MySQL Replication vs Galera: which is better for your workload?

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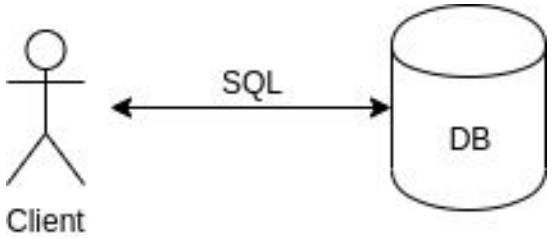
Профессиональная конференция
для разработчиков высоконагруженных
систем

Replication is better than standalone

- Standalone

- Less parts leading to less faults
- New transactions reading committed data instantly
- You know where to find a database



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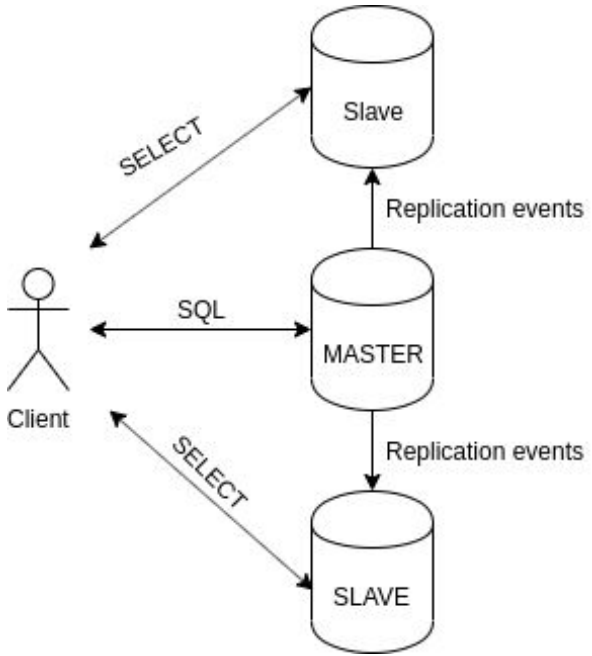
Replication is better than standalone



Replication

- Database service is alive on multiple node faults
- Easy to increase READ performance by adding servers
- Proxy servers distribution the load

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Statement (SQL) replication

- Non-deterministic queries crashing replication
  - UUID(), RAND()
  - DELETE/UPDATE + LIMIT без ORDER BY
- READ COMMITTED / READ UNCOMMITTED

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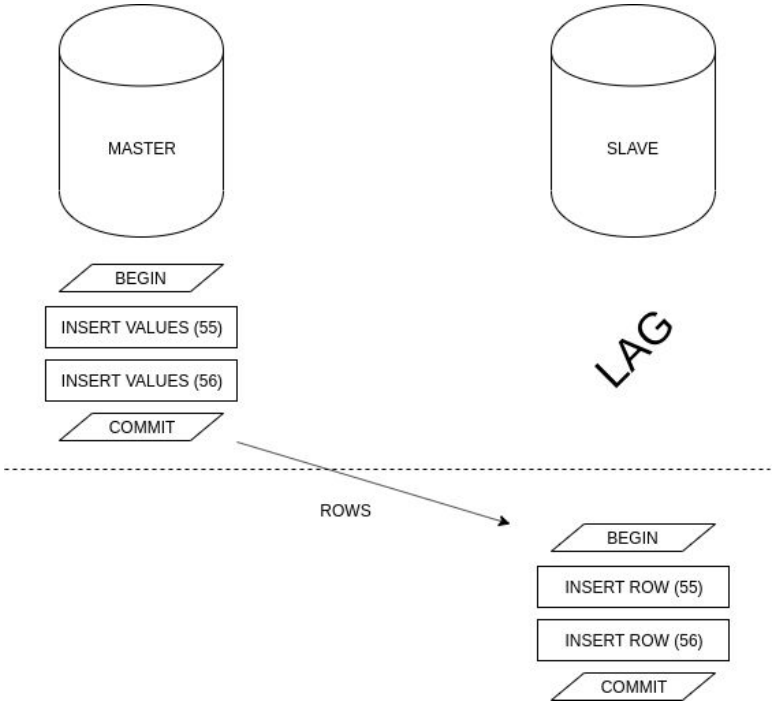
ROW based replication

- How to find a row?
  - Primary Key!
- What to transfer?
  - row before
  - row after
  - partial row



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Replication files

- binary log
- relay log
- master.info relay-log.info
  - could be stored inside InnoDB tables

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Replication: faults

- semi-sync
  - Does the slave receive replication event?
  - COMMIT waits for the confirmation from at least single slave
    - rpl_semi_sync_master_wait_for_slave_count
- crash-safe slave (default 8.0)
  - relay-log-info-repository=TABLE
  - relay-log-recovery=ON

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Replication: group commit

- InnoDB => MySQL: Transaction is ready!
  - PREPARE
  - multiple transactions committed in parallel
- MySQL => InnoDB: binlog fsync finished
- binlog_group_commit_sync_delay
- binlog_group_commit_sync_no_delay_count

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Replication: GTID

- binlog file name and position is different everywhere
- server“s UUID + seqno(transaction on server)
- Snapshot identified by: (uuid1:seq1, uuid2:seq2...)
  - long sets...
- CREATE SELECT – problem
- tmp tables in transactions – also not supported

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Replication: WRITESET

- Replication event:
  - db.table.PK
  - row
- For each row calculate XXHASH64(PK)
- Foreign keys are not supported

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Parallel slave

- slave_parallel_type
  - DATABASE
  - LOGICAL_CLOCK
- binlog_transaction_dependency_tracking
  - COMMIT_ORDER
  - WRITESET, WRITESET_SESSION

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It“s almost a multi-master!

- Synchronous multi-master is a reliable solution
  - transaction write conflict? ROLLBACK
  - error applying the row?
    - recreate the node

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Group Replication

- New network protocol
  - eXtended COMmunication
- cluster members state monitoring
- single-primary, multi-primary
  - primary role switchover

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Group Replication: XCom

- Based on Paxos (Mencius)
- Strict transaction commit order in cluster
- Dynamic membership
- Fault detection

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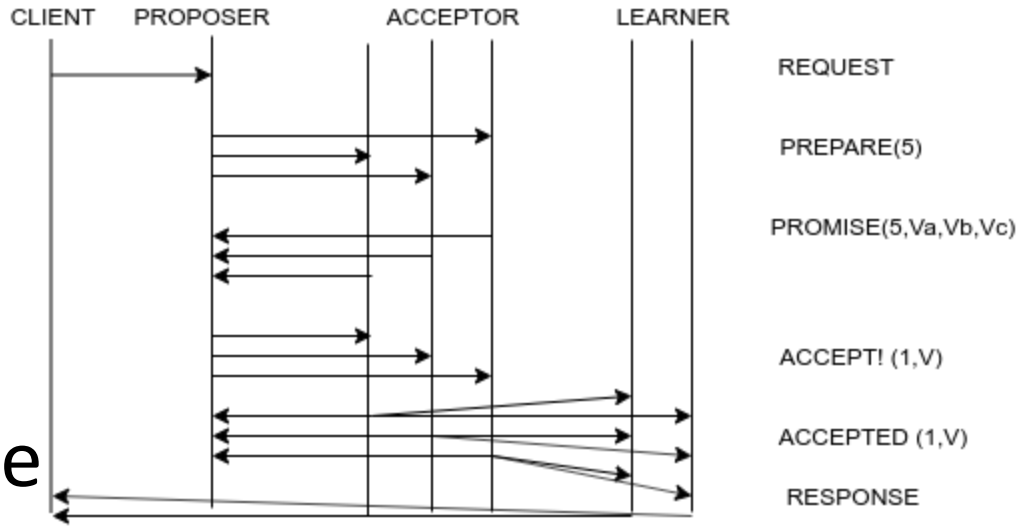
Paxos

1) Elect the leader
2) Transfer the transaction
3) Majority accepts the transaction
4) COMMIT!



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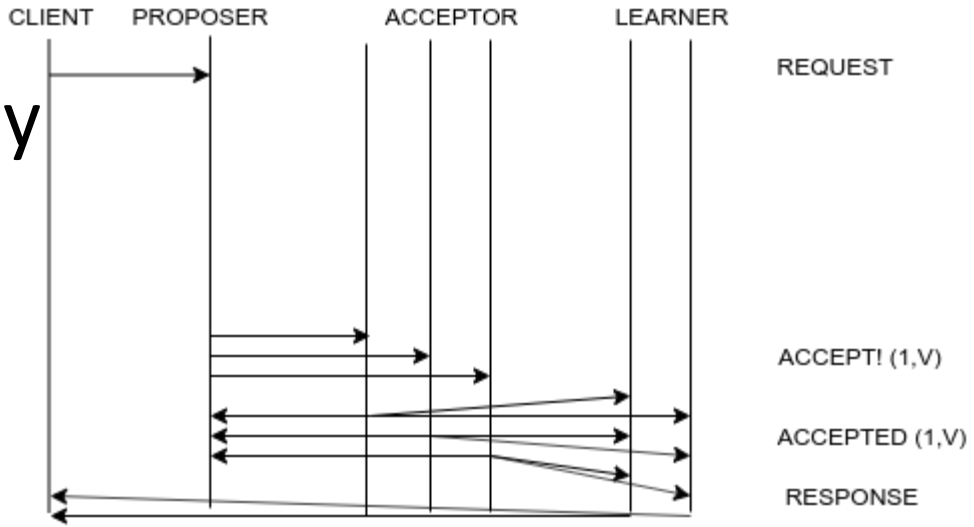
Multi-Paxos

- Elect the leader only once
- Skip elections (prepare)
- Leader proxies messages



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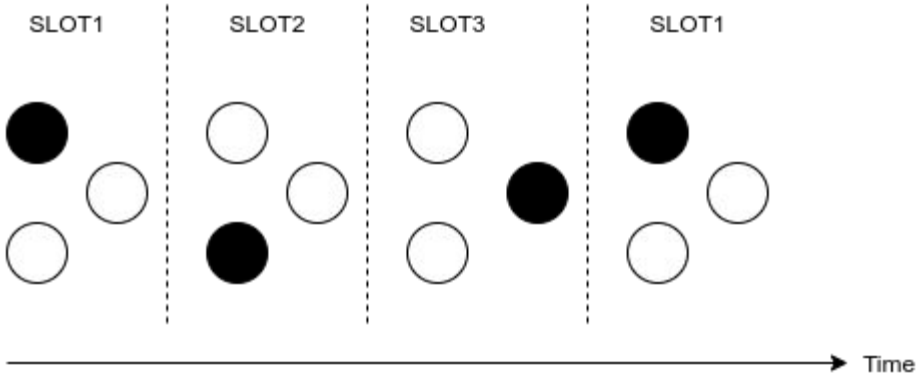
Mencius

- Every node has a leader slot
- nothing to suggest?
  - send a SKIP



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XCom: optimizations

- handles empty slots
- batch processing for multiple transactions
- full transaction data transfered just once

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XCom: restrictions

- up to 9 nodes
- long message processing? Node evicted from cluster
  - group_replication_member_expel_timeout = 5 seconds
  - group_replication_transaction_size_limit = 143MB
  - group_replication_communication_max_message_size = 10MB

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Group Repl.: Single Primary

- Better than async replication!
  - automatic recovery after fault
  - guarantees the same row values on all nodes

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Group Repl.: Multi Primary

- Advanced mode
- no Gap Locks, READ COMMITTED
- no SERIALIZABLE
- DDL – problem
- FK – problem

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Group Repl.: consistency

- group_replication_consistency
  - EVENTUAL – do not wait
  - BEFORE_ON_PRIMARY_FAILOVER
  - BEFORE – wait for previous transactions to commit
  - AFTER – wait for transaction to be applied everywhere
  - BEFORE_AND_AFTER

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Group Repl.: instrumentation

- Performance Schema tables
  - replication_group_member_stats
  - replication_group_members
  - replication_connection_status
  - replication_applier_status

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Repair: incremental

- Do you have a server with older GTID?
- Do you have old binary logs?
- Applies the difference between old state and current cluster state incrementally

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Repair: manual

- mysqldump
  - too slow for real databases
  - mysqlpump – better
- Xtrabackup
  - same as GTID-replication setup
- MySQL Enterprise Backup
  - not open source, subscription required

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CLONE Plugin

- Similar to MEB/Xtrabackup
- FILE COPY
- PAGE COPY
- REDO COPY

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InnoDB Cluster: MySQL Router

- proxy MySQL network protocol
- Monitors cluster membership
- Run it directly on application server
- Different TCP ports for RW and RO

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InnoDB Cluster: MySQL Shell

- X Dev API
- Admin API
- Shell API
- SQL
- Python & JavaScript library

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InnoDB Cluster: MySQL Shell

- Checks server configuration
- fixes the configuration with mysql-auto.cnf
- Creates the cluster
- Can add new nodes with CLONE
- cluster.status()

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Summary: InnoDB Cluster

- Over 3 years after release, many changes implemented during last year
- Use with MySQL 8.0.17+ !
- There is no WAN optimizations
- Good encryption for network and storage
- NoSQL by using X protocol

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Percona XtraDB Cluster

- Synchronous replication
- Since 2012 (5.5)
- Galera-based
- Current development focus:
  - autonomous usage (reduce ops)
  - fix bugs

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Galera

- Full database on each node
- Slow as a slowest node
- Virtually synchronous
- Error for each query after loosing quorum on the node
- COMMIT – can return error
- COMMIT – at least RTT long
- Problematic with large transactions (improved with Galera 4/PXC8)

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Galera: Binlog

- binary logs are not used directly
- binlog could be disabled
- Uses hooks in InnoDB code
- ROW events saved in Gcache
- write-set: all rows modified by transactions

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Galera: DML processing

- BEGIN;
- queries...
- COMMIT:
  - Extract write-set
  - Get a Transaction ID
  - write-set transfer
  - wait for certification
  - return OK to the client

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Galera: consensus, trx id

- Totem single-ring ordering and membership
- Every node certifies all transactions
- seqno incremented globally in the cluster

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Galera: *_seqno

- global_seqno (x,y,z)
- local_seqno n1(a,b,c) n2(a,p,r) n3(m, n, o)
- last_seen_seqno
  - for the trx under certification
  - helps to detect certification boundaries
- depends_seqno

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Galera: Flow Control

- Async write-set copy
- Async apply
  - global transaction ordering
- Receive queue
  - Flow Control (PXC: 100+ transactions)

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Galera: readings after DML

- Virtually synchronous
- wsrep_sync_wait – SELECT waits until proper seqno on all nodes
- Galera4/PXC8: functions for wait

  $transaction_gtid = SELECT WSREP_LAST_SEEN_GTID();
  SELECT WSREP_SYNC_WAIT_UPTO_GTID($transaction_gtid);

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PXC: ProxySQL

- Intelligent load balancer
- Implements MySQL network protocol
- Can balance:
  - queries
  - transactions
  - users
- SELECT / INSERT+UPDATE+DELETE separation

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ProxySQL: setup

- Clustering: multiple ProxySQL servers
  - Automatic sync for settings and state
  - not a single point of failure
  - you can run it on application server directly
- Uses mysql network protocol for configuration MySQL, TCP/6032.

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ProxySQL: setup

- Stores details for all nodes at **mysql_servers**
- checks node availability
- Multiple server roles (reader,writer, backup writer) in **mysql_galera_hostgroups**

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ProxySQL: users

- ProxySQL stores all users in **mysql_users**
- MySQL should have same users and passwords
  - add users on one PXC node
  - setup access rights (GRANT/REVOKE) in MySQL
- proxysql-admin --config-file=/etc/proxysql-admin.cnf **--syncusers**

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ProxySQL: routing

- **mysql_query_rules**:
  - SELECT: processed by «readers»
  - SELECT ... FOR UPDATE: processed by «writer»
  - other queries: processed by writer to reduce conflicts
- Query routing:
  - RegEx
  - by user name (prod_ro, prod_rw)

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PXC: WAN

- Voting weights to calculate quorum
- Arbiter
- Multiple settings for different timeouts
- Segments: reduce WAN traffic`

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PXC: DDL

- Total Order Isolation
  - block all queries on all nodes
  - wait for ALTER TABLE applied in parallel everywhere
  - pt-online-schema-change helps a lot
- Rolling Schema Upgrade
  - apply node by node
  - hard to use

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PXC: Recovery

- SST: Full backup and restore
  - xtrabackup
  - rsync (disabled in PXC8 due to REDO logging changes)
  - mysqldump (deprecated, removed from PXC8)
- IST: incremental
  - node gets the difference from donor“s Gcache

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PXC: version upgrades

- Major version:
  - Stop whole cluster
  - update OS packages
  - start without galera: --wsrep-provider='none'
  - mysql_upgrade
  - repair other nodes by SST

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PXC: version upgrades

- Minor:
  - stop the node
  - upgrade OS packages
  - start without galera: --wsrep-provider='none'
  - mysql_upgrade
  - repeat operation on other nodes

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PXC8: version upgrades

- Major and minor:
  - JOINER can connect to older cluster
  - After SST: mysql_upgrade stats automatically
- Is a DONOR an async slave?
  - RESET SLAVE ALL executed automatically

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PXC: instrumentation

- Performance Schema
  - wait & stage instruments
  - mutex/cond variables
  - files
  - threads
- SHOW STATUS
  - Used by Percona Monitoring and Management
  - PXC8: wsrep_monitor_status

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Galera4/PXC8: instrumentation

- mysql.wsrep_cluster
- mysql.wsrep_cluster_members
- mysql.wsrep_streaming_log

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PXC8: big transactions

- Galera 4 feature
- Streaming Replication
  - splits transaction in parts
  - after first part certification
    - conflicting transactions are rolled back
    - use READ COMMITTED!

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PXC8: Streaming replication

- Too many rows:
  - fragment replicated before the COMMIT
- Hot rows
  - Use manual SR to get high priority lock:
  - START TRANSACTION;
    SET SESSION wsrep_trx_fragment_unit='statements';
    SET SESSION wsrep_trx_fragment_size=1;

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How to evaluate replication?

- Kubernetes
  - Percona K8S Operator for PXC
  - MySQL Operator
- dbdeployer

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dbdeployer

- Linux or OS X

```
$ VERSION=1.42.0
$ OS=linux
$ origin=https://github.com/datacharmer/\
dbdeployer/releases/download/v$VERSION
$ wget $origin/dbdeployer-$VERSION.$OS.tar.gz
$ tar -xzf dbdeployer-$VERSION.$OS.tar.gz
$ chmod +x dbdeployer-$VERSION.$OS
$ sudo mv dbdeployer-$VERSION.$OS /usr/local/bin/dbdeployer
$ dbdeployer downloads list
```


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dbdeployer: download

- get a tar.{gz,xz} from the official site
- Check libraries with: ldd bin/mysqld

```
$ dbdeployer downloads list
$ dbdeployer downloads get \
mysql-8.0.18-linux-glibc2.12-x86_64.tar.xz
$ dbdeployer unpack \
mysql-8.0.18-linux-glibc2.12-x86_64.tar.xz
```


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Innodb Cluster

- Locally
- Uses different TCP ports

```
dbdeployer deploy --topology=group \
  replication 8.0.18 --single-primary
```


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PXC

- PXC8 currently a bit more complex

```
dbdeployer deploy --topology=pxc \
  replication pxc5.7.27
```


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Summary

	PXC	InnoDB Cluster
Automatic recovery	+	8.0.17
Load balancer	ProxySQL	MySQL Router
Multi-Master	+	default: single
API/cmd for control		mysqlshell
WAN	+	
Big transactions	8.0	
“mature”	+	
Supported by Percona	+	+

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Questions?

- ?
- ?

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