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How not to screw up when building HA cluster

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Alexander Kukushkin

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ABOUT ME

Alexander Kukushkin

Database Engineer @ZalandoTech

The Patroni guy

alexander.kukushkin@zalando.de

Twitter: @cyberdemn

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WE BRING FASHION TO PEOPLE IN 17 COUNTRIES

17 markets

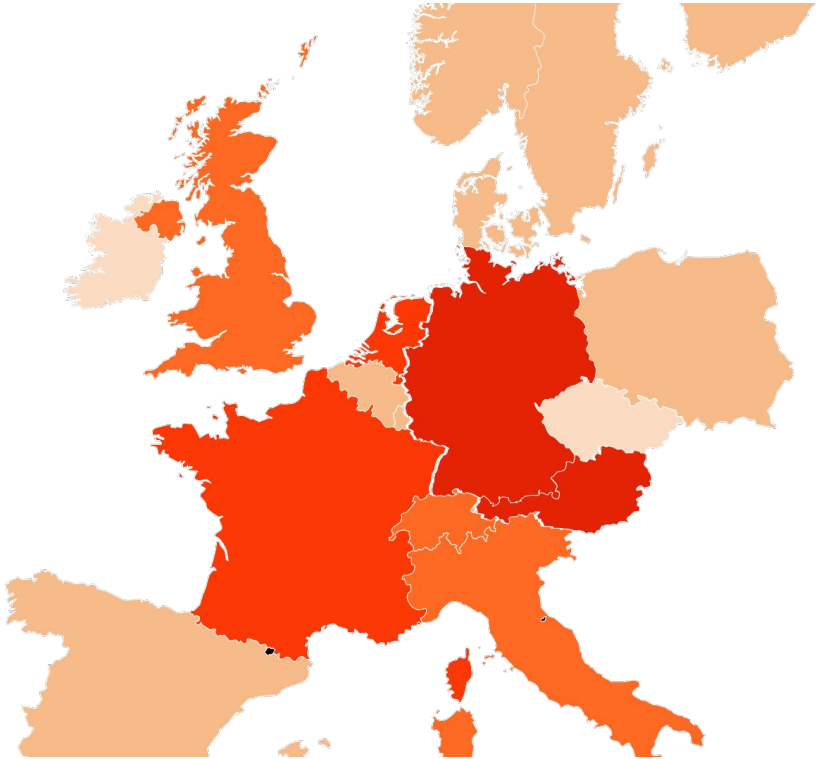
7 fulfillment centers

23 million active customers

4.5 billion € net sales 2017

200 million visits per month

15,000 employees in Europe



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FACTS & FIGURES

> 300 databases

on premise

> 650 clusters

in the Cloud (AWS)

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AGENDA

What is High Availability?

Disaster recovery

Automatic failover done right

Examples of real incidents

What HA will not solve?

Wrap it up

What is ~~High~~ Availability?

Availability

$$A = \frac{E[\text{uptime}]}{E[\text{uptime}] + E[\text{downtime}]}$$

Causes of Downtime

- Scheduled downtime (often excluded from availability)
  - Hardware/BIOS/Firmware upgrade
  - Software update
- Unscheduled downtime
  - Datacenter failure (natural disasters, fire, power outage)
  - Network splits
  - Hardware failure (CPU, network card, disk controller, disk)
  - Software/Data corruption (Bugs in application/OS code)
  - User error (rm -fr $PGDATA, DROP/TRUNCATE table, UPDATE/DELETE without WHERE clause)

Availability	Downtime			
	Year	Month	Week	Day
99% (“Two nines”)	3.65 d	7.31 h	1.68 h	14.4 m
99.9% (“Three nines”)	8.77 h	43.83 m	10.08 m	1.44 m
99.95% (“Three and a half nines”)	4.38 h	21.92 m	5.04 m	43.2 s
99.99% (“Four nines”)	52.6 m	4.38 m	1.01 m	8.64 s
99.999% (“Five nines”)	5.26 m	26.3 s	6.05 s	864 ms
99.9999% (“Six nines”)	31.56 s	2.63 s	604.8 ms	86.4 ms
99.99999% (“Seven nines”)	3.16 s	262.98 ms	60.48 ms	864 µs

What is HA anyway?

- No Official Definition appears to exist!

- Wikipedia:
  - **High availability** (HA) is a characteristic of a system, which aims to ensure an **agreed** level of operational performance, usually **uptime**, for a higher than normal period.

SLA, SLI, and SLO

- A **Service-Level Agreement** (**SLA**) is an agreement between a service provider and a client.
  - Type of service to be provided
  - Desired performance level (especially availability, reliability and responsiveness)
  - **Monitoring** process and service level **reporting**
  - Steps for reporting issues
  - Response and issue resolution time-frame
- A **Service-Level Indicator (SLI)** is a measure of the service level provided by a service provider to a customer
  - **Availability**
  - Latency
  - Throughput
- A **Service-Level Objective (SLO)** is a key element of **SLA;** a goal that service provider wants to reach

Causes of Unscheduled Downtime

- Hardware failure
- Network splits
- Datacenter failure
- Software failure/Data corruption
- User error

Automatic failover

Disaster recovery

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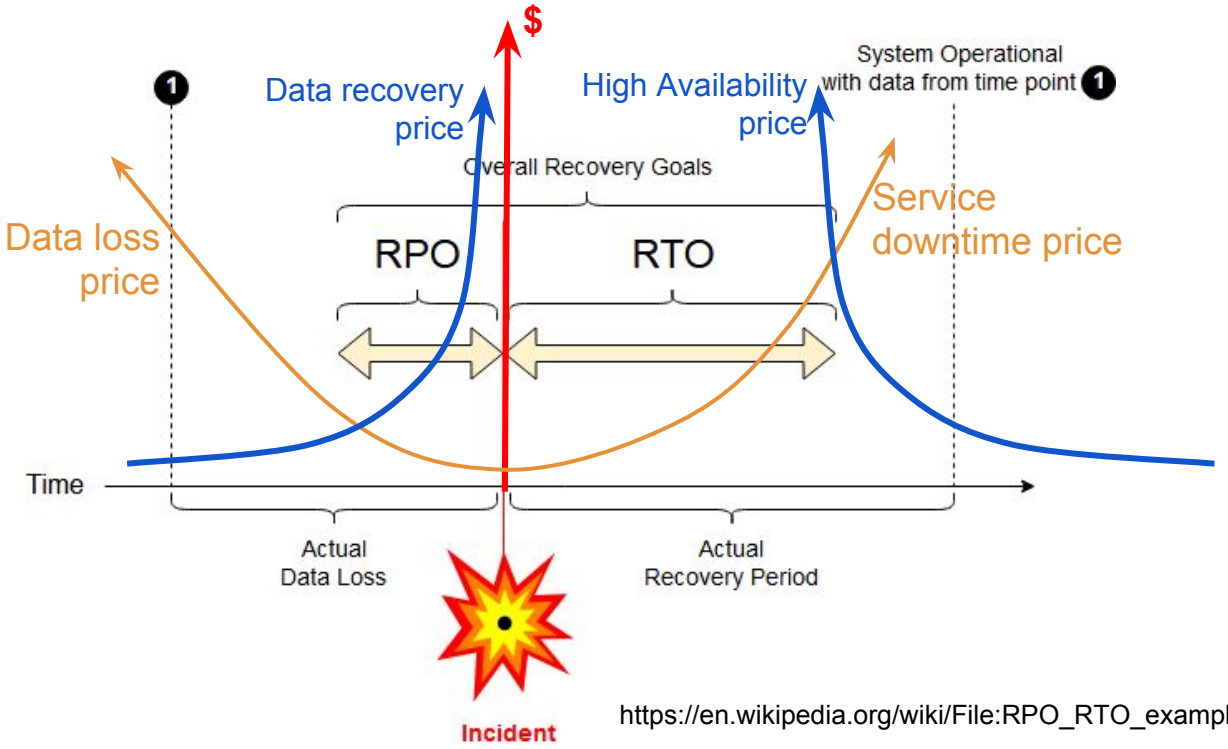
Disaster recovery

- Involves a set of policies, tools and procedures to enable the recovery or continuation of vital technology infrastructure and systems following a natural or human-induced disaster

- Recovery point objective (**RPO**) and recovery time objective (**RTO**) are two important measurements in disaster recovery and downtime
  - A **recovery point objective (RPO)** is defined by business continuity planning. It is the maximum targeted period in which data (transactions) might be lost from an IT service due to a major incident
  - The **recovery time objective (RTO)** is the targeted duration of time and a service level within which a business process must be restored after a disaster (or disruption) in order to avoid unacceptable consequences associated with a break in business continuity

Disaster recovery



https://en.wikipedia.org/wiki/File:RPO_RTO_example_converted.png

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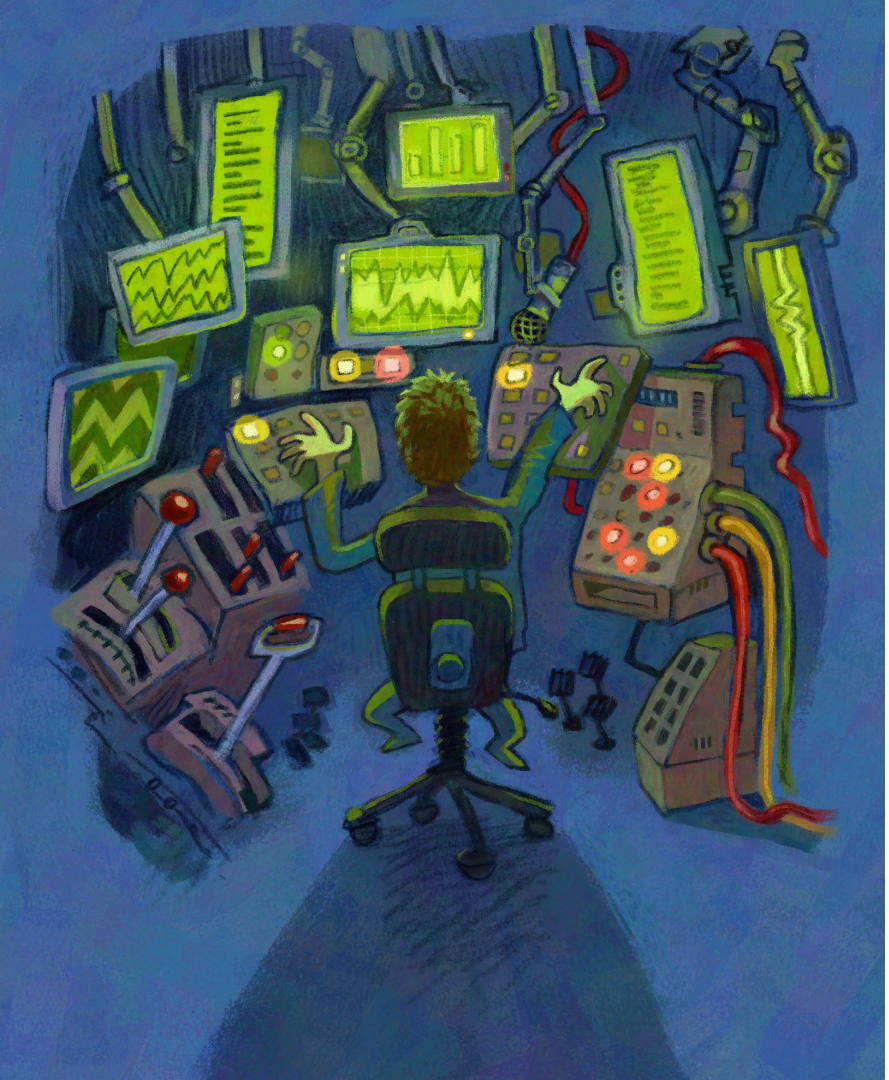
RPO, RTO & PostgreSQL

- Automatic failover won't help to backup and restore data
  - Enable backups and log archiving
    - archive_timeout - how often postgres should archive WALs
    - pg_receivewal
  - Recovery from the backup might take hours
    - Consider having a delayed replica (recovery_min_apply_delay)
- if RTO is higher than 15 minutes, you don't need automatic failover!
  - Unless you are running hundreds of clusters
- synchronous replication - to prevent data loss during failover

Sub-second Automatic Failover

- In general it is possible, but VERY expensive
- This is a price for complexity of such system
  - Complexity is often decreasing availability
  - The more elements a system has, the more reliable each element has to be
- Trade-off between the speed of failure detection and false positives

High Availability and Disaster Recovery Need Each Other!



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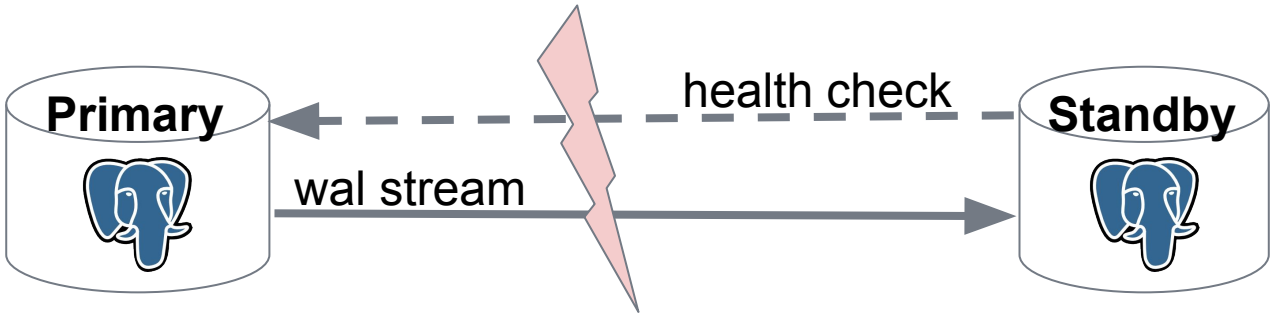
Multimaster?

- PostgreSQL XC/XL
  - Data nodes + Coordinators + 2PC + GTM(SPOF)
- BDR
  - logical replication + conflict resolution
    - eventual consistency
- Postgres Pro Enterprise (proprietary)
  - logical replication + E3PC

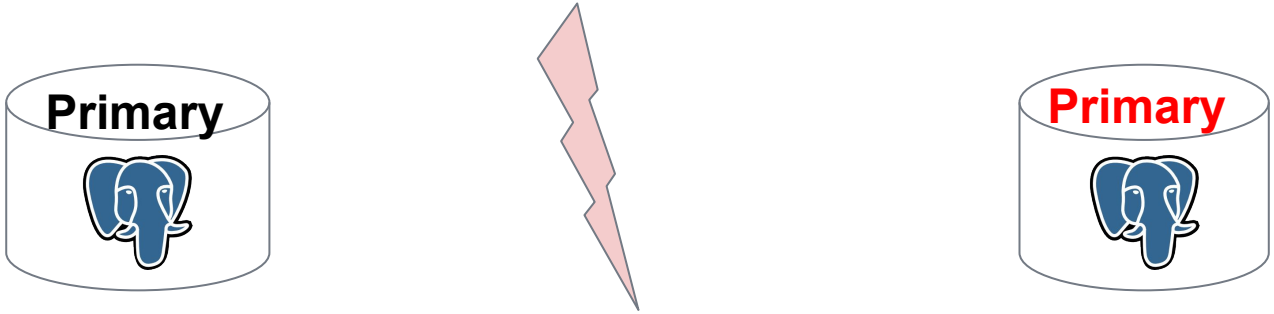
A good HA system

- Quorum
  - Helps to deal with network splits
  - Requires at least 3 nodes
- Fencing
  - Make sure the old primary is unaccessible. STONITH!
- Watchdog
  - Primary should not run if supervising HA process failed

No Quorum and no Fencing



No Quorum and no Fencing



https://github.com/MasahikoSawada/pg_keeper

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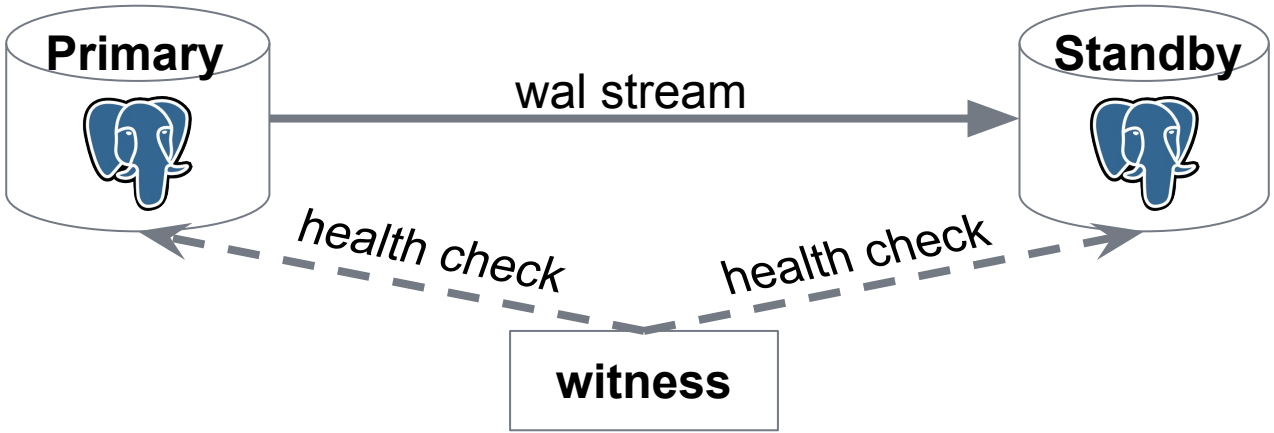
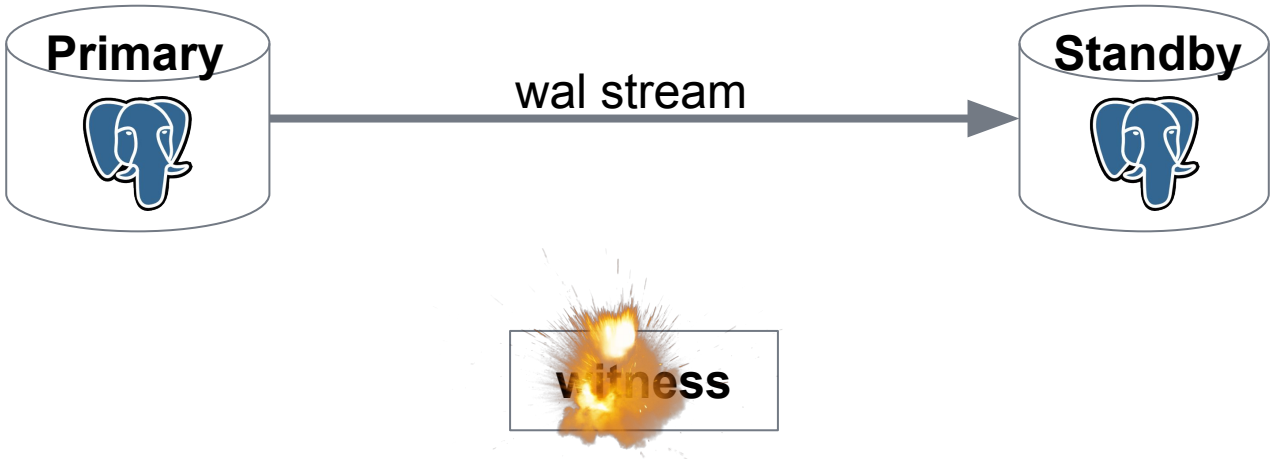
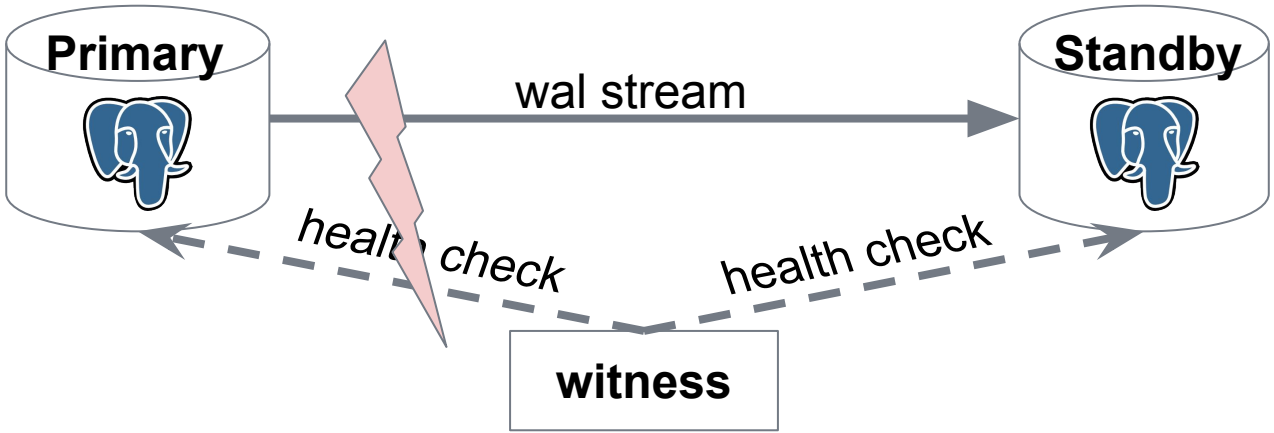
Witness node is making decisions



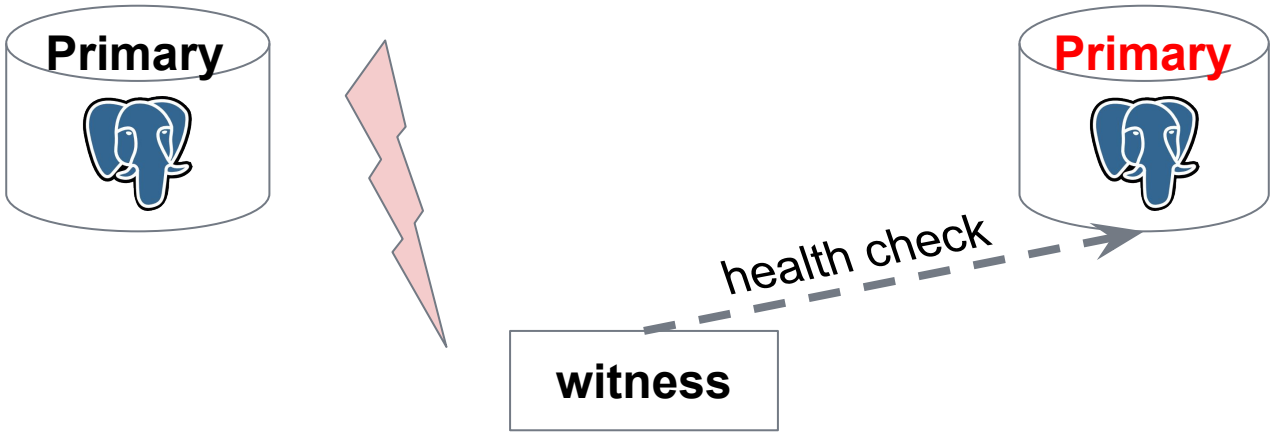
Witness node dies



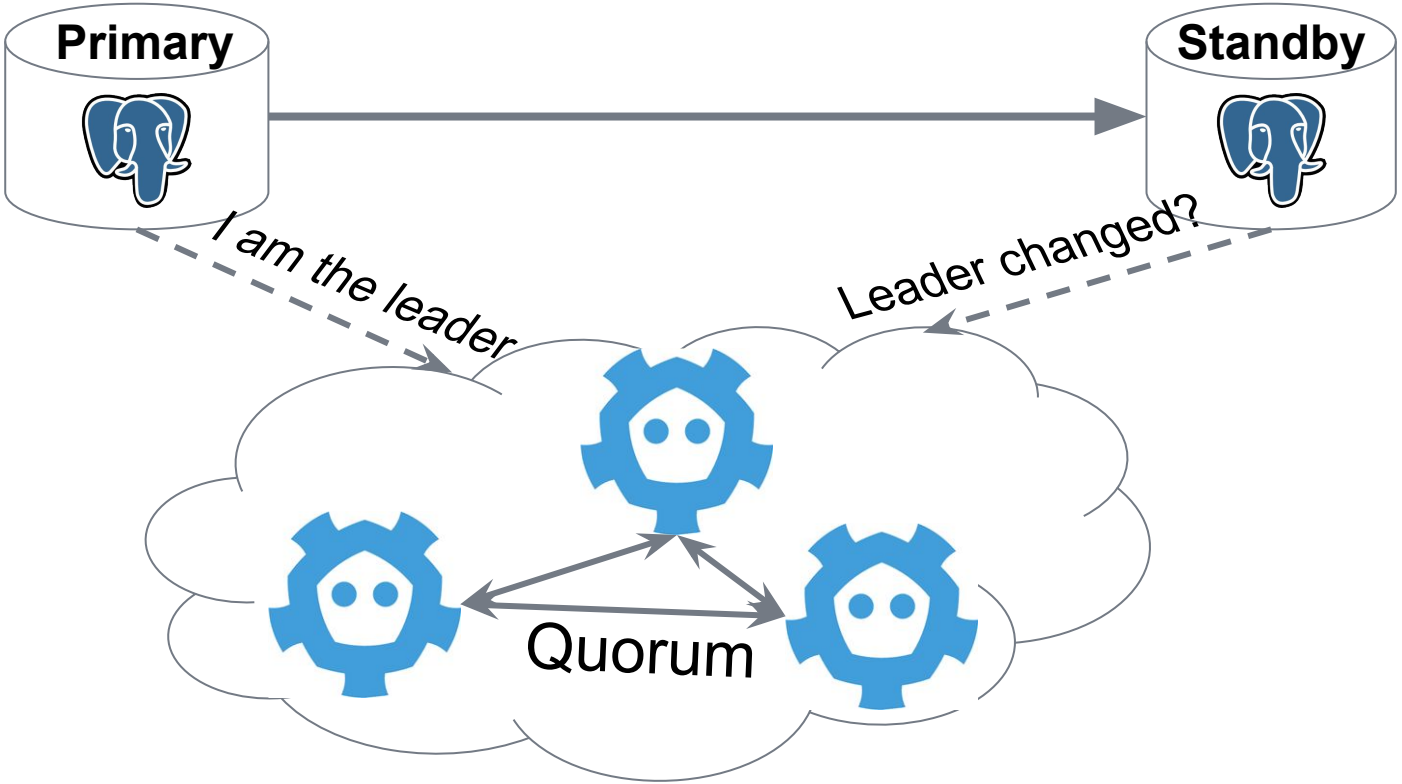
Witness and no Fencing



Witness and no Fencing



Automatic failover done right



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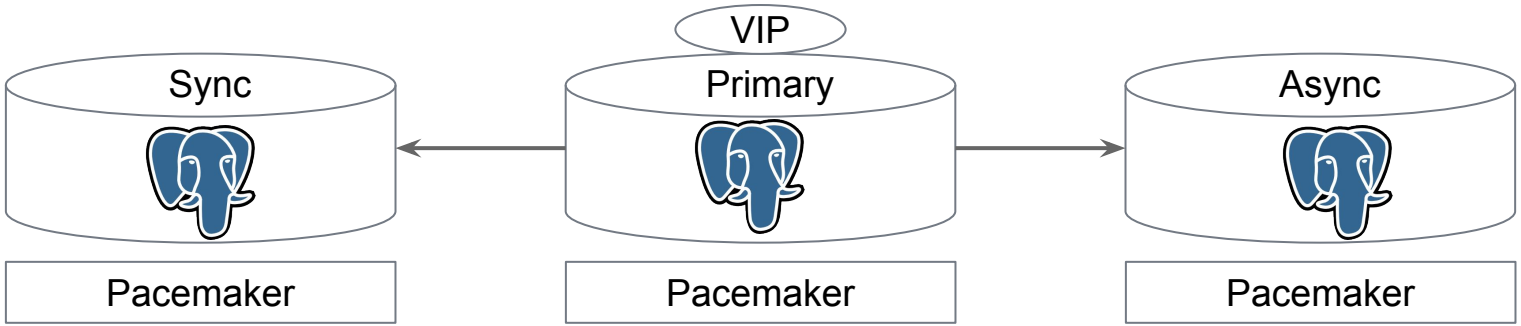
Learn your HA system

GoCardless Incident



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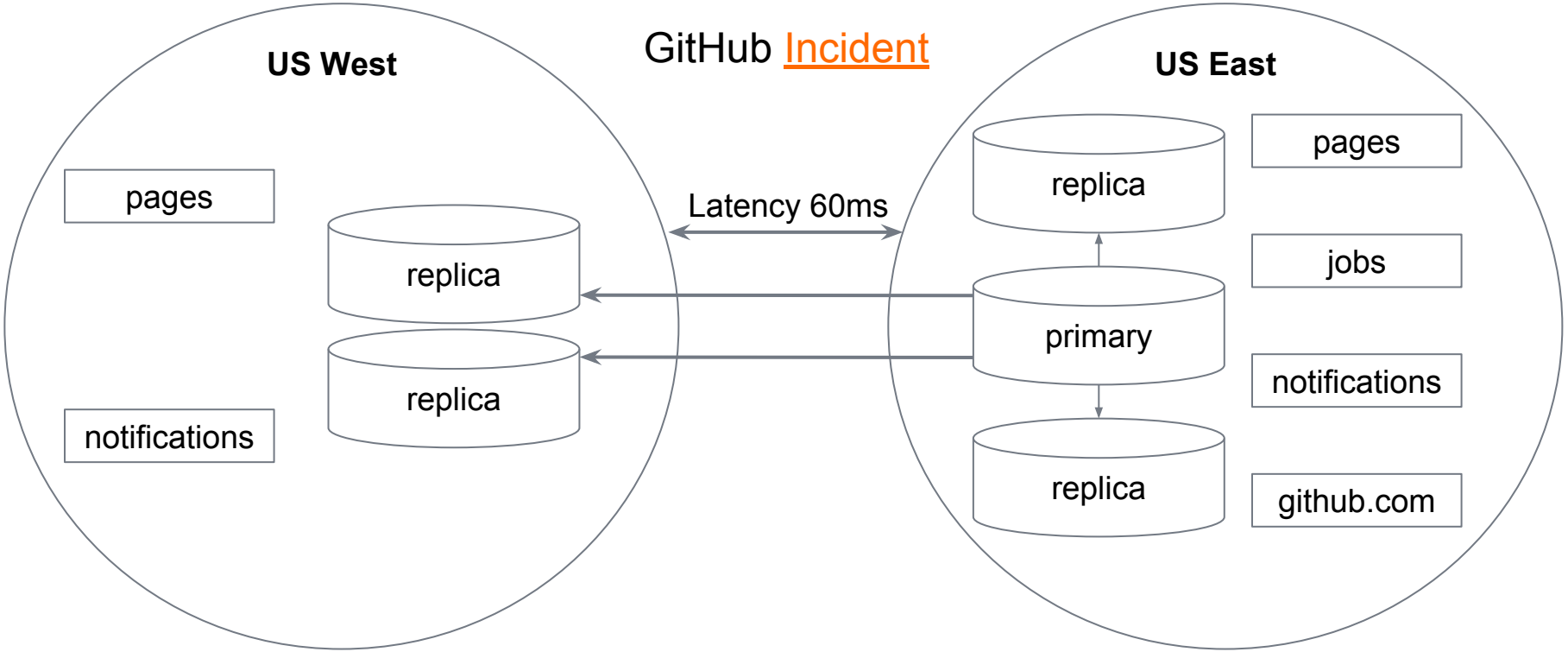
GoCardless Incident

- Failed raid controller on the primary
- Primary was manually terminating (hope on auto failover)
- Auto Failover didn’t work due to coincident crash of postgres on sync replica
- Spend 1h30m trying to trigger a failover using Pacemaker!
- Manually promoted sync replica
- Total outage 1h50m

GoCardless Lessons

- HA systems usually are quite complex
- Running them is similar to flying modern airplane
  - Mostly autopilot
  - But sometimes it fails
  - You need to know how to “fly” manually
- Learn your HA system
  - Try to break it and fix afterwards

Resource Planning



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GitHub Incident

- Network split due to network maintenance
- Automatic failover from East to West Coast datacenter
- Applications from East are slow due to latency between East and West
- Switchback to East wasn’t possible due to a few seconds of writes which were not replicated
- Rebuild of all replicas in the East took nearly 16 hours
- Total time of incident 24h11m

GitHub Lessons

- Avoid doing cross-region failover if you don’t have 100% resources symmetry
- MySQL can’t do **pg_rewind** :)

Broken Disaster Recovery procedures

GitLab Incident

- Primary-Replica setup (no automatic failover)
- Increased database load on the primary resulted in **replica falling behind**
  - **WAL segment** needed for replica was **recycled** by primary
- A few attempts to rebuild replica with pg_basebackup (--checkpoint=spread)
- rm -fr $PGDATA on the primary! (**human error**)
- Three different backups were done only **once a day** (**no WAL archiving**)
  - pg_dump was **always failing** due to major version mismatch!
  - Azure disk snapshots were **disabled** for database servers!
  - LVM snapshots were **working** and periodically tested by restoring them to staging
    - Incident happened nearly 24 hours after the last snapshot was taken!
    - “Luckily”, someone manually created the snapshot 6 hours before the incident
- Recovery from LVM snapshot took longer than 18 hours

GitLab Lessons

- **RPO** and **RTO** were not set or not adequate to their business needs
  - Daily snapshots only and no WAL archiving (**RPO** = 24 hours)
  - Streaming replication can’t be used for Disaster Recovery
    - Unless it is a “delayed” replica
- Runbooks can’t replace fire-drills
- Backups must be monitored and tested

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Examples of real incidents

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Wrap it up

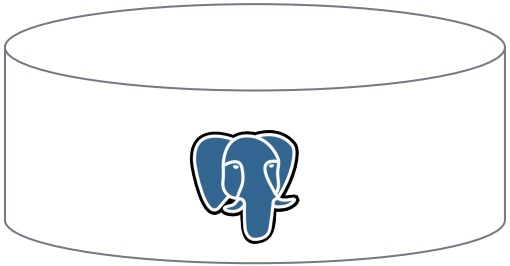
Monitoring

- HA doesn’t solve all problems with postgres, it won't cover:
  - Hardware errors, CPU load, Memory, etc...
  - Disk space for $PGDATA, tablespaces and pg_wal
  - autovacuums, checkpoints
  - Tables and indexes bloat
  - Queries performance
  - etc...
- Depending on **RPO** you maybe don’t need HA at all, but monitoring is a must
  - Don’t forget to monitor your HA system!

Everything must be monitored

Monitoring

High Availability



Disaster Recovery

Configuration tuning

- OS configuration tuning
  - Huge pages, shared memory, semaphores, overcommit, etc...
- PostgreSQL configuration tuning
  - shared_buffers, max_wal_size, checkpoint completion_target, random_page_cost, etc...
- HA won’t do it for you!

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Wrap it up

- Always start with Disaster Recovery planning
  - Define **RPO** and **RTO**
    - Depending on **RTO** you maybe don’t need **HA**
  - Build the Availability you need, not the Availability you want
- Test everything
  - High Availability system
  - Backups!
- Do regular fire-drills

Thank you!

Questions?

Feedback: https://2019.fosdempgday.org/f