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

Clients

Load Balancer(s)

Redundant switches

SQL+Mgm
+AppServer
+WebServer...

Data node

Bonding

Data node
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**
- 1 x SATA 7200RPM
  - For a read-most, write not so much
  - No redundancy (but other data node is the mirror)

**mid-end**
- 1 x SAS 10KRPM
  - Heavy duty (many MB/s)
  - No redundancy (but other data node is the mirror)

**high-end**
- 4 x SAS 10KRPM
  - Heavy duty (many MB/s)
  - Disk redundancy (RAID1+0) hot swap

- REDO, LCP, BACKUP – written sequentially 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 10K RPM (preferably)

**High-end**

- UNDOLOG (REDO LOG)
- TABLESPACE 1
- TABLESPACE 2
- (REDO LOG / UNDO LOG)
- LCP

4 x SAS 10-15K RPM (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) / (4 x 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
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:
  ```sql
  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

```bash
#give explicit nodeid in config.ini:
[mysqld]
id=8
hostname=X

# in my.cnf:
ndb_connectstring="nodeid=8;x,y"
ndb_cluster_connection_pool=1
```
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)
Administration 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`

````
# give explicit nodeid in config.ini
[mysqld]
id=8
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# in my.cnf:
ndb_connectstring="nodeid=8;x,y"
ndb_cluster_connection_pool=1
```
Administation Layer

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

```
binlog_do_db=mysq
```

```
syncrepl
```

Diagram:

- App layer
- SQL layer
- Storage layer
- Admin layer
Online Upgrades

• Change Online
  • OS, SW version (7.0.x → 7.1.x)
  • configuration
    • E.g, increase DM, IM, Buffers, redo log, [mysqld] slots etc
  • hardware (upgrade more RAM etc)

• These procedures require 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
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