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MySQL Cluster Deployment Best Practices

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Agenda

- Cluster Setup
  - Minimal & Recommended Setup
  - Networking & Hardware Selection
- Disk Data Tables
- Configuration
- Administration
  - Online/Offline Operations
  - Backup and restore
- Monitoring

Minimal Setup

4 Computers having:

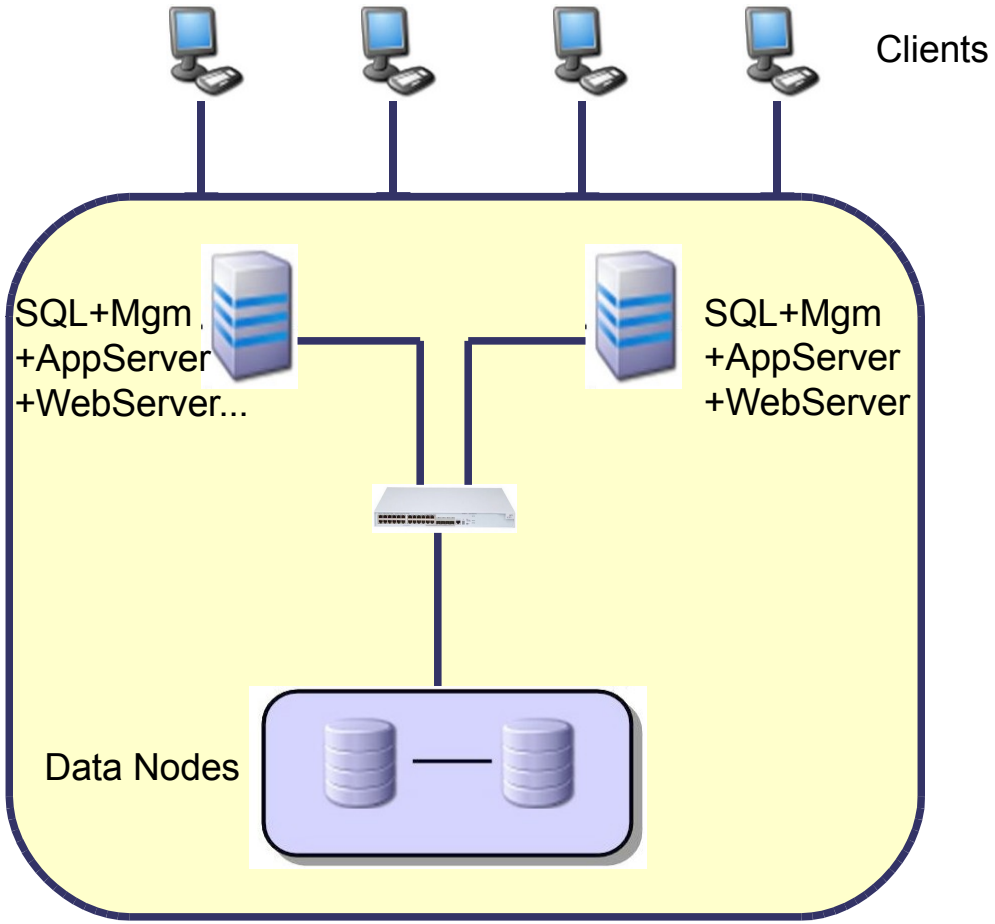
- 2 Data nodes
- 2 MySQL Servers
- 2 Management Nodes

Never:

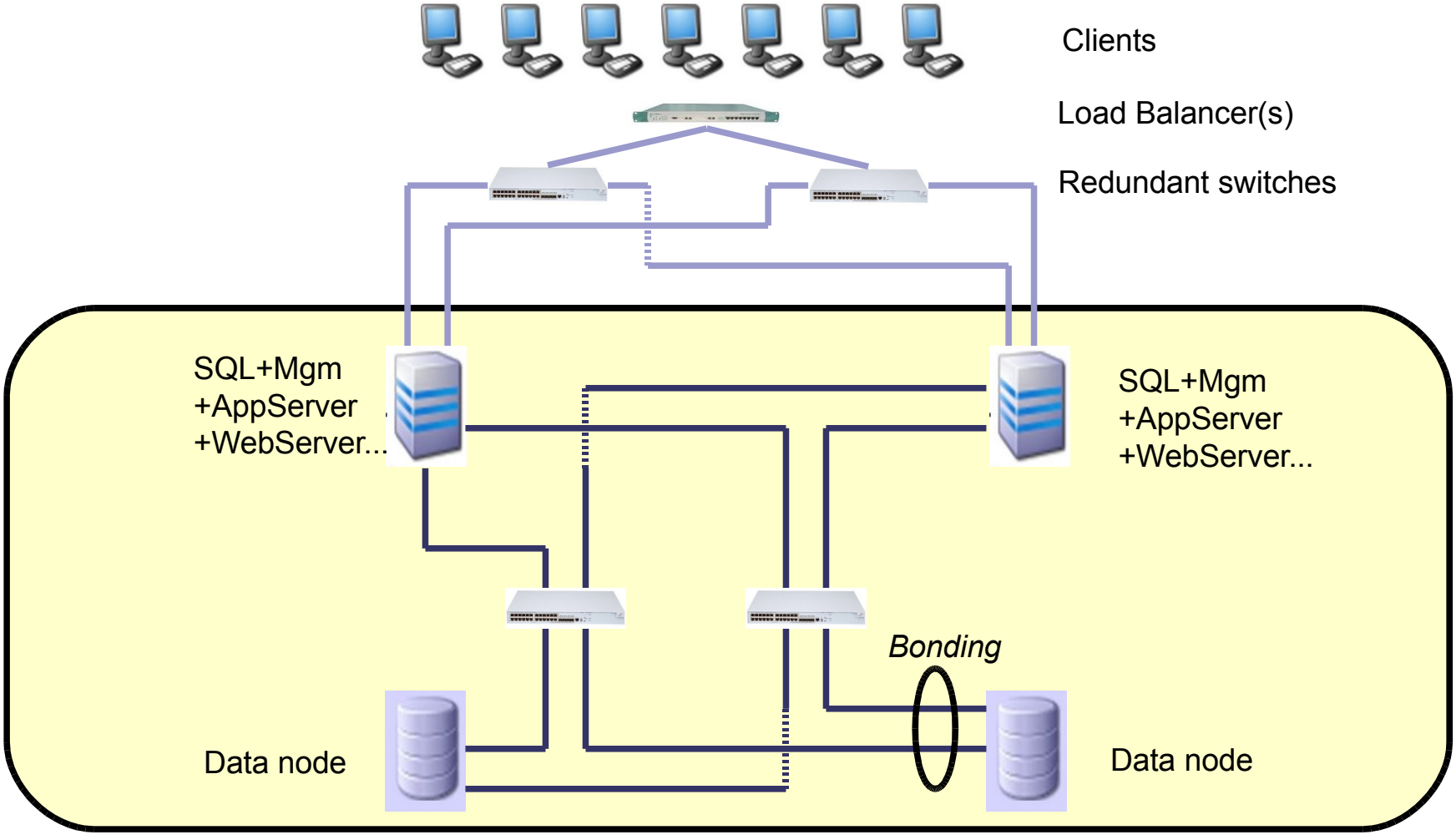
- Co-locate data node and management node! (split brain/network partitioning)

However :

- No redundant network
- SPOF
- No DRP



Recommended Setup



Networking

- Dedicated >= 1GB/s networking
- Prevent network failures (NIC x 2, Bonding)
- Use Low-latency networking (Dolphin...) if >= 8 data nodes or want higher throughput and lower latency
- Use dedicated network for cluster communication
- No security layer to management node (remote shutdown allowed ....)
- Enable port 1186 access only from cluster nodes and administrators

Hardware Selection - RAM & CPU

- Storage Layer (data nodes)
  - One data node can (7.0+) use 8 cores
  - **CPU**: 2 x 4 core (Nehalem works really well). Fast CPU → fast processing of messages.
  - **RAM**: As much as you need
    - a 10GB data set will require 20GB of RAM (because of redundancy
    - Each node will then need 2 x 10 / #of data nodes. (2 data nodes → 10GB of RAM → 16GB RAM is good
  - **Disk space:** 10xDataMemory + space for BACKUP + TableSpace (if disk data tables)
- SQL Layer (MySQL Servers)
  - **CPU**: 2 – 16 cores
  - **RAM**: Not so important – 4GB enough (depends on connections and buffers)

Hardware Selection - Disk Subsystem

low-end	mid-end	high-end
		
1 x SATA 7200RPM • For a read-most, write not so much • No redundancy (but other data node is the mirror)	1 x SAS 10KRPM • Heavy duty (many MB/s) • No redundancy (but other data node is the mirror)	4 x SAS 10KRPM • Heavy duty (many MB/s) • Disk redundancy (RAID1+0) hot swap

- REDO, LCP, BACKUP – written sequentually in small chunks (256KB)
- If possible, use Odirect = 1

Filesystem

- Most customers uses EXT3(Linux) and UFS (Solaris)
  - Ext2 could be an option (but recovery is longer)
- XFS – we haven't experienced so much...
- ZFS
  - You must separate journal (Zil) and filesystem
- Mount with noatime
- Raw device is not supported

Hardware Selection - Disk Data Storage

Minimal recommended

LCP
REDOLOG
UNDOLOG

TABLESPACE

2 x SAS 10KRPM (preferably)

high-end

UNDOLOG
(REDO LOG)

TABLESPACE 1

TABLESPACE 2

(REDO LOG / UNDO LOG)
LCP

4 x SAS 10-15KRPM (preferably)

- Use High-end for heavy read write (1000's of 10KB records per sec) of data (e.g Content Delivery platforms)
- SSD for TABLESPACE is also interesting – not much experience of this yet
- Having TABLESPACE on separate disk is good for read perf.
- Enable WRITE_CACHE on devices

Configuration - Disk Data Storage

- Use Disk Data tables for
  - Simple accesses (read/write on PK)
  - Same for innodb – you can easily get DISK BOUND (iostat)
- Set
  - `DiskPageBufferMemory=3072M`
    - is a good start if you rely a lot on disk data – like the Innodb_Buffer_Pool, but set it as high as you can!
    - Increased chance that a page will be cached
  - `SharedGlobalMemory=384M-1024M`
  - `UNDO_BUFFER=64M to 128M` (if you write a lot)
    - You cannot change this BUFFER later!
    - Specified at LOGFILE GROUP creation time
  - `DiskIOThreadPool=[ 8 .. 16 ]` (introduced in 7.0)

Configuration - General

- Set
  - `MaxNoOfExecutionThreads<=#cores`
    - Otherwise contention will occur → unexpected behaviour.
  - `RedoBuffer=32-64M`
    - If you need to set it higher → your disks are probably too slow
  - `FragmentLogFileSize=256M`
  - `NoOfFragmentLogFiles= 6 x DataMemory (in MB) / (4x 256MB)`
    - Most common issue – customers never configure big enough redo log
- The above parameters (and others, also for MySQL) are set with
  - www.severalnines.com/config

Application : Primary Keys

- To avoid problems with
  - Cluster 2 Cluster replication
  - Recovery
  - Application behavior (KEY NOT FOUND.. etc)
- ALWAYS DEFINE A PRIMARY KEY ON THE TABLE!
  - A hidden PRIMARY KEY is added if no PK is specified. BUT..
    - .. NOT recommended
    - The hidden primary key is e.g not replicated (between Clusters)!!
    - There are problems in this area, so avoid the problems!
- So always, at least have
  `id BIGINT AUTO_INCREMENT PRIMARY KEY`
  - Even if you don't “need” it for you applications

Application : Query Cache

- Don't cache everything in the Query Cache
  - It is very expensive to invalidate over X mysql servers
  - A write on one server will force the others to purge their cache.
- If you have tables that are read only (or change very seldom):
  - my.cnf:
    - `query_cache_type=2 (DEMAND)`
  - `SELECT SQL_CACHE <cols> .. FROM table;`
- This can be good for STATIC data

Application : Transactions

- Failed transactions must be retried by the application
- If the REDOLOG or REDOBUFFER is full the transaction will be aborted
  - This differs from INNODB behaviour
- There are also other resources / timeouts
  - `"Lock wait timeout"` – transaction will abort after `TransactionDeadlockDetectionTimeout`
  - `MaxNoOfConcurrent[Operations/Transactions]`
    - You can then increase this
- Nodefail/noderestart will cause transaction to abort

Application : Transactions

- Transactions (large updates)
  - Remember NDB is designed for many and short transactions
  - You are recommended to UPDATE / DELETE in small chunks
  - Use LIMIT 10000 until all records are UPDATED/DELETED
- MaxNoOfConcurrentOperations sets the upper limit for how many records than can be modified simultaneously on one data node.
  - MaxNoOfConcurrentOperations=1000000 will use 1GB of RAM
  - Despite it is possible, we do recommend DELETE/UPDATE in smaller chunks.

Application : Table locks

- FLUSH TABLE WITH READ LOCK;
- LOCK TABLES <table> READ;
  - Only locks the table(s) on the LOCAL mysql server
  - You must get the LOCK on all mysql servers

Application : Schema Operations

- Don't use too much `CREATE/DROP TABLE` of NDB tables
  - It is a heavy operation within Cluster
  - Takes much longer than with standard MySQL

Log Only What Needs To Be Recovered

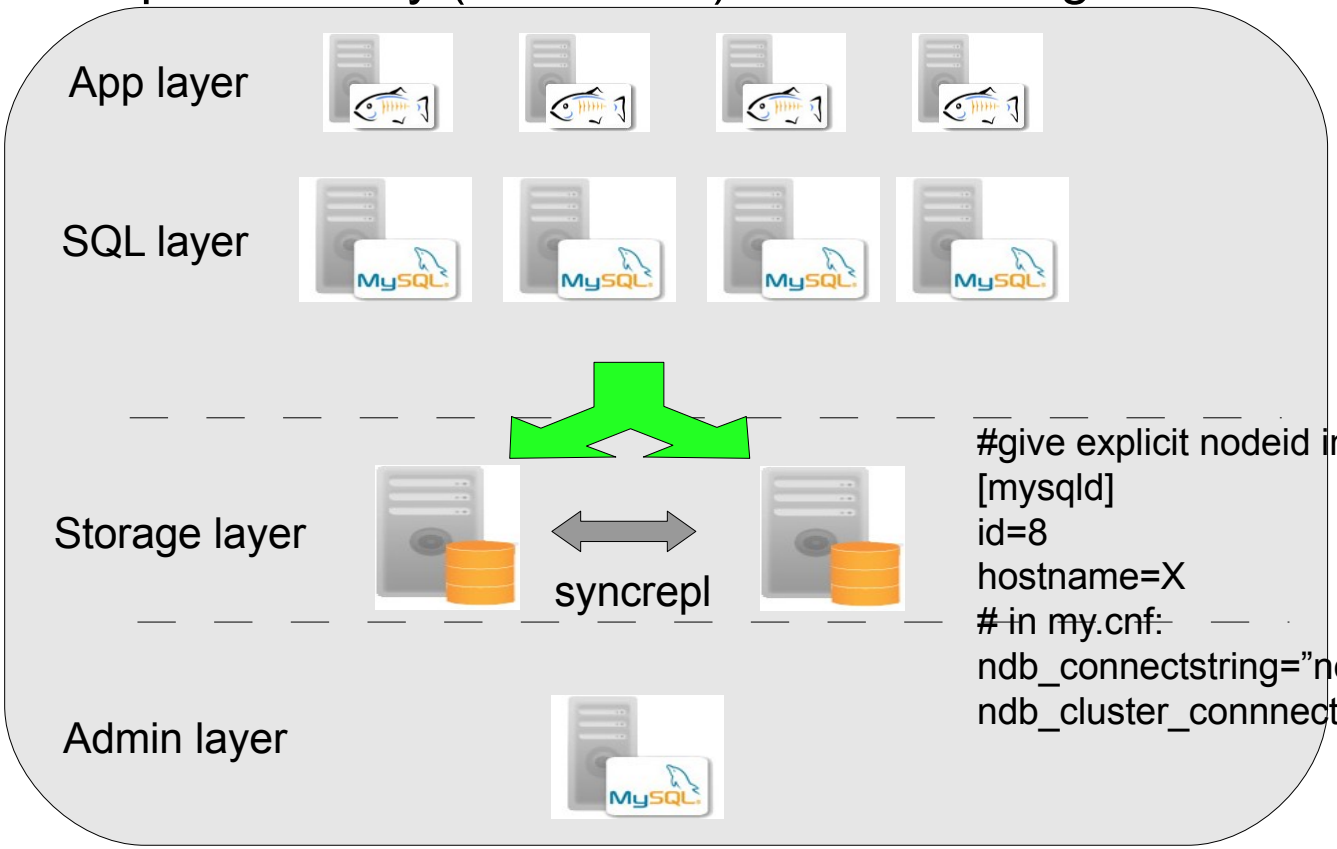
- Some types of tables account for a lot of WRITEs, but does not need to be recovered (E.g, Session tables)
- A session table is often unnecessary to REDO LOG and to CHECKPOINT
- Create these tables as 'NO LOGGING' tables:

```
mysql> set @ndb_curr_val=@@ndb_table_no_logging;

mysql> set ndb_table_no_logging=1;

mysql> create table session_table(..) engine=ndb;

mysql> set ndb_table_no_logging=@ndb_curr_val;
```

- 'session_table' will not be
  - REDO logged or Checkpointed → No disk activity for this table!
- After System Restart it will be there, but empty!

Administration Layer

- Introduce a MySQL Server for administration purposes!
  - Should never ever get application requests
  - Simplifies heavy (non online) schema changes

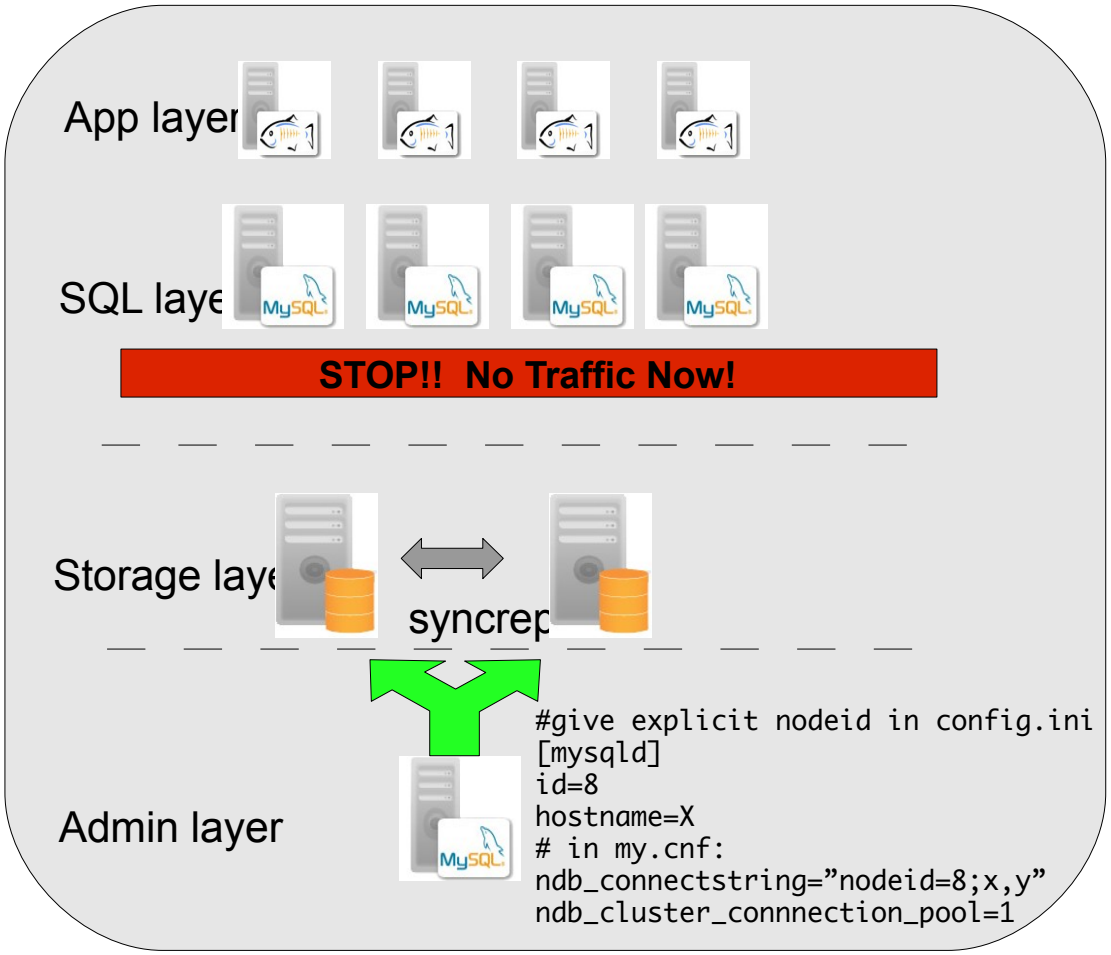


Administration Layer

- Modifying Schema is NOT online when you do:
  - Rename a table
  - Change data type
  - Change storage size
  - Drop column
  - Rename column
  - Add/Drop a PRIMARY KEY
- Altering a 1GB table requires 1GB of free DataMemory (copying)
- Online (and ok to do with transactions ongoing):
  - Add column (ALTER ONLINE …)
  - CREATE INDEX
  - Online add node (see my presentation from last year how to do it)

Admistration Layer

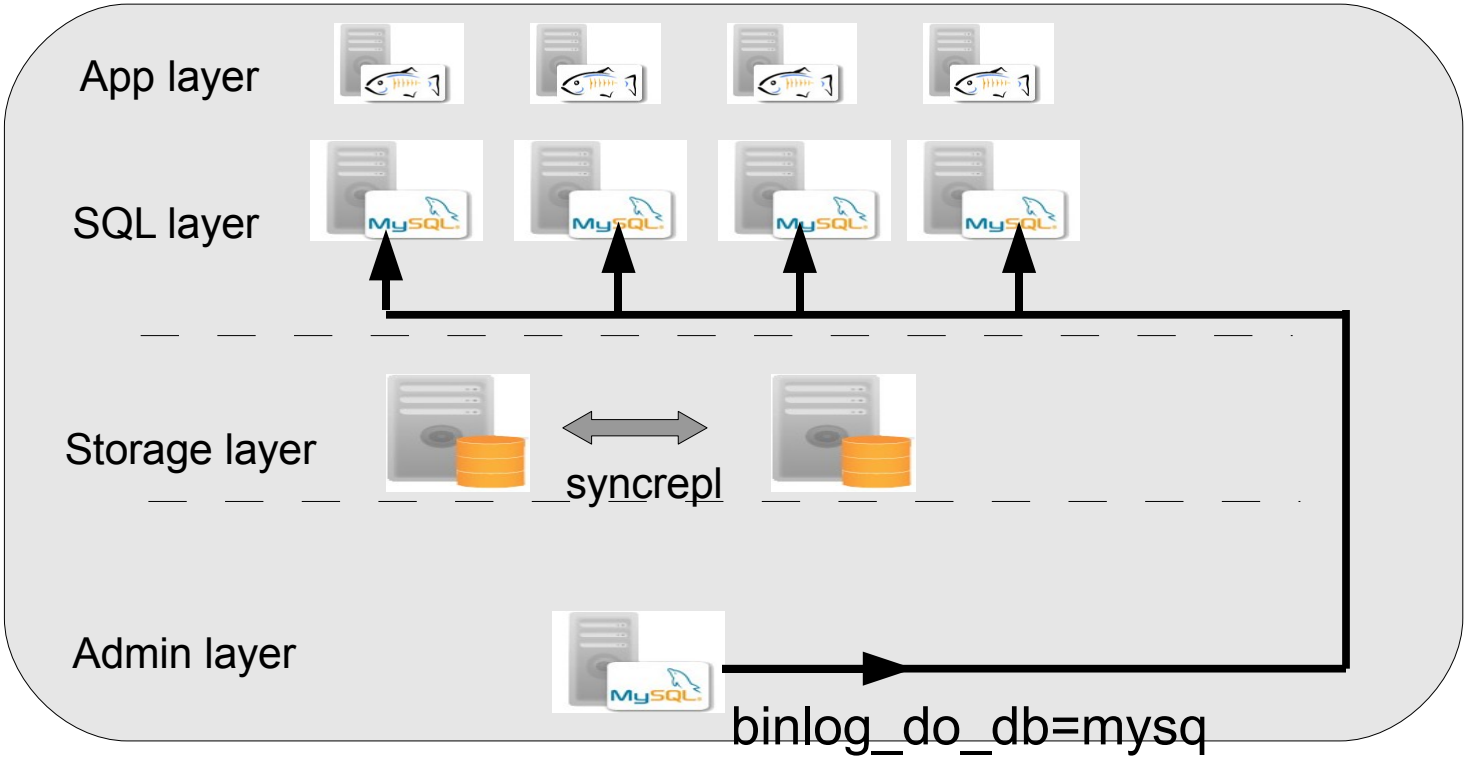
- ALTER TABLE etc (non-online DDL) performed on Admin Layer!



- 1. Block traffic from SQL layer to data nodes
  - ndb_mgm> ENTER SINGLE USER MODE 8
  - Only Admin mysqld is now connected to the data nodes
- 2. Perform heavy ALTER on admin layer
- 3. Allow traffic from SQL layer to data nodes
  - ndb_mgm> EXIT SINGLE USER MODE

Admistration Layer

- You can also set up MySQL Replication from Admin layer to the SQL layer
  - Replicate mysql database
    - GRANT, SPROCs etc will be replicated.
  - Keeps the SQL Layer aligned¨



Online Upgrades

- Change Online
  - OS, SW version (7.0.x → 7.1.x)
  - configuration
    - E.g, incease DM, IM, Buffers, redo log, [mysqld] slots etc
  - hardware (upgrade more RAM etc)
- These procedures requires a Rolling Restart
  - Change config.ini, copy it over to all ndb_mgmd
  - Stop BOTH ndb_mgmd, start BOTH ndb_mgmd
  - Restart one data node at a time
  - Restart one mysqld at a time
- Adding data nodes (from 7.0)
  - See my presentation from Last Year (UC 2009)
- Adding MySQL Servers
  - Make sure you have free [mysqld] slots
  - Start the new mysqld

Backup

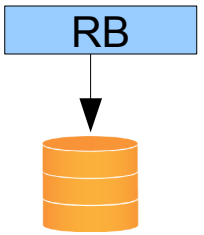
- Backup of NDB tables
  - Online – can have ongoing transactions
  - Consistent – only committed data and changes are backed up
  - `ndb_mgm -e "START BACKUP"`
  - Copy backup files from data nodes to safe location
- Non-NDB tables must be backed up separately
  - Mysql system tables are stored only in MYISAM.
  - You want to backup (for each mysql server)
    - mysql database
    - Triggers, SP ...
  - Use 'mysqldump'
    - `mysqldump mysql > mysql.sql`
    - `mysqldump --no-data --no-create-info -R > routines.sql`
  - Copy my.cnf & config.ini files

Restore

- ndb_restore is in many cases the MOST write intensive operation on Cluster
  - The problem is that ndb_restore produce REDO LOG
  - This is unnecessary but a fact for now
  - Restores many records in parallel, no throttling..
    - So 128 or more small records may be fine, but 128 BLOBs .

Temporary error: 410: REDO log buffers overloaded, consult online manual (increase RedoBuffer, and|or decrease TimeBetweenLocalCheckpoints, and|or increase NoOfFragmentLogFiles)

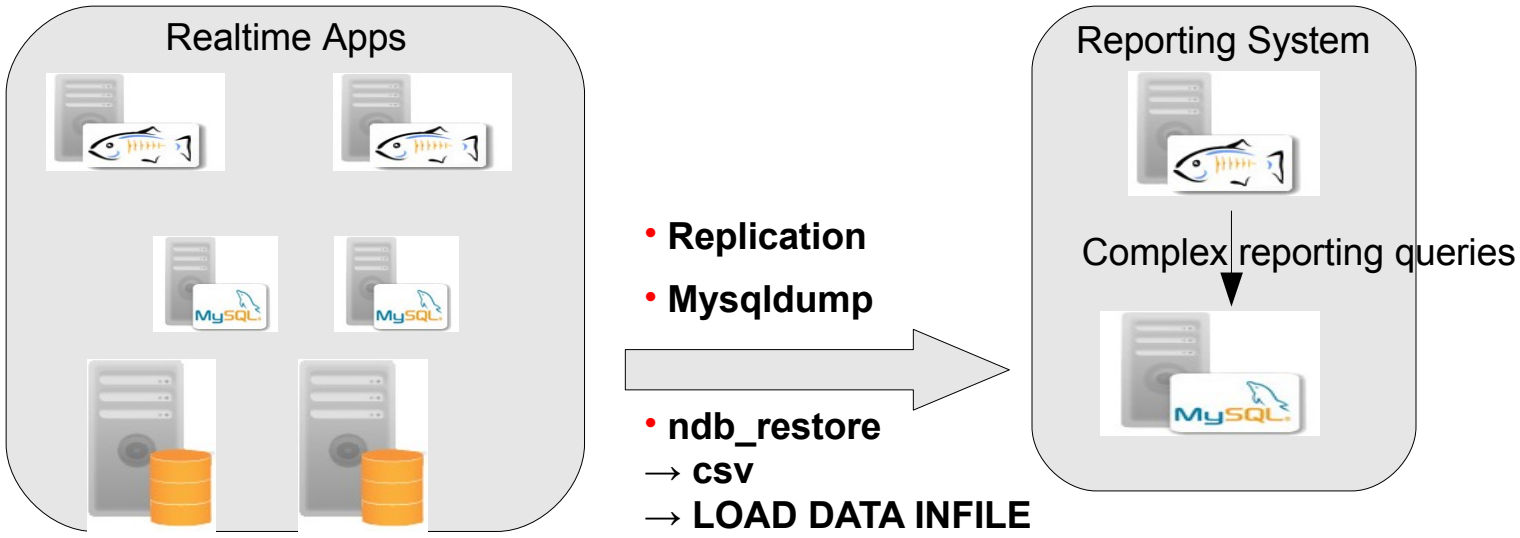
- If you run into this during restore
  - Try increase RedoBuffer (a value of higher than 64MB is seldom practical nor needed)
  - Run only one *instance* of ndb_restore
  - ndb_restore -p10 ....
    - Or even a lower value, e.g, -p1
  - If this does not help → faster disk(s) is/are needed



Synced every TBGCP

Separate Realtime and Reporting

- MySQL Cluster is really good for
  - Short, many parallel transactions
  - Is bad at most reporting type queries (complex JOINs).
- For reporting, replicate/copy out data to a reporting server more suitable for the job
  - MySQL Server running Innodb
  - For replication see http://johanandersson.blogspot.com/2009/05/ha-mysql-write-scaling-using-cluster-to.html



Scaling

- One data node can (7.0+) use up to 8 cores
  - CPU: Reaches bottleneck at about 370% CPU
  - DISK: iostat -kx 1 : Check util; await, svctime etc..
  - NETWORK: iftop (linux) - add another data node (spread load)
  - Add data node (online or offline)
- MySQL Server
  - CPU: About the same – 300-500%
  - DISK: Should not be a factor
  - NETWORK:
  - Add another MySQL Server to offload query processing

Monitoring

- Mandatory to monitor
  - CPU/Network/Memory usage
  - Disk capacity (I/O) usage
  - Network latency between nodes
  - Node status ...
  - Used Index/Data Memory
- www.severalnines.com/cmon- monitors data nodes and mysql servers
- New in 7.1 :
  - NDB$INFO Table in INFORMATION_SCHEMA
  - Check node status
  - Check buffer status etc
  - Statistics

Questions?

- Talk to us outside! We offer cheap consulting this week:
  - One question one beer.
- Go to the other sessions :

MySQL Cluster Performance Tuning Best Practices
2.00pm Wednesday 04/14/2010
Location: Ballroom D

MySQL Cluster and Pushdown-joins (In Pursuit of the Holy Grail)
Jonas Oreland
3.05pm Wednesday 04/14/2010
Location: Ballroom B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