Protecting your data with Patroni and pgBackRest

PGDay Russia 2021

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Somewhere in the time vortex

Few words about the speaker

KAMEDATA
DEVOPS AND DATA ENGINEERING

- Born in 1972
- Passionate about IT since 1982
- Joined the Oracle DBA secret society in 2004
- In love with PostgreSQL since 2006
- PostgreSQL tattoo on the right shoulder
- Freelance devops and data engineer

Getting in touch

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- **Blog:** https://pgdba.org
- **Twitter:** @4thdoctor_scarf
- **Github:** https://github.com/the4thdoctor
- **Linkedin:** https://www.linkedin.com/in/federicocampoli/
- **Youtube:** https://www.youtube.com/c/FedericoCampoli

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Greetings, programs!

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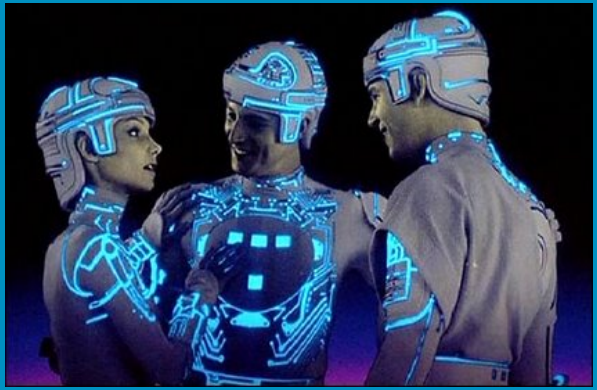

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Image source
https://liveforfilms.wordpress.com/2009/07/09/greetings-program-tron-2-synopsis/

PostgreSQL

https://www.postgresql.org/

- Enteprise class RDBMS
- ACID compliant
- HA and DR
- With one tiny little catch...
- No built in mechanism for automating backups or failover

Some PostgreSQL auto failover options

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- ~~B.Y.O.T, shell script, manually operated, Cthulhu summoning...~~
- Automated with third party tools
  - repmgr
  - pg_auto_failover
  - PostgreSQL Automatic Failover (PAF)
  - Patroni

Patroni

https://github.com/zalando/patroni
Patroni is an auto failover system developed in python by Zalando.
The tool relies on a distributed consensus store (DCS) to maintain the cluster status.
Patroni is available in the pgdg official repository

Patroni

- Developed in Python
- Supports for DCS etcd,consul,zookeper
- Support for python RAFT (requires pysyncobj module)
- Automated boostrap and replica setup
- Automated failover/switchover
- Centralised configuration for PostgreSQL stored in DCS
- Very resilient to split brain
- HAProxy or pgbouncer for connection routed via api check

Caveats

- Everything is managed by Patroni
- Some parts of the documentation is unclear (yes, standby_cluster I'm talking of you)
- Client only in interactive mode, you need to build your api call (e.g. via ansible uri module)

Some PostgreSQL backup options

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- ~~logical with pg_dump~~
- physical with tools like
  - pg_basebackup
  - barman
  - WAL-E/WAL-G
  - pgBackRest

pgBackRest

https://pgbackrest.org/
pgBackRest is a simple and reliable solution for automatic the backups.
pgBackRest is a community driven project.

pgBackRest

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- Physical backup tool
- Implements HA/DR
- Differential,incremental and full backup
- Parallel jobs configurable
- Can backup from the standby servers
- Async WAL push and pull
- Developed initially in perl now fully migrated to C
- ini style configuration
- Available in deb/yum pgdg repositories
- Cloud backup options GCP/S3/Azure
- Multiple repositories configurable
- Self contained backup repository

Caveats

- Configuring remote backups via SSH may be complex
- Beware of when configuring archive-push-queue-max.
  There is the risk of wal files not being archived if the limit is reached.

The rule of thumb

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RTFM

Advanced pgBackRest

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For advanced topics on pgBackRest please check Stefan Fercot's Talk
Unleash the Power within pgBackRest
https://pgday.ru/en/2021/papers/297

The grid

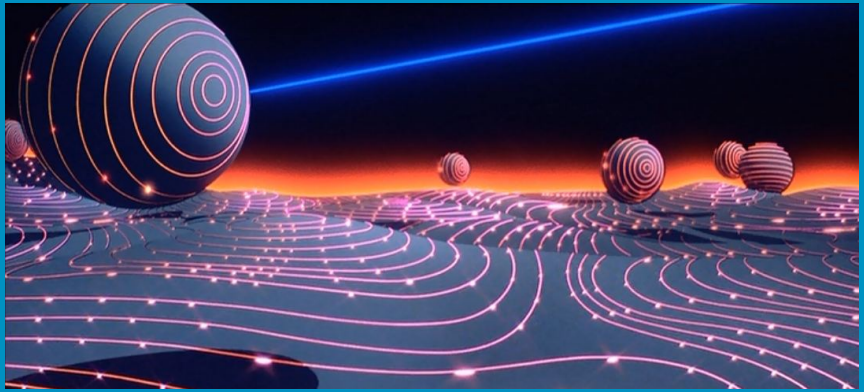

Image source

https://siftingthroughpatterns.wordpress.com/2012/05/12/why-kevin-flynn-is-the-true-villain-behind-tron-legacy/

Patroni super biased configuration

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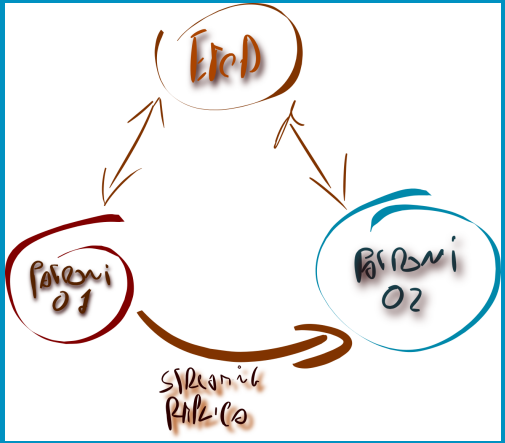

Setup

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For our example we'll use CentOS 7 and a GCP bucket

- etcd01
- patroni01
- patroni02

Configure and install the software

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- (Optional) Setup /etc/hosts with the names
- Open the required ports on firewalld
- Install etcd on the etcd server
- Configure and start etcd
- Install PostgreSQL 13 and patroni on the two patroni nodes
- Configure patroni
- Start patroni
- profit

Hosts (optional)

If there is no DNS service in place is a good idea to have the /etc/hosts file set for resolving the names

```
127.0.0.1       localhost localhost.localdomain localhost4 localhost4.localdomain4
::1         localhost localhost.localdomain localhost6 localhost6.localdomain6

192.168.56.40   patroni01
192.168.56.41   patroni02
192.168.56.43   etcd01

# The following lines are desirable for IPv6 capable hosts
::1     localhost ip6-localhost ip6-loopback
ff02::1 ip6-allnodes
ff02::2 ip6-allrouters
```

Firewalld

etcd01

```
sudo firewall-cmd --permanent --zone=public --add-port=2380/tcp
sudo firewall-cmd --permanent --zone=public --add-port=2379/tcp

sudo systemctl reload firewalld
```

patroni01, patroni02

```
sudo firewall-cmd --permanent --zone=public --add-port=5432/tcp
sudo firewall-cmd --permanent --zone=public --add-port=8008/tcp

sudo systemctl reload firewalld
```

etcd01 setup

Install etcd

```
sudo yum install etcd
```

etcd01 setup

Then configure the environment file
/etc/etcd/etcd.conf

```
ETCD_LISTEN_PEER_URLS="http://192.168.56.43:2380"
ETCD_LISTEN_CLIENT_URLS="http://192.168.56.43:2379"
ETCD_NAME="etcd01"
ETCD_INITIAL_ADVERTISE_PEER_URLS="http://192.168.56.43:2380"
ETCD_ADVERTISE_CLIENT_URLS="http://192.168.56.43:2379"
ETCD_INITIAL_CLUSTER="etcd01=http://192.168.56.43:2380"
ETCD_INITIAL_CLUSTER_STATE=new
```

etcd01 setup

Start the service and check the cluster is healty

```
sudo systemctl start etcd

etcdctl --endpoints "http://192.168.56.43:2379" cluster-health
member 6bf749bb3ab16843 is healthy: got healthy result from http
    ://192.168.56.43:2379
cluster is healthy
```

postgresql install

Install the PostgreSQL yum repository and PostgreSQL 13

```
sudo yum install -y \
https://download.postgresql.org/pub/repos/yum/reporpms/EL-7-x86_64/pgdg-redhat-repo-
    latest.noarch.rpm
sudo yum install -y postgresql13 postgresql13-contrib postgresql13-server
```

patroni install

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Install the epel-release first then patroni and patroni-etcd

```
sudo yum install -y epel-release
sudo yum install -y patroni patroni-etcd
```

Configure patroni dcs section I

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On both patroni machines create the directory /etc/patroni
Then add a new configuration file into the directory named patroni.yml

```
scope: test
namespace: /patroni_test/
name: patroni01 #this values should be unique within the namespace and scope
log:
  dir: /var/log/patroni
restapi:
  listen: 192.168.56.40:8008
  connect_address: 192.168.56.40:8008
etcd:
  hosts: 192.168.56.43:2379
bootstrap:
  dcs:
    ttl: 10
    loop_wait: 10
    retry_timeout: 10
    maximum_lag_on_failover: 1048576
  postgresql:
```

Configure patroni dcs section II


```
    use_pg_rewind: true
    use_slots: false
    parameters:
      wal_level: 'replica'
      archive_mode: 'off'
      unix_socket_directories: '/var/run/postgresql/.'
method: initdb
initdb:  # Note: It needs to be a list (some options need values, others are
    switches)
- encoding: UTF8
- data-checksums
pg_hba:  # Add following lines to pg_hba.conf after running 'initdb'
- host replication replicator 0.0.0.0/0 md5
- host all all 0.0.0.0/0 md5
users:
```

Configure patroni postgresql section I

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```
postgresql:
  listen: "*:5432"
  connect_address: patroni01:5432 #this is the local machine name, should be set
      accordingly
  data_dir: /var/lib/pgsql/data/postgresql0
  bin_dir: /usr/pgsql-13/bin/
  pgpass: /tmp/pgpass0
  authentication:
    replication:
      username: replicator
      password: postgres_replica
    superuser:
      username: postgres
      password: postgres_super
    rewind:  # Has no effect on postgres 10 and lower
      username: rewind_user
      password: postgres_rewind
  parameters:
    wal_level: 'replica'
    archive_mode: 'off'
```

Configure patroni postgresql section II

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```
    unix_socket_directories: '/var/run/postgresql/.'
tags:
    nofailover: false
    noloadbalance: false
    clonefrom: false
    nosync: false
```

Create the systemd service file I

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In /etc/systemd/system create the file patroni.service

```
[Unit]
Description=Runners to orchestrate a high-availability PostgreSQL
After=syslog.target network.target

[Service]
Type=simple

User=postgres
Group=postgres

# Read in configuration file if it exists, otherwise proceed
EnvironmentFile=-/etc/patroni_env.conf

WorkingDirectory=/var/lib/pgsql

# Start the patroni process
ExecStart=/bin/patroni /etc/patroni/patroni.yml
```

Create the systemd service file II

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```
# Send HUP to reload from patroni.yml
ExecReload=/bin/kill -s HUP $MAINPID

# only kill the patroni process, not it's children, so it will gracefully stop postgres
KillMode=process

# Give a reasonable amount of time for the server to start up/shut down
TimeoutSec=30

# Do not restart the service if it crashes, we want to manually inspect database on failure
Restart=no

[Install]
WantedBy=multi-user.target
```

Enable and start the patroni service

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On both patroni machines

```
sudo systemctl daemon-reload
sudo systemctl enable patroni
sudo systemctl start patroni
```

Patroni bootstrap

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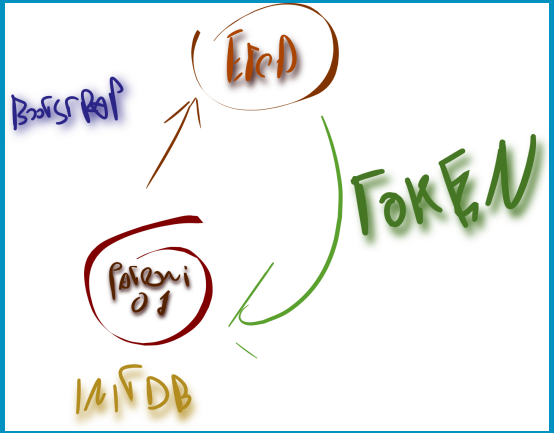
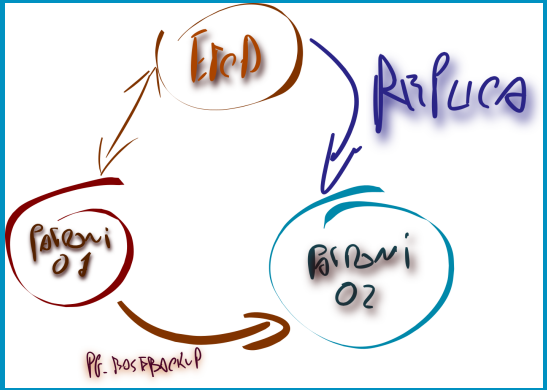



```
[root@patroni01 patroni]# patronictl -c /etc/patroni/patroni.yml list
+ Cluster: test (6981078877725420504) -----+----+-----------+
| Member     | Host       | Role    | State   | TL | Lag in MB |
+------------+------------+---------+---------+----+-----------+
| patroni01 | patroni01 | Leader | running |  1 |           |
+------------+------------+---------+---------+----+-----------+
```

Patroni cloning




```
[root@patroni01 patroni]# patronictl -c /etc/patroni/patroni.yml list
+ Cluster: test (6981078877725420504) ------+----+-----------+
| Member     | Host       | Role    | State   | TL | Lag in MB |
+------------+------------+---------+---------+----+-----------+
| patroni01 | patroni01 | Leader  | running |  1 |           |
| patroni02 | patroni02 | Replica | running |  1 |         0 |
+------------+------------+---------+---------+----+-----------+
```

The light cycle maze

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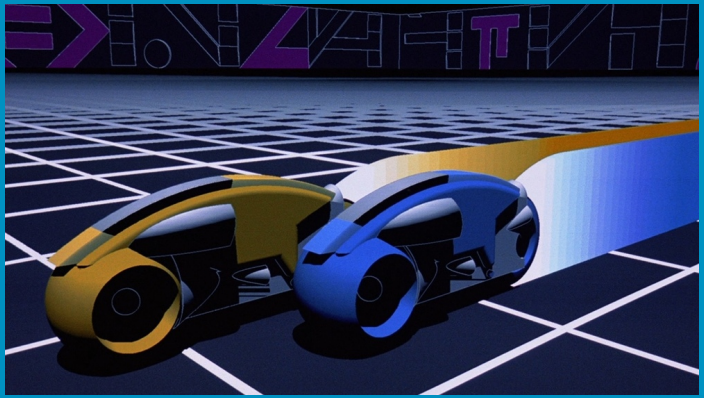

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Image source

https://geektyrant.com/news/the-history-of-the-tron-lightcycle-infographic

Patroni and pgBackRest

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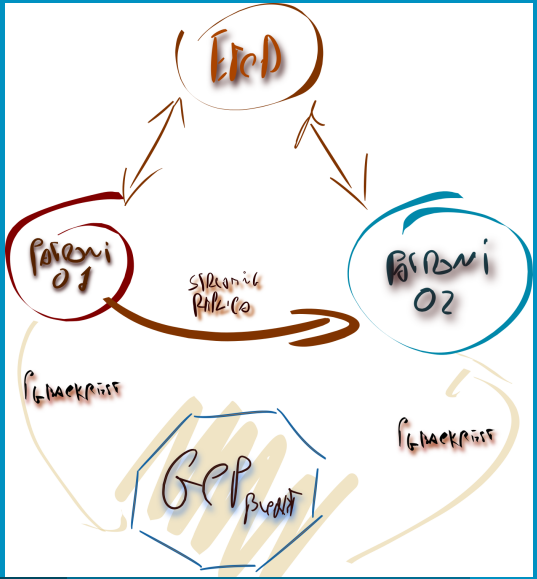

Configure and install the software

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- Install pgBackRest on both patroni servers
- Create the GCP bucket
- Create the shared key json file and grant access to the GCP bucket
- Configure pgBackRest for using the GCP bucket
- Configure patroni to use pgBackRest
- Run the pgBackRest first backup
- profit

Configure pgbackrest

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On both patroni machines edit the file /etc/pgbackrest.conf

```
[global]
repo1-type=gcs
repo1-path=/repo
repo1-gcs-bucket=patroni-pgbackrest
repo1-gcs-key=/etc/gcp_files/gcp-key.json
repo1-retention-full=1
log-level-console=info
log-level-file=debug
log-path=/var/log/patroni/

[test]
pg1-path=/var/lib/pgsql/data/postgresql0
pg1-port=5432
pg1-user=postgres
```

Optional, configure .pgpass

If the local login is made with password authentication it may be necessary to configure the .pgpass file in the PostgreSQL data directory.

```
patroni01:5432:*:postgres:postgres_super
```

Save the gcp-key.json

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Create the directory /etc/gcp_files and save into it the file gcp-key.json generated by the GCP console.
Directoy and file must be accessible by the user running pgbackrest.

```
{
  "type": "service_account",
  "project_id": "XXXXXXXXXXXX",
  "private_key_id": "XXXXXXXXXXXX",
  "private_key": "-----BEGIN PRIVATE KEY-----
XXXXXXXXXXXXXXXXXXX
-----END PRIVATE KEY-----
",
  "client_email": "XXXXXXXXXXXX",
  "client_id": "XXXXXXXXXXXX",
  "auth_uri": "https://accounts.google.com/o/oauth2/auth",
  "token_uri": "https://oauth2.googleapis.com/token",
  "auth_provider_x509_cert_url": "https://www.googleapis.com/oauth2/v1/certs",
  "client_x509_cert_url": "https://www.googleapis.com/robot/v1/metadata/x509/XXXXXXXXXXXXXX"
}
```

Configure patroni for using pgbackrest

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```
patronictl -c /etc/patroni/patroni.yml edit-config
##add the following lines
postgresql:
  parameters:
    archive_command: pgbackrest --stanza=test archive-push %p
    archive_mode: 'on'
```

After saving the command patronictl -c /etc/patroni/patroni.yml list will show the pending restart status

```
+ Cluster: test (6981352535078471124) ------+----+-----------+-----------------+
| Member    | Host      | Role    | State   | TL | Lag in MB | Pending restart |
+-----------+-----------+---------+---------+----+-----------+-----------------+
| patroni01 | patroni01 | Leader  | running |  1 |           | *               |
| patroni02 | patroni02 | Replica | running |  1 |         0 | *               |
+-----------+-----------+---------+---------+----+-----------+-----------------+
```

Restart patroni for applying the changes

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```
patronictl -c /etc/patroni/patroni.yml restart test
+ Cluster: test (6981352535078471124) ------+----+-----------+-----------------+
| Member    | Host      | Role    | State   | TL | Lag in MB | Pending restart |
+-----------+-----------+---------+---------+----+-----------+-----------------+
| patroni01 | patroni01 | Leader  | running |  1 |           | *               |
| patroni02 | patroni02 | Replica | running |  1 |         0 | *               |
+-----------+-----------+---------+---------+----+-----------+-----------------+
When should the restart take place (e.g. 2021-07-05T10:39)  [now]:
Are you sure you want to restart members patroni01, patroni02? [y/N]: y
Restart if the PostgreSQL version is less than provided (e.g. 9.5.2)  []:
Success: restart on member patroni01
Success: restart on member patroni02
```

Run the first backup

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Create the stanza and then run the backup

```
pgbackrest --stanza=test stanza-create
2021-07-05 09:41:31.677 P00   INFO: stanza-create command begin 2.34: --exec-id
    =7404-761f890e --log-level-console=info --log-level-file=info --log-path=/var/log
    /patroni --pg1-path=/var/lib/pgsql/data/postgresql0 --pg1-port=5432 --pg1-user=
    postgres --repo1-gcs-bucket=patroni-pgbackrest --repo1-gcs-key=<redacted> --repo1
    -path=/repo --repo1-type=gcs --stanza=test
2021-07-05 09:41:32.284 P00   INFO: stanza-create for stanza 'test' on repo1
2021-07-05 09:41:33.182 P00   INFO: stanza-create command end: completed
    successfully (1506ms)

pgbackrest --stanza=test backup
```

Check the backup status

Check the backup status

```
pgbackrest info
stanza: test
    status: ok
    cipher: none

    db (current)
        wal archive min/max (13): 000000010000000000000004/000000010000000000000004

        full backup: 20210705-145357F
            timestamp start/stop: 2021-07-05 14:53:57 / 2021-07-05 14:54:44
            wal start/stop: 000000010000000000000004 / 000000010000000000000004
            database size: 24.0MB, database backup size: 24.0MB
            repo1: backup set size: 2.9MB, backup size: 2.9MB
```

End of line

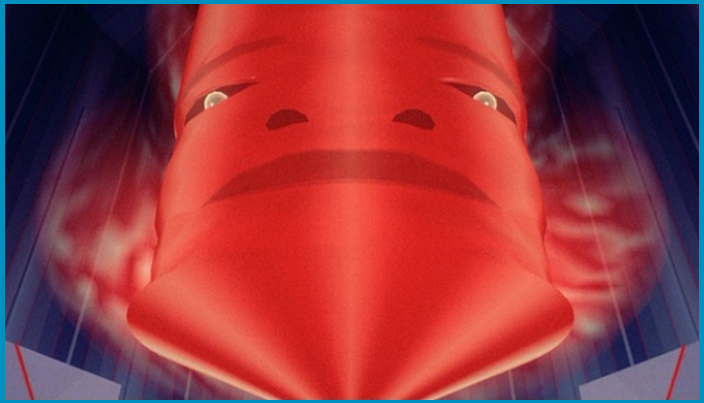

Image source

https://tron.fandom.com/wiki/Master_Control_Program

Recovering from a complete datacenter loss

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- Install and configure etcd
- Install and configure pgBackRest
- Install PostgreSQL and patroni
- Configure patroni to bootstrap and clone from pgBackRest
- Start patroni
- profit

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Check the pgbackrest can access the repository

```
pgbackrest info
stanza: test
    status: ok
    cipher: none

    db (current)
        wal archive min/max (13): 000000010000000000000004/000000010000000000000004

        full backup: 20210705-145357F
            timestamp start/stop: 2021-07-05 14:53:57 / 2021-07-05 14:54:44
            wal start/stop: 000000010000000000000004 / 000000010000000000000004
            database size: 24.0MB, database backup size: 24.0MB
            repo1: backup set size: 2.9MB, backup size: 2.9MB
```

Configure the custom bootstrap script for patroni

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Create the file /etc/patroni/boot_pgbackrest.sh

```
#!/usr/bin/env bash

while getopts ":-:" optchar; do
  [[ "${optchar}" == "-" ]] || continue
  case "${OPTARG}" in
    datadir=* )
        DATA_DIR=${OPTARG#*=}
        ;;
    scope=* )
        SCOPE=${OPTARG#*=}
        ;;
  esac
done

/usr/bin/pgbackrest --stanza=$SCOPE --link-all restore
```

Make the file executable

Configure the patroni boostrap section

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```
bootstrap:
  .....
  postgresql:
      use_pg_rewind: true
      use_slots: false
      parameters:
        wal_level: 'replica'
        archive_mode: 'on'
        archive_command: 'pgbackrest --stanza=test archive-push %p'
        unix_socket_directories: '/var/run/postgresql/.'
      recovery_conf:
        recovery_target_timeline: latest
        restore_command: /usr/bin/pgbackrest --stanza=test archive-get %f "%p"
  method: pgbackrest
  pgbackrest:
    command: /etc/patroni/boot_pgbackrest.sh
    keep_existing_recovery_conf: False
    recovery_conf:
      recovery_target_timeline: latest
      restore_command: /usr/bin/pgbackrest --stanza=test archive-get %f "%p"
```

Add pgbackrest for creating replicas

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```
postgresql:
  create_replica_methods:
    - pgbackrest
  pgbackrest:
    command: /usr/bin/pgbackrest --stanza=test restore --delta --link-all
    keep_data: True
    no_params: True
  parameters:
    wal_level: 'replica'
    archive_mode: 'on'
    archive_command: 'pgbackrest --stanza=test archive-push %p'
    unix_socket_directories: '/var/run/postgresql/.'
  recovery_conf:
    recovery_target_timeline: latest
    restore_command: /usr/bin/pgbackrest --stanza=test archive-get %f "%p"
  .....
```

Create the empty PGDATA on the patroni machines

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```
mkdir -p /var/lib/pgsql/data/postgresql0
chown postgres:postgres /var/lib/pgsql/data/postgresql0
chmod 0700 /var/lib/pgsql/data/postgresql0
```

Start patroni and wait for the bootstrap to complete

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```
sudo systemctl start patroni
patronictl -c /etc/patroni/patroni.yml list
+ Cluster: test (initializing) ---+-------------------------------+----+-----------+
| Member     | Host       | Role    | State                         | TL | Lag in MB |
+------------+------------+---------+-------------------------------+----+-----------+
| patroni01 | patroni01 | Replica | running custom bootstrap script |    |   unknown |
+------------+------------+---------+-------------------------------+----+-----------+

patronictl -c /etc/patroni/patroni.yml list
+ Cluster: test (6981439838068958622) -----+----+-----------+
| Member     | Host       | Role   | State   | TL | Lag in MB |
+------------+------------+--------+---------+----+-----------+
| patroni01 | patroni01 | Leader | running |  2 |           |
+------------+------------+--------+---------+----+-----------+
```

Start patroni on the second node

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```
sudo systemctl start patroni

patronictl -c /etc/patroni/patroni.yml list
+ Cluster: test (6981439838068958622) ----------------+----+-----------+
| Member     | Host       | Role    | State            | TL | Lag in MB |
+------------+------------+---------+------------------+----+-----------+
| patroni01 | patroni01 | Leader  | running          |  2 |           |
| patroni02 | patroni02 | Replica | creating replica |    |   unknown |
+------------+------------+---------+------------------+----+-----------+

patronictl -c /etc/patroni/patroni.yml list
+ Cluster: test (6981439838068958622) ------+----+-----------+
| Member     | Host       | Role    | State   | TL | Lag in MB |
+------------+------------+---------+---------+----+-----------+
| patroni01 | patroni01 | Leader  | running |  2 |           |
| patroni02 | patroni02 | Replica | running |  2 |         0 |
+------------+------------+---------+---------+----+-----------+
```

I fight for the users

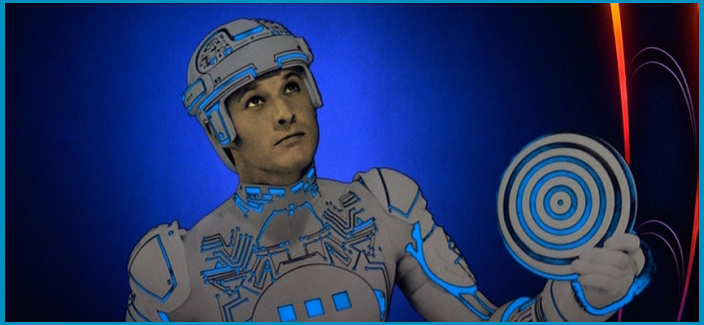

Image source

https://disney.fandom.com/wiki/Tron_(character)

Wrap up

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- Patroni and pgBackRest are amazing
- Patroni requires the DBA to change their point of view
- Patroni doesn't implement the DR
- but pgBackRest does it!
- This example is missing a lot of pieces (security, connection routing...)
- Using tools like Puppet or Ansible is a very,very,very,very,very good idea
- Always RTFM!

Thank you for listening!

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Any questions?

Protecting your data with Patroni and pgBackRest

PGDay Russia 2021

Federico Campoli

Somewhere in the time vortex