What can’t pgBackRest do for you?

data egret

Your remote PostgreSQL DBA team

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Who Am I?

- Stefan Fercot
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- pgBackRest fan & contributor
- aka. pgstef
- https://pgstef.github.io

pgBackRest

- aims to be a simple, reliable backup and **restore** system
- current release: 2.49 (November 27, 2023)
- local or remote operation (via SSH or TLS server)
- parallel and asynchronous operations
- S3, Azure, and GCS support
- client-side encryption (aes-256-cbc)
- …

Disclaimer

Talk aimed at intermediate and advanced users

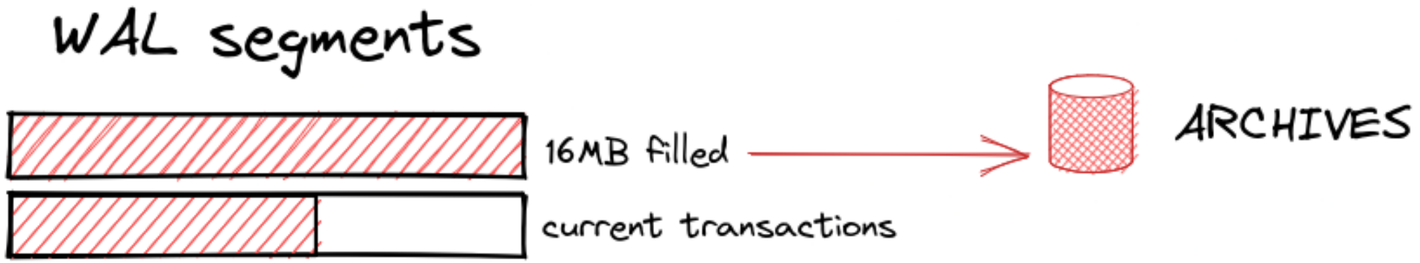
- Basic knowledge assumed about:
  - PostgreSQL continous archiving setup
  - How to make a PostgreSQL base backup
  - pgBackRest initial setup

What can’t pgBackRest do for you?

Archiving system

- `archive_command` vs `pg_receivewal` (not supported)
- how to improve it?
- what can go wrong with archiving?

WAL archiving process



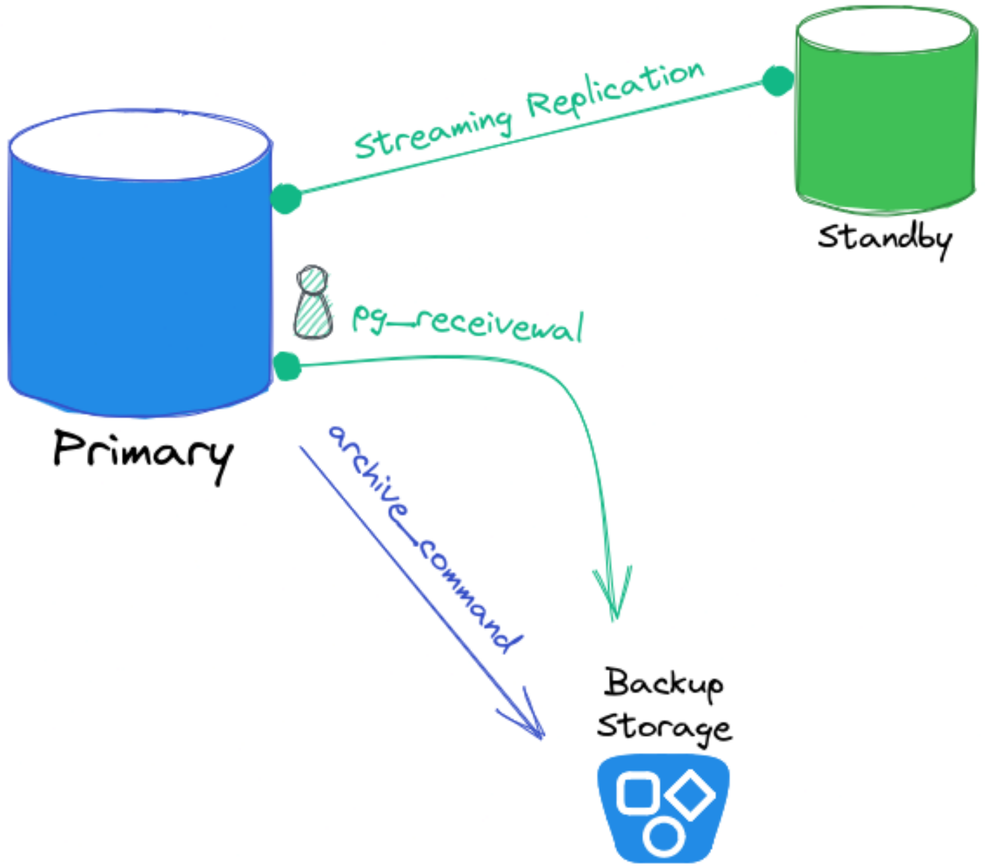
Benefits and drawbacks

- archiver process
  - easy to setup
  - maximum 1 WAL possible to lose
- `pg_receivewal`
  - more complex implementation
  - only the last transactions are lost
  - replication slot advised!

`.partial` WAL file

- usually < 16MB
- `pg_receivewal` = standby without data
- `.partial` is pushed by the standby server at promote time

Example (1)


Streaming Replication
Standby
pg_receivewal
Primary
archive_command
Backup
Storage

Example (2)

```
archive_command = 'cp %p /shared/archives/%f'
```

```
pg_receivewal -D /shared/receivewal -v
```

```
/usr/pgsql-15/bin/pgbench -i -s 65
```

Example (3)

```
$ ps -o pid,cmd fx
    PID CMD
  24154 /usr/pgsql-15/bin/postmaster -D /var/lib/pgsql/15/data/
  ...
  24403  \_ postgres: walsender ... streaming 0/34EDA448
  24893  \_ postgres: walsender ... streaming 0/34EDA448
```

```
$ ls /shared/archives
...
000000010000000000000033
```

```
$ ls /shared/receivewal
...
000000010000000000000033
000000010000000000000034.partial
```

Example (4)

```
$ psql -c "SELECT pg_promote();"
```

```
$ ls /shared/archives/
...
000000010000000000000034.partial
00000002.history
```

`pg_receivewal` still points to the old primary!

Timelines

A correct restore from backup, PITR or not,…

…always involves a timeline switch!

- archive recovery complete -> new timeline
  - part of WAL segment file names
  - to identify the series of WAL records generated after that recover
  - `.history` files

Faster archiving?

- async archiving
- compression types
- compression level

Async archiving

- using `archive-async=y`
  - temporary data (acknowledgments) stored into the `spool-path`
  - early archiving using `process-max` processes

Compression types

- file compression types supported (`compress-type`):
  - `bz2` - bzip2
  - `gz` - gzip (default)
  - `lz4`
  - `zst` - Zstandard

Compression level

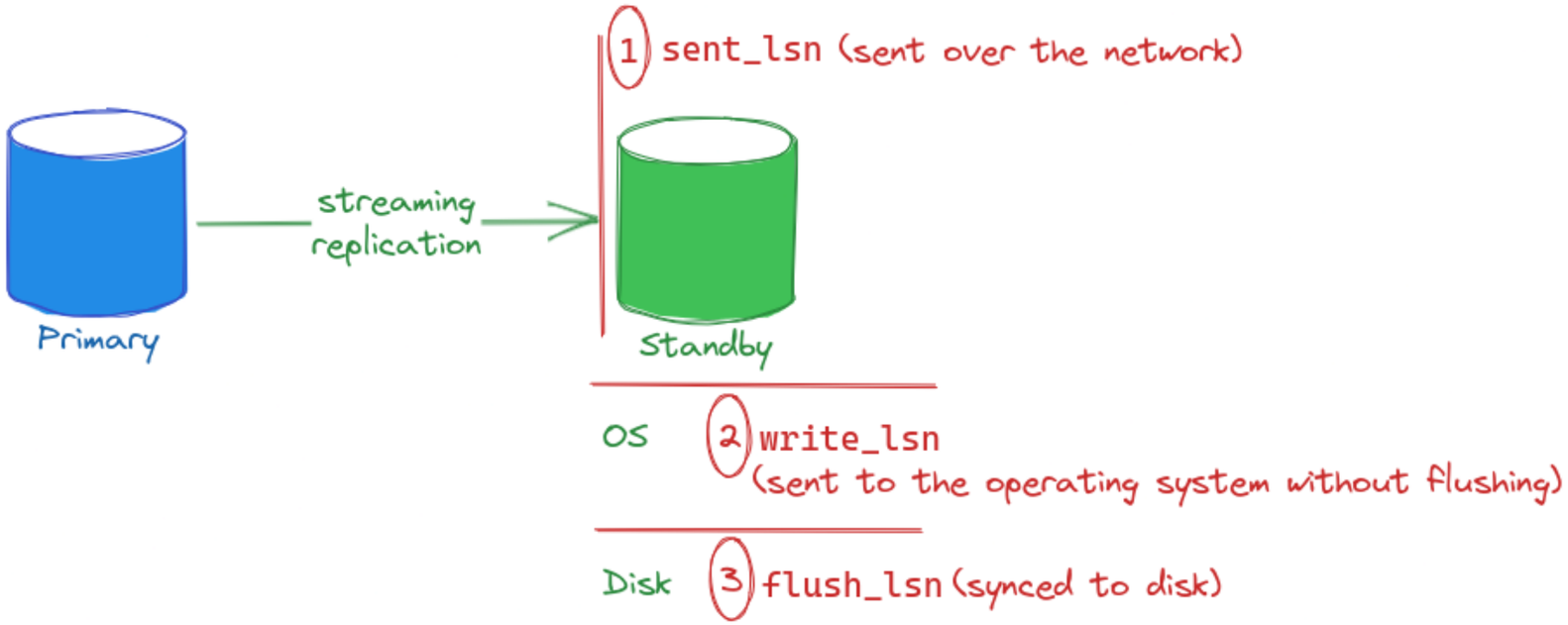
- when `compress-level` is not specified
  - defaults levels based on `compress-type`
    - bz2 - 9
    - gz - 6
    - lz4 - 1
    - zst - 3

Example (1) - initial state

```
SELECT application_name, sent_lsn, write_lsn, flush_lsn FROM pg_stat_replication;
 application_name |  sent_lsn  | write_lsn  | flush_lsn
------------------+------------+------------+-----------
 walreceiver      | 0/37000148 | 0/37000148 | 0/37000148
 pg_receivewal    | 0/37000148 | 0/37000148 | 0/37000000
(2 rows)
```

```
SELECT last_archived_wal FROM pg_stat_archiver;
    last_archived_wal
--------------------------
 000000010000000000000036
(1 row)
```

Replication states



Example (2) - archiving too slow

```
/usr/pgsql-15/bin/pgbench -n -P 1 -T 60 -j 2 -c 50
```

```
SELECT application_name, sent_lsn, write_lsn, flush_lsn FROM pg_stat_replication;
 application_name |  sent_lsn  | write_lsn  | flush_lsn
------------------+------------+------------+-----------
 walreceiver      | 0/5C9DA7D0 | 0/5C9DA7D0 | 0/5C9D3EE0
 pg_receivewal    | 0/5C9DA7D0 | 0/58AABAE8 | 0/58000000
(2 rows)
```

```
SELECT last_archived_wal FROM pg_stat_archiver;
    last_archived_wal
--------------------------
 000000010000000000000004B
(1 row)
```

Example (3) - final state

```
SELECT application_name, sent_lsn, write_lsn, flush_lsn FROM pg_stat_replication;
 application_name |  sent_lsn  | write_lsn  | flush_lsn
------------------+------------+------------+-----------
 walreceiver      | 0/5F602258 | 0/5F602258 | 0/5F602258
 pg_receivewal    | 0/5F602258 | 0/5F602258 | 0/5F000000
(2 rows)
```

```
SELECT last_archived_wal FROM pg_stat_archiver;
    last_archived_wal
--------------------------
 000000010000000000000005E
(1 row)
```

Example (4) - improvements

```
process-max=2
archive-async=y
compress-type=zst
```

```
/usr/pgsql-15/bin/pgbench -n -P 1 -T 60 -j 2 -c 50
```

```
SELECT application_name, sent_lsn, write_lsn, flush_lsn FROM pg_stat_replication;
 application_name |  sent_lsn  | write_lsn  | flush_lsn
------------------+------------+------------+-----------
 walreceiver      | 0/7F0BB8B8 | 0/7F000000 | 0/7F000000
 pg_receivewal    | 0/7F0BB8B8 | 0/7BF40470 | 0/7B000000
(2 rows)
```

```
SELECT last_archived_wal FROM pg_stat_archiver;
    last_archived_wal
--------------------------
 000000010000000000000007D
(1 row)
```

What can go wrong with archiving?

Things can get worst… and it will! (Laetitia Avrot)

Archiving fails…

```
ERROR: [082]: WAL segment ... was not archived before the 60000ms timeout
 HINT: check the archive_command to ensure that all options are correct
 HINT: check the PostgreSQL server log for errors
```

`archive-push` console output goes into the PostgreSQL logs!

Error example (1)

```
ERROR: [103]: unable to find a valid repository:
 repo1: [FileMissingError] unable to load info file '.../archive/demo/archive.info'
  or '.../archive/demo/archive.info.copy':
 FileMissingError: unable to open missing file '.../archive/demo/archive.info' for read
 FileMissingError: unable to open missing file '.../archive/demo/archive.info.copy' for read
 HINT: archive.info cannot be opened but is required to push/get WAL segments.
 HINT: is archive_command configured correctly in postgresql.conf?
 HINT: has a stanza-create been performed?
```

Error example (2)

```
ERROR: [050]: unable to acquire lock on file '/tmp/pgbackrest/demo-archive.lock': Permission denied
  HINT: does 'postgres:postgres' running pgBackRest have permissions
                                                on the '/tmp/pgbackrest/demo-archive.lock' file?
```

asynchronous archiving uses an archive lock to prevent more than one async process being launched

WAL segments piling up…

an error prevent PostgreSQL to remove/recycle the WAL file!

```
$ ls data/pg_wal/archive_status |grep .ready
...
000000010000000000000C7.ready
000000010000000000000C8.ready
000000010000000000000C9.ready
```

Archiving queue

- `archive-push-queue-max`
  - maximum size of the PostgreSQL archive queue
  - prevent the WAL space from filling up until PostgreSQL stops completely…
  - …but generate **missing archives**!
- very important to monitor archiving to ensure it continues working

Monitoring

What & How?

Logs

- `log-level-console` (stdout): **warn** by default
- `log-level-file` : **info** by default
- usually interesting to set `log-level-console` to **info** and `log-level-file` to **debug**

Archive-push

```
[demo:archive-push]
log-level-console=debug
```

`info` command - json output

```
$ pgbackrest info --stanza=demo --output=json
"archive":[{
   "database":{
      "id":1,
      "repo-key":1
   },
   "id":"15-1",
   "max":"000000010000000000000DA",
   "min":"000000010000000000000099"
}],
   "backup":[{
         "archive":{"start":"000000010000000000000099","stop":"000000010000000000000009"},
...
```

Backups

- retention
  - how old is your latest backup?
  - how old is your latest **full** backup?
  - how old is your **oldest** full backup?
  - how many full, diff or incr backups are in the repository?
  - does it meet the retention settings?

Backups - example

```
Long message   : full=1
Long message   : diff=0
Long message   : incr=3
Long message   : latest_bck=20231012-140212F_20231013-083055I
Long message   : latest_bck_type=incr
Long message   : latest_bck_age=3h28m33s
Long message   : latest_full=20231012-140212F
Long message   : latest_full_age=21h57m10s
Long message   : oldest_bck=20231012-140212F
Long message   : oldest_bck_age=21h57m10s
```

example generated with check_pgbackrest

Archives

- backup command checks archives needed for the consistency

```
$ pgbackrest --stanza=demo backup --type=full
...
INFO: check archive for segment(s) 000000010000000000000DC:000000010000000000000DC
...
```

- info command shows oldest and latest WAL archive in the repository

```
$ pgbackrest --stanza=demo info
...
wal archive min/max (15): 000000010000000000000099/000000010000000000000DC
```

Archives - questions

- what if archives needed for the backups consistency get removed after the backup?
- are all the archives between oldest and latest (from info) present is the repository?

```
Long message   : latest_archive_age=2m51s
Long message   : latest_archive=000000010000000000000E7
Long message   : latest_bck_archive_start=000000010000000000000DC
Long message   : latest_bck=20231013-122650F
Long message   : oldest_archive=000000010000000000000099
Long message   : oldest_bck_archive_start=000000010000000000000099
```

Archives and timeline switch

- WAL archives on different timelines found…

```
$ pgbackrest --stanza=demo info
...
wal archive min/max (15): 000000010000000000000099/0000000200000000000000E8
```

- parse `.history` file, find switch point and define boundary WAL

```
$ pgbackrest repo-get --stanza=demo archive/demo/15-1/00000002.history
1 0/E856A0E8  no recovery target specified
```

```
SELECT pg_walfile_name('0/E856A0E8');
     pg_walfile_name
--------------------------
 000000010000000000000E8
```

Locks

- check `lock-path` content

```
$ ls /tmp/pgbackrest
demo-archive.lock
demo-backup.lock
```

Restore

pgBackRest handles the restore,
PostgreSQL handles the recovery !

Let’s talk about `restore` command and recovery targets…

Restore type?

- `--type` (and `--target` to reach)
  - default - to the end of the archive stream
  - immediate - to backup consistency point
  - lsn - to LSN (Log Sequence Number), `recovery_target_lsn`
  - name - to restore point, `recovery_target_name`
  - xid - to transaction id, `recovery_target_xid`
  - time - to a specific timestamp, `recovery_target_time`
  - …

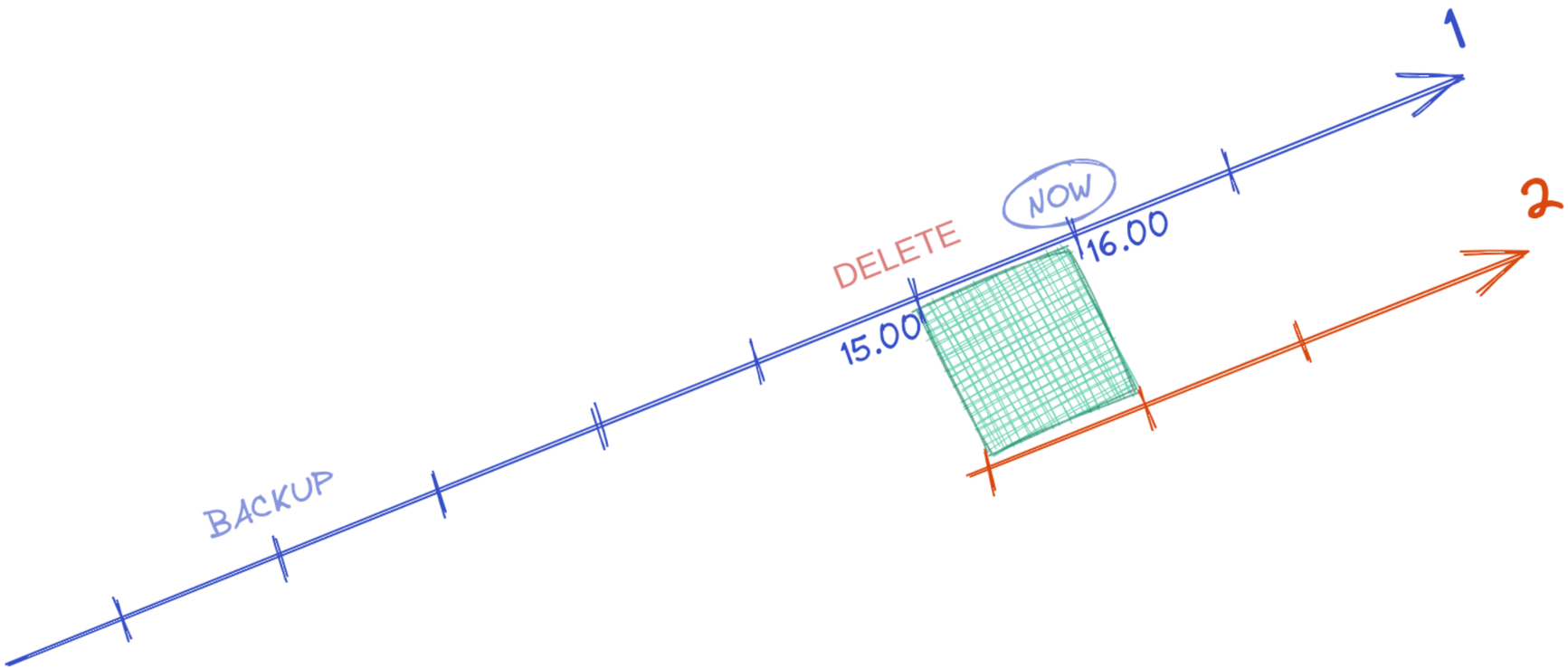
Backup set

- `--set`
  - default: latest
  - auto-select for **time** and **lsn** target

Timeline

- `--target-timeline`
  - `recovery_target_timeline`
  - default: `latest` (v12+) or `current` (< v12)

Timeline (2)



Selective restore

- `--db-include`
  - databases not specifically included will be restored as sparse, zeroed files
  - built-in databases (template0, template1, and postgres) are always restored unless specifically excluded
- `--db-exclude`
  - databases excluded will be restored as sparse, zeroed files
  - with the `--db-include` option, only apply to built-in databases

Summary

- tweak your archiving system (async, compression type,…)
- monitor your backups and archives
- regularly try to restore your backups

Schrödinger's Law of Backups

> *The condition/state of any backup is unknown until a restore is attempted.*

Questions?

Thank you for your attention!