Postgresql

High Availability.

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What do we want?
High Availability!
When do we want it?
FATAL: the database system is starting up
What is “high availability”?

Technologies and processes intended to minimize time the database system is not able to execute the application’s workload.
This means...

- ... high uptime.
- ... fast recovery or provisioning of replacement server.
- ... rerouting the application (if required) to the new server.
- In short, minimal time in which there “is no database.”
We’ll focus on…

- … solutions that use streaming replication to maintain a failover system.
- A couple of exceptions.
- Logical replication (slony, bucardo, londiste, pg_logical) has many virtues, but is not primarily a high availability tool.
What do we want?

- Automatic promotion
- Reprovisions failed servers
- Single endpoint
- Load balancing
- Environment agnostic
- Any number of secondaries
- Connection pooling
- Open source
So, what does this?
Nothing.
No current solution does it all.

- Everything has trade-offs.
- You get to decide based on:
  - Your environment.
  - Your requirements.
  - Your patience with scripting.
We’ll talk about...

- Shared storage
- Bare streaming replication
- HAProxy
- pgpool2
- pg_shard
- Heroku
- Amazon RDS
- Patroni
- Stolon
You forgot “x”!

• Yes, I did. Oh, well!
• This set is representative of what’s out there right now.
• Others are really not “high availability” solutions, but more for sysadmin convenience.
• Not that there’s anything wrong with that.
You can write Facebook in PHP.

- Many of these solutions can be scripted to have more complex and advanced functionality.
- Focus here is on out-of-the-box functionality.
The Options.
Shared Storage

• Database volume is shared at the disk block or file system level.
  • DRBD, NFS, SAN, etc., etc.
• A standby machine (configured, not active) is waiting to come up on primary failure.
• Applications rerouted via VIP or manually.
It does:

- Single endpoint *
- Any number of secondaries
- Open source
It doesn’t:

- Automatic promotion
- Reprovisions failed servers
- Load balancing
- Environment agnostic
- Connection pooling
Notes.

- Significant performance overhead.
- `fsync-non-compliance` danger.
- “No” risk of losing a committed transaction.
- Master failures can destroy shared storage, so that’s bad.
Bare streaming replication.

- Primary server takes all write traffic.
- Secondary server might handle load balancing, or just run as a standby.
- On failure, manual promotion of secondary, manual rerouting of application (or VIP), manual...
- ... well, you get the idea.
It does:

• Single endpoint *
• Environment agnostic
• Any number of secondaries
• Open source
It doesn’t.

• Automatic promotion
• Reprovisions failed servers
• Load balancing
• Connection pooling
Notes.

- Allows for pgbouncer as a pooling option.
- Tools exist to help with some tasks (handyrep, repmgr, etc.).
- Requires human intervention.
- Might be all a relatively simple setup requires.
HAProxy

- HAProxy in front of a cluster of secondaries.
- If any secondary fails, HAProxy marks it down.
- Primary as backup server.
- If primary fails, manually promote a secondary to new role.
Primary

HAProxy

Secondary

Primary

Secondary
It does:

- Single endpoint *
- Load balancing *
- Environment agnostic
- Any number of secondaries
- Open source
It doesn’t:

• Automatic promotion
• Reprovisions failed servers
• Connection pooling
Notes.

- Write traffic must be directed to primary.
- Lua scripting support might advance to allow for automatic promotion? Maybe?
- Mostly for balancing across secondaries.
- Requires HAProxy 1.6.
• The traditional solution to this problem.
• Front-end tool that accepts connections, and routes them.
• Can parse queries to assign to primaries or secondaries.
pgpool2

Primary

Secondary
It does:

- Automatic promotion
- Single endpoint
- Load balancing
- Environment agnostic

- Any number of secondaries
- Open source
It doesn’t:

• Reprovisions failed servers *
• Connection pooling
Notes.

- Despite name, does not do “connection pooling” in the multiplexing sense.
- Does not have the best reputation for ease of installation or maintenance.
- Requires external scripting to do promotion and node management.
pg_shard

• Extension to PostgreSQL from Citus Data.
• A master node receives queries.
• A series of shard nodes holds portions of the data.
• HA provided by multiple shards holding the same set of data.
Master

Shard

Shard

Shard

Shard
It does:

- Automatic promotion *
- Reprovisions failed servers *
- Single endpoint
- Load balancing

- Any number of secondaries *
- Open source
It doesn’t:

• Environment agnostic
• Connection pooling
Notes.

- Master is a single point of failure.
- ... so it needs its own HA solution.
- Not transparent to clients.
- Significant restrictions on types of queries and the schema.
- Not just an HA solution: Also does distributed querying.
Heroku

• Commercial PostgreSQL-as-a-service offering.

• Specific for applications running on Heroku’s compute service.

• Essentially a managed community PostgreSQL instance.

• You do not have superuser on the database.
Big Old Cloud of Apps ➔ Database
Database

Big Old Cloud of Apps

Database
Big Old Cloud of Apps → Database
It does:

- Automatic promotion
- Reprovisions failed servers
- Single endpoint
- Load balancing *

- Any number of secondaries
- Connection pooling *
It doesn’t:

- Environment agnostic
- Open source
Notes.

- Heroku manages the database instance for you.
- Accounts can create their own secondaries, for both load balancing and failover purposes.
- Complex relationship between HA features and account plans.
Amazon RDS

- Amazon’s PostgreSQL-as-a-service offering.
- A package of:
  - A managed EC2 instance.
  - A managed PostgreSQL instance.
  - A “shadow” failover machine (using proprietary replication technology).
Big Old Cloud of EC2 Instances → Database
Big Old Cloud of EC2 Instances → Database
Big Old Cloud of EC2 Instances

Database
It does:

- Automatic promotion
- Reprovisions failed servers
- Single endpoint
It doesn’t:

- Load balancing
- Environment agnostic
- Any number of secondaries
- Connection pooling
- Open source
Notes.

- Strange environment if you are used to community PostgreSQL.
- Can put pgbouncer in front for pooling.
- Can create secondaries, but they are load-balance only, not HA.
- You do not have superuser on the database.
Patroni

- [https://github.com/zalando/patroni](https://github.com/zalando/patroni)
- Python tool/daemon for managing PostgreSQL servers.
- New, under active development.
- Uses HAProxy as its front end tool.
- Uses etcd or Zookeeper as a distributed system config database.
HAProxy

Primary

Secondary
It does:

- Automatic promotion
- Reprovisions failed servers
- Single endpoint
- Any number of secondaries
- Open source
It doesn’t:

• Load balancing
• Environment agnostic
• Connection pooling
Notes.

- The HAProxy is used to route to the current primary.
- You can provision secondaries, but they’re on a different endpoint.
- Hear more about it later today!
Stolon

- [https://github.com/sorintlab/stolon](https://github.com/sorintlab/stolon)
- Relatively new.
- Under active development.
- Written in Go.
It does:

- Automatic promotion
- Single endpoint
- Any number of secondaries
- Open source
It doesn’t:

• Reprovisions failed servers
• Load balancing
• Environment agnostic
• Connection pooling
Notes.

- Requires etcd or consul.
- Has a custom proxy.
- New secondary provisioning possible (?) if using kubernetes.
Another way to look at it.
How much do you like systems administration?
How much do you like system administration?

- I would rather eat my own foot: Heroku, Amazon RDS.
- Some, but I don’t want to live it: Bare streaming replication, HAProxy.
- I’m OK with it (and don’t mind some development): pg_shard, Patroni, Stolon.
- I laugh at danger: pgpool2.
One thing nothing does.

- Completely transparent failover.
- All solutions will break connections or cancel queries on a failure.
- Applications recover from this with varying degrees of grace.
So.
The perfect HA tool is yet to be.

• More work needs to be done here.

• … and a lot is being done.

• … but for deployments right now, you need to make some choices among the available tools.
Some day.
Thank you!

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