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ADVANCED MYSQL REPLICATION ARCHITECTURES

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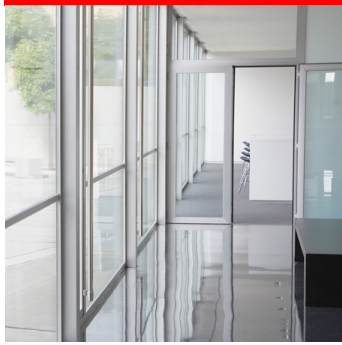
Agenda



- MySQL Replication Basics
- Traditional Architectures
- Load Balancing
- Data Aggregation and Multi-source Replication
- Hierarchical Replication
- Data Integration
- MySQL 5.6 and Advanced Replication Architectures Enablers

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MySQL Replication Basics

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Components

- Master
  - Changes data
  - Logs changes (events) into a file (the binary log)
- Slave
  - Retrieves events from the master
  - Replays the events on the slaves databases
- Binary Log
  - Records every change on the master (in either format: *row* or *statement*)
  - Split into transactional groups

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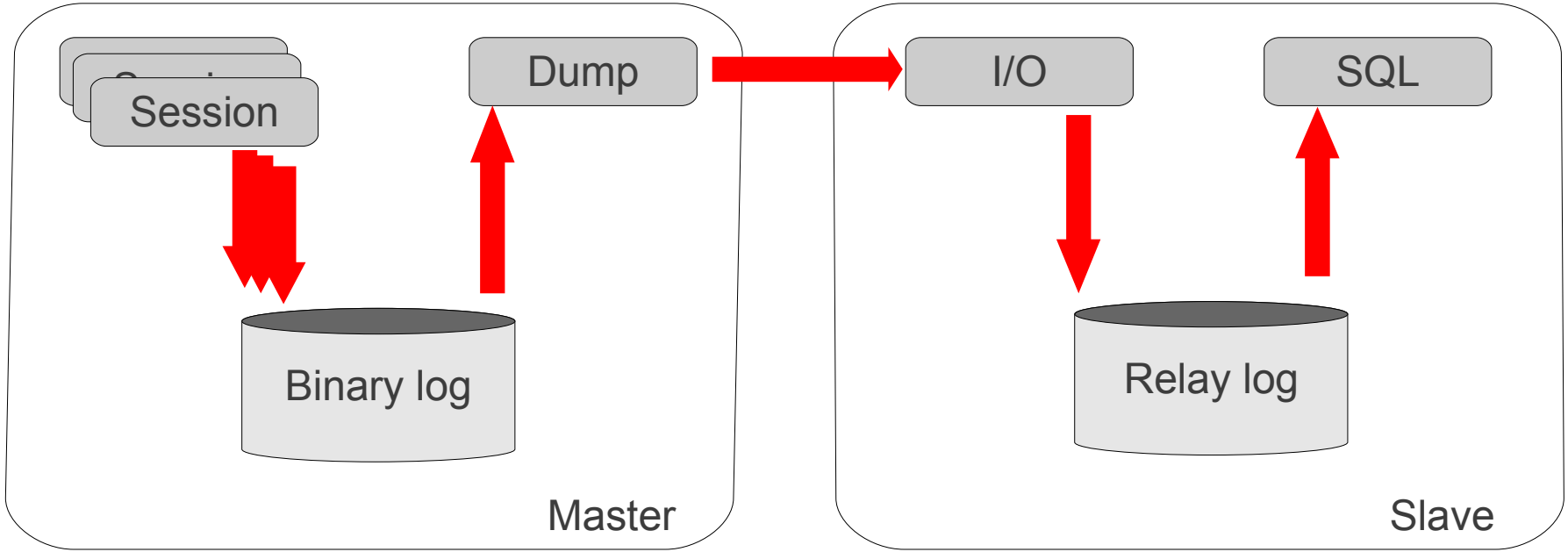
Big Picture



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Propagating the Changes

- Asynchronous Replication
  - Transactions are committed and externalized without interaction with the replication layer.
  - Events are propagated after the commit operation is acknowledged.
  - Faster but vulnerable to lost updates on server crashes and inconsistency.
  - Built into the server.
- Semi-synchronous Replication
  - Master commits transaction but waits for at most one slave to acknowledge having received and stored the correspondent event before replying to the client.

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Traditional Architectures

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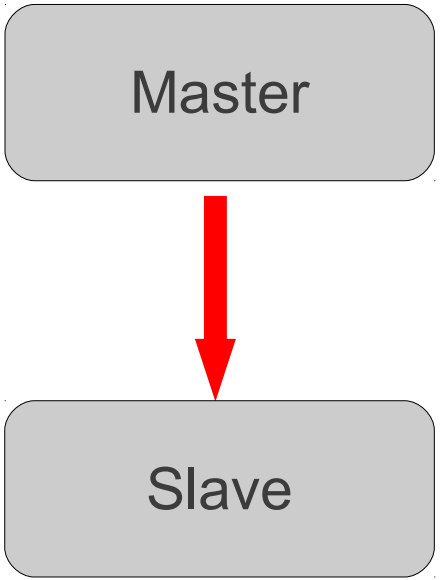
Single Master, Single Slave



- Backups
- Reports
- Disaster Recovery (geographically distant servers)
- Recovering from Human errors (Time-delayed replication)
- Add more slaves seamlessly

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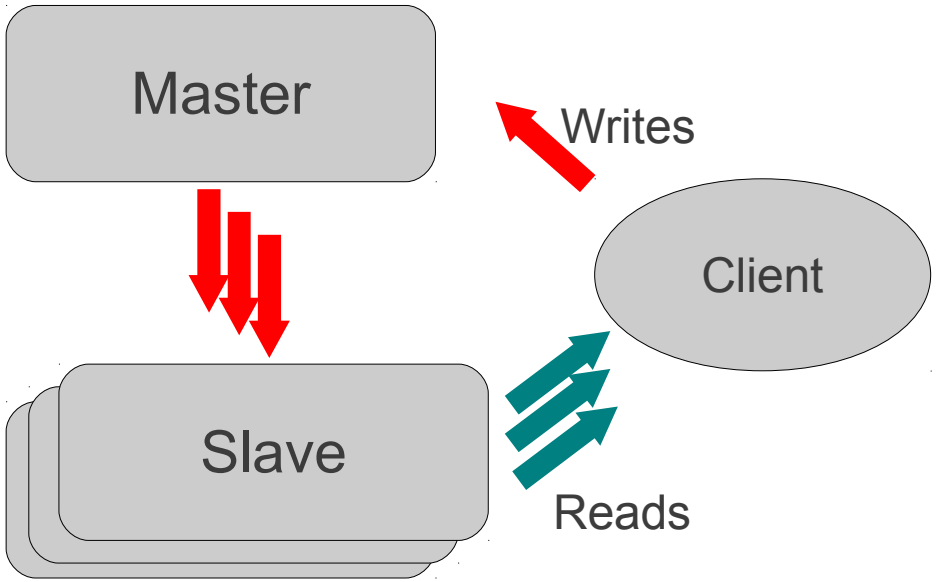
Scaling-out read operations



- Off-loading the master
  - Different type of queries routed to different servers
- Different hardware profiles for master and slaves
  - SSD for enhancing master performance
  - Large RAM / caches to enhance Slaves performance
- Load Balancing
- Query routing policies

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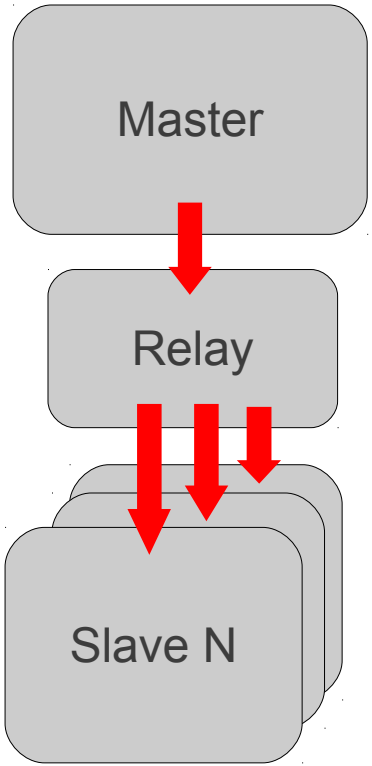
Relay Server



- Relay Slave.
- Blackhole storage engine.
  - No data stored on the relay slave.
- Reduce load at the master.
- Improved master side filtering.
  - Sensitive data can be kept only at one physical server.
- Relay has binary log active.

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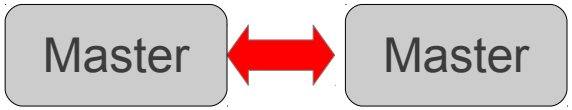
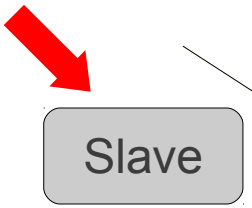
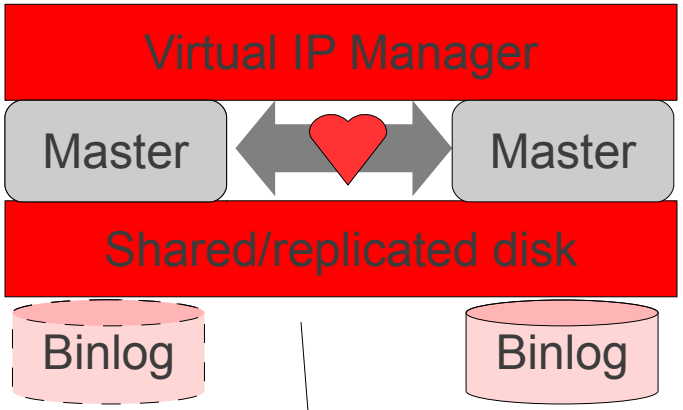
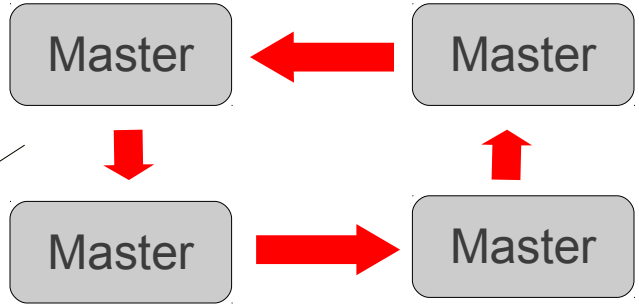
High Availability





Dual Masters





Circular Replication

Active/Passive Shared disk

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High Availability

- High Availability: fail-over
  - Servers can crash (hardware, software or even power failure).
  - Services should not.
- Dual masters, circular replication (conflict free partition workload on each).
  - Seamless fail-over of affected partitions
  - Scaling out with slaves.
    - Ready to step up and replace a failed master (on dual masters what out for whether the slave is already ahead of second master – slave promotion instead)
- Active / Passive – binlog is shared by the two master's, on fail-over binlog positions match

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Load Balancing

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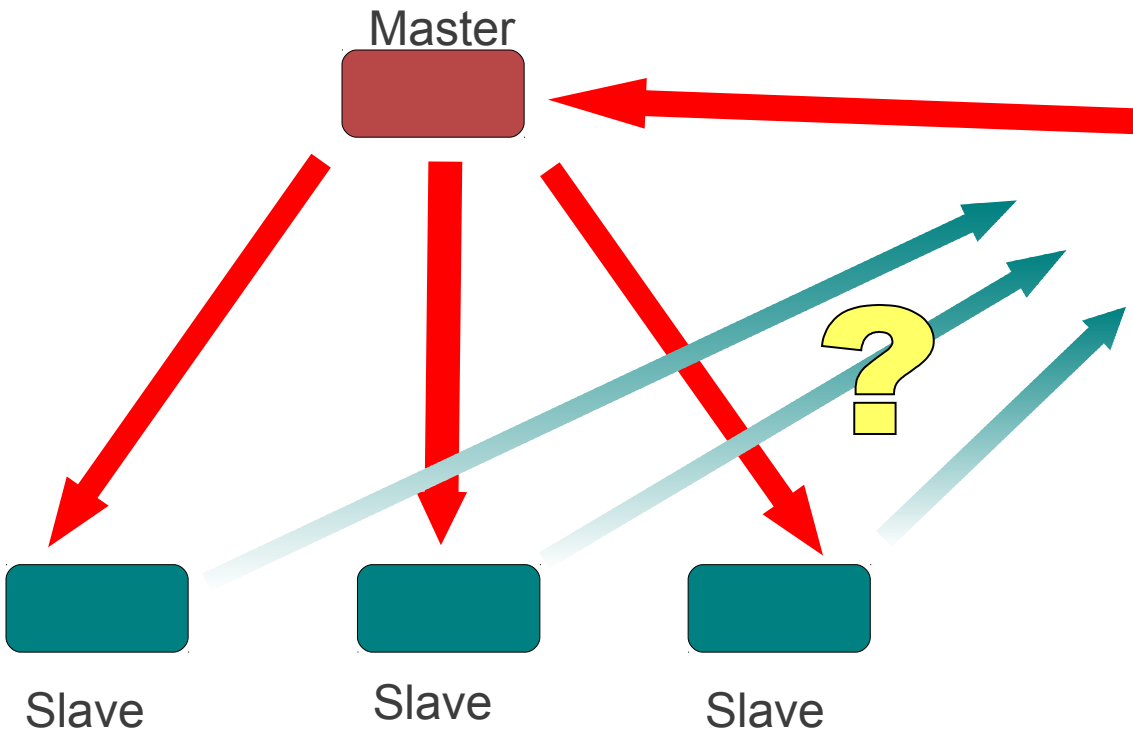
Load Balancing



Writes to a master.

Client

Reads from a pool of slaves.

From which one?

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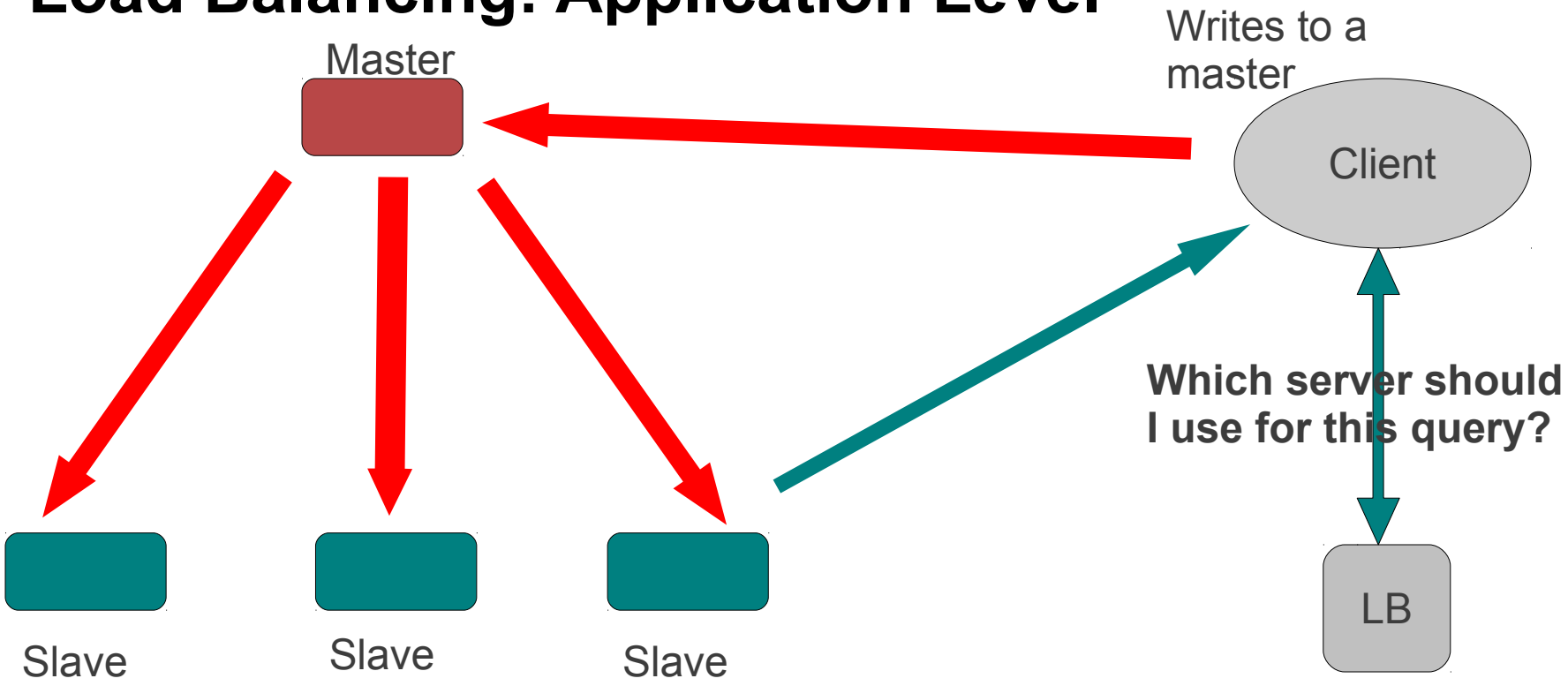
Load Balancing: Application Level



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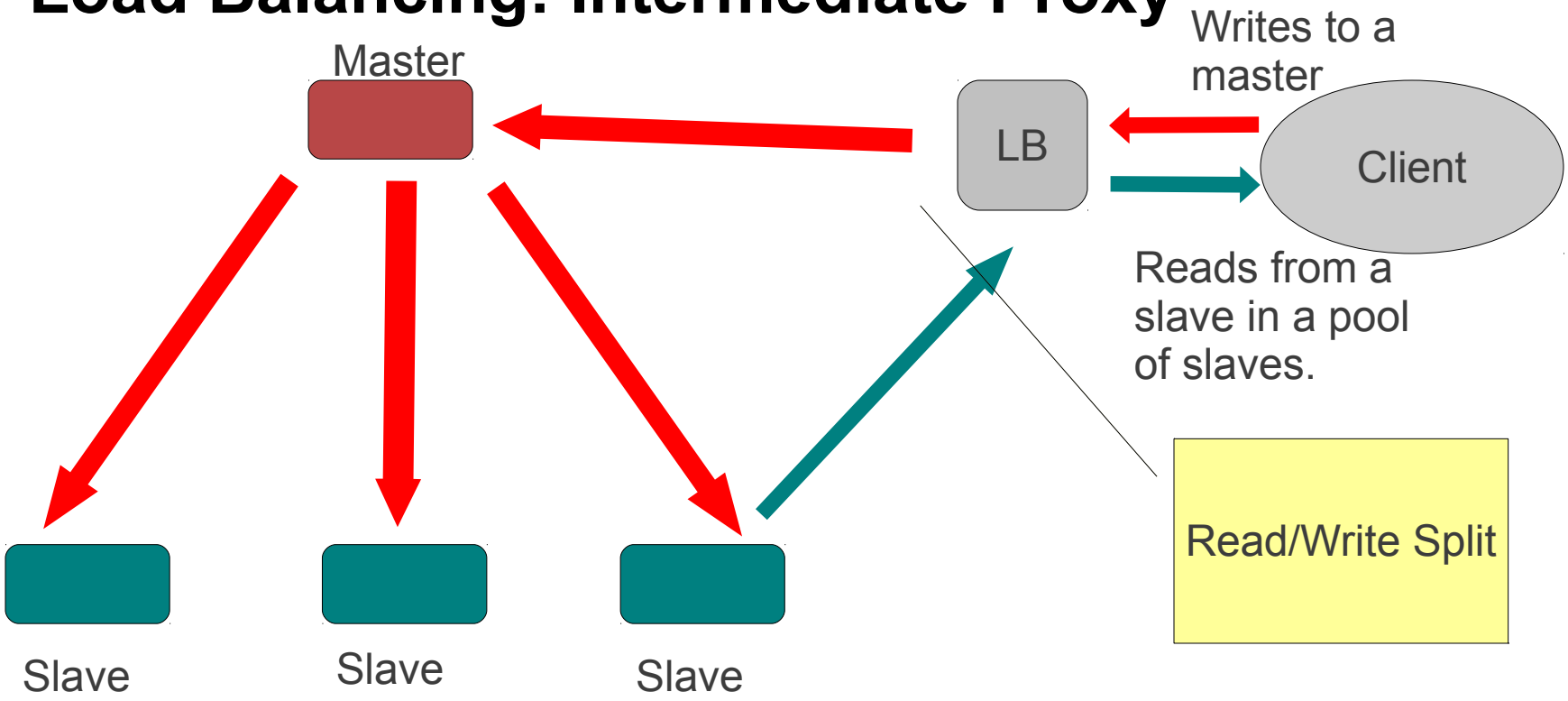
Load Balancing: Intermediate Proxy



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Load Balancing

- Requires monitoring tools (status and performance)
  - Servers crash every now and then!
- Requires intelligent query routing (reads vs writes)
  - Which queries go where?
- Session consistency is something to keep in mind!
- Enter MySQL Proxy (alpha quality), PHP mysqlnd, Connector/J …
  - http://dev.mysql.com/downloads/mysql-proxy/
  - http://dev.mysql.com/downloads/connector/php-mysqlnd

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Hierarchical Replication

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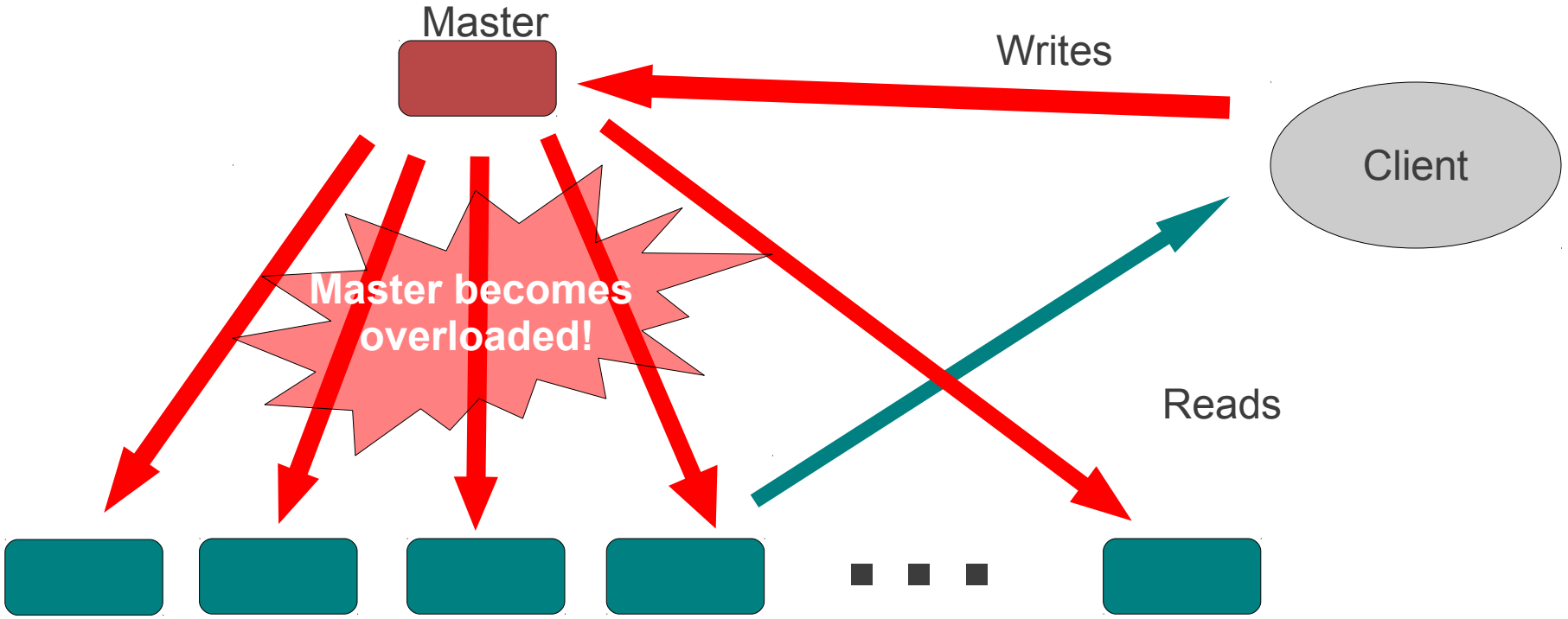
Hierarchical Replication



Hundreds of slaves connected to the master.

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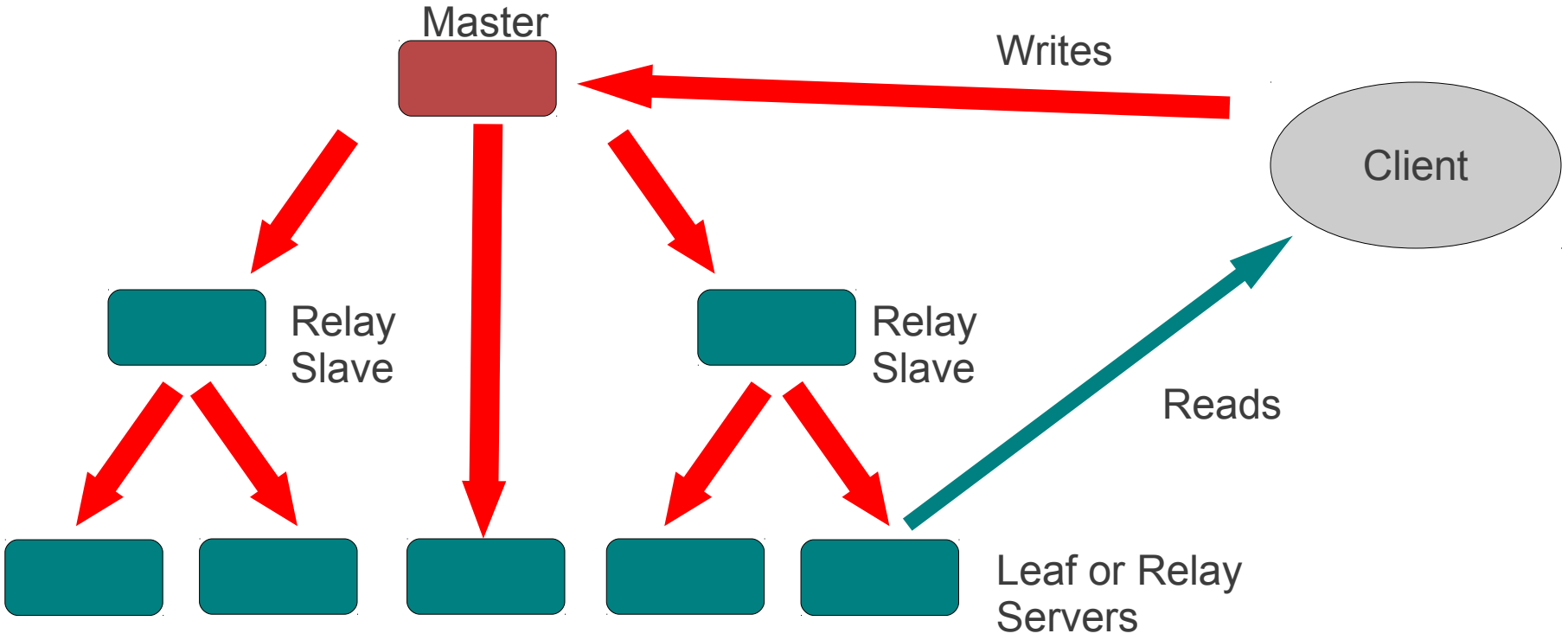
Hierarchical Replication



Hundreds of slaves more down the hierarchy ...

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Hierarchical Replication

- Scale-out hundreds of servers
  - Blackhole storage engine on relays.
  - Relay servers have binary logs ON, leaf slaves do not need it.
- Group data domains/partitions
  - Sensitive information routed through parts of the hierarchy.
  - Event filtering.

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Hierarchical Replication

- Hierarchy-wide consistency!
  - Asynchronous propagation => writes take time to propagate from master to slaves: reading from a slave may return stale data.
  - Event positions are filename and offset => different on every intermediate slave.
  - Wait for data to propagate.
    - Global transaction identifiers (**provided by the server starting from MySQL 5.6.5 DMR**).
    - Poll each relay server down the chain until data has propagated.

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Data Aggregation: Multi-source Replication

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Multi-source Replication

- Why?
  - Aggregate data from different masters, different data-centers, different clusters
- How?
  - Time-share Replication
    - Typically round-robin policy
    - Aggregating data from clusters in different timezones
    - Slave controlled by specific client
    - You can do it all at SQL level
      - http://mysqlmusings.blogspot.pt/2011/04/round-robin-multi-source-in-pure-sql.html

  - Inter-cluster
- Requirements: Conflict free load

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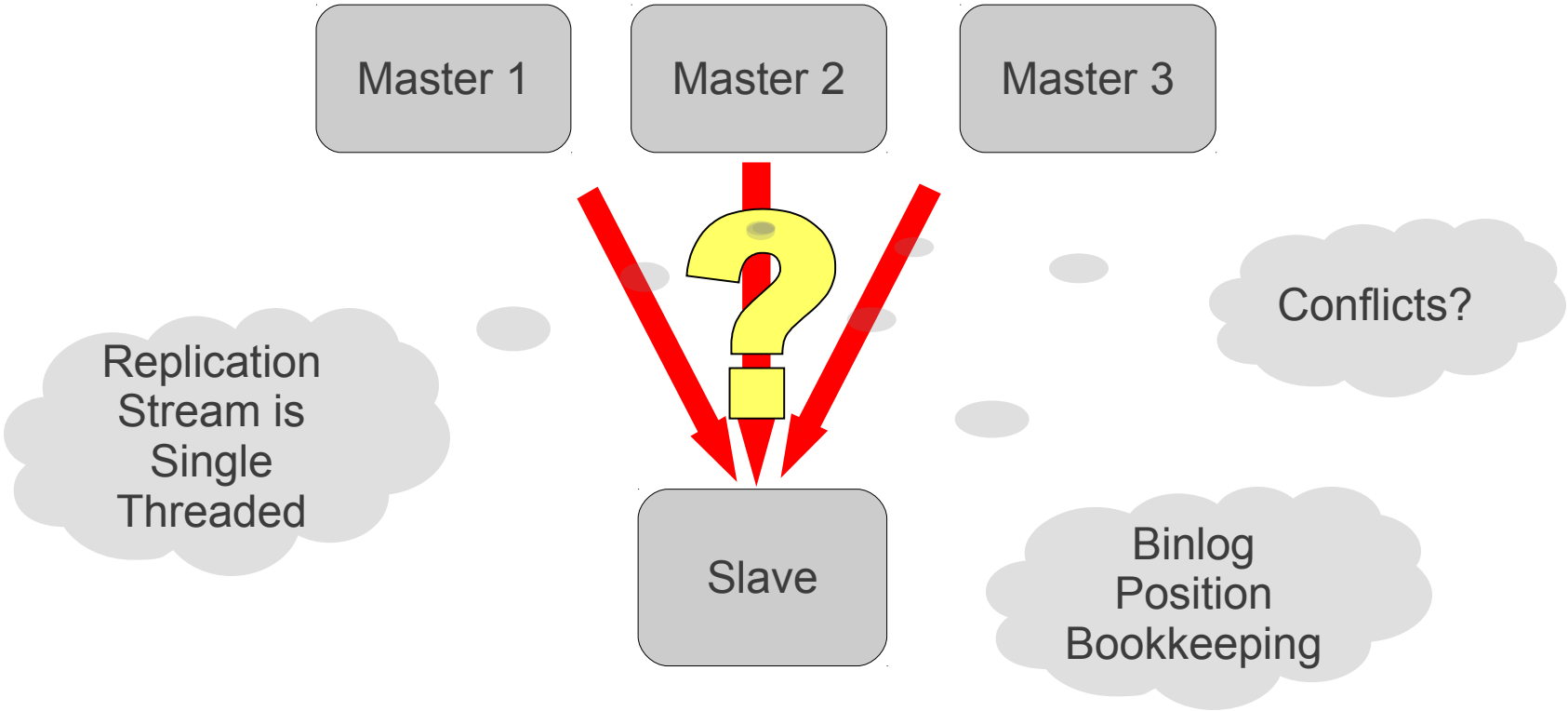
Multi-source Replication



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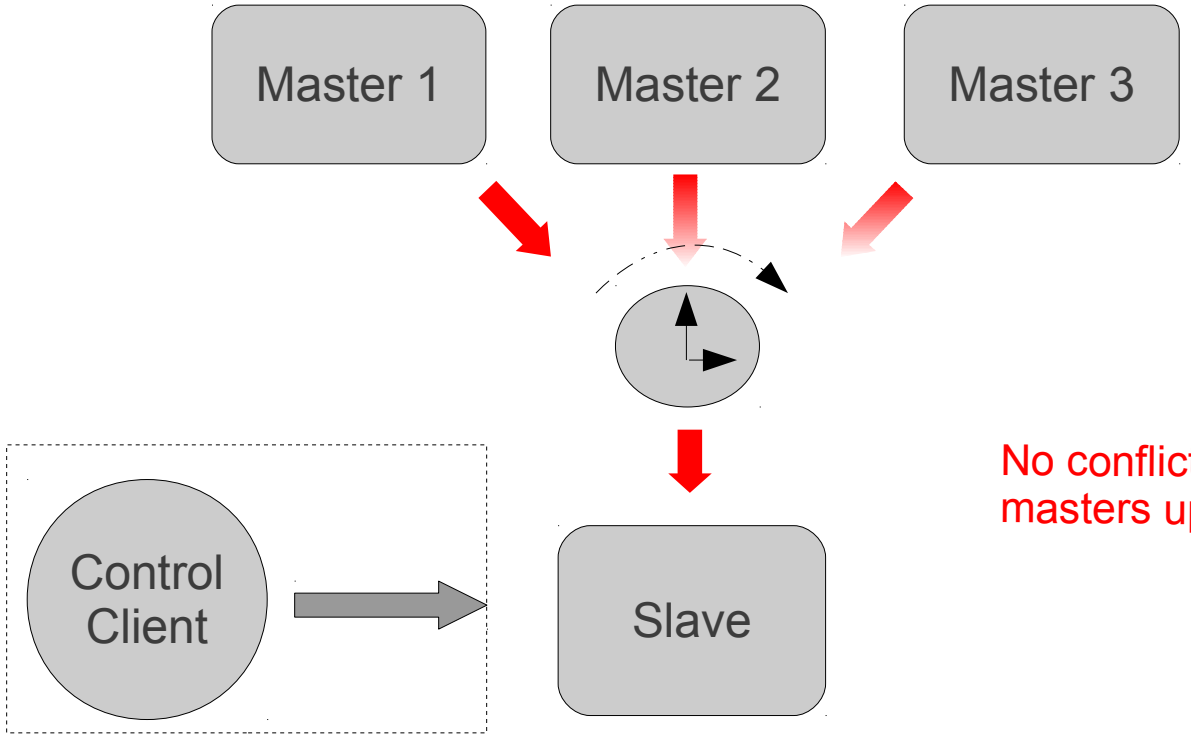
Multi-source Replication: Time share



No conflict resolution, so let masters update different data

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Data Integration

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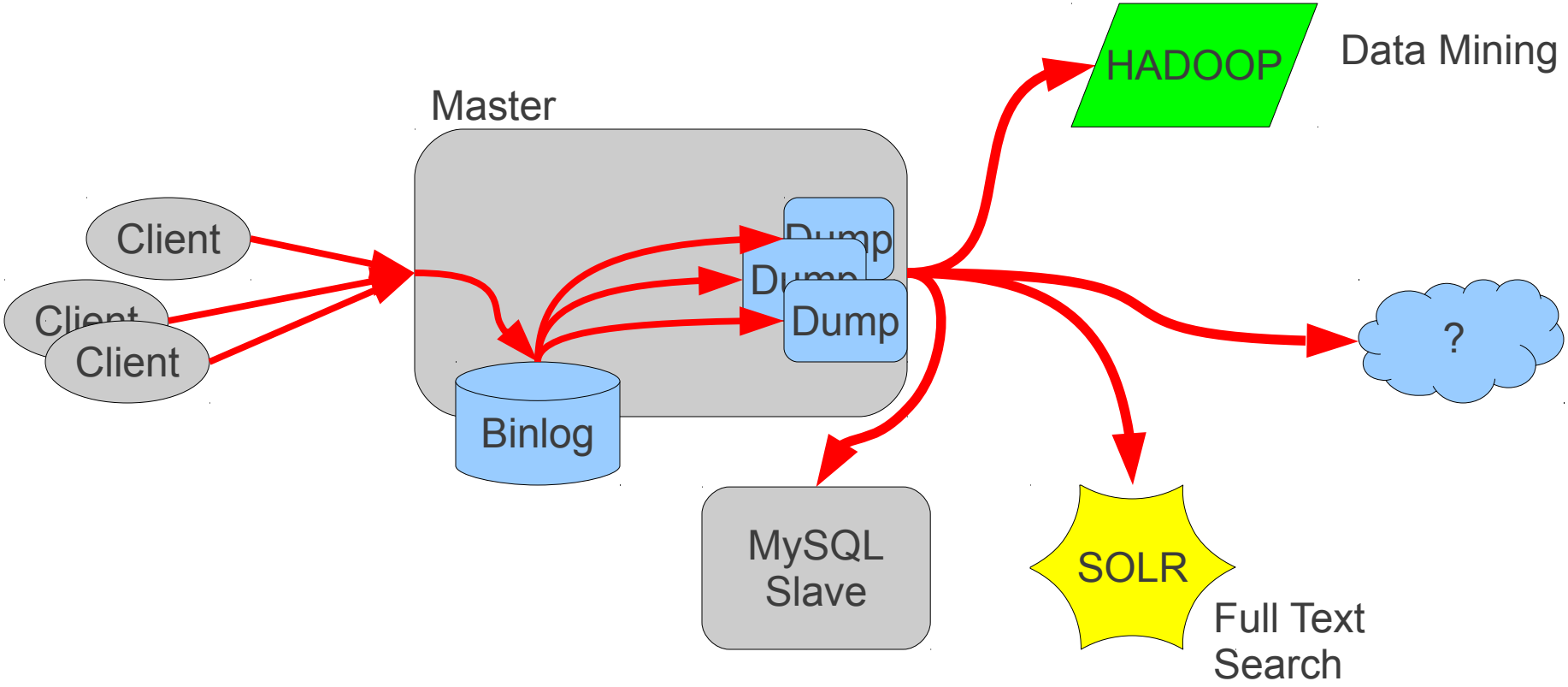
Integrate Data Into Other Systems



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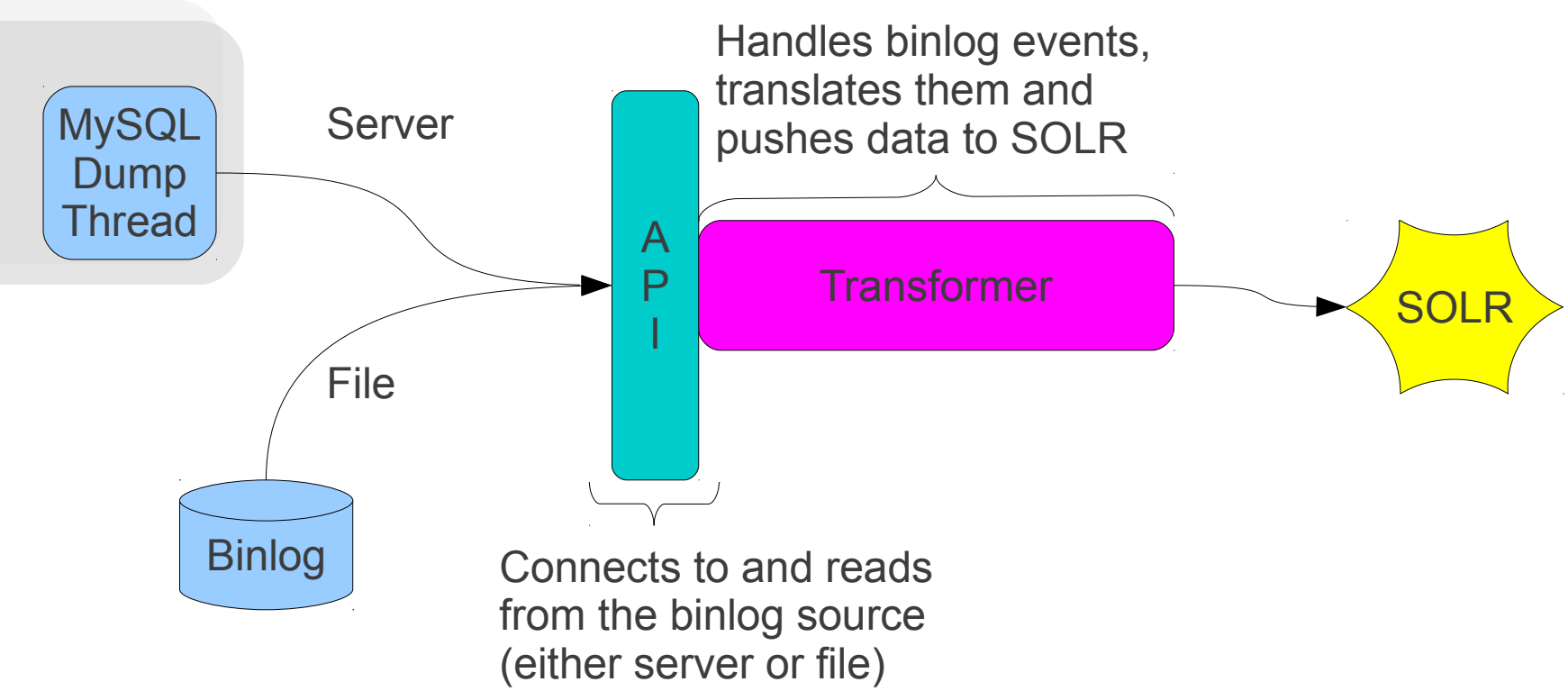
Integrate Data Into Other Systems
via mysql binary log API



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Integrate Data Into Other Systems

- Library to process replication events
- Application Programming Interface
- Simple, extensible, efficient
  - Just hook a client thread in the wait_for_next_event handler!
- Something you can preview (not GA yet):
  - https://launchpad.net/mysql-replication-listener
  - http://www.oscon.com/oscon2011/public/schedule/detail/18785
  - https://blogs.oracle.com/MySQL/entry/mysql_5_6_replication_new

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MySQL 5.6 and Advanced Replication Architectures Enablers

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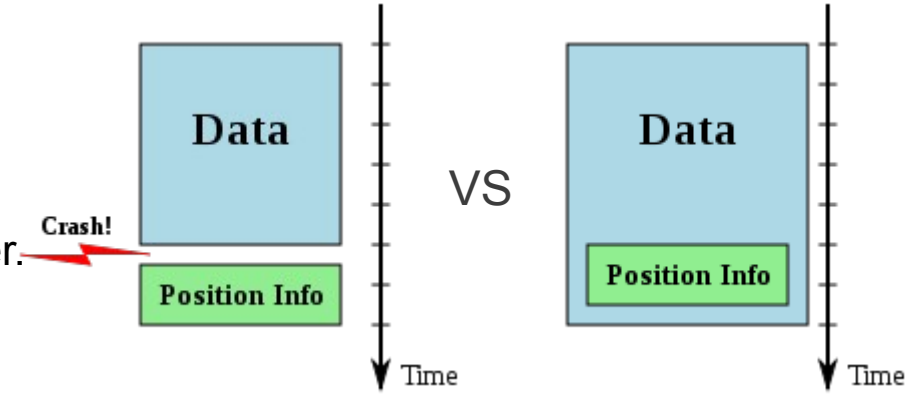
Replication Metadata on System Tables

- Crash-safe (replication metadata stored in transactional tables)
  - Robust, highly available setups
- SQL interface to metadata
  - Access data through regular user session.
  - Self-contained: time-shared multi-source easily implemented in SQL and in the server.
  - Make use of special features like MySQL events, stored procedures, triggers, etc...



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Global Trans Ids: Automatic Failover and more...

- Promote any slave to be the new master.
- Automatically pick replication stream correctly:
  - Slave auto-positioning;
  - Slave automatically skips transactions that already exist in the server.
- Advanced topologies with much more automatic reconfiguration.
  - Session consistency facilitator.

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Global Trans Ids: Automatic Failover and more...

- Logical Identifier: (*Server UUID, Transaction Number);*
  - Human readable/friendly;
  - Uniquely assigned when the transaction executes;
  - Preserved when the transaction is re-applied.
- Server State: set of applied transactions.
  - Enables slave auto-positioning;
  - Failover facilitator;
  - Protects against undesirable transaction re-execution
- Feature designed to work with transactional engines (InnoDB).

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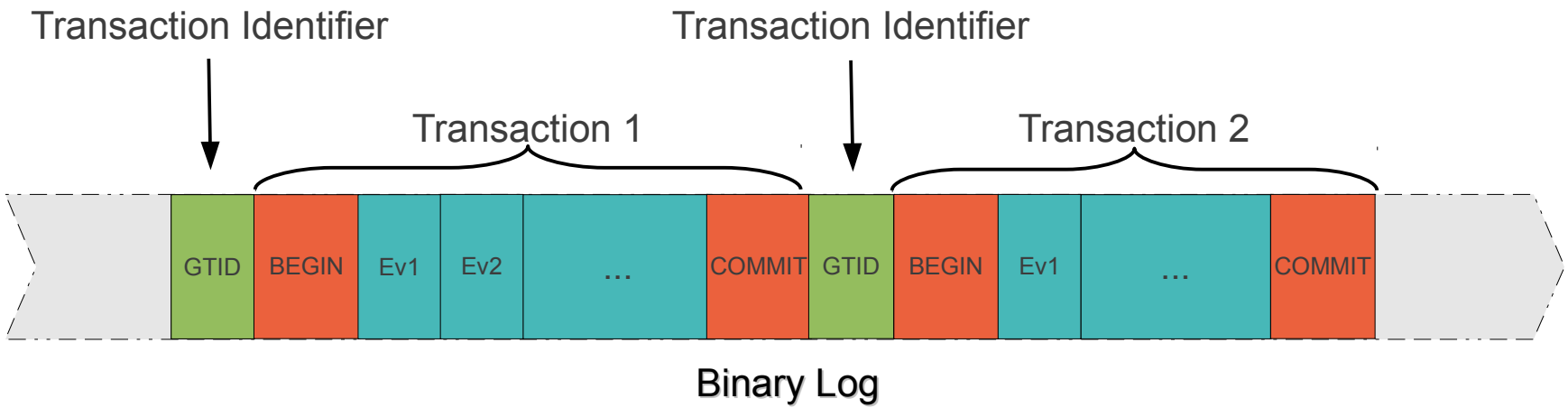
Global Trans Ids: Automatic Failover and more...

- Persistence:
  - It is written to the binary log.
  - Precedes a collection of events that comprise a transaction.

5.6 DMR



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MySQL Utilities: What is it?

- A collection of Python utilities for managing MySQL databases
- MySQL Workbench Plugin
- Available under the GPLv2 license
- Written in Python
- Python library to grow solutions for common administrative problems
- Download MySQL Workbench from:
  - **http://www.mysql.com/downloads/workbench/**
- You can also download the latest development source code tree for the MySQL Workbench Utilities from:
  - **http://launchpad/net/mysql-utilities**

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MySQL Utilities: What can I do with it?

- Easily administer MySQL servers from the command line
  - mysqldbcompare – compare databases
  - mysqldbcopy – copy databases between servers
  - **mysqlfailover** – Automatic fail-over
  - **mysqlrpladmin –** General replication administration utility
  - **mysqlrplshow** – show a graph of your topology
  - **mysqlreplicate** – setup replication
  - mysqlrplcheck – check replication configuration
  - ...
- Build your own tools on top of the core of the library, e.g., automate timeshare multi-source replication setup or failing-over to a slave

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MySQL Proxy

- Simple program in-between client and mysql server
  - Monitor, analyze, transform, load balance
  - Use cases and possibilities are enormous
- Alpha Release Available at:
  - **http://dev.mysql.com/downloads/mysql-proxy/**
- Documentation available at:
  - **http://dev.mysql.com/doc/refman/5.5/en/mysql-proxy.html**

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The Binary Log API

- A C++ library used for connecting to a MySQL server and process the replication stream as a slave.
- Enables complex setups and data streaming to heterogeneous slaves.
- Not GA.
- Source code is publicly available at (licensed under GNU GPL v2):
  - **https://launchpad.net/mysql-replication-listener**

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Summary

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Summary

- MySQL replication concepts and components: replication is simple
- Popular MySQL replication use case scenarios: replication is flexible and versatile
- Scenarios that take MySQL replication to a whole new more advanced level:
  - Load Balancing
  - Hierarchical replication
  - Data replication and aggregation
  - Data integration
- MySQL features that are enablers for more advanced replication scenarios
  - Including some of the shiny new features included in the latest MySQL 5.6 DMRs.

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Q&A

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Hardware and Software

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