

MySQL Backup and DR - From Strategy to Execution

MinervaDB DR Ops.

Speaker Bio

- Name - Shiv Iyer
- Occupation:
 - Founder and Principal of MinervaDB
 - Database Architect, Database Engineer, DBA, Data SRE and Data Ops. Geek
 - Open Source Database Systems Infrastructure Operations Expert
 - Technology focus:
 - Open Source Database Systems - Performance, Scalability, High Availability and Database SRE
 - MySQL
 - MariaDB
 - InnoDB
 - RocksDB
 - PostgreSQL
 - ClickHouse



Database Systems Backup and DR

- **Create a copy of data that can be recovered in the event of a primary data failure**
- **Primary data failure events:**
 - Hardware or software failure.
 - Data corruption due to human error or application failure eventually causing data deletion.
 - Virus or other malicious attacks.
- **Backup policy:**
 - Frequency of Backup and DR efficiency - The more time passes between backup copies, the more potential for data loss when recovering from a backup.
- **Backup validation policy:**
 - Confirm backups are not corrupted, truncated or deleted.
 - Using MySQL replication with *pt-table-checksum*

MySQL Backup Strategies

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Full Backup

- Full backup backs up the whole database.
- **Transaction log is included in full backup** - You can do full database recovery after the completion of full database backup restoration.
- Durability and reliability of the database full backup is up to the time backup finished.
- Storage intensive and time consuming.
- If you have a larger database, Combine full backup with differential backups.



Differential Backup

- Differential backup is based on on the most recent and previous full data backup.
- Differential backup captures only the data that has changed since that full backup.
- Full backups, except for copy-only backups, can serve as the base for a series of differential backups, including database backups, partial backups, and file backups.
- The differential backups are most recommended when the subset of a database is modified more frequently than the rest of the database.

Incremental Backup

- Both differential and incremental backup does only backing up changed files.
- An incremental backup only includes the data that has changed since the previous backup, a differential backup contains all of the data that has changed since the last full backup.
- Incremental backup is the fastest backup type since it only backs-up increments.
- Expensive full restoration - Full database restore operations are slow. Because, you need the first full backup and all increments since then.

Why differential backup is faster compared to incremental backup ?

- Restoration of differential backup never requires more than two backup sets. Incremental backups, on the other hand, could require a great number of backup sets.
- Faster recovery time, In differential backup you need only a full backup and the latest differential backup to restore the entire data repository.

Most commonly used MySQL Backup tools and strategies

- mysqldump
- mysqlpump
- MySQL Enterprise Backup
- Percona XtraBackup
- MySQL Replication for HA and Disaster Recovery.
- Zero Data Loss MySQL Ops. Architecture for performance, reliability and availability.

mysqldump - MySQL Logical Backup Solution

- **mysqldump** is a MySQL client utility which can be used to perform logical backups.
- The **mysqldump** generate output in SQL (default and most commonly used to reproduce MySQL schema objects and data), CSV, other delimited text or XML format.
- Flexible backup solution - You can tweak the output file before restoration.
mysqldump is not a scalable DR solution larger MySQL databases, Replaying SQL is too expensive from both disk ops. and index building perspective.

Backup all MySQL databases with **mysqldump**

```
mysqldump --all-databases --single-transaction --quick --lock-tables=false >  
full-backup-$(date +%F).sql -u root -p
```

mysqldump options used in the above script

- *--single-transaction* when used in mysqldump will issues BEGIN SQL statement before dumping data from the server, dumps the consistent state of the database at the time when **START TRANSACTION** was issued without blocking any applications.
- *--quick*: To enforce dumping tables row by row, Recommended for very large MySQL databases
- *--lock-tables=false*: Do not lock tables for this backup session

Backup a specific MySQL database with mysqldump

```
mysqldump -u username -p MDBMASTER --single-transaction --quick  
--lock-tables=false > MDBMASTER-backup-$(date +%F).sql
```

mysqldump options used in the above script

- *--single-transaction* when used in mysqldump will issues BEGIN SQL statement before dumping data from the server, dumps the consistent state of the database at the time when **START TRANSACTION** was issued without blocking any applications.
- *--quick*: To enforce dumping tables row by row, Recommended for very large MySQL databases
- *--lock-tables=false*: Do not lock tables for this backup session

Backup a specific MySQL table with **mysqldump**

```
mysqldump -u username -p --single-transaction --quick --lock-tables=false  
MDBMASTER tab1 > MDBMASTER-tab1-$(date +%F).sql
```

mysqldump options used in the above script

- *--single-transaction* when used in mysqldump will issues BEGIN SQL statement before dumping data from the server, dumps the consistent state of the database at the time when **START TRANSACTION** was issued without blocking any applications.
- *--quick*: To enforce dumping tables row by row, Recommended for very large MySQL databases
- *--lock-tables=false*: Do not lock tables for this backup session



Restrictions of **mysqldump**

- **mysqldump** does not dump performance_schema or sys schema by default. To enforce dumping or logical backup of any of these schema objects, You have to explicitly mention them –databases option or if you want to just dump performance_schema use –skip-lock-tables option.
- **mysqldump** does not dump the INFORMATION_SCHEMA schema.
- **mysqldump** does not dump the InnoDB CREATE TABLESPACE statements.
- **mysqldump** does not dump the NDB Cluster ndbinfo information database.
- **mysqldump** includes statements required to recreate the general_log and slow_query_log tables for dumps of the mysql database. But, Log table contents are not dumped



mysqldump - Faster MySQL Logical Backup

- MySQL introduced a parallel logical backup utility with MySQL 5.7.8 - mysqldump
- By default, mysqldump uses one processing queue with two threads.
- To increase the number of threads, You can tune system variable *--default-parallelism*.
- Much better orchestration possible – You can backup selected databases, tables, stored programs and user accounts etc.
- By default mysqldump will not backup performance_schema, sys schema, ndbinfo by default, You have to name them with *--databases* or *--include-databases* option
- mysqldump does not dump INFORMATION_SCHEMA schema.
- Faster secondary indexes creation, The indexes created only after inserting rows !

Plain simple backup using mysqlpump:

```
[root@localhost mysqlpump2018-06-23-25-49]# mysqlpump -u root -p employees > employeeebakup$(date '+%Y-%m-%H-%M-%S').sql
```

Enter password:

Dump progress: 1/4 tables, 0/630999 rows

Dump progress: 2/6 tables, 541250/3919384 rows

Dump progress: 4/6 tables, 1306627/3919384 rows

Dump progress: 5/6 tables, 2128435/3919384 rows

Dump progress: 5/6 tables, 3081685/3919384 rows

Dump completed in 5309 milliseconds

```
[root@localhost mysqlpump2018-06-23-25-49]#
```


Using mysqlpump based backup with 6 threads:

```
[root@localhost mysqlpump2018-06-23-25-49]# mysqlpump -u root -p employees --default-parallelism=6 >
employeebackup$(date '+%Y-%m-%H-%M-%S').sql
```

Enter password:

Dump progress: 0/5 tables, 250/3477363 rows

Dump progress: 2/6 tables, 606250/3919384 rows

Dump progress: 3/6 tables, 1272103/3919384 rows

Dump progress: 5/6 tables, 2028185/3919384 rows

Dump progress: 5/6 tables, 2932185/3919384 rows

Dump progress: 5/6 tables, 3864185/3919384 rows

Dump completed in 5503 milliseconds

```
[root@localhost mysqlpump2018-06-23-25-49]#
```

Using mysqlpump to backup only selected databases, spawned 5 threads to backup employee and sakila database...

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```
[root@localhost mysqlpump2018-06-23-25-49]# mysqlpump -u root -p employees  
--parallel-schemas=5:employees,sakila --default-parallelism=6 > backup$(date '+%Y-%m-%H-%M-%S').sql
```

Enter password:

Dump progress: 1/6 tables, 0/3919384 rows

Dump progress: 2/6 tables, 635250/3919384 rows

Dump progress: 3/6 tables, 1354353/3919384 rows

Dump progress: 5/6 tables, 2219935/3919384 rows

Dump progress: 5/6 tables, 3066185/3919384 rows

Dump completed in 5279 milliseconds

```
[root@localhost mysqlpump2018-06-23-25-49]#
```



Using mysqlpump to backup selected database and schema:

```
[root@localhost mysqlpump2018-06-23-25-49]# mysqlpump -u root -p --databases employees.titles > emp.titles$(date '+%Y-%m-%H-%M-%S').sql
```

Enter password:

Dump completed in 437 milliseconds

```
[root@localhost mysqlpump2018-06-23-25-49]#
```

Restore the backup from mysqlpump

Both mysqldump and mysqlpump generate MySQL logical backup in .SQL file so restoration is quite an straightforward process:

```
mysql -u root -p < backup.SQL
```



MySQL Enterprise Backup

- Proprietary hot / online backup tool for MySQL from MySQL Enterprise Edition of Oracle
- Transparent page compression for InnoDB.
- Backup history available for all members of Group Replication by making sure backup_history table is updated on primary node after each mysqlbackup operation.
- Storage engine of the mysql.backup_history table on a backed-up server has switched from CSV to InnoDB.
- MySQL Enterprise Backup 8.0.20 supports encrypted InnoDB undo logs .
- MySQL Enterprise Backup 8.0.20 supports high performance incremental backup by setting page tracking functionality on MySQL (*set --incremental=page-track*).
- Much better MySQL Enterprise Backup 8.0 troubleshooting with now mysqlbackup prints a stack trace after being terminated by a signal.
- Selective restores of tables or schema from full backup for Table-Level Recovery (TLR)

Percona XtraBackup - Most popular
open source hot / online backup solution
for MySQL / InnoDB

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What makes Percona XtraBackup obvious choice for MySQL Backup and DR ?

- Hot backup solution for InnoDB without blocking / locking transaction processing.
- Point-in-time recovery for InnoDB.
- MySQL incremental backup support.
- Percona XtraBackup supports incremental compressed backups.
- High performance streaming backup support for InnoDB.
- Parallel backup and copy-back support for faster backup and restoration.
- Secondary indexes defragmentation support for InnoDB.
- Percona XtraBackup support rsync to minimize locking.
- Track Percona XtraBackup history with Backup history table.
- Percona XtraBackup supports offline backup.



Percona XtraBackup - Best practices

- Databases really get really big, Plan compressed backup from day one (being conservative about storage is a good habit for a DBA / SRE)
- Percona XtraBackup uses qpress for compression, generates *.qp files

#Compressed Percona XtraBackup

```
xtrabackup --backup --compress --target-dir=/prod-idb-data/data-backups/
```

#Decompress the backup from Percona XtraBackup

```
xtrabackup --decompress --target-dir=/prod-idb-data/data-backups/
```

#Remove .qp files (2.3.7+ / 2.4.6+)

```
xtrabackup --decompress --remove-original --target-dir=/prod-idb-data/data-backups/
```

Percona XtraBackup - Incremental Backup

#Sunday Full Backup

```
xtrabackup --backup --target-dir=/prod-idb-data/data-backups/Sunday-full
```

#Monday Full Backup

```
xtrabackup --backup --target-dir=/prod-idb-data/data-backups/Monday-inc \  
--incremental-basedir=/prod-idb-data/data-backups/Sunday-full
```

#Tuesday Full Backup

```
xtrabackup --backup --target-dir=/prod-idb-data/data-backups/Tuesday-inc \  
--incremental-basedir=/prod-idb-data/data-backups/Monday-inc
```



Percona XtraBackup - Best practices

Generate metadata to restore the backup efficiently by adding --print-param option

This MySQL options file was generated by XtraBackup.

```
[mysqld]
```

```
datadir = /infra2/databuild/mysql/
```

```
innodb_data_home_dir = /databuild/innodb/
```

```
innodb_data_file_path = ibdata1:10M:autoextend
```

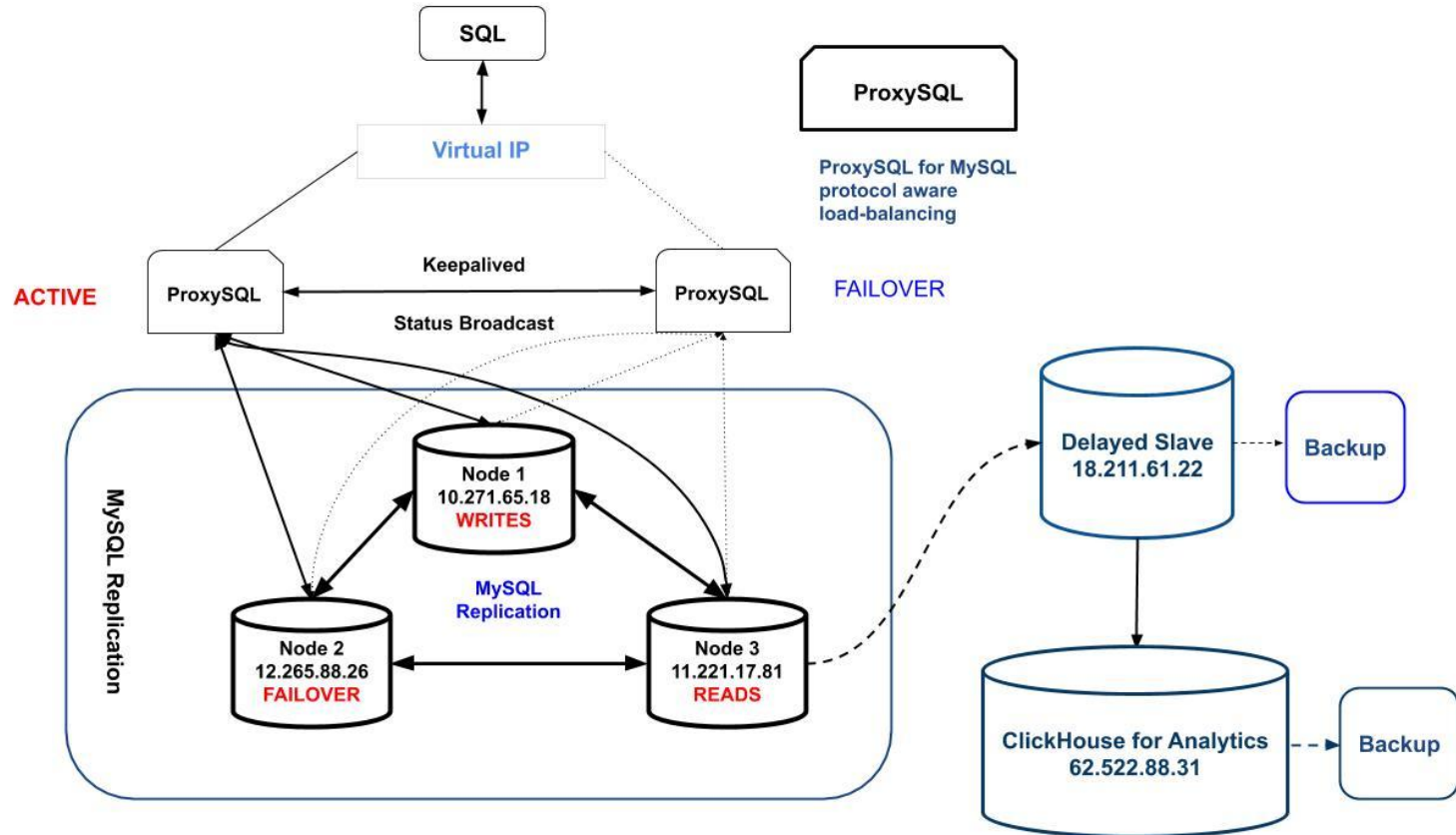
```
innodb_log_group_home_dir = /databuild/innodb-logs/
```

P.S.- We recommend you to redirect this output into a file in the target directory of the backup

Maximum Database Availability and Reliability Solution Architecture for MySQL Infrastructure Operations

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