PERCONA

Percona Xtrabackup

From Zero to Hero

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Percona Xtrabackup: From Zero to Hero

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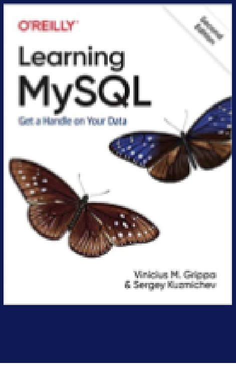
- Senior Software Engineer @ Percona
- Working on Xtrabackup Project
- Author of key features
  - FIFO Datasink / xbcloud multi-thread
  - Memory Estimation
  - ZSTD Compression Support
  - Xbcloud exponential Backoff
  - Xbcloud instance profile
  - KMIP & KMS Keyring Component Integration

Vinicius Grippa

- Senior Support Engineer @ Percona
- MySQL and MongoDB specialist
- Working with databases for 18 years
- Co-Author of the book Learning MySQL



Content

Before we start

- Launch tutorial docker container:

Unset

```
docker run -d --privileged --name percona_live -p 9091:9091 \
altmannmarcelo/pxb_pl:latest
```

- If you are running ARM (M1/M2) ask presenter for access to a remote instance credentials. (U: **root** P: **xtrabackup1sAwesome**)

- Check container is up and running:

Unset

```
docker logs -n 1 percona_live
```

We expect to see: **`Everything is up and running.`**

- Enter container (launch at least two sessions):

Unset

```
docker exec -it percona_live bash
```

- MySQL **`root`** user is installed with **`auth_socket`** (no password)
- There is a **`/bin/run_load.sh`** script to simulate load during backups
- We will make usage of debug sync points:
    - Way of stopping the program at a specific point in the code:
    - Widely used on test suite to make certain conditions deterministically
    - Only available on Debug builds
    - **NOT SUITABLE FOR PRODUCTION**
    - Example: https://github.com/percona/percona-xtrabackup/blob/percona-xtrabackup-8.0.32-26/storage/innobase/xtrabackup/src/backup_mysql.cc#L1663

Full Backup

- Check there is no employee named **Roy**:

Unset

```
mysql> SELECT * FROM employees.employees WHERE first_name = 'Roy'\G
Empty set (0.09 sec)
```

- Start to simulate load:

Unset

```
/bin/run_load.sh run
```

- Take a full backup:

Unset

```
xtrabackup --backup --target-dir=/backups/full \
--register-redo-log-consumer --debug_sync='log_status_get'
```

We should see the backup has been stopped at **`log_status_get`** sync point and a kill command to resume the backup:

```
2023-04-28T15:22:40.613320-00:00 0 [Note] [MY-011825] [Xtrabackup] Selecting LSN and
binary log position from p_s.log_status
2023-04-28T15:22:40.613388-00:00 0 [Note] [MY-011825] [Xtrabackup] DEBUG: Suspending
at debug sync point 'log_status_get'Resume with 'kill -SIGCONT 173'

[1]+  Stopped                 xtrabackup --backup --target-dir=/backups/full
--debug_sync='log_status_get'
```

- Check table employees has already been copied:

Unset

```
ls -l /backups/full/employees/employees.ibd
```

- Roy was hired. Add him to the database:

Unset

```
mysql> INSERT INTO employees.employees VALUES (500000, '1988-05-21',
'Roy', 'Trenneman', 'M', '2023-05-22');
```

- Resume backup:

Unset

```
kill -SIGCONT 173
```

Wait for Xtrabackup to complete

- Stop load script
- Stop MySQL and remove datadir:

Unset

```
mysql -e shutdown
rm -rf /var/lib/mysql
```

- Prepare backup

Unset

```
xtrabackup --prepare --target-dir=/backups/full
```

- Copy backup to datadir and adjust folder ownership:

Unset

```
xtrabackup --copy-back --target-dir=/backups/full
```

```
chown -R mysql.mysql /var/lib/mysql
```

- Start MySQL

Unset

```
mysqld --user=mysql &
```

- Check if Roy is an employee:

Unset

```
mysql> SELECT * FROM employees.employees WHERE first_name = 'Roy'\G
*************************** 1. row ***************************
     emp_no: 500000
birth_date: 1988-05-21
first_name: Roy
 last_name: Trenneman
     gender: M
 hire_date: 2023-05-22
1 row in set (0.09 sec)
```

Incremental Backup

- Install page tracking component

Unset

```
mysql> INSTALL COMPONENT "file://component_mysqlbackup";
```

- Check there is no employee named **Maurice** nor **Jen**

Unset

```
mysql> SELECT * FROM employees.employees WHERE first_name = 'Maurice'
OR first_name = 'Jen'\G
Empty set (0.09 sec)
```

- Start to simulate load:

Unset

```
/bin/run_load.sh run
```

- Take a full backup - Monday

Unset

```
xtrabackup --backup --page-tracking --target-dir=/backups/inc_mon_full
```

Wait for backup to complete

- On Tuesday Maurice was hired. Add him to the database:

Unset

```
mysql> INSERT INTO employees.employees VALUES (500001, '1988-05-21',
'Maurice', 'Moss', 'M', '2023-05-23');
```

- Take the Tuesday incremental backup

Unset

```
xtrabackup --backup --page-tracking --target-dir=/backups/inc_tue \
--incremental-basedir=/backups/inc_mon_full
```

- On Wednesday Jen was hired. Add her to the database

Unset

```
mysql> INSERT INTO employees.employees VALUES (500002, '1988-05-21',
'Jen', 'Barber', 'F', '2023-05-24');
```

- Take the Wednesday incremental backup

Unset

```
xtrabackup --backup --page-tracking --target-dir=/backups/inc_wed \
--incremental-basedir=/backups/inc_tue
```

- Stop load script
- Stop MySQL and remove datadir:

Unset

```
mysql -e shutdown
rm -rf /var/lib/mysql
```

- Prepare **inc_mon_full** backup

Unset

```
xtrabackup --prepare --apply-log-only \
--target-dir=/backups/inc_mon_full
```

- Prepare **inc_tue** backup

Unset

```
xtrabackup --prepare --apply-log-only \
--target-dir=/backups/inc_mon_full --incremental-dir=/backups/inc_tue
```

- Prepare **inc_wed** backup

Unset

```
xtrabackup --prepare --target-dir=/backups/inc_mon_full \
--incremental-dir=/backups/inc_wed
```

- Copy backup to datadir and adjust folder ownership:

Unset

```
xtrabackup --copy-back --target-dir=/backups/inc_mon_full
chown -R mysql.mysql /var/lib/mysql
```

- Start MySQL

Unset

```
mysqld --user=mysql &
```

- Check there is employee named **Maurice** nor **Jen**

Unset

```
mysql> SELECT * FROM employees.employees WHERE first_name = 'Maurice'
OR first_name = 'Jen'\G
```

Streaming

- Check MinIO console access: http://127.0.0.1:9091 (U: **admin** P: **password**)
- Check S3 API access:

Unset

```
aws --endpoint-url http://127.0.0.1:9090 s3 ls
2023-05-03 00:59:18 perconalive
```

- Check there is no employee named **Douglas**

Unset

```
mysql> SELECT * FROM employees.employees WHERE first_name =
'Douglas'\G
Empty set (0.09 sec)
```

- Start to simulate load:

Unset

```
/bin/run_load.sh run
```

- Take a backup streaming to S3:

Unset

```
xtrabackup --backup --page-tracking --stream=xbstream \
--extra-lsndir=/backups/meta_full | xbcloud put --storage=s3 \
--s3-endpoint=http://127.0.0.1:9090 --s3-access-key=admin \
--s3-secret-key=password --s3-bucket=perconalive full_backup
```

- Douglas was hired. Add her to the database

Unset

```
mysql> INSERT INTO employees.employees VALUES (500003, '1988-05-21',
'Douglas', 'Reynholm', 'M', '2023-05-22');
```

- Take an incremental backup streaming to S3:

Unset

```
xtrabackup --backup --stream=xbstream \
--extra-lsndir=/backups/meta_inc \
--incremental-basedir=/backups/meta_full | xbcloud put \
--storage=s3 --s3-endpoint=http://127.0.0.1:9090 \
--s3-access-key=admin --s3-secret-key=password \
--s3-bucket=perconalive inc_backup
```

- Stop load script
- Stop MySQL and remove datadir:

Unset

```
mysql -e shutdown
```

```
rm -rf /var/lib/mysql
```

- List folder on **perconalive** bucket:

Unset

```
aws --endpoint-url http://127.0.0.1:9090 s3 ls s3://perconalive
                           PRE full_backup/
                           PRE inc_backup/
```

- Create a folder, download and extract full backup

Unset

```
mkdir /backups/stream_full
xbcloud get --storage=s3 --s3-endpoint=http://127.0.0.1:9090 \
--s3-access-key=admin --s3-secret-key=password \
--s3-bucket=perconalive full_backup | xbstream -x -C \
/backups/stream_full
```

- Create a folder, download and extract full backup

Unset

```
mkdir /backups/stream_inc
xbcloud get --storage=s3 --s3-endpoint=http://127.0.0.1:9090 \
--s3-access-key=admin --s3-secret-key=password \
--s3-bucket=perconalive inc_backup | xbstream -x -C \
/backups/stream_inc
```

- Prepare full backup

Unset

```
xtrabackup --prepare --apply-log-only \
--target-dir=/backups/stream_full
```

- Prepare incremental backup

Unset

```
xtrabackup --prepare --target-dir=/backups/stream_full \
--incremental-dir=/backups/stream_inc
```

- Copy backup to datadir and adjust folder ownership:

Unset

```
xtrabackup --copy-back --target-dir=/backups/stream_full
chown -R mysql.mysql /var/lib/mysql
```

- Start MySQL

Unset

```
mysqld --user=mysql &
```

- Check if Douglas is an employee:

Unset

```
mysql> SELECT * FROM employees.employees WHERE first_name =
'Douglas'\G
```

Bonus - Inspect xbstream raw chunk

- Xbstream layout is available at https://bit.ly/xbstream-format
- Download xbstream chunk

```
Unset
FILE=xtrabackup_checkpoints.00000000000000000000
aws --endpoint-url http://127.0.0.1:9090 s3 cp \
s3://perconalive/full_backup/${FILE} /tmp/${FILE}

FILE=xtrabackup_checkpoints.00000000000000000001
aws --endpoint-url http://127.0.0.1:9090 s3 cp \
s3://perconalive/full_backup/${FILE} /tmp/${FILE}
```

- Inspect Payload chunk

```
Unset
xbstream_viewer.sh /tmp/xtrabackup_checkpoints.00000000000000000000
Magic: XBSTCK01
Type: P (Payload)
Path Length:          22
Path: xtrabackup_checkpoints
Payload Size:                    137
Payload Offset:                  0
Checksum:  2788090455
*****Payload*****
backup_type = full-backuped
from_lsn = 0
to_lsn = 367403611
last_lsn = 367403611
```

```
flushed_lsn = 366904398
redo_memory = 0
redo_frames = 0
```

- Inspect End Of File chunk

Unset

```
xbstream_viewer.sh /tmp/xtrabackup_checkpoints.00000000000000000001
Magic: XBSTCK01
Type: E (End of File)
Path Length:          22
Path: xtrabackup_checkpoints
```

Encryption & Compression

NOTE: Encryption & compression are not tied together, you can only encrypt or only compress if you want to.

- Generate a random key to be used for encryption

Unset

```
echo -n $(openssl rand --base64 24) > /backups/enc_key
```

- Take a compressed(**ZSTD**) and encrypted (**AES256**) backup

Unset

```
xtrabackup --backup --encrypt=AES256 \
--encrypt-key-file=/backups/enc_key --compress=zstd \
--target-dir=/backups/enc_comp_full
```

- Attempt to read **xtrabackup_info** from first backup example (/backups/full/xtrabackup_info)

Unset

```
cat /backups/full/xtrabackup_info
```

- Attempt to read **xtrabackup_info.zst.xbcrypt** from encrypted backup

Unset

```
cat /backups/enc_comp_full/xtrabackup_info.zst.xbcrypt
```

- Decrypt and decompress the backup

Unset

```
xtrabackup --remove-original --decompress --decrypt=AES256 \
--encrypt-key-file=/backups/enc_key \
--target-dir=/backups/enc_comp_full/
```

- Stop MySQL and remove datadir:

Unset

```
mysql -e shutdown
rm -rf /var/lib/mysql
```

- Prepare backup

Unset

```
xtrabackup --prepare --target-dir=/backups/enc_comp_full
```

- Copy backup to datadir and adjust folder ownership:

Unset

```
xtrabackup --copy-back --target-dir=/backups/enc_comp_full
chown -R mysql.mysql /var/lib/mysql
```

- Start MySQL

Unset

```
mysqld --user=mysql &
```

Single Table Backup / Partial Restore

Scenario 1 - Backup and restore a single table

- Backup **employees** table only

Unset

```
xtrabackup --backup --tables=employees.employees \
--target-dir=/backups/emp
```

- Accidentally, run a **DELETE** without **WHERE**

Unset

```
mysql> DELETE FROM employees.employees;
-- panic moment --
mysql> SELECT * FROM employees.employees;
```

- Prepare the backup

Unset

```
xtrabackup --prepare --export --target-dir=/backups/emp/
```

- Discard Tablespace and import backup files (keep the session open)

Unset

```
mysql> SET FOREIGN_KEY_CHECKS=0;
mysql> ALTER TABLE employees.employees DISCARD TABLESPACE;
```

- Copy backup files to datadir

Unset

```
cp /backups/emp/employees/employees.* /var/lib/mysql/employees/
```

```
chown mysql.mysql /var/lib/mysql/employees/employees.*
```

- One mysql session, import the tablespace

Unset

```
mysql> ALTER TABLE employees.employees IMPORT TABLESPACE;
mysql> SET FOREIGN_KEY_CHECKS=1;
mysql> SELECT * FROM employees.employees;
-- relief moment --
```

Scenario 2 - Restore a single table from a full backup

- Accidentally, run a **DELETE** without **WHERE**

Unset

```
mysql> DELETE FROM employees.employees;
-- panic moment --
mysql> SELECT * FROM employees.employees;
```

- On our first backup - export all tablespaces

Unset

```
xtrabackup --prepare --export --target-dir=/backups/full/
```

- Discard Tablespace and import backup files (keep the session open)

Unset

```
mysql> SET FOREIGN_KEY_CHECKS=0;
mysql> ALTER TABLE employees.employees DISCARD TABLESPACE;
```

- Copy backup files to datadir

Unset

```
cp /backups/full/employees/employees.* /var/lib/mysql/employees/
chown mysql.mysql /var/lib/mysql/employees/employees.*
```

- On the previously open mysql session, import the tablespace

Unset

```
mysql> ALTER TABLE employees.employees IMPORT TABLESPACE;
mysql> SET FOREIGN_KEY_CHECKS=1;
mysql> SELECT * FROM employees.employees;
-- relief moment --
```

Point In Time Recovery

Note: For PITR we need a copy of binary logs. Xtrabackup does not backup binary logs, you need to backup your binlogs. In our example we will use a local copy of binlogs. For production environments, please check Using mysqlbinlog to Back Up Binary Log Files

Note: We will be using the fake master approach. Check more details here

- Take a full backup

Unset

```
xtrabackup --backup --target-dir=/backups/pitr
```

- Employee Richmond was hired as Database Administrator with a salary of $80k during his probationary period

Unset

```
mysql> INSERT INTO employees.employees VALUES (500005, '1988-05-21',
'Richmond', 'Avenal', 'M', '2023-05-22');
mysql> INSERT INTO employees.titles VALUES
 (500005, 'Database Administrator', '2023-05-22', NULL);
mysql> INSERT INTO employees.salaries VALUES (500005, 80000,
'2023-05-22', '2023-08-21');
```

- Check current **Richmond** full record

Unset

```
mysql> SELECT emp_no, first_name, last_name, ANY_VALUE(title) AS
title, MAX(salary) AS salary FROM employees.employees JOIN
employees.titles USING (emp_no) JOIN employees.salaries USING (emp_no)
WHERE emp_no = 500005;
+--------+------------+-----------+------------------------+--------+
| emp_no | first_name | last_name | title                  | salary |
+--------+------------+-----------+------------------------+--------+
| 500005 | Richmond   | Avenal    | Database Administrator |  80000 |
+--------+------------+-----------+------------------------+--------+
```

- Simulate incident by running **incident.sh** at bash terminal

Unset

```
incident.sh
```

- **Richmond** has passed probation period and got a $10k raise

Unset

```
mysql> INSERT INTO employees.salaries VALUES (500005, 90000,
'2023-08-22', '2024-08-21');
```

- Check current **Richmond** full record

Unset

```
mysql> SELECT emp_no, first_name, last_name, ANY_VALUE(title) AS
title, MAX(salary) AS salary FROM employees.employees JOIN
employees.titles USING (emp_no) JOIN employees.salaries USING (emp_no)
WHERE emp_no = 500005;
ERROR 1146 (42S02): Table 'employees.titles' doesn't exist
```

Restore process

- Stop MySQL

Unset

```
mysql -e shutdown
```

- Prepare backup

Unset

```
xtrabackup --prepare --target-dir=/backups/pitr
```

- Check backup binlog coordinations

Unset

```
cat /backups/pitr/xtrabackup_binlog_info
binlog.000017   157
```

- Copy all binlogs after **binlog.000017**

Unset

```
cd /var/lib/mysql
ls binlog.0*
#-- binlog.000014  binlog.000015  binlog.000016  binlog.000017
mkdir /backups/binlogs/
cp binlog.000017 /backups/binlogs/
```

- Remove old datadir and copy backup to datadir

Unset

```
rm -rf /var/lib/mysql/*
xtrabackup --copy-back --target-dir=/backups/pitr
```

- Copy backup binlog, adjust relay index and folder ownership:

Unset

```
cp /backups/binlogs/binlog.000017 /var/lib/mysql/relay.000017
echo "relay.000017" > /var/lib/mysql/relay.index
chown -R mysql.mysql /var/lib/mysql
```

- Start MySQL with below configuration

Unset

```
mysqld --replicate-same-server-id --log-replica-updates=OFF \
--skip-slave-start --relay-log=relay --relay_log_index=relay.index \
--user=mysql &
```

- Inspect binlog, identify position of **DROP** statement

Unset

```
root@7dc31004f432:/var/lib/mysql# mysqlbinlog -vvvv \
--start-position=157 /var/lib/mysql/relay.000017 | grep -B 15 DROP
#230506 17:50:48 server id 1  end_log_pos 1086 CRC32 0x5632eed7   Xid =
289
COMMIT/*!*/;
# at 1086
#230506 17:50:58 server id 1  end_log_pos 1163 CRC32 0x77ce2cc5
Anonymous_GTID  last_committed=3 sequence_number=4     rbr_only=no
original_committed_timestamp=1683395458393853
immediate_commit_timestamp=1683395458393853 transaction_length=218
# original_commit_timestamp=1683395458393853 (2023-05-06
17:50:58.393853 UTC)
# immediate_commit_timestamp=1683395458393853 (2023-05-06
17:50:58.393853 UTC)
```

```
/*!80001 SET
@@session.original_commit_timestamp=1683395458393853*//*!*/;
/*!80014 SET @@session.original_server_version=80032*//*!*/;
/*!80014 SET @@session.immediate_server_version=80032*//*!*/;
SET @@SESSION.GTID_NEXT= 'ANONYMOUS'/*!*/;
# at 1163
#230506 17:50:58 server id 1  end_log_pos 1304 CRC32 0x3ef8eb55   Query
thread_id=16     exec_time=0      error_code=0     Xid = 292
use `employees`/*!*/;
SET TIMESTAMP=1683395458/*!*/;
SET @@session.pseudo_thread_id=16/*!*/;
DROP TABLE `titles` /* generated by server */
```

On above example, DROP happened at position 1163, we will want to execute up to previous position (#at 1086)

- Check current **Richmond** full record

```
Unset
mysql> SELECT emp_no, first_name, last_name, ANY_VALUE(title) AS
title, MAX(salary) AS salary FROM employees.employees JOIN
employees.titles USING (emp_no) JOIN employees.salaries USING (emp_no)
WHERE emp_no = 500005;
+--------+------------+-----------+-------+--------+
| emp_no | first_name | last_name | title | salary |
+--------+------------+-----------+-------+--------+
|   NULL | NULL       | NULL      | NULL  |   NULL |
+--------+------------+-----------+-------+--------+
1 row in set (0.02 sec)
```

Note: No **Richmond** in the database yet

- Start replica up to the position of DROP

Unset

```
mysql> CHANGE REPLICATION SOURCE TO RELAY_LOG_FILE='relay.000017',
RELAY_LOG_POS=157, SOURCE_HOST='dummy';
mysql> START REPLICA UNTIL RELAY_LOG_FILE = 'relay.000017',
RELAY_LOG_POS=1086;
```

- Monitor **SHOW REPLICA STATUS \ G** validate **Relay_Log_File** and **Relay_Log_Pos** has reached the desired position:

Unset

```
mysql> SHOW REPLICA STATUS\G
*************************** 1. row ***************************
             Replica_IO_State:
                  Source_Host: dummy
                  Source_User:
                  Source_Port: 3306
                Connect_Retry: 60
              Source_Log_File:
          Read_Source_Log_Pos: 4
               Relay_Log_File: relay.000017
                Relay_Log_Pos: 1086
```

- Check current **Richmond** full record

Unset

```
mysql> SELECT emp_no, first_name, last_name, ANY_VALUE(title) AS
title, MAX(salary) AS salary FROM employees.employees JOIN
employees.titles USING (emp_no) JOIN employees.salaries USING (emp_no)
WHERE emp_no = 500005;
```

```
+--------+------------+-----------+------------------------+--------+
| emp_no | first_name | last_name | title                  | salary |
+--------+------------+-----------+------------------------+--------+
| 500005 | Richmond   | Avenal    | Database Administrator |  80000 |
+--------+------------+-----------+------------------------+--------+
1 row in set (0.00 sec)
```

Note: **Richmond** is now in the database but with an old salary.

- Now we want to skip the DROP event and continue to apply the next event onwards

Unset

```
root@7dc31004f432:/var/lib/mysql# mysqlbinlog -vvvv \
--start-position=1086 /var/lib/mysql/relay.000017 | grep -A10 DROP
DROP TABLE `titles` /* generated by server */
/*!*/;
# at 1304
#230506 17:51:04 server id 1  end_log_pos 1383 CRC32 0x5879d1ea
Anonymous_GTID  last_committed=4 sequence_number=5     rbr_only=yes
original_committed_timestamp=1683395464024775
immediate_commit_timestamp=1683395464024775 transaction_length=293
/*!50718 SET TRANSACTION ISOLATION LEVEL READ COMMITTED*//*!*/;
# original_commit_timestamp=1683395464024775 (2023-05-06
17:51:04.024775 UTC)
# immediate_commit_timestamp=1683395464024775 (2023-05-06
17:51:04.024775 UTC)
/*!80001 SET
@@session.original_commit_timestamp=1683395464024775*//*!*/;
/*!80014 SET @@session.original_server_version=80032*//*!*/;
/*!80014 SET @@session.immediate_server_version=80032*//*!*/;
SET @@SESSION.GTID_NEXT= 'ANONYMOUS'/*!*/;
```

Note: The next valid event after DROP is #at 1304

- Reconfigure replication to that event

Unset
```
mysql> CHANGE REPLICATION SOURCE TO RELAY_LOG_FILE='relay.000017',
RELAY_LOG_POS=1304, SOURCE_HOST='dummy';
mysql> START REPLICA;
```

- Re-check current **Richmond** full record

Unset
```
mysql> SELECT emp_no, first_name, last_name, ANY_VALUE(title) AS
title, MAX(salary) AS salary FROM employees.employees JOIN
employees.titles USING (emp_no) JOIN employees.salaries USING (emp_no)
WHERE emp_no = 500005;
+--------+------------+-----------+------------------------+--------+
| emp_no | first_name | last_name | title                  | salary |
+--------+------------+-----------+------------------------+--------+
| 500005 | Richmond   | Avenal    | Database Administrator |  90000 |
+--------+------------+-----------+------------------------+--------+
1 row in set (0.00 sec)
```

Note: For GTID based replication the process is similar, but instead of adjusting the relay log position we will add empty transactions with the GTIDs we want to skip - check Skipping Transactions With GTIDs

Note: You can tune PITR by using multiple parallel workers

Bonus - Single Table Point In Time Recovery

Utilizing Replication Filters and either example from Single Table Backup / Partial Restore

- Take a full backup

Unset

```
xtrabackup --backup --target-dir=/backups/pitr_single_table
```

- Marcelo And Vinicius got hired as DBA with a salary of $120k, lets add them to the database

Unset

```
INSERT INTO employees.employees VALUES (500006, '1988-05-21',
'Marcelo', 'Altmann', 'M', '2023-05-22');
INSERT INTO employees.titles VALUES (500006, 'Database Administrator',
'2023-05-22', NULL);
INSERT INTO employees.salaries VALUES (500006, 120000, '2023-05-22',
'2023-08-21');
INSERT INTO employees.employees VALUES (500007, '1988-05-21',
'Vinicius', 'Grippa', 'M', '2023-05-22');
INSERT INTO employees.titles VALUES (500007, 'Database Administrator',
'2023-05-22', NULL);
INSERT INTO employees.salaries VALUES (500007, 120000, '2023-05-22',
'2023-08-21');
```

- You need to provide to QA team, a MySQL instance with only employees table. Table must have up to date data.
- Initialize a new datadir and start mysql on port 3307

Unset

```
mkdir /var/lib/mysql-qa
chown -R mysql.mysql /var/lib/mysql-qa
mysqld --initialize-insecure --user=mysql --datadir=/var/lib/mysql-qa
mysqld --user=mysql --datadir=/var/lib/mysql-qa --skip-networking \
--socket=/tmp/mysql_qa.sock &
```

- Create employees database & table and discard its tablespace

Unset

```
mysql --socket=/tmp/mysql_qa.sock --prompt='qa> '
qa> CREATE DATABASE employees;
qa> CREATE TABLE employees.employees (
  `emp_no` int NOT NULL,
  `birth_date` date NOT NULL,
  `first_name` varchar(14) NOT NULL,
  `last_name` varchar(16) NOT NULL,
  `gender` enum('M','F') NOT NULL,
  `hire_date` date NOT NULL,
  PRIMARY KEY (`emp_no`)
) ENGINE=InnoDB;
qa> ALTER TABLE employees.employees DISCARD TABLESPACE;
```

- Prepare backup and copy employees files

Unset

```
xtrabackup --prepare --export --target-dir=/backups/pitr_single_table
cp /backups/pitr_single_table/employees/employees.* \
/var/lib/mysql-qa/employees/
chown -R mysql.mysql /var/lib/mysql-qa/employees/employees.*
```

- Import backup employees tablespace (ensure you are on qa instance)

Unset

```
mysql --socket=/tmp/mysql_qa.sock --prompt='qa> '
qa> ALTER TABLE employees.employees IMPORT TABLESPACE;
```

- Check Marcelo and Vinicius are employees

Unset

```
qa> SELECT * FROM employees.employees WHERE first_name IN ('Marcelo',
'Vinicius')\G
Empty set (0.16 sec)
```

- Stop QA instance

Unset

```
mysql --socket=/tmp/mysql_qa.sock -e shutdown
```

- Check backup binlog coordinations

Unset

```
cat /backups/pitr_single_table/xtrabackup_binlog_info
binlog.000018    157
```

- Flush binlogs on origins instance and copy all binlogs after **binlog.000018** skipping the last log (current open by mysqld)

Unset

```
mysql -e 'FLUSH BINARY LOGS'
cd /var/lib/mysql
ls binlog.0*
#-- binlog.000016  binlog.000017  binlog.000018  binlog.000019
cp binlog.000018 /var/lib/mysql-qa/relay.000018
echo "relay.000018" > /var/lib/mysql-qa/relay.index
chown -R mysql.mysql /var/lib/mysql-qa/relay.*
```

- Start MySQL QA instance

Unset

```
mysqld --user=mysql --datadir=/var/lib/mysql-qa --skip-networking \
--socket=/tmp/mysql_qa.sock --replicate-same-server-id \
--log-replica-updates=OFF --skip-slave-start --relay-log=relay \
--relay_log_index=relay.index &
```

- Configure replication

Unset

```
mysql --socket=/tmp/mysql_qa.sock --prompt='qa> '
qa> CHANGE REPLICATION SOURCE TO RELAY_LOG_FILE='relay.000018',
RELAY_LOG_POS=157, SOURCE_HOST='dummy';
qa> CHANGE REPLICATION FILTER REPLICATE_DO_TABLE =
(employees.employees);
qa> START REPLICA;
```

- Check Marcelo & Vinicius are employees

Unset

```
qa> SELECT * FROM employees.employees WHERE first_name IN ('Marcelo',
    -> 'Vinicius')\G
*************************** 1. row ***************************
    emp_no: 500006
birth_date: 1988-05-21
first_name: Marcelo
 last_name: Altmann
    gender: M
 hire_date: 2023-05-22
1 row in set (0.18 sec)
```

- Only Marcelo is an employee. Lets check replication status

Unset

```
qa> SHOW REPLICA STATUS\G
*************************** 1. row ***************************
. . .
Replica_SQL_Running: No
. . .
Last_SQL_Errno: 1146
Last_SQL_Error: Coordinator stopped because there were error(s) in the
worker(s). The most recent failure being: Worker 1 failed executing
transaction 'ANONYMOUS' at master log , end_log_pos 762. See error log
and/or performance_schema.replication_applier_status_by_worker table
for more details about this failure or others, if any.

qa> SELECT LAST_ERROR_MESSAGE FROM
performance_schema.replication_applier_status_by_worker WHERE
LAST_ERROR_NUMBER = 1146\G
*************************** 1. row ***************************
```

```
LAST_ERROR_MESSAGE: Worker 1 failed executing transaction 'ANONYMOUS'
at master log , end_log_pos 762; Error executing row event: 'Table
'employees.titles' doesn't exist'
1 row in set (0.00 sec)
```

- Adjust replication filter to only do PITR (Apply replication events) for employees table

Unset

```
qa> CHANGE REPLICATION FILTER REPLICATE_DO_TABLE =
(employees.employees);
qa> START REPLICA;
qa> SELECT * FROM employees.employees WHERE first_name IN ('Marcelo',
'Vinicius')\G
*************************** 1. row ***************************
    emp_no: 500006
birth_date: 1988-05-21
first_name: Marcelo
 last_name: Altmann
    gender: M
 hire_date: 2023-05-22
*************************** 2. row ***************************
    emp_no: 500007
birth_date: 1988-05-21
first_name: Vinicius
 last_name: Grippa
    gender: M
 hire_date: 2023-05-22
2 rows in set (0.17 sec)
```