Demystifying Postgres Logical Replicat

An introduction to the upcoming feature

Emanuel Calvo

Sr. Technical Services Engineer - Remote DBA

Webinar

June 15th

PERCONA

Who's me?

- Known as 3manuek. More info at 3manuek.com
- Currently working as a Remote DBA at Percona.
- Past positions: PalominoDB, 2ndQuadrant, iMedicare, 8kData, Pythian, Globant.

The path of the replication in Postgres

- Streaming replication incorporated in 9.0.
- Cascading streaming replication introduced in 9.2.
- Switch timeline added in 9.3.
- Logical Decoding added in 9.4.
- More support to LD added in 9.6.
- Postgres 10 Logical replication natively supported.

Streaming and logical replication

- Streaming replication is a byte-by-byte replication, the whole instance (all databases) are replicated.
- Logical replication is supported through pglogical for +9.4
- Natively supported in the next Postgres release (10).

Replication flow for MySQL DBAs

- MySQL
  - Engine log + Binlog -> byte encoded -> binlog stream -> binlog apply
  - Cross-engine Events are append to the binlog (unless skipped sql_log_bin)
  - Slaves filter using do%
  - Row_format: Replicates the change or the complete statement
- Postgres
  - WAL -> Logical Decoding/output_plugin -> logical log -> sender -> receiver & apply
  - Filtering is done at publisher
  - Closer to row based replication

Feature capabilities

- LR replicates data objects based upon their replication identity (generally a primary key).
- Destination server is writable. Different indexes and security definition.
- Cross-version support
- Event-based filtering
- Less write amplification than streaming replication
- Publications can have several subscriptions

What can be achieved with LR?

- Storage flexibility through replicating smaller sets (even partitioned tables)
- Flexible topology
- Minimum server load compared with trigger based solutions
- Allows parallel streaming across publishers
- Migrations and upgrades
- Multi source replication for consolidation
- Data distribution
- Flexible replication chains
- Data transformation

Limitations

- Can’t stream over to the same host (subscription will get locked).
- Tables must have the same full qualified name between publication and subscription.
- Subscriptions can have more columns or different order *but* the types and column names must match between P/S.
- Database superuser is needed for P/S creation.

Elements

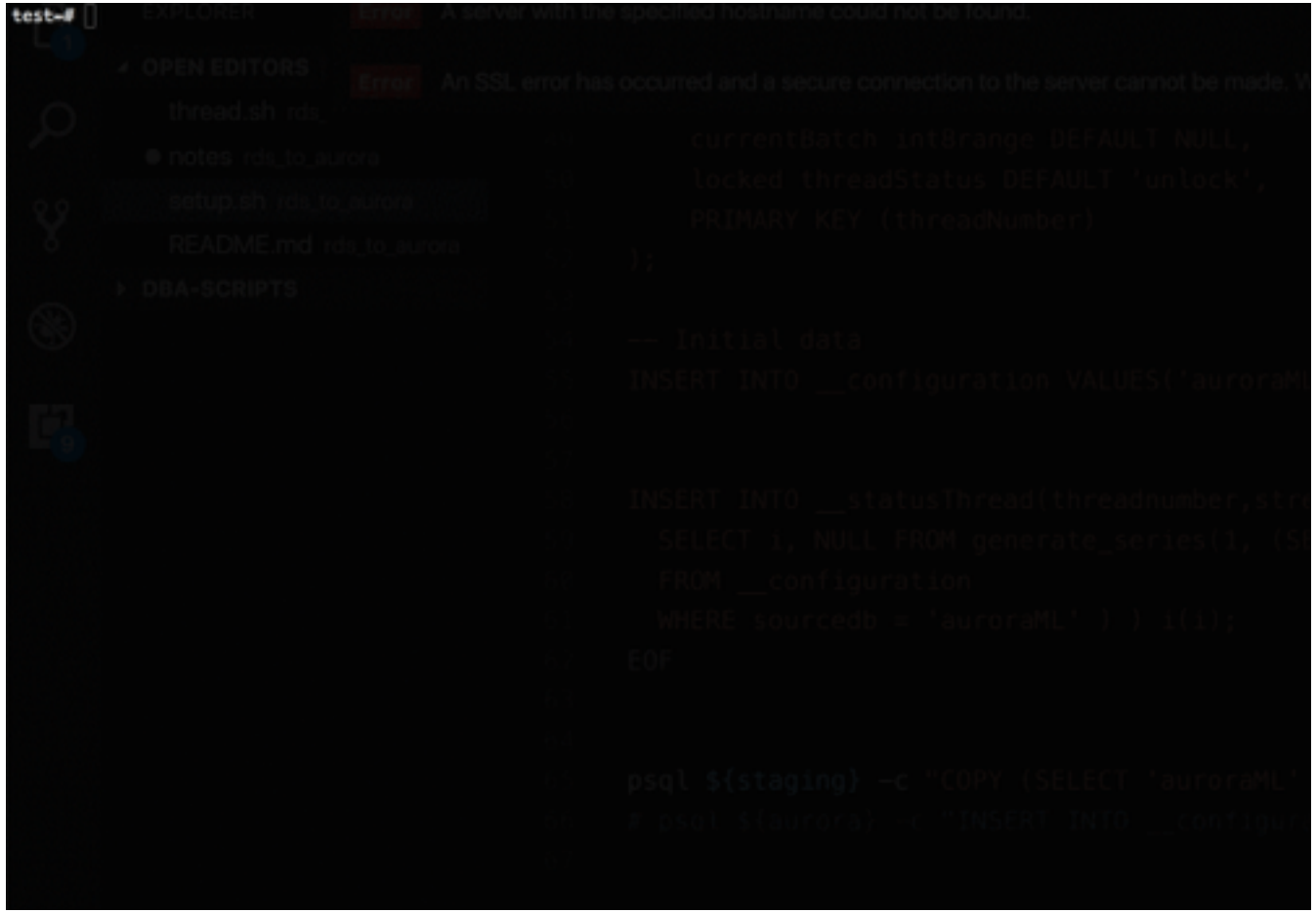
- Logical Decoding
  - Replication Slots
  - Output plugin
- Exported Snapshot
- Publication
- Subscription

[Logical] Replication slots

- Keep track of the replication.
- Each replica stream has one in the origin for tracking consuming changes.
- Locations are explicitly in LSN (log sequence number).
- catalog_xmin is the transaction number
- Slots are placed in the origin.

```
slot_name |  plugin  | slot_type | datoid | database | temporary | active | active_pid | xmin | catalog_xmin | restart_lsn | confirmed_flush_lsn
----------+----------+-----------+--------+----------+-----------+--------+------------+------+--------------+-------------+---------------------
s_data3   | pgoutput | logical   |  16384 | percona  | f         | t      |       5089 |      |          568 | 0/15FFD78   | 0/15FFE90
s_data    | pgoutput | logical   |  16384 | percona  | f         | t      |       1948 |      |          568 | 0/15FFE58   | 0/15FFE90
```

Example of [I] replication slots



PERCONA

Output Plugin

- Converts WAL records entries into custom output
- Internal plugin name is `pgoutput`.
- For testing Logical Decoding capabilities, `test_decoding`.

Exported snapshot

- Sharing visibility between transactions by exporting the current snapshot of the transaction.
- This is used for the initial COPY.
- Can be used to query outside a transaction but sharing its visibility.

Publication

- Publications can have more than one subscriber.
- Tables added to the publication must be declared with REPLICA IDENTITY. Otherwise subsequent operations will fail.

publication_parameter

publish (string)

'insert, update, delete' is the default (all events).

Subscription

- Subscriptions receive changes through replication slots.
- More than one replication slot may needed for the initial data copy.
- The session_replication_role is set to `replica` in order to avoid triggers on tables to be executed on replica.
- **DDL of replicated tables must previously exist.**
- If creating a replication slot, it will use the name of the subscriber, so beware as slots are in the origin (you will need to specify different subscription names across subscribers).
- You can have many subscriber to one publication.

Subscription —cont

- You can synchronize tables by using REFRESH option.

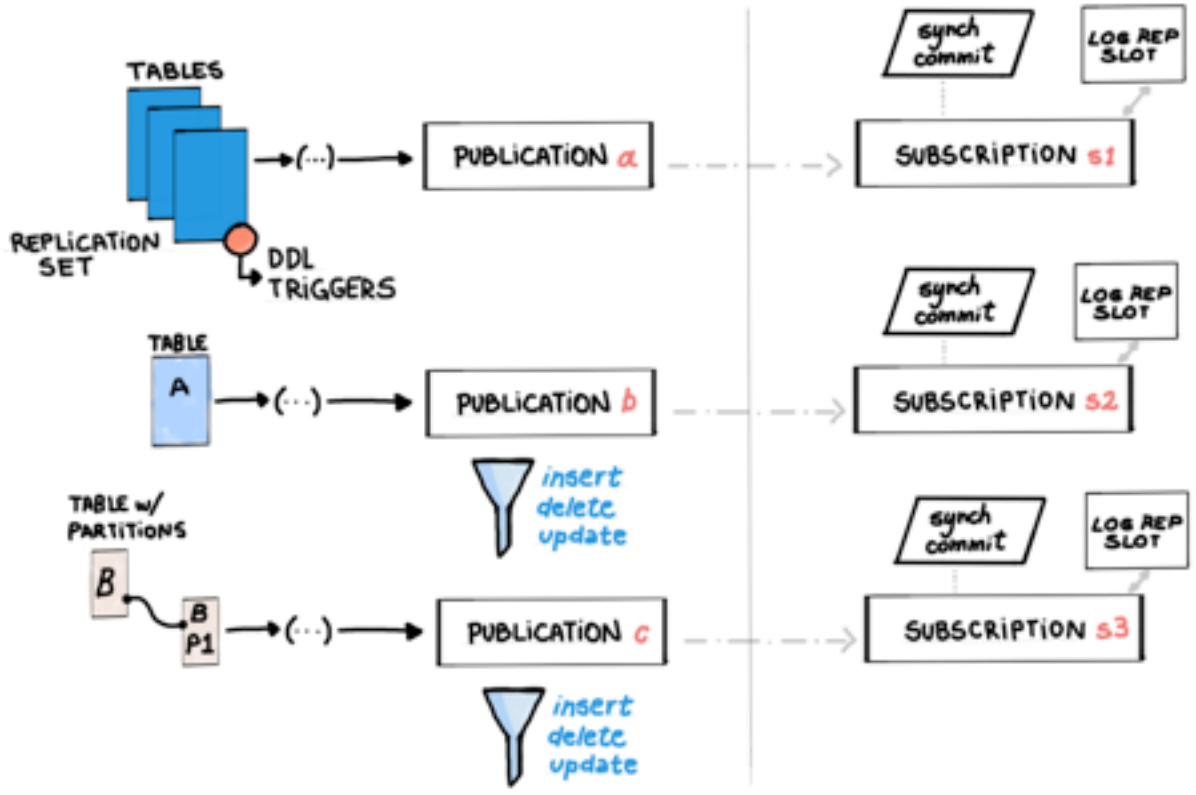
```
ALTER SUBSCRIPTION name SET PUBLICATION publication_name [, ...] { REFRESH [ WITH
( refresh_option value [, ... ] ) ] | SKIP REFRESH }
ALTER SUBSCRIPTION name REFRESH PUBLICATION [ WITH ( refresh_option value [, ... ] ) ]
```

```
refresh_option
  copy_data (boolean)
```

subscription_parameter

copy_data
create_slot
enabled
slot_name
synchronous_commit
connect (afecta copy_data, create_slot y enabled)

Examples



PERCONA

Basic definition

```
CREATE PUBLICATION P_main_P0 FOR TABLE main_shard0 WITH
(publish = 'insert, update');  -- no delete

CREATE SUBSCRIPTION S_main_P0
  CONNECTION 'port=7777 user=postgres dbname=master'
  PUBLICATION P_main_P0 WITH (create_slot =true, copy_data
=true);
```

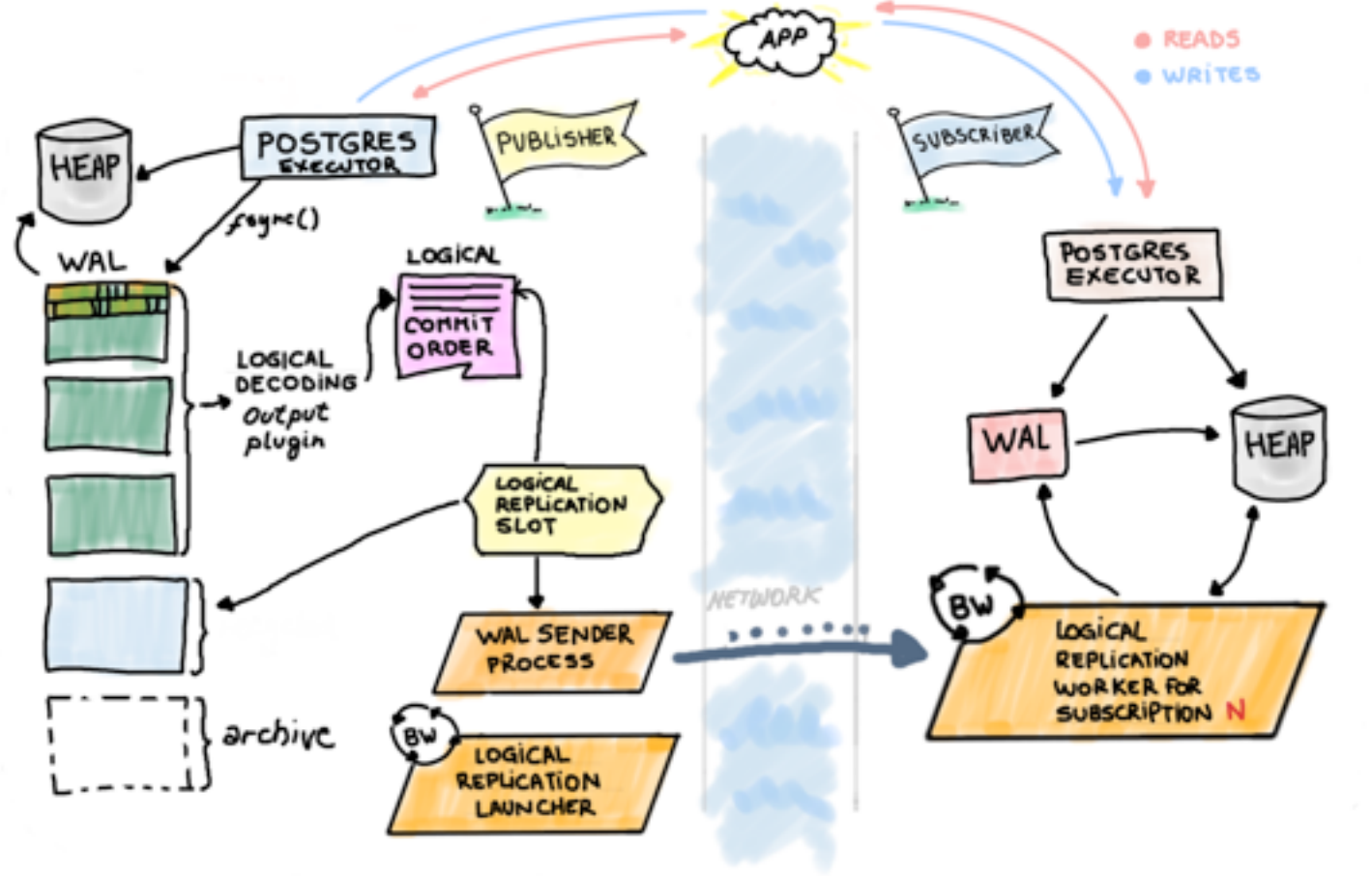
NOTE: Slot name will be the subscription name in the publisher

Adding publication sources and updating subscriptions

```
CREATE PUBLICATION P_queue_test FOR TABLE queue WITH (publish =
'insert, update,delete');
CREATE PUBLICATION P_queue2_test FOR TABLE queue2 WITH (publish =
'insert, update,delete');
CREATE SUBSCRIPTION S_queue_test
  CONNECTION 'port=8888 user=postgres dbname=percona'
  PUBLICATION P_queue_test WITH (create_slot =true, copy_data =true);

ALTER SUBSCRIPTION S_queue_test SET PUBLICATION P_queue_test,
P_queue2_test REFRESH WITH (copy_data = true);
ALTER SUBSCRIPTION S_queue_test REFRESH PUBLICATION WITH (copy_data =
true);
```

Flow



PERCONA

Conflicts

- Any violation in constraints stops replication.
- UPDATE and DELETE operations on missing data will be skipped.
- Transaction can be omitted using `pg_replication_origin_advance(subscriber_name , position)`. aka `sql_skip_counter`.
- Current position can be seen at `pg_replication_origin_status` at subscriber.

Replica Identity

- Which identity is used for conflict resolution:

```
    REPLICA IDENTITY { DEFAULT | USING INDEX index_name |
FULL | NOTHING }
```

Monitoring

- Publisher:

```
select * from pg_replication_slots;
```

- Subscribers:

```
percona=# select pg_replication_origin_progress(r.r, true) FROM (select roname from
pg_replication_origin where roident = 1) r(r);
 pg_replication_origin_progress  | 0/17024E0

postgres=# select * from pg_replication_origin;
 roident |  roname
---------+----------
       1 | pg_16394

percona=# select * from pg_replication_origin_status ;
 local_id | external_id | remote_lsn | local_lsn
----------+-------------+------------+-----------
        1 | pg_16503    | 0/17024E0  | 0/16DEE30
```

Monitoring — cont.

- Subscribers:

```
select * from pg_stat_subscription where subname = 's_queue';" percona
-[ RECORD 1 ]---------+-----------------------------
subid                 | 16418
subname               | s_queue
pid                   | 5293
relid                 |
received_lsn          | 0/1678E98
last_msg_send_time    | 2017-04-25 19:25:15.858439+00
last_msg_receipt_time | 2017-04-25 19:25:15.858475+00
latest_end_lsn        | 0/1678E98
latest_end_time       | 2017-04-25 19:25:15.858439+00
```

Minimum configuration

```
wal_level = logical #minimal, replica, or logical
Max_wal_senders = 10
Wal_keep_segments # don't use it if slots
Max_replication_slots =10
max_worker_processes = 8

#Subscribers
max_logical_replication_workers = 4   # taken from
max_worker_processes
max_sync_workers_per_subscription = 2 # taken from
max_logical_replication_workers
```

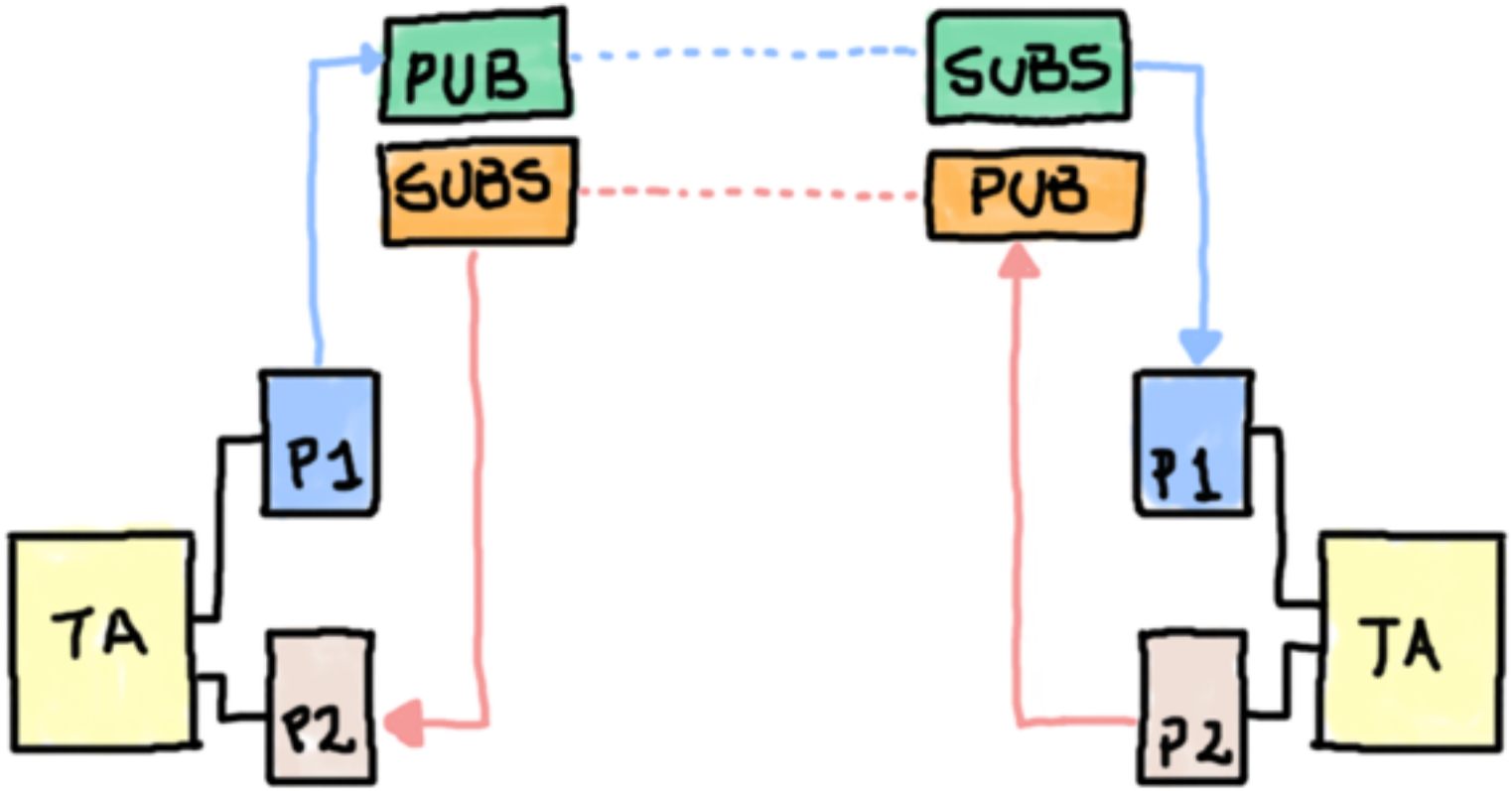
Related functions (decoding)

- pg_create_logical_replication_slot
- pg_drop_replication_slot

Consuming (get) /Seeing(peek) changes (will fail with pgoutput, but this works with other logical decoding plugins):

- pg_logical_slot_*peek*_changes
- pg_logical_slot_*get*_changes
- pg_logical_slot_*get*_binary_changes
- pg_logical_slot_*peek*_binary_changes

Partitions and Logical Replication



pglogical

- Extension, providing similar capabilities as the future native implementation
- Additional flexibility, by allowing row filtering
- Manageable through functions
- It allows define Replication Sets
- Supports Synchronous commit
- Logical Decoding over WAL
- Stream is in commit order
- For versions over 9.4
- On subscriber it executes triggers as ENABLE REPLICA (basic transformation).

BDR

- Bi-directional replication.
- Currently is a fork, intended to be an extension on 9.6
- Allows master-master replication up to 48 nodes (or more).
- Conflict detection
- Selective replication

RDS test_decoding support

- A basic and premature implementation is on RDS by using test_decoding
- Not much documented in RDS documentation, but functional.

Reference links

- Upcoming postgres 10 features by Robert Hass
- Logical Replication and Partitioning features by me
- First insights by Robert Hass
- RDS test_decoding support

Showcase

How playing with LR looks like.

Cases

- Showcase LR conflict
- Showcase publication with many subscribers
- Bug?

Percona Live Europe Call for Papers is Open!

September 25-27th, 2017

Radisson Blu Royal Hotel, Dublin, Ireland

Focusing on Time Series Databases

- MySQL, MongoDB, Open Source Databases
- Business/Case Studies, Developers, Operations
- Learn from and Engage with Experts

Submit Your Proposal by July 17th!

www.percona.com/live/e17

Database Performance Matters