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Percona XtraBackup - New Features and Improvements

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Marcelo Altmann

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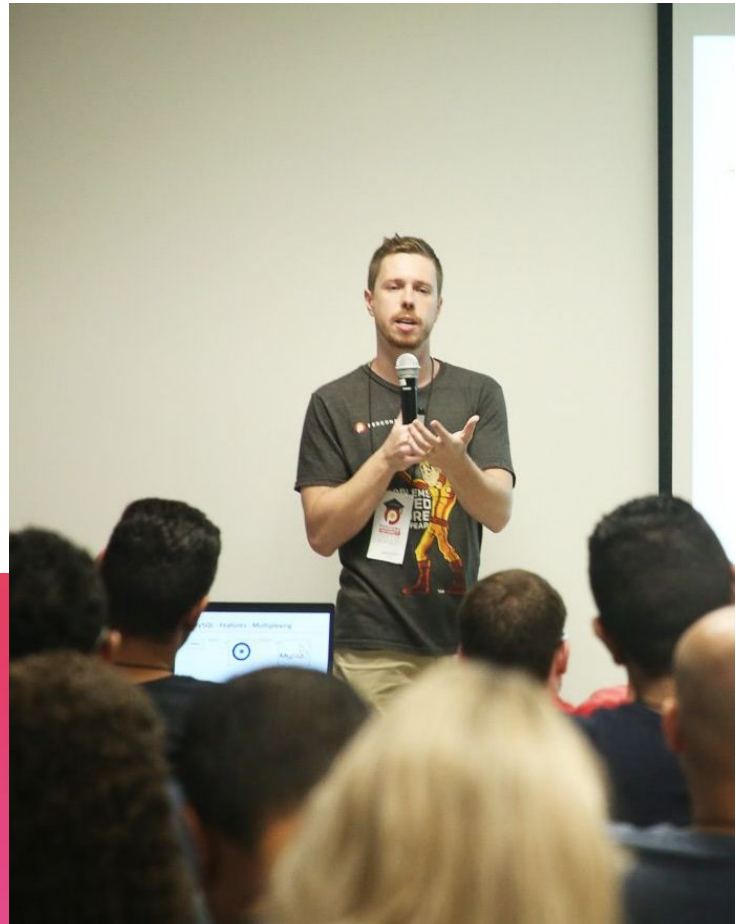
  - Joined in 2016 as Senior Support Engineer
  - PXB / PS / PXC
  - Member Bugs Escalation Committee



High level overview

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- Full Backup
  - Start Redo Follow
  - Discover InnoDB tablespaces to copy
  - Copy InnoDB tables
  - Copy Non-InnoDB Tables
  - Snapshot of all engines (log_status table)
  - Stop Redo Follow

High level overview

- Incremental Backup
  - Start Redo Follow
  - Discover InnoDB tablespaces to copy
  - Copy Delta pages InnoDB tables
  - Copy Non-InnoDB Tables
  - Snapshot of all engines (log_status table)
  - Stop Redo Follow

High level overview

- Full prepare
  - InnoDB crash recovery
  - Replay the records copied during the backup
- Incremental prepare
  - Directly apply delta pages to full backup
  - Innodb crash recovery

Not so new features

Not so new features

- `--rsync` for non-InnoDB tables
  - Reduces the time non-InnoDB tables remain under lock
  - Copies all non-InnoDB tables without lock to backup dir
  - Lock Non-InnoDB tables
  - Rsync copies only modified non-InnoDB tables

Not so new features

- `--prepare --export`
  - InnoDB Transportable Tablespaces
  - Allows users to restore individual tables into running MySQL instances

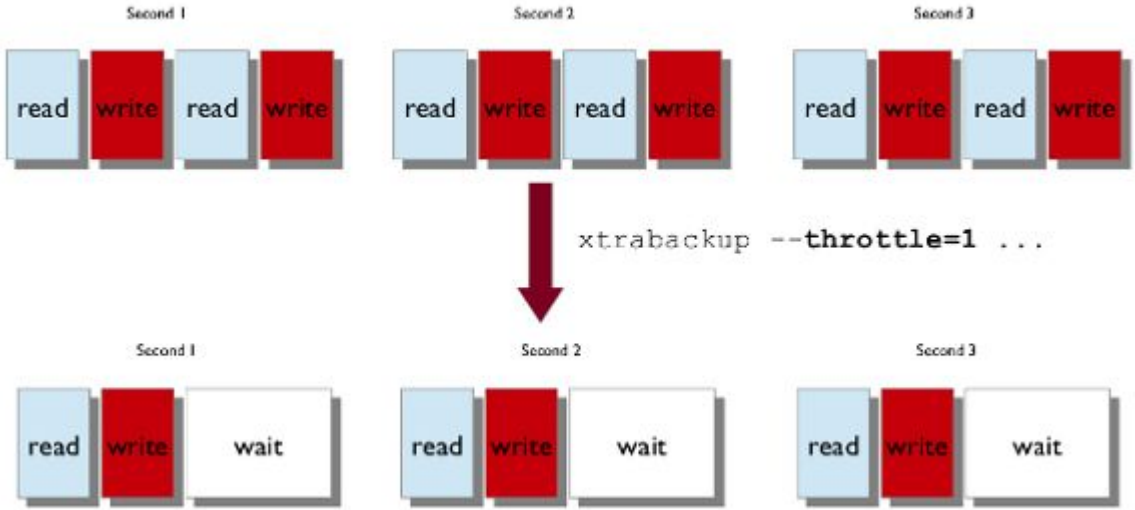
```
mysql> CREATE TABLE test.export_test (
a int(11) DEFAULT NULL
) ENGINE=InnoDB DEFAULT CHARSET=latin1;

$ xtrabackup --backup --target-dir=/backup
```

Not so new features

```
$ xtrabackup --prepare --export --target-dir=/backup

mysql> ALTER TABLE test.export_test DISCARD TABLESPACE;

$ cp /backup/test/export_test* /var/lib/mysql/test

mysql> ALTER TABLE test.export_test IMPORT TABLESPACE;
```

Not so new features

- `--throttle` – let's the backup flow without saturating the disk
  - Limits the number of read / write chunk (10MB) done per second



Not so new features

- `--dump-innodb-buffer-pool` for provisioning new servers
  - Uses server InnoDB Preload Buffer Pool
  - PXB ask the server to create a new snapshot of BP
  - Space->page map file copied at `--copy-back`
  - Decreases the warm-up period
  - Useful for provisioning new slaves or PXC

xbcloud - Storage Class

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xbcloud - Storage Class

- Added in 8.0.22 & 2.4.21
- Community contribution from Benoît Knecht - PXB-2112
- By default xbcloud uploads to standard storage class
- Different storage class have time difference in regards to the availability of the files
- Meaning in different costs $$$
- Controlled by parameter
  - --s3-storage-class
  - --google-storage-class
  - --azure-tier-class

xbcloud - Storage Class

- Amazon S3:
  - Standard Storage Class – costs $0.021 per GB * 500GB * 365 days = $3,832.50
  - Glacier Deep Archive Storage Class – costs $0.00099 per GB * 500GB * 365 days = $180.68 (a difference of **$3,651.83**)
- Google Cloud:
  - Standard Storage Class – costs $0.020 per GB * 500GB * 365 days = $3,650.00
  - Archive Storage Class – costs $0.0012 per GB * 500GB * 365 days = $219.00 (a difference of **$3,431.00**)

xbcloud - Azure Blob Storage

xbcloud - Azure Blob Storage

- Added in 8.0.27 & 2.4.25
- Increases current support providers S3 / Google cloud (s3 compatible) / MinIO
- New Cloud provider support into xbcloud - Microsoft Azure Blob Storage
- --azure-storage-account
- --azure-container-name
- --azure-access-key
- --azure-endpoint
- --azure-tier-class

xbcloud - Exponential backoff

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xbcloud - Exponential backoff

- Added in 8.0.26 & 2.4.24
- Make uploads/downloads more resilient on unstable networks
- Uses exponential backoff algorithm
- Pauses the upload of failed chunk and retry later
- If new error comes in, double the sleep time (+ random ms)
- Allow users to put a cap in sleep time
- Based on a list of pre-defined errors
- Allow users to add new errors to the list

xbcloud - Exponential backoff

- `--max-retry` – number of retries for each chunk before giving-up
- `--max-backoff` – Max number of seconds to sleep between retires
- `--curl-retriable-errors` - Additional comma separated list of CURL errors
- `--http-retriable-errors` - Additional comma separated list of HTTP errors

Encryption - Keyring components

Encryption - Keyring components

- MySQL TDE - Transparent Data Encryption
- Each Entity (Table, redo, undo, binlog, doublewrite) has a set of keys on its header
- This key is used to encrypt the data inside the entity
- Entity key is stored encrypted by a Master Key
- Master Key is controlled by keyring component
- Up to 8.0.26 - keyring file and vault (PS only)

Encryption - Keyring components

- 8.0.27 - Introduction of Key Management Interoperability Protocol KMIP
- open standard developed by OASIS (Organization for Advancement of Structured Information Standards) for the encryption of stored data and cryptographic key management.
- Hashicorp Vault Enterprise - KMIP secrets
- IBM
- Others

Encryption - Keyring components

- 8.0.28-21 (not yet released) - Introduction of AWS Key Management Service - KMS
- Available across other services from AWS
- https://aws.amazon.com/kms/
- Similar to keyring file, but master key is kept encrypted by the KMS key.

Log re-design

Log re-design

- Introduced in 8.0.28-20
- Extends server log formatting
- Better readability

Log re-design

```
xtrabackup: recognized client arguments: --user=root --host=127.0.0.1 --port=3310 --backup=1 --stream=xbstream --port=3306 --no-version-check=1
/slow/binaries/pxb/percona-xtrabackup-8.0.26-18-Linux-x86_64.glibc2.17/bin/xtrabackup version 8.0.26-18 based on MySQL server 8.0.26 Linux (x86_6
4) (revision id: 4aecf82)
220514 15:06:33 Connecting to MySQL server host: 127.0.0.1, user: root, password: not set, port: 3306, socket: not set
Using server version 8.0.26-16
220514 15:06:33 Executing LOCK TABLES FOR BACKUP...
xtrabackup: uses posix_fadvise().
xtrabackup: cd to /tmp/data/
xtrabackup: open files limit requested 0, set to 65536
xtrabackup: using the following InnoDB configuration:
xtrabackup:   innodb_data_home_dir = .
xtrabackup:   innodb_data_file_path = ibdata1:12M:autoextend
xtrabackup:   innodb_log_group_home_dir = ./
xtrabackup:   innodb_log_files_in_group = 2
xtrabackup:   innodb_log_file_size = 50331648
Number of pools: 1
xtrabackup: inititialize_service_handles suceeded
220514 15:06:33 Connecting to MySQL server host: 127.0.0.1, user: root, password: not set, port: 3306, socket: not set
xtrabackup: Redo Log Archiving is not set up.
220514 15:06:33 >> log scanned up to (18198822)
xtrabackup: Generating a list of tablespaces
xtrabackup: Generating a list of tablespaces
Scanning './'
Completed space ID check of 2 files.
Allocated tablespace ID 1 for sys/sys_config, old maximum was 0
Using undo tablespace './undo_001'.
Using undo tablespace './undo_002'.
Opened 2 existing undo tablespaces.
220514 15:06:33 [01] Streaming ./ibdata1
220514 15:06:33 [01]        ...done
```

Log re-design

```
2022-05-14T15:08:48.842475-03:00 0 [Note] [MY-011825] [Xtrabackup] recognized client arguments: --user=root --host=127.0.0.1 --port=3310 --backup
=1 --stream=xbstream --port=3306 --no-version-check=1
xtrabackup version 8.0.28-20 based on MySQL server 8.0.28 Linux (x86_64) (revision id: c1634697765)
2022-05-14T15:08:48.842558-03:00 0 [Note] [MY-011825] [Xtrabackup] Connecting to MySQL server host: 127.0.0.1, user: root, password: not set, por
t: 3306, socket: not set
2022-05-14T15:08:48.849206-03:00 0 [Note] [MY-011825] [Xtrabackup] Using server version 8.0.26-16
2022-05-14T15:08:48.850882-03:00 0 [Note] [MY-011825] [Xtrabackup] Executing LOCK TABLES FOR BACKUP ...
2022-05-14T15:08:48.852888-03:00 0 [Note] [MY-011825] [Xtrabackup] uses posix_fadvise().
2022-05-14T15:08:48.852925-03:00 0 [Note] [MY-011825] [Xtrabackup] cd to /tmp/data/
2022-05-14T15:08:48.852956-03:00 0 [Note] [MY-011825] [Xtrabackup] open files limit requested 0, set to 65536
2022-05-14T15:08:48.853008-03:00 0 [Note] [MY-011825] [Xtrabackup] using the following InnoDB configuration:
2022-05-14T15:08:48.853029-03:00 0 [Note] [MY-011825] [Xtrabackup] innodb_data_home_dir = .
2022-05-14T15:08:48.853044-03:00 0 [Note] [MY-011825] [Xtrabackup] innodb_data_file_path = ibdata1:12M:autoextend
2022-05-14T15:08:48.853103-03:00 0 [Note] [MY-011825] [Xtrabackup] innodb_log_group_home_dir = ./
2022-05-14T15:08:48.853123-03:00 0 [Note] [MY-011825] [Xtrabackup] innodb_log_files_in_group = 2
2022-05-14T15:08:48.853146-03:00 0 [Note] [MY-011825] [Xtrabackup] innodb_log_file_size = 50331648
2022-05-14T15:08:48.854066-03:00 0 [Note] [MY-013251] [InnoDB] Number of pools: 1
2022-05-14T15:08:48.854862-03:00 0 [Note] [MY-011825] [Xtrabackup] inititialize_service_handles suceeded
2022-05-14T15:08:49.054155-03:00 0 [Note] [MY-011825] [Xtrabackup] Connecting to MySQL server host: 127.0.0.1, user: root, password: not set, por
t: 3306, socket: not set
2022-05-14T15:08:49.060419-03:00 0 [Note] [MY-011825] [Xtrabackup] Redo Log Archiving is not set up.
2022-05-14T15:08:49.154855-03:00 0 [Note] [MY-011825] [Xtrabackup] Starting to parse redo log at lsn = 18198584
2022-05-14T15:08:49.155290-03:00 1 [Note] [MY-011825] [Xtrabackup] >> log scanned up to (18199058)
2022-05-14T15:08:49.357300-03:00 0 [Note] [MY-011825] [Xtrabackup] Generating a list of tablespaces
2022-05-14T15:08:49.357379-03:00 0 [Note] [MY-011825] [Xtrabackup] Generating a list of tablespaces
2022-05-14T15:08:49.357421-03:00 0 [Note] [MY-012204] [InnoDB] Scanning './'
2022-05-14T15:08:49.358635-03:00 0 [Note] [MY-012208] [InnoDB] Completed space ID check of 2 files.
2022-05-14T15:08:49.359671-03:00 0 [Warning] [MY-012091] [InnoDB] Allocated tablespace ID 1 for sys/sys_config, old maximum was 0
2022-05-14T15:08:49.359797-03:00 0 [Note] [MY-013252] [InnoDB] Using undo tablespace './undo_001'.
2022-05-14T15:08:49.360191-03:00 0 [Note] [MY-013252] [InnoDB] Using undo tablespace './undo_002'.
2022-05-14T15:08:49.361009-03:00 0 [Note] [MY-012910] [InnoDB] Opened 2 existing undo tablespaces.
2022-05-14T15:08:49.361984-03:00 2 [Note] [MY-011825] [Xtrabackup] Streaming ./ibdata1
2022-05-14T15:08:49.460787-03:00 2 [Note] [MY-011825] [Xtrabackup] Done: Streaming ./ibdata1
```

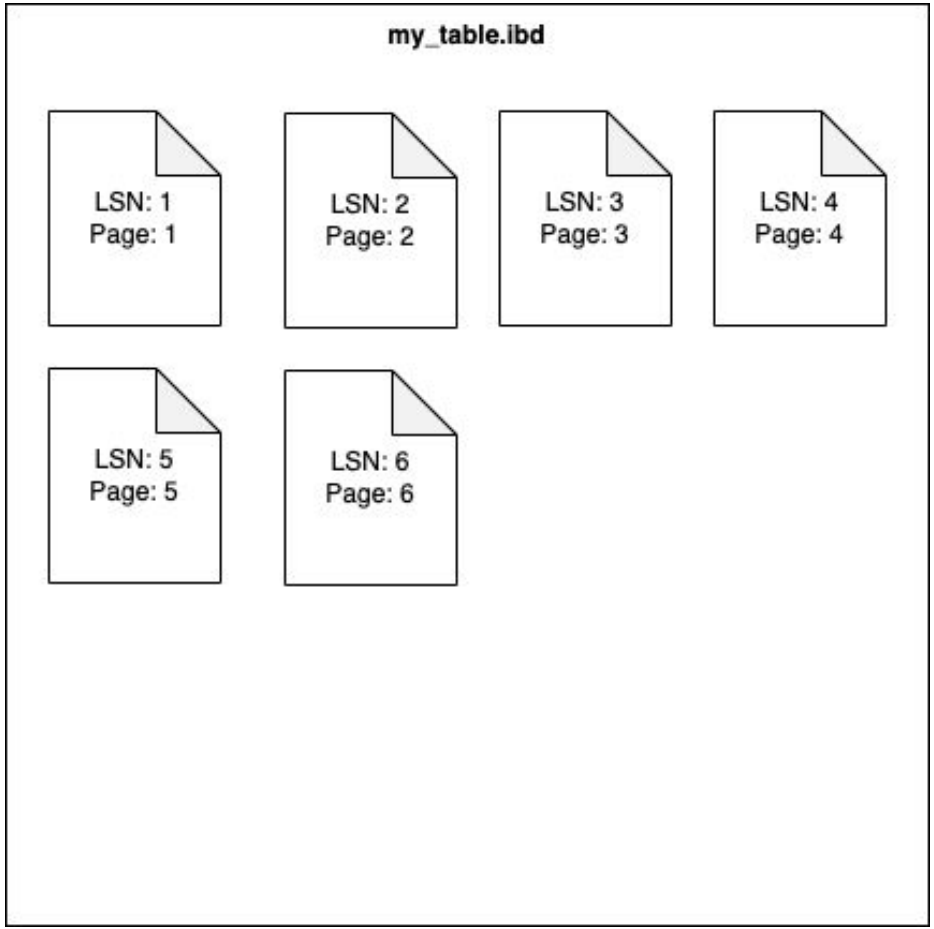
Page Tracking

Page Tracking

- 8.0.27-19 - Introduction of Page tracking
- MySQL Added component in 8.0.18
- Percona had its own implementation
- Used in incrementals
- How it works:

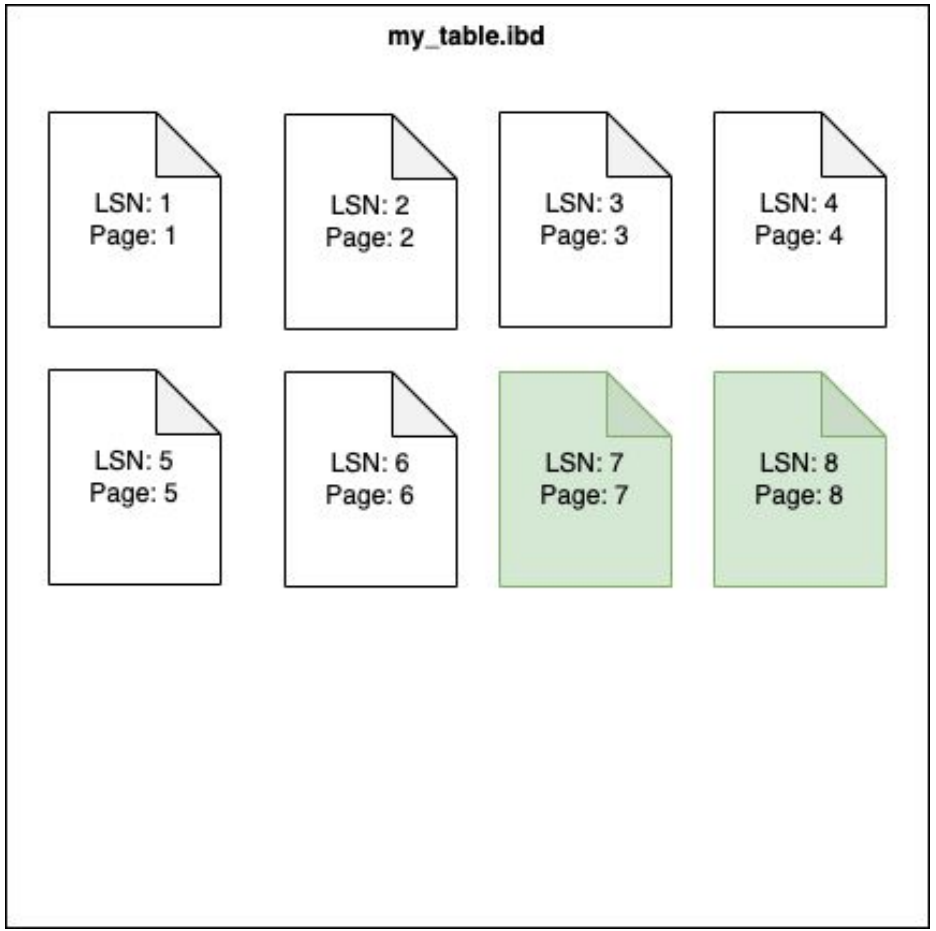
Page Tracking

- After each backup checkpoint LSN Is noted
- LSN 6



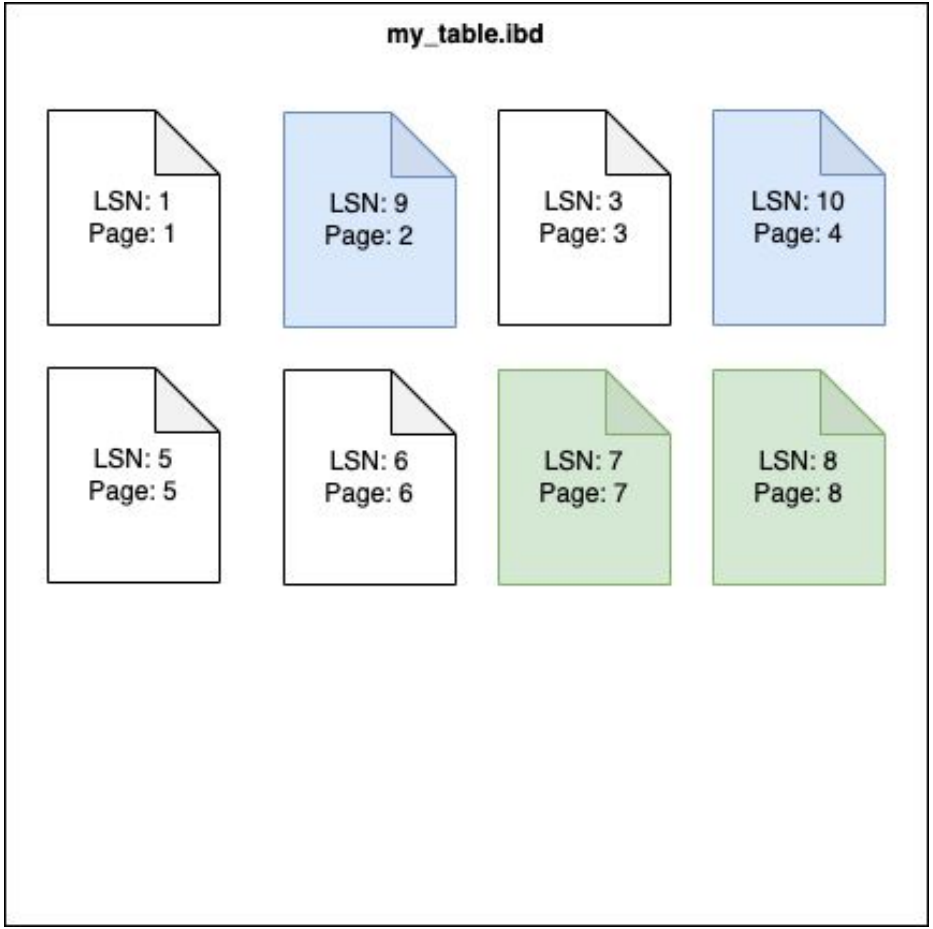
Page Tracking

- After each backup checkpoint LSN Is noted
- LSN 6
- `INSERT INTO my_table …`



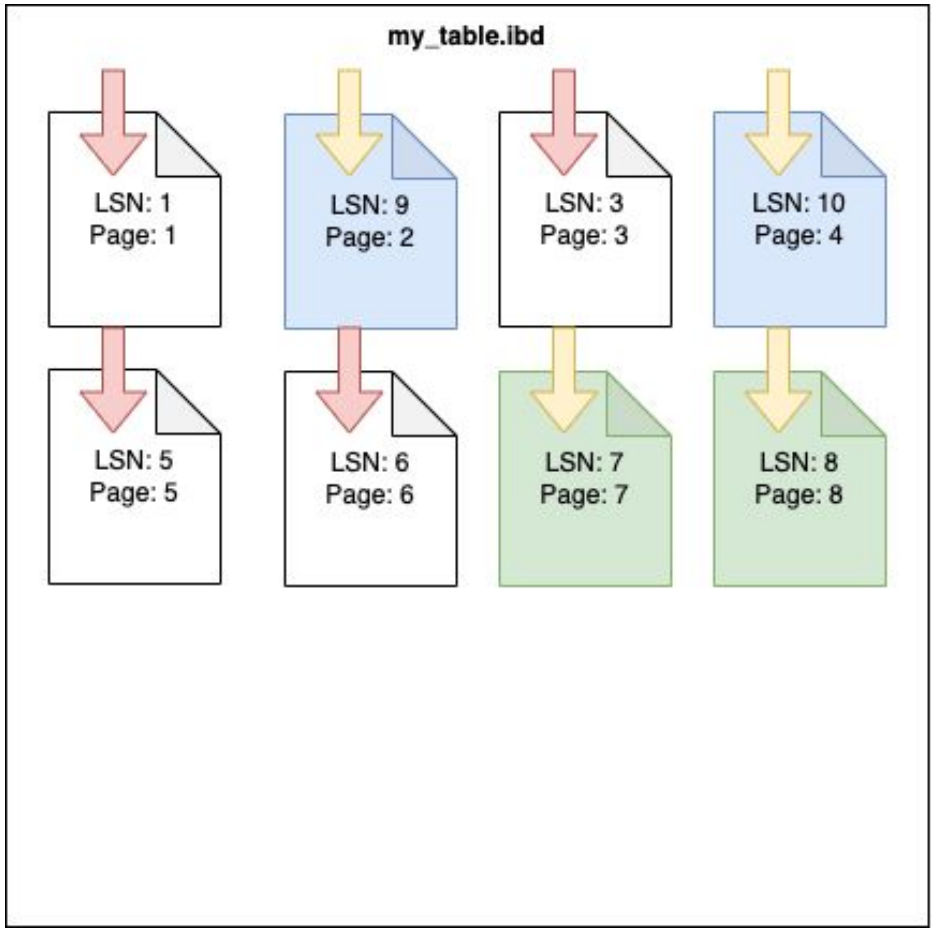
Page Tracking

- After each backup checkpoint LSN Is noted
- LSN 6
- `INSERT INTO my_table …`
- `UPDATE my_table …`



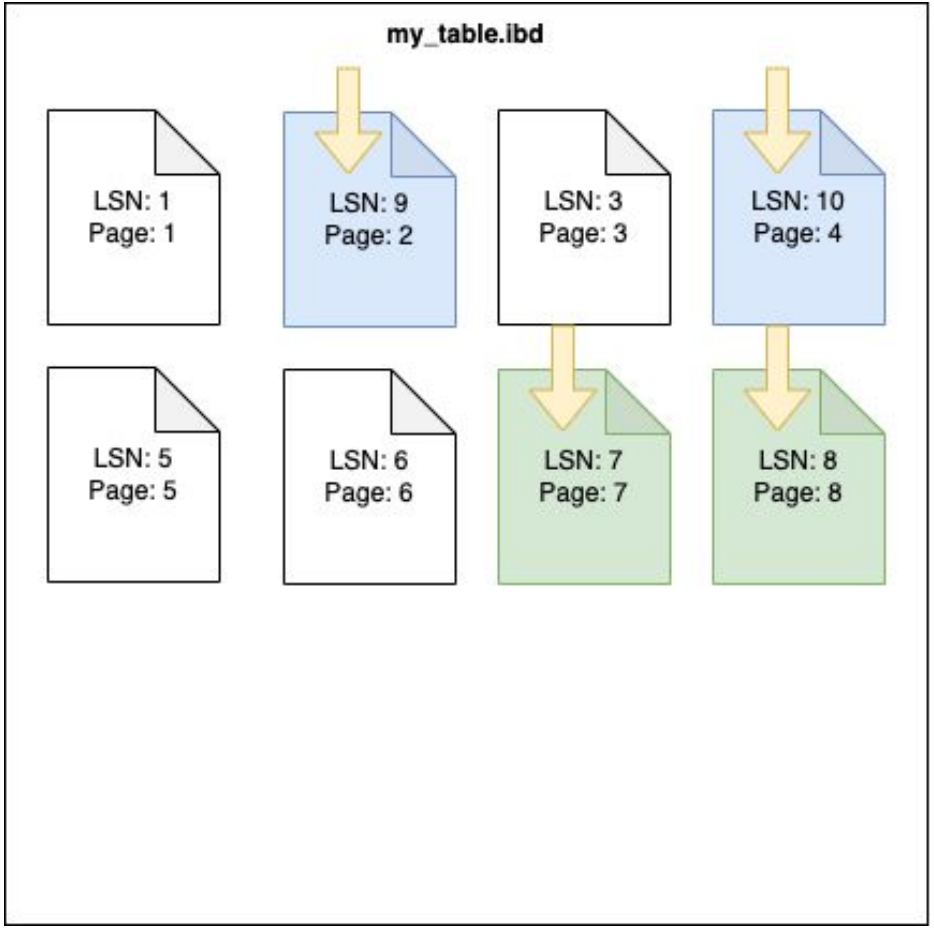
Page Tracking

- Without page tracking
- Brutal force
- Full scan



Page Tracking

- With page tracking
- PXB asks Page Tracking for pages Changed since last backup up to now
- Gets direct access to changed pages
- Useful for big dataset where only a small % of the data changes



Page Tracking

- Tests:
- In our test where one percent of data was changed after the full backup of 100 GB, an incremental backup took 30 seconds compared to the 5 minutes duration without page tracking.
- Page tracking perform better when up to 50% of the data has changed from base backup
- Faster backups = less redo log to apply = page tracking also helps on `--prepare`

Prepare Memory Prediction

Prepare Memory Prediction

- Not released yet (PR 1317 / PXB-2710)
- Buffer pool at --prepare:
  - 512 pages for database pages
  - Remaining used for in memory hash records to be applied
  - If full, call it a batch, apply what we have by loading the pages, once done, evict all pages
  - Start a new batch and continue to parse
- By default, PXB only allocates 128MB (same as default innodb buffer pool size)
- Not a fit for most of workloads
- Can be adjusted via `--use-memory`

Prepare Memory Prediction

- PXB already parses redo log entries while copying them at `--backup`
- Memory will be calculated up-in-front while doing `--backup` operation
- Number of free frames will also be calculated
- New parameter added to control this functionality:
- `--use-free-memory-pct` – Indicates the % of free memory PXB can use for `--prepare` operation.
- If enough memory is available whole prepare can be done in a single batch

Prepare Memory Prediction

- Test
- 2G of redo log
- Default config = 67 seconds to --prepare
- With predict memory = 44 seconds (~65% of time)
- Reduces 35%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