Requirements (In general)

- Web Scalability
- Realtime in memory performance
- High Availability
- LowTotal Cost of Ownership (On premise or inhouse)

- ACID compliance
- Needs to be deployed in house (Due to the sensitivity of data stored)

Features

- Automatic Sharding (Provides web scalability and real time performance)
    - With complete application transparency
- Distributing read/write operations all cluster nodes (where each acts as a master node)
    - Support adding new node without a down time
- Provides ability to perform complex joint operations across database shards
- 99.999% Availability (5 minutes of downtime per year)
- A Shared-nothing infrastructure (Guarantees no dependency between the cluster nodes)
    - Data is replicated synchronously between nodes ensuring multiple copies of data are always available.

Architectures

1. MySQL Cluster: Diskless option

For the Diskless option the following restrictions apply :

- No disk data
- Loss of data in case of Cluster failure
- No backup

2. MySQL Cluster Manager (commercial product)

MySQL Cluster Manager is software which simplifies the creation and management of the MySQL Cluster database by automating common management tasks. MySQL Cluster Manager is not an open source software. It is available only as a part of the *commercial MySQL Cluster Carrier Grade Edition (CGE)* database.

By using MySQL Cluster Manager, Database Administrators (DBAs) and Systems Administrator are more productive, enabling them to focus on strategic IT initiatives and respond more quickly to changing user requirements. At the same time, risks of database downtime that previously resulted from manual configuration errors, are significantly reduced. MySQL Cluster database are supported by MySQL Cluster 6.3 and above.

- Management complexity and overhead.
- Risk of downtime through the automation of configuration and change management processes.
- Custom scripting of management commands or developing and maintaining in-house management tools.

3. NDB Cluster

NDB Cluster is a technology that enables clustering of in-memory databases in a shared-nothing system. The shared-nothing architecture enables the system to work with very inexpensive hardware, and with a minimum of specific requirements for hardware or software.

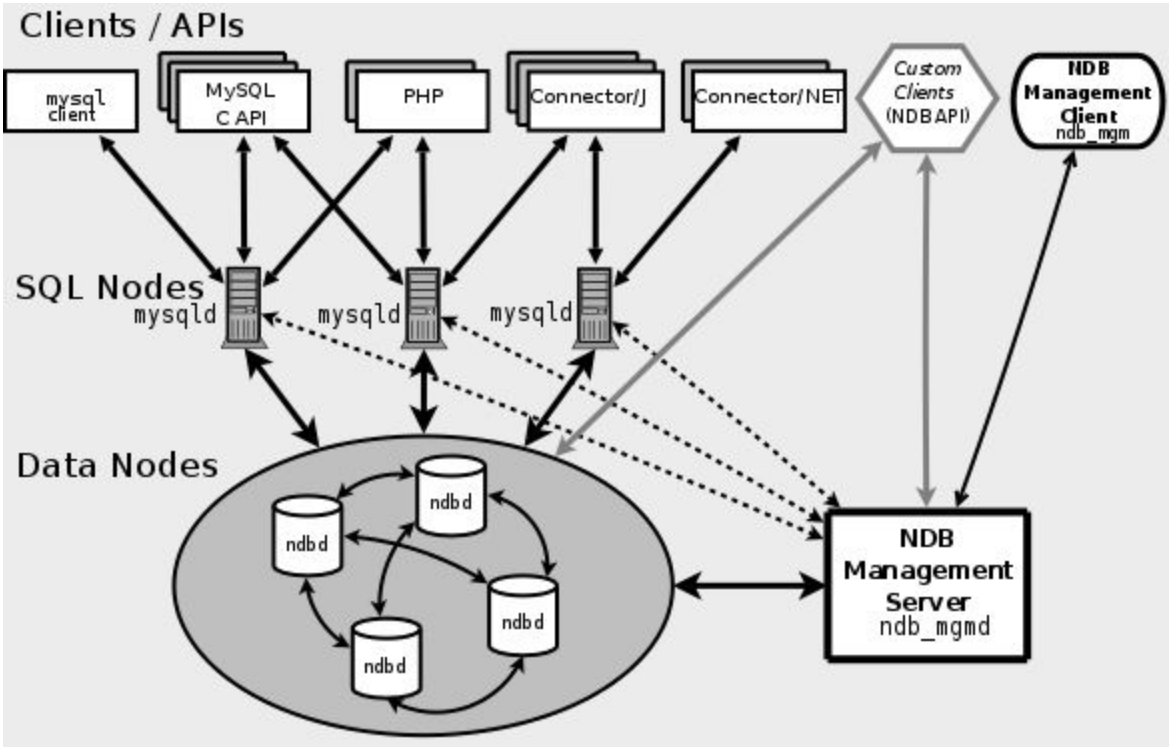
NDB Cluster is designed not to have any single point of failure. In a shared-nothing system, each component is expected to have its own memory and disk, and the use of shared storage mechanisms such as network shares, network file systems, and SANs is not recommended or supported.

NDB Cluster integrates the standard MySQL server with an in-memory clustered storage engine called `NDB` (which stands for "***N***etwork ***D***ata***B***ase"). In our documentation, the term `NDB` refers to the part of the setup that is specific to the storage engine, whereas "MySQL NDB Cluster" refers to the combination of one or more MySQL servers with the `NDB` storage engine.

An NDB Cluster consists of a set of computers, known as hosts, each running one or more processes. These processes, known as nodes, may include MySQL servers (for access to NDB data), data nodes (for storage of the data), one or more management servers, and possibly other

specialized data access programs. The relationship of these components in an NDB Cluster is shown here:

- It is a product with its own list of features, and quite different from Galera Cluster or MySQL InnoDB Cluster.
- One main difference is the use of NDB engine, not InnoDB, which is the default engine for MySQL.
- In NDB cluster, data is partitioned across multiple data nodes while Galera Cluster or MySQL InnoDB Cluster contain the full data set on each of the nodes.
- This has serious repercussions in the way MySQL NDB Cluster deals with queries which use JOINs and large chunks of the dataset.



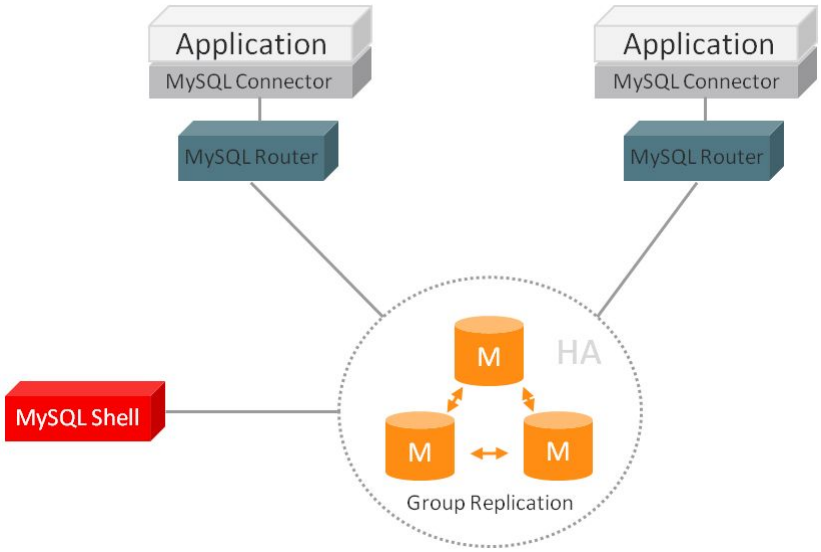
4. MySQL InnoDB Cluster

MySQL InnoDB cluster provides a complete high availability solution for MySQL. Each MySQL server instance runs MySQL Group Replication, which provides the mechanism to replicate data within InnoDB clusters, with built-in failover.

In the default single-primary mode, an InnoDB cluster has a single read-write server instance – the primary. Multiple secondary server instances are replicas of the primary. If the primary fails, a secondary is automatically promoted to the role of primary.

- InnoDB Cluster uses the Group Replication plugin to allow for virtually synchronous replication, while also providing a MySQL Router that is aware of the cluster state.

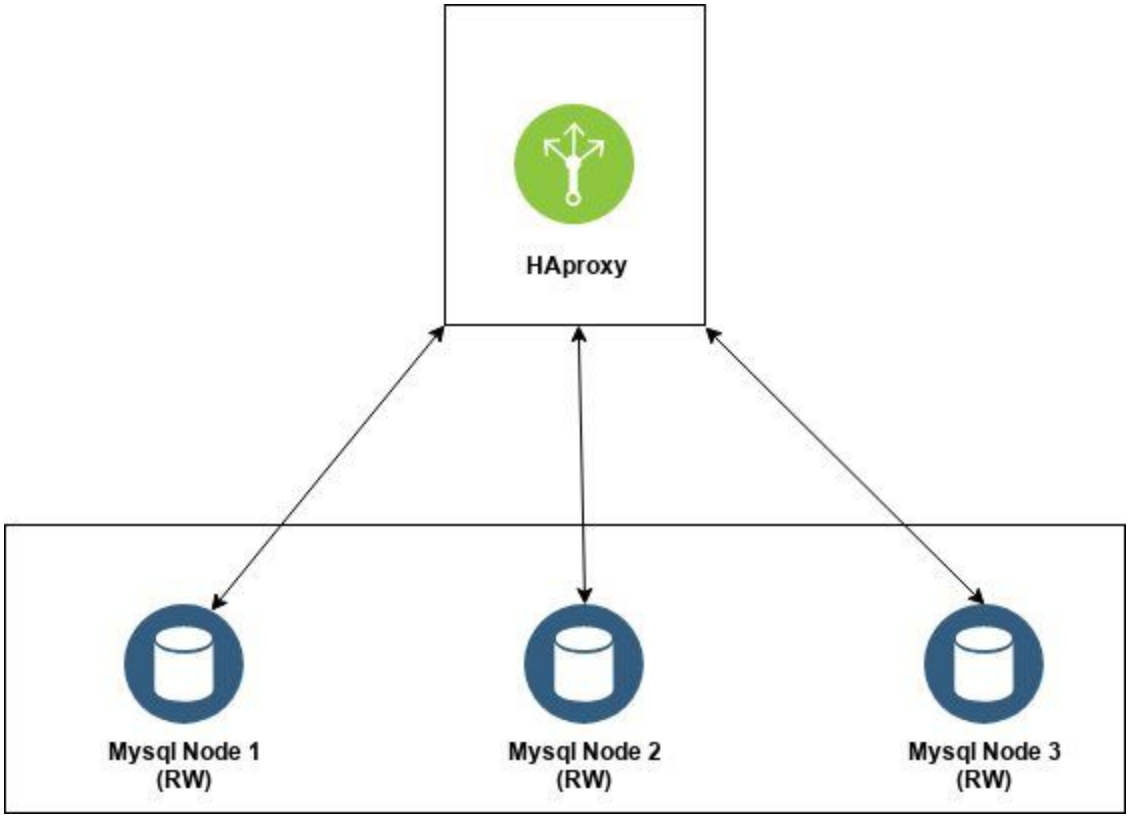
- InnoDB Cluster also provides a new MySQL Shell to interact with the cluster commands.



5. Galera Cluster for MySQL

Galera Cluster for MySQL is an OpenSource true Multi-Master Cluster based on synchronous replication. It's an easy-to-use, high-availability solution, which provides high system up-time, no data loss and scalability for future growth.

- True Multi-master: Active-Active Cluster Read and write to any node at any time.
- Synchronous Replication: No slave lag, no data is lost at node crash.
- Tightly Coupled: All nodes hold the same state. No diverged data between nodes allowed.
- Multi-threaded: Slave For better performance. For any workload.
- No Master-Slave Failover Operations or Use of VIP.
- Hot Standby: No downtime during failover (since there is no failover).
- Automatic Node Provisioning: No need to manually back up the database and copy it to the new node.
- Supports InnoDB.
- Transparent to Applications Required no (or minimal changes) to the application.
- No Read and Write Splitting Needed.
- Easy to Use and Deploy



6. Percona Server for MySQL

Percona Server for MySQL is a distribution of the MySQL relational database management system created by Percona. Percona Server for MySQL is an open source relational database management system. It is a free, fully compatible drop in replacement for Oracle MySQL.

- The software includes a number of scalability, availability, security and backup features only available in MySQL's commercial Enterprise edition.
- The software includes XtraDB, an enhanced distribution of the InnoDB Storage Engine.

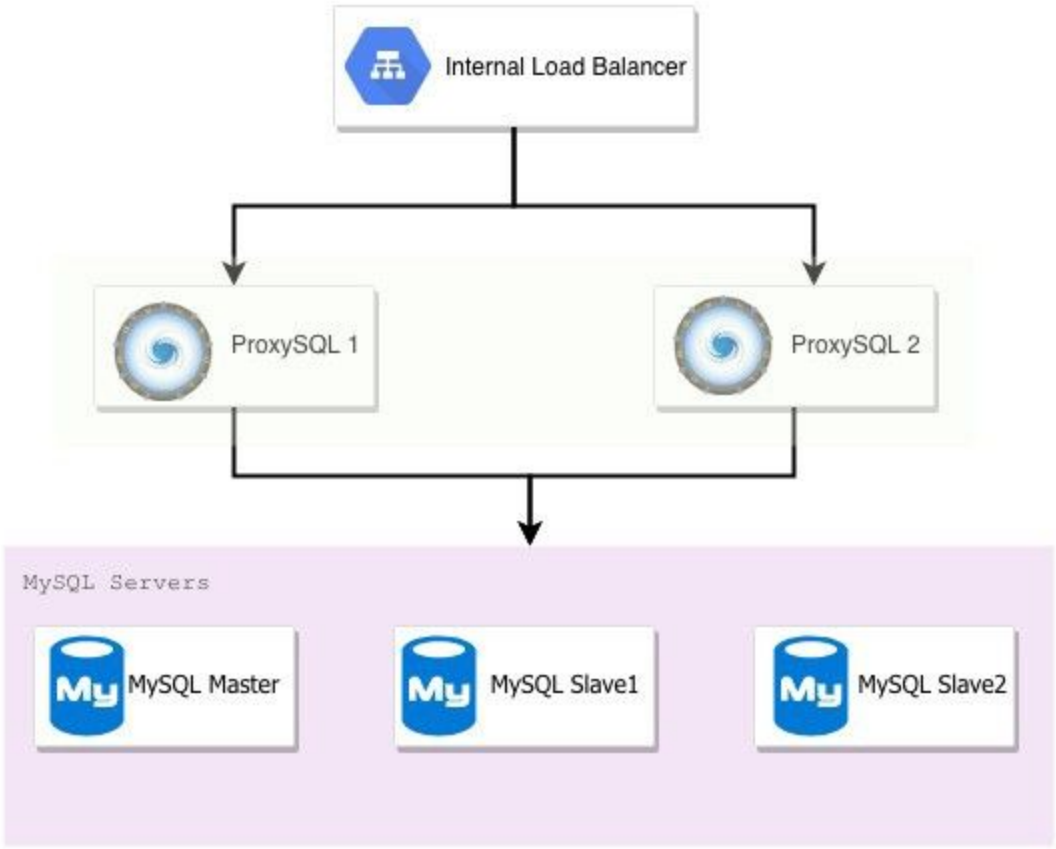
Official Oracle Product	License
MySQL Server	GPL/Commercial
The InnoDB Storage Engine (Plugin edition)	GPL/Commercial
InnoDB Hot Backup	Commercial

Official Percona Product	License
Percona Server	GPL
The XtraDB Storage Engine	GPL
XtraBackup	GPL

7. ProxySQL

Proxy SQL is a High-performance MySQL proxy with a GPL license. It is a MySQL protocol aware data gateway where,

- Clients connect to ProxySQL
- Requests are evaluated by ProxySQL and various actions performed.



Conclusion

- MySQL Cluster: Diskless option
  - Was **skipped**,
    - Since it does not meet the requirements of not losing data.
- MySQL Cluster Manager
  - Was **skipped**,
    - Since its a commercial product and needs license.
- NDB Cluster
  - Was **skipped** because,
    - NDB has a different db engine than Innodb (not as same Galera Cluster or MySQL InnoDB Cluster.)
    - It has noncompliances with SQL Syntax (where certain MySQL features will produce errors)
- MySQL InnoDB Cluster
  - Was **chosen** as **option 1** because,

        - Uses Group Replication.
          It uses the innoDB engine (same as its used in single node instances, which developers use)
        - The option which has the least amount of dependencies on third parties
        - Don't have to rely on external tools, scripts or other components
        - It leverages proven MySQL features including InnoDB, GTIDs, binary logs, multi-threaded slave execution, multi-source replication and Performance Schema.

- Galera Cluster for MySQL
    - Was **chosen** as **option 2** because,
        - Uses Master-Master replication with HA proxy.
        - It uses the innoDB engine (same as its used in single node instances, which developers use)
        - It has the least amount of configurations compared to option one, though it has dependencies on Galera.
        - It has Automatic Node Provisioning feature where its not needed to manually back up the database and copy it to the new node.

- Percona Server for MySQL
    - Was **skipped** because,
        - Has a modified/different db engine than Innodb
        - It has dependencies on Percona on receiving db engine updates
- ProxySQL
    - Was **skipped** because,
        - Current requirements does not indicate need of a proxy in front of clustered mysql DB

References

1. How To Create a Multi-Node MySQL Cluster on Ubuntu 18.04 (Using MYSQL Cluster Manager)
   https://www.digitalocean.com/community/tutorials/how-to-create-a-multi-node-mysql-cluster-on-ubuntu-18-04

2. Creating a MySQL cluster from two master nodes
   https://towardsdatascience.com/high-availability-mysql-cluster-with-load-balancing-using-haproxy-and-heartbeat-40a16e134691

3. MySQL Cluster CGE (Carrier Grade Edition)
   https://www.mysql.com/products/cluster/

4. NDB Cluster Overview
   https://dev.mysql.com/doc/refman/5.6/en/mysql-cluster-overview.html
   https://dev.mysql.com/doc/refman/5.6/en/mysql-cluster-ndb-innodb-engines.html
   https://dev.mysql.com/doc/mysql-router/8.0/en/mysql-router-innodb-cluster.html
   https://www.alibabacloud.com/blog/how-to-configure-mysql-master-slave-replication-on-ubuntu-16-04_593982
   https://dev.mysql.com/doc/refman/5.6/en/mysql-cluster-limitations-syntax.html
   https://tech.jocke.no/2011/03/13/mysql-cluster-how-to-with-load-balancing-failover/
   https://github.com/mdom/ansible-mysql-cluster
   https://github.com/tmeralus/ansible-role-mysql-cluster

5. Galera Cluster for MySQL
   https://galeracluster.com/products/
   https://github.com/shyamjos/deploy-mysql-cluster

6. Percona Server for MySQL
   https://www.percona.com/software/mysql-database/percona-server
   https://www.youtube.com/watch?v=h8LKzs-I-qM
   https://github.com/cdelgehier/ansible-role-XtraDB-Cluster

7. Proxy SQL
   https://medium.com/searce/reduce-mysql-memory-utilization-with-proxysql-multiplexing-cbe09da7921c
   https://www.youtube.com/watch?v=53v-KrcPaIU
   https://github.com/timorunge/ansible-proxysql

8. MySQL InnoDB Cluster
   https://www.mysql.com/products/enterprise/high_availability.html
   https://dev.mysql.com/doc/mysql-router/8.0/en/mysql-router-general-using-deploying.html
   https://dinfratechsource.com/2018/11/10/mysql-innodb-cluster-a-complete-high-availability-solution-for-mysql/
   https://www.slideshare.net/mysqlusercamp/experience-with-mysql-ha-solution-and-group-replication
   https://towardsdatascience.com/high-availability-mysql-cluster-with-load-balancing-using-haproxy-and-heartbeat-40a16e134691

All in one
https://github.com/severalnines/ansible-clustercontrol

Author : Yasas De Silva
Github : https://github.com/myasas