High Availability and Automatic Failover in PostgreSQL using Open Source Solutions

PostgreSQL High Availability

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What is High Availability for database servers ?

- **High Availability in our routine database life.**
  - An always-on mechanism
  - Avoid data loss during disasters
  - Higher uptime for business
  - An immediate action upon a detection of failure (but not minutes or days)
  - Avoiding a single point of failure
  - Decrease or minimize the Unscheduled downtime
  - Seamless database fail-overs for Application and Business
  - Ability to perform both manual and automatic failover
  - Faster Point-in-time-recovery (PITR)

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PostgreSQL Replication

- **Streaming Replication in PostgreSQL**
  - WAL Segments are streamed to Standby/Slave and replayed on Slave.
  - Not a Statement/Row/Mixed Replication like MySQL.
  - This can be referred to as a byte-by-byte or Storage Level Replication
  - Slaves are always Open for Read-Only SQLs but not Writes
  - You cannot have different Schema or data in a Master and a Slave in Streaming Replication.
  - Allows Cascading Replication
  - Supports both Synchronous and Asynchronous Replication
  - Supports a Delayed Standby for faster PITR

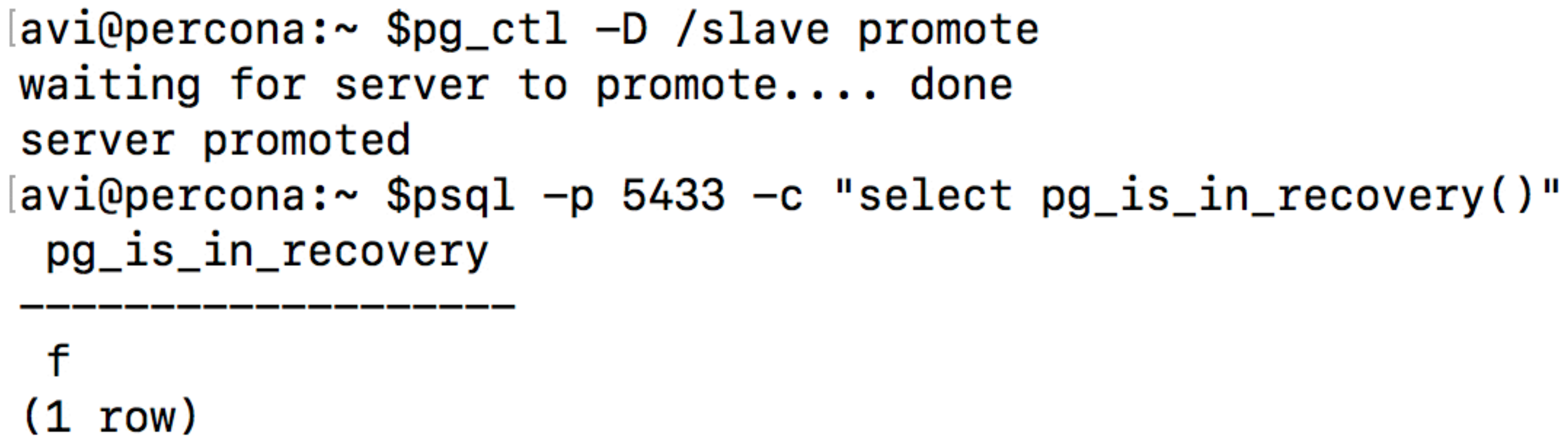
PostgreSQL Replication

- **Logical Replication and Logical Decoding for PostgreSQL 10 and above**
  - Allows for Replication of selected Tables using Publisher and Subscriber Model.
  - Similar to binlog_do_db in MySQL, but no DDL Changes are replicated.
  - Subscribers are also open for Writes automatically
  - Used in Data Warehouse environments that stores Data fetched from multiple OLTP Databases for Reporting, etc.
  - A friendly solution for Database Upgrades

PostgreSQL features and extensions for HA and Automatic failover

- Minimize data loss using **Synchronous Replication** in PostgreSQL.
- May reduce data loss on failover during huge replication lag using the **Archiving** feature in PostgreSQL.
- Faster and easy failover using **promote** or **trigger_file.**
- Faster catch-up of old Master using the extension **pg_rewind**.
- Re-direct READS and REPORTING jobs to a Slave using **hot_standby**.
- Allow long running reporting jobs on Slave to succeed upon changes on Master, using **hot_standby_feedback**, **max_standby_streaming_delay** and **max_standby_archive_delay.**
- Achieve flashback like Oracle features using **recovery_min_apply_delay** on Slave.

Manual Failover using promote



```
[avi@percona:~ $pg_ctl -D /slave promote
waiting for server to promote.... done
server promoted
[avi@percona:~ $psql -p 5433 -c "select pg_is_in_recovery()"
 pg_is_in_recovery
-------------------
 f
(1 row)
```

Manual Failover using trigger_file

- **Using trigger_file**

```
avi@percona:~ $grep "trigger_file" /slave/recovery.conf
trigger_file = '/tmp/failover'
avi@percona:~ $
avi@percona:~ $touch /tmp/failover
avi@percona:~ $psql -p 5433 -c "select pg_is_in_recovery()"
 pg_is_in_recovery
-------------------
 f
(1 row)
```

```
2018-10-31 15:55:42.313 EDT [7926] LOG:  started streaming WAL from primary at 0/E000000 on timeline 1
2018-10-31 15:57:32.498 EDT [7922] LOG:  trigger file found: /tmp/failover
2018-10-31 15:57:32.498 EDT [7926] FATAL:  terminating walreceiver process due to administrator command
2018-10-31 15:57:32.500 EDT [7922] LOG:  invalid record length at 0/E001FA8: wanted 24, got 0
2018-10-31 15:57:32.500 EDT [7922] LOG:  redo done at 0/E001F70
2018-10-31 15:57:32.508 EDT [7922] LOG:  selected new timeline ID: 2
2018-10-31 15:57:32.558 EDT [7922] LOG:  archive recovery complete
2018-10-31 15:57:32.565 EDT [7920] LOG:  database system is ready to accept connections
```

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Open Source Solutions for Automatic Failover in PostgreSQL

- **List of few Open Source projects for HA and Automatic Failover**
  - Patroni
  - Stolon
  - repmgr
  - PostgreSQL Automatic Failover (PAF)
  - pglookout
  - pgPool-II

Lets discuss a few of the most widely discussed tools

Patroni

- **Patroni**
  - Fork of Governor
  - PostgreSQL cluster management template/framework
  - Talks to a distributed consensus key-value store to decide the state of the Cluster
  - Distributed consensus can be obtained using etcd, ZooKeeper, Consul, etc for electing a leader.
  - Continuous monitoring and automatic failover
  - Built-in automation for bringing back a failed node to cluster.
  - REST APIs for cluster configuration and further tooling.
  - Provides infrastructure for transparent application failover
  - Distributed consensus for every action and configuration
  - Integration with Linux watchdog for avoiding split-brain syndrome.
  - Supports both manual and automatic failover

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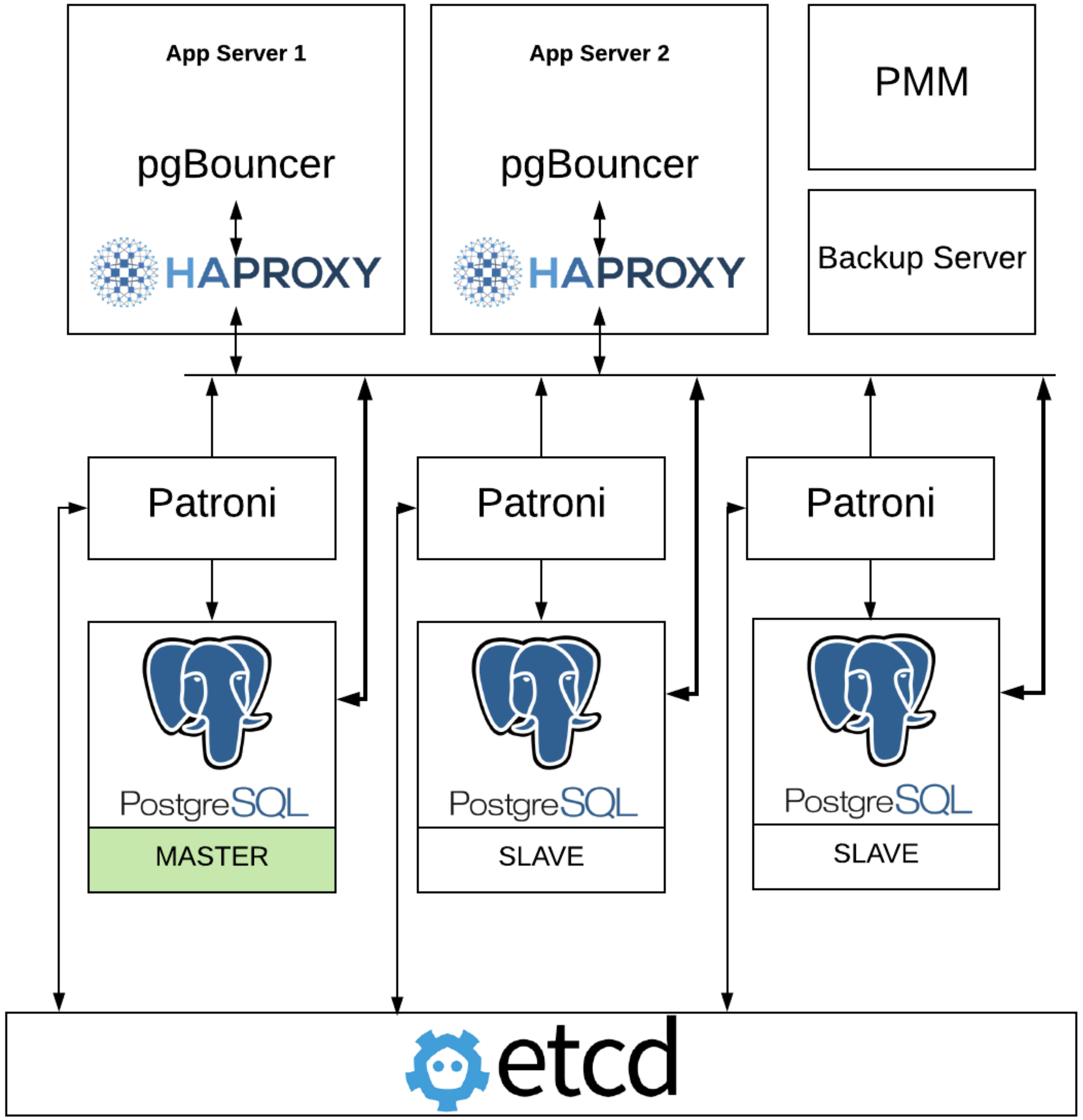
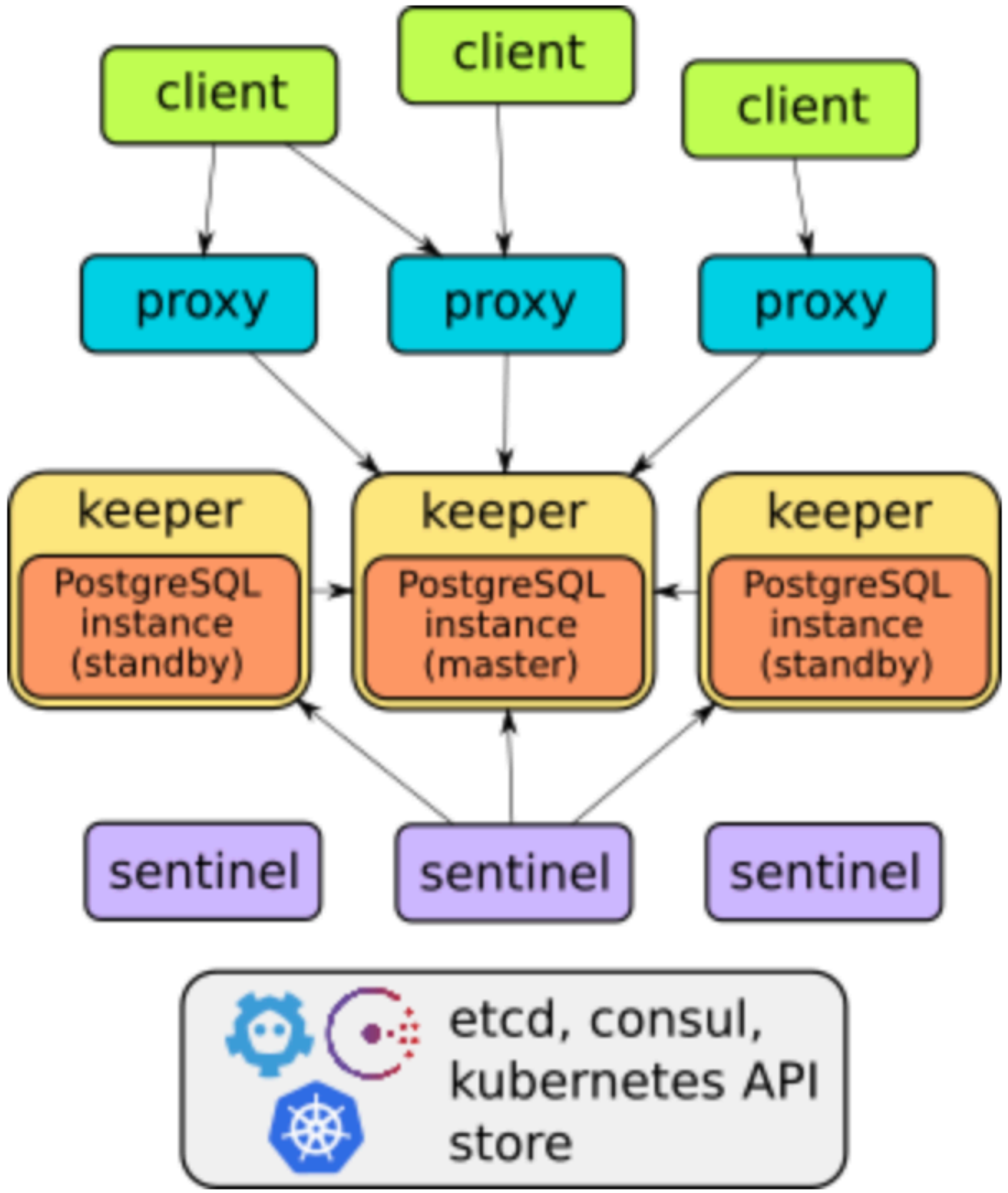

App Server 1
pgBouncer
HAPROXY
App Server 2
pgBouncer
HAPROXY
PMM
Backup Server
Patroni
Patroni
Patroni
PostgreSQL
MASTER
PostgreSQL
SLAVE
PostgreSQL
SLAVE
etcd

REPMGR

- **REPMGR**
  - Uses repmgrd installed in each node for management and monitoring
  - Supports both manual and automatic failover
  - Supports configuring a Witness server to avoid split brain scenario.
  - Provides a view : **replication_status** for monitoring and history of replication lag and node status.
  - Supports over 18 user-friendly commands to perform actions such as :
    - Cloning a Master/Primary
    - Switchover to promote a standby and demote the master
    - Rejoining a node to cluster
    - Promote to promote a standby
    - check node status
    - primary/standby register and unregister
  - Supports executing custom scripts upon automatic failover using **promote_command** and **follow_command**.

Stolon

- **Stolon**
  - Cloud-native HA solution that supports PostgreSQL cluster inside Kubernetes, IaaS and VMs.
  - Uses etcd, consul or Kubernetes API server for distributed consensus.
  - Composed of 3 components :
    - **keeper** : Maintains a cluster view as provided by sentinel(s).
    - **sentinel** : Monitors keepers and builds the cluster view
    - **proxy** : Re-directs connects to Master always for a seamless Application failover.
  - Built on top of PostgreSQL Streaming replication - Synchronous and Asynchronous
  - Supports command line client - **stolonctl** and **kubectl** to perform actions such as :
    - Initialize a cluster
    - Promoting a standby
    - check status


client
client
client
proxy
proxy
proxy
keeper
PostgreSQL instance (standby)
keeper
PostgreSQL instance (master)
keeper
PostgreSQL instance (standby)
sentinel
sentinel
sentinel
etcd, consul, kubernetes API store

pgPool-II

- **pgPool-II**
  - Supports Connection Pooling
  - Manages Replication
  - Load Balancing of Reads and Writes
  - Parses SQLs to determine if it is a read or write
  - Ability to configure weights to balance reads between master and slave
  - Supports Automatic Failover
  - Connections exceeding the max_connections are queued on pgPool-II without rejecting them.
  - Must use Active-Passive pgPool setup for high availability

Points to Remember

- Make sure to test the tool you use for automatic failover.
- Ensure to have a good backup strategy that helps you manage panic situations.
- Be prepared for a data loss and build the ability to manage it from the application.
- The architecture of your HA solution depends on your environment.
- Build the ability to distinguish reads and writes in the application layer for better scalability.
- Perform routine disaster recovery drills through a manual failover to ensure that the setup is reliable.
- Ensure to monitor for patches and perform updates of your PostgreSQL and the HA solution.

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Questions ??