-Master Replication

- Useful for easier failover
- Not suitable for load-balancing
  - Writes still end up on both machines
  - Neither machine has the authorative data
- Don't write to both masters!
- Use Sharding or Partitioning instead (e.g. MySQL Proxy)

MySQL Replication as an HA Solution

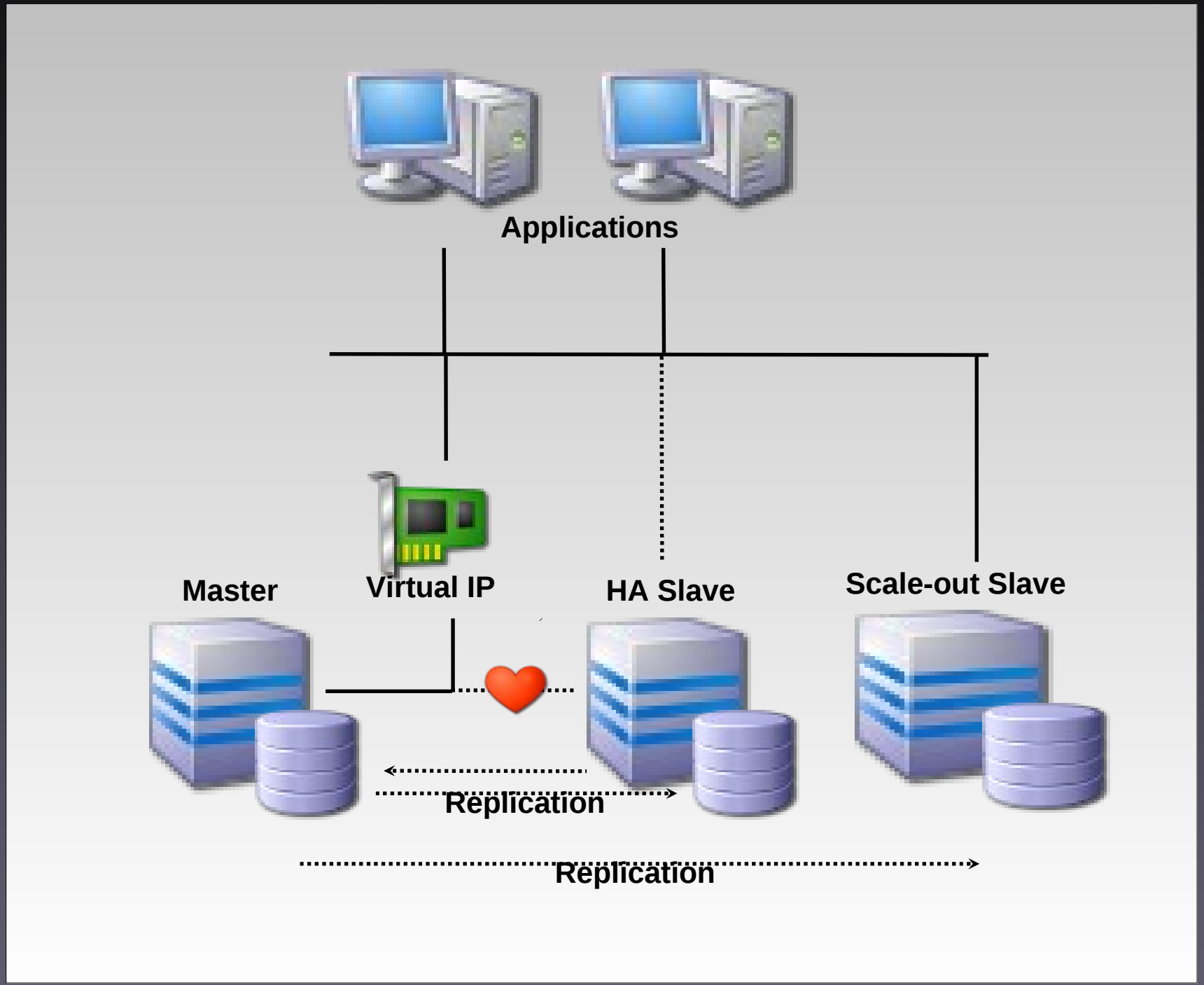
- What happens if the Master fails?
  - The application won't work anymore
  - Slave has nothing to replicate from
- What happens if the Slave fails?
  - Data will no longer be replicated
- This doesn’t sound like High Availability?
  - Correct!
  - Replication is just one component of an HA setup
  - It doesn’t implement all parts of an HA Solution!

Replication & HA

- Combined with Heartbeat
- Virtual IP takeover
- Slave gets promoted to Master
- Side benefits: load balancing & backup
- Tricky to fail back
- No automatic conflict resolution
- Proper failover needs to be scripted

Linux-HA / Hearbeat

- Supports 2 or more nodes
- Resource monitoring
- Active fencing mechanism: STONITH
- Policy-based resource management, dependencies & constraints
- Time-based rules
- Includes support for many applications
- GUI support
- Low dependencies / requirements
- Subsecond node failure detection

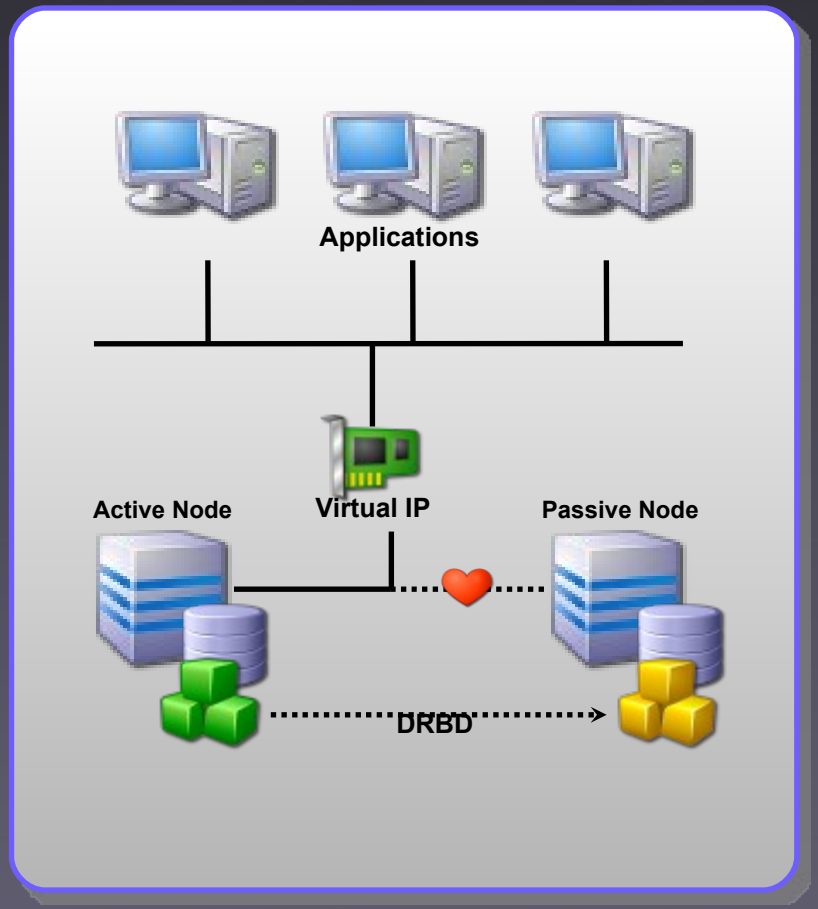

Applications
Virtual IP
Master
HA Slave
Scale-out Slave
Replication
Replication

DRBD

- Distributed Replicated Block Device
- “RAID-1 over network”
- Synchronous/asynchronous block replication
- Automatic resync on recovery
- Application-agnostic
- Can mask local I/O errors
- Active/passive configuration by default
- Dual-primary mode (requires a cluster filesystem like GFS or OCFS2)
- http://drbd.org/

DRBD in detail

- DRBD Replicates data between two disk partitions
- DRBD integrates nicely with Linux-HA and other HA Solutions
- MySQL runs on the Active node as usual
- MySQL is dormant on the Passive node
- DRBD is Linux only



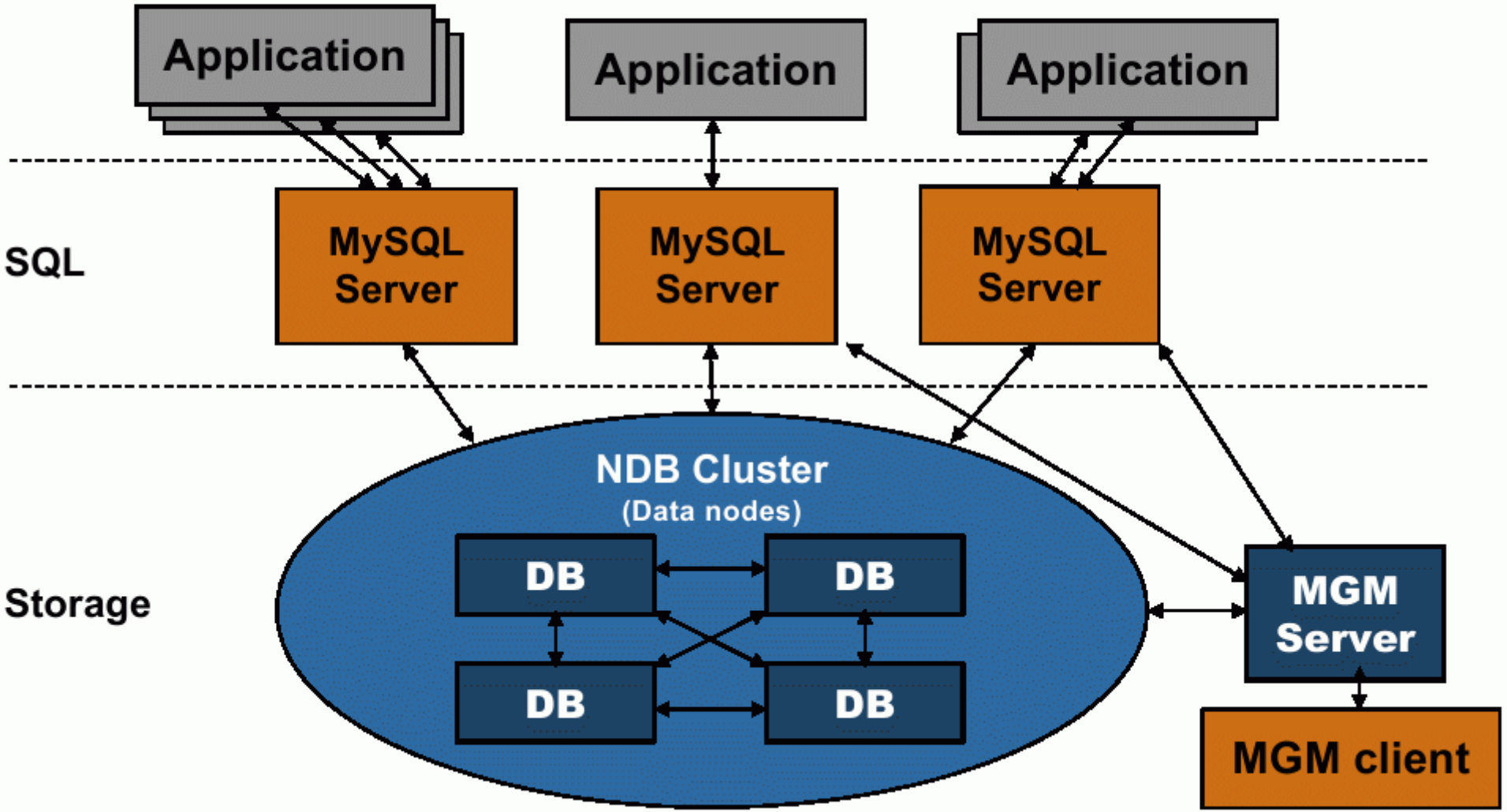
MySQL Cluster

- Shared-nothing architecture
- Automatic partitioning
- Distributed Fragments
- Synchronous replication
- Fast automatic fail-over of data nodes
- Automatic resynchronization
- Transparent to Application
- Supports Transactions

MySQL Cluster

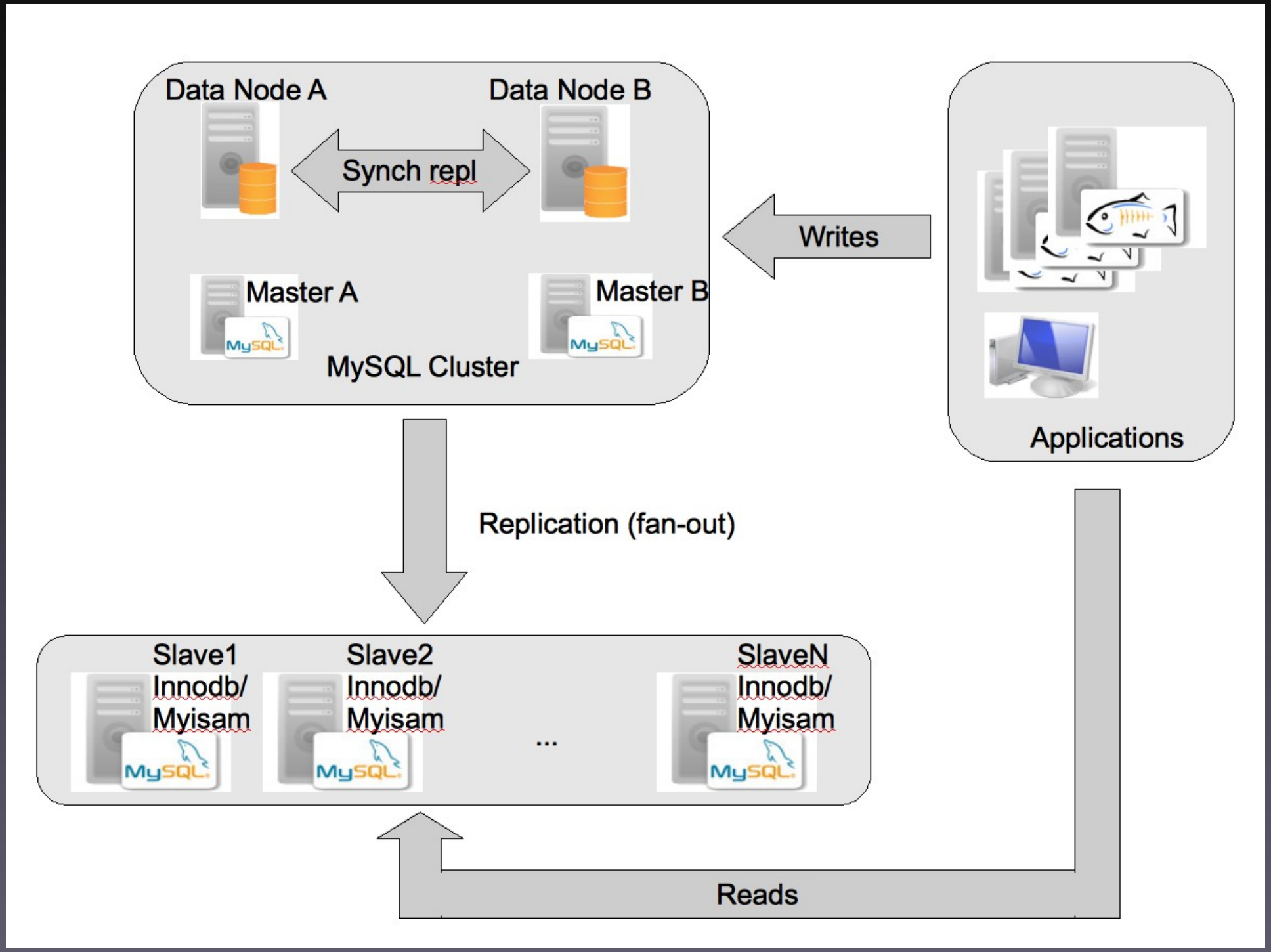
- In-memory indexes
- Not suitable for all query patterns (multi-table JOINs, range scans)
- No support for foreign key constraints
- Not suitable for large datasets/transactions
- Latency matters
- Can be combined with MySQL Replication (RBR)

Cluster Components



MySQL Cluster & Replication

- MySQL Cluster
  - Easy failover from one master to another
  - Scaling writes to multiple masters
- Asynchronous replication from Cluster to multiple slaves
- Reads are distributed to slave servers (running InnoDB/MyISAM)
- Quick setup of new slaves (using Cluster Online Backup)
- Easy failover and quick recovery



http://johanandersson.blogspot.com/2009/05/ha-mysql-write-scaling-using-cluster-to.html

	Requirements	MySQL Replication	MySQL Replication & Heartbeat	MySQL, Heartbeat & DRBD	MySQL Cluster
Availability	Automated IP Failover	No	Yes	Yes	No
	Automated DB Failover	No	No	Yes	Yes
	Typical Failover time	Varies	Varies	< 30s	< 3s
	Auto resync of data	No	No	Yes	Yes
	Geographic redundancy	Yes	Yes	MySQL Replication	MySQL Replication
Scalability	Built-in load balancing	MySQL Replication	MySQL Replication	MySQL Replication	Yes
	Read-intensive	Yes	Yes	MySQL Replication	Yes
	Write-intensive	No	No	Possible	Yes
	#Nodes/Cluster	Master/Slave(s)	Master/Slave(s)	Active/Passive	255

MMM – MySQL Master-Master Replication Manager

- Collection of scripts to perform monitoring/failover and management
- Master-Master replication configurations (one writable node)
- Failover by moving virtual IP
- http://code.google.com/p/mysql-master-master/

Flipper

- Perl Script that manages pairs of MySQL servers replicating to each other.
- Automatic switchover, triggered manually
- Enables one half of the pair to be taken offline for maintenance work while the other half carries on dealing with queries from clients
- Moves IP addresses based on a role ("read-only", "writable") between two nodes in the master pair, to ensure that each role is available
- http://provenscaling.com/software/flipper/

Red Hat Cluster Suite

- HA and load balancing
- Supports up to 128 nodes
- Shared storage
- Monitors services, file systems and network status
- Fencing (STONITH) or distributed lock manager
- Configuration synchronization
- http://www.redhat.com/cluster_suite/

Solaris Cluster / OpenHA Cluster

- Provides failover and scalability services
- Solaris / OpenSolaris
- Kernel-level components plus userland
- Agents monitor applications
- Geo Edition to provide Disaster Recovery using Replication
- Open Source since June 2007
- See Thorsten's FrOSCon talk for more details! (Sunday, 11:15, HS4)
- http://www.opensolaris.org/os/community/ha-clusters/

Related tools / Links

- Linux Heartbeat
  http://linux-ha.org/
- Red Hat Cluster Suite
  http://www.redhat.com/cluster_suite/
- Sun Open High Availability Cluster
  http://opensolaris.org/os/project/ha-mysql/
- Linux Cluster Information Center
  http://www.lcic.org/ha.html

Tools/Links

- MySQL Multi-Master Replication Manager
  http://code.google.com/p/mysql-master-master/
- Maatkit
  http://maatkit.sourceforge.net/
- Mon – scheduler and alert management
  http://www.kernel.org/software/mon/
- Continuent Tungsten Replicator
  https://community.continuent.com/community/tungsten-replicator

Q & A

Questions, Comments?

Thank you!

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Eliminating the SPOF

- Identify what will fail
  - Disks
  - Fans
- Find out what can fail
  - Network cables
  - Power supplies
  - CPUs
  - NICs
    - OOM

HA Components

- Heartbeat
  - Checks that services that are being failed over, are alive.
  - Can check individual servers, software services, networking etc.
- HA Monitor
  - Configuration of the services
  - Ensures proper shutdown and startup
  - Allows manual control
- Shared storage / Replication

Rules of High Availability

- Prepare for failure
- Aim to ensure that no important data is lost
- Keep it simple, stupid (KISS)
- Complexity is the enemy of reliability
- Automate it
- Test your setup frequently!

Split-Brain

- Communications failures can lead to separated partitions of the cluster
- If those partitions each try and take control of the cluster, then it's called a split-brain condition
- If this happens, then bad things will happen http://linux-ha.org/BadThingsWillHappen
- Use Fencing or Moderation/Arbitration to avoid it