

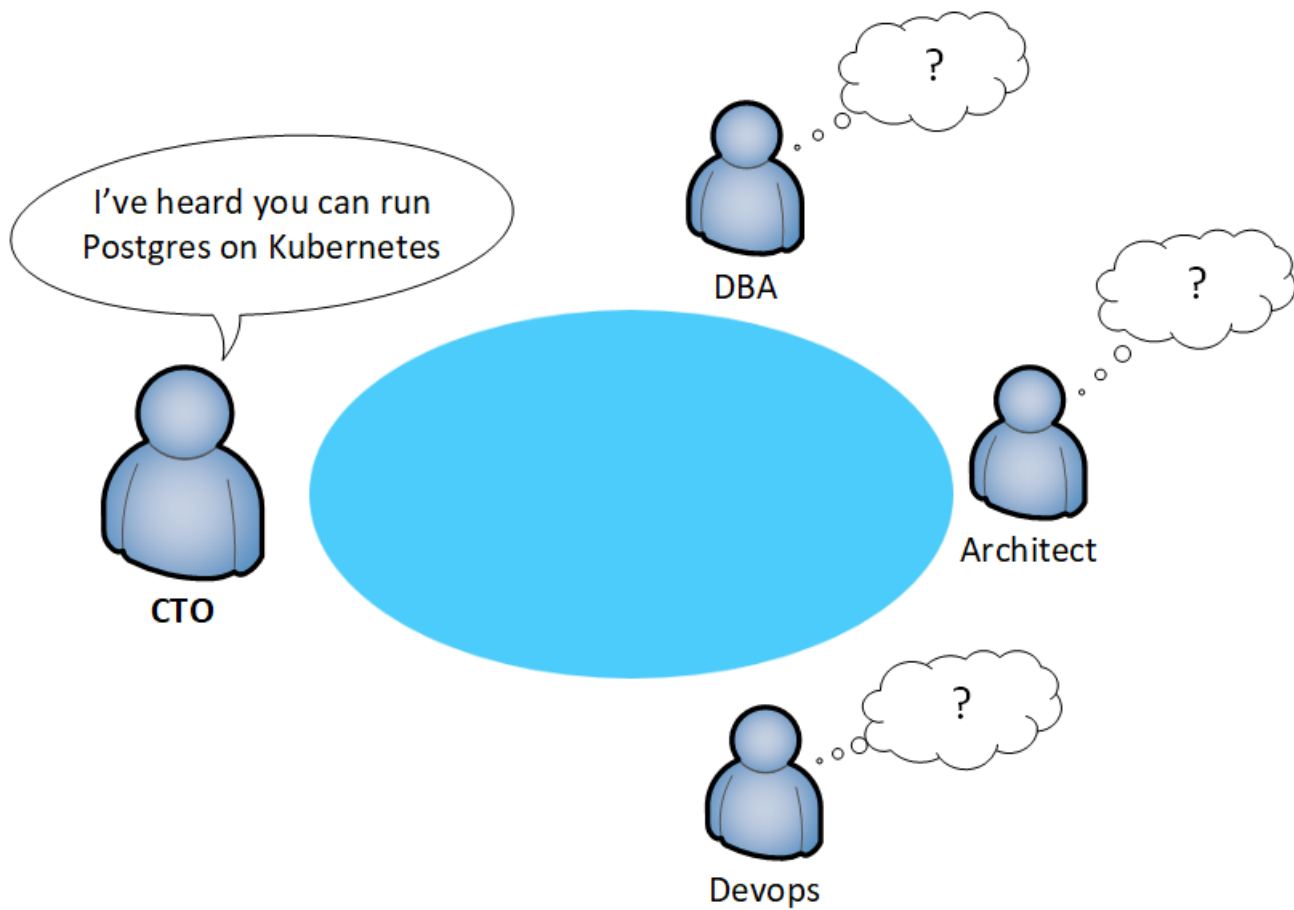
Running PostgreSQL on Kubernetes: Is It a Blessing or a Curse?

PGDay Belgium 2025

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UCLL – Leuven, Belgium



Hello!

I am Emrah Becer



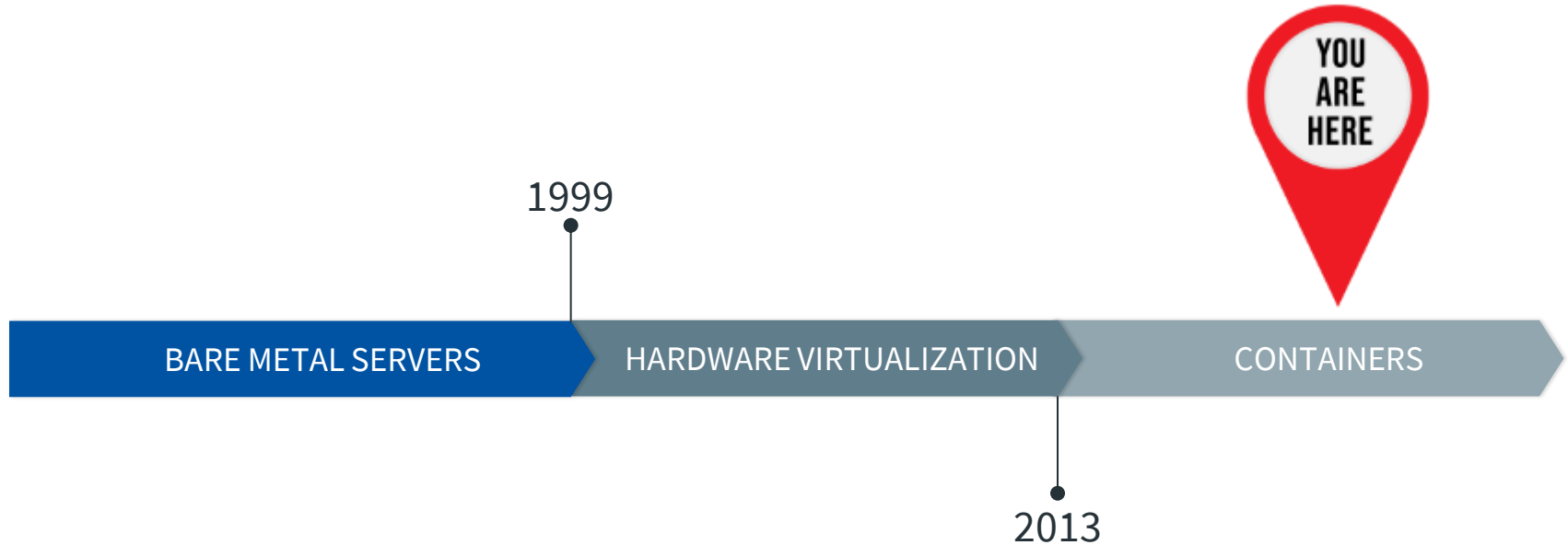
- * A computer engineer who spent last 20 years administering databases.
- * Currently working as an independent PostgreSQL consultant at European Patent Office (EPO)
- * Have special interest in Linux kernel and database internals

A decorative background featuring a network diagram with nodes and lines, primarily located on the left and bottom right sides of the slide.

Evolution of Virtualization Technologies

How we ended up with containers

Trend in Modern Virtualization Technologies

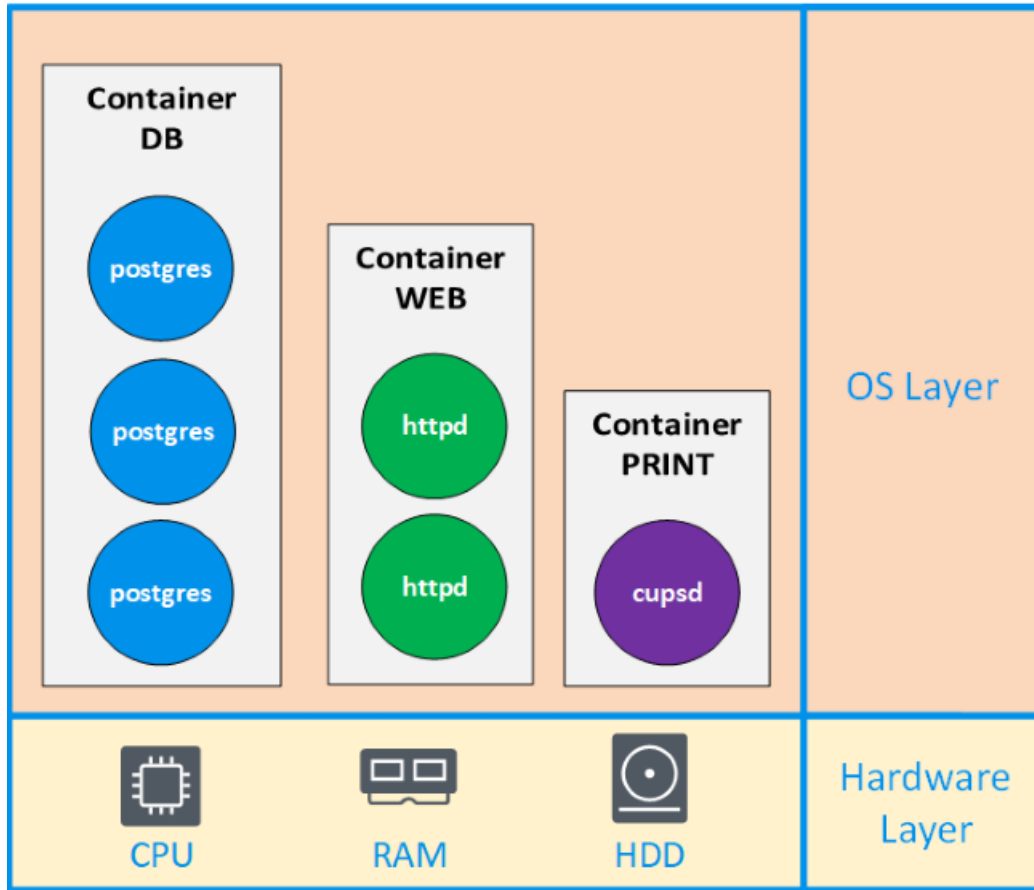




Fitting the Elephant Inside a Container

A new way of running your postgres

Postgres Inside a Container



A decorative network diagram in the top-left corner, consisting of a complex web of interconnected nodes and lines. The nodes are represented by circles of varying sizes, some with concentric rings, and the lines are thin and grey. The overall shape is roughly triangular, pointing towards the top-left.

Technology Behind Containers

How the magic works



“

Container = A Group of Processes

Linux Kernel Does All The Work



Namespaces:

- ◎ Isolate processes

Control Groups (Cgroups):

- ◎ Limit resources
- ◎ Reserve resources

Pivot_Root:

- ◎ Restrict file access

A decorative network diagram in the top-left corner, featuring a complex web of interconnected nodes and lines, with some nodes highlighted in blue and others in grey.

Administering Containers

The easy way

The Docker Project



- ◎ Simplified working with containers
- ◎ Increased containers' popularity and adoption

The Docker Hub



- ◎ Repositories for docker images
- ◎ Download images created by others
- ◎ Upload images you've built

The PostgreSQL Docker Community



Provides images for:

- ⦿ <major>.<minor> versions of postgres
- ⦿ Different CPU architectures (x86, arm, ppc etc.)



1 billion+ downloads so far.

https://hub.docker.com/_/postgres

Docker with Postgres is Great



- ◎ For development and test environments
- ◎ If you don't have a DBA background



A decorative network diagram in the top-left corner, consisting of a series of interconnected nodes and lines, some solid and some dashed, in a light gray color.

Going Beyond Docker

When you simply need more

The Need For a Container “Orchestrator”



- ◎ Horizontal Scalability
- ◎ High Availability
- ◎ Load Balancing

Open Source Container Orchestrators



Kubernetes

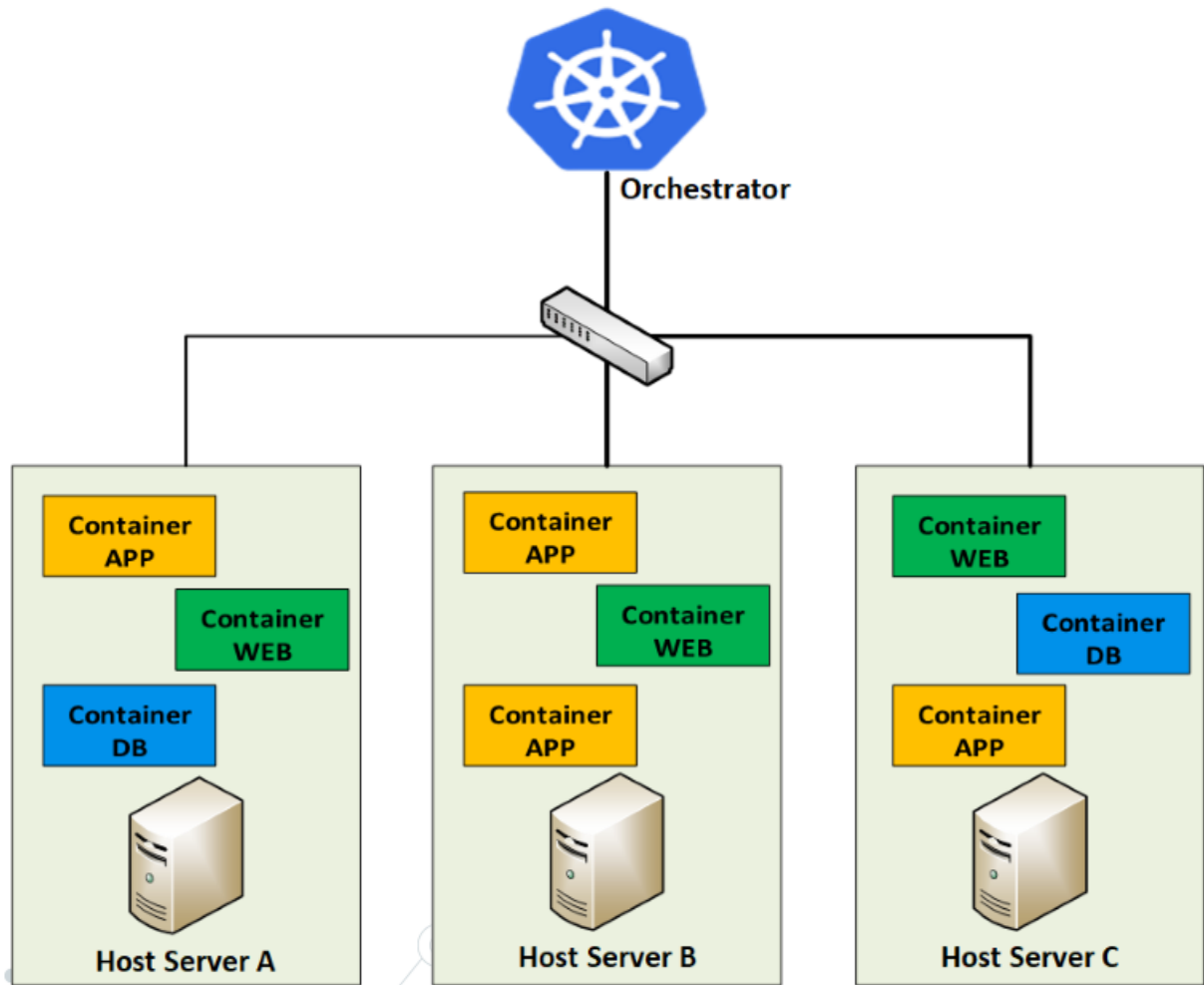


Docker Swarm



Redhat Openshift

Kubernetes Cluster



A decorative network diagram in the top-left corner, consisting of a series of interconnected nodes and lines, some of which are highlighted with larger circles.

Running a Production Postgres Cluster on Kubernetes

Time to get more serious

The Need For a Kubernetes Operator

- ◎ Kubernetes is a generic platform
- ◎ Can be extended using “operators”



“

Postgres Operator = Make Kubernetes Postgres Aware

Open Source PostgreSQL Operator Projects

- © Zalando Postgres Operator
- © CloudNativePG
- © CrunchyData

The Zalando Postgres Operator Project

- ◎ Written in GO
- ◎ Docker Image
- ◎ Based on Ubuntu
- ◎ Postgres and Patroni bundled together

A decorative network diagram in the top-left corner, featuring a complex web of interconnected nodes and lines, with some nodes highlighted in blue.

A Complete Running Example of Postgres Cluster on Kubernetes

Finally !..

Step 1: Define your Postgres Cluster

- ◎ Postgres Operator is declarative.
- ◎ YAML (Yet Another Markup Language) files
- ◎ Infrastructure As a Code

Postgres Cluster Definition (Part 1)

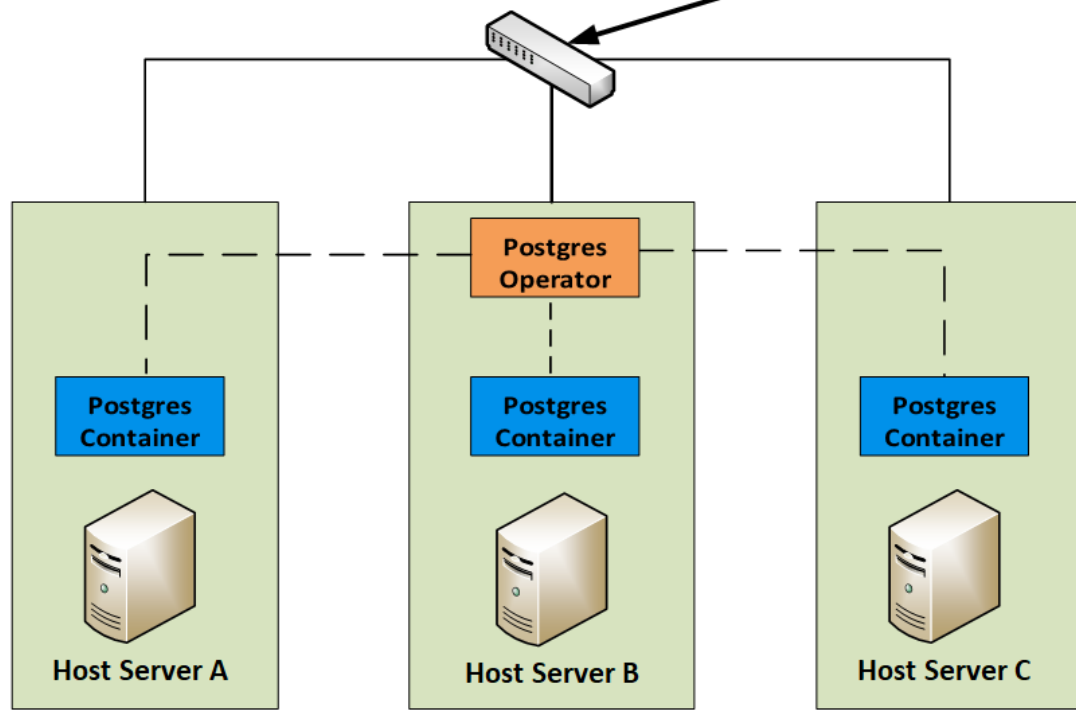
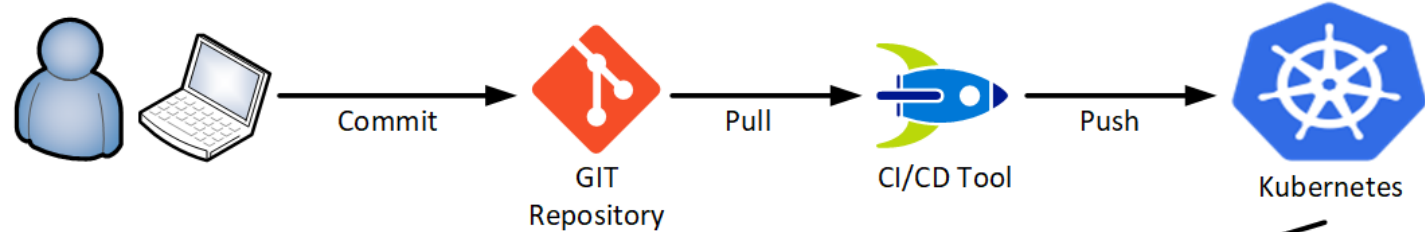
```
apiVersion: "acid.zalan.do/v1"
kind: postgresql
metadata:
  name: my-first-pg-cluster
spec:
  dockerImage: ghcr.io/zalando/spilo-17:4.0-p2
  numberOfInstances: 3
  users:
    my_dba_user:
      - superuser
    hr_user:
      - login
  databases:
    hrdb: hr_user
```

Postgres Cluster Definition (Part 2)

```
postgresql:  
  version: "16"  
  parameters:  
    shared_buffers: "1024MB"  
    max_connections: "50"  
    log_statement: "all"  
  volume:  
    size: 20Gi  
  resources:  
    requests:  
      cpu: 500m  
      memory: 2Gi  
    limits:  
      cpu: 2000m  
      memory: 4Gi
```

Step 2: Deploy the Cluster Configuration to Kubernetes

- ◎ Build a pipeline from GIT to Kubernetes
- ◎ Use a CI/CD tool like ArgoCD



Postgres
Pipeline

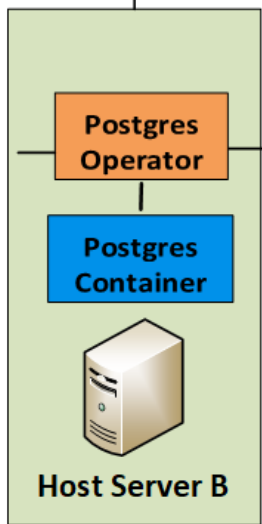
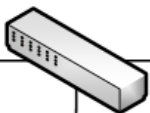


Backup/Restore and Disaster Recovery Features

- ◎ Backups are stored in S3 (simple storage service) buckets
- ◎ On-prem or cloud S3 buckets
- ◎ Patroni standby cluster



Primary Kubernetes
Cluster



Primary Patroni Cluster



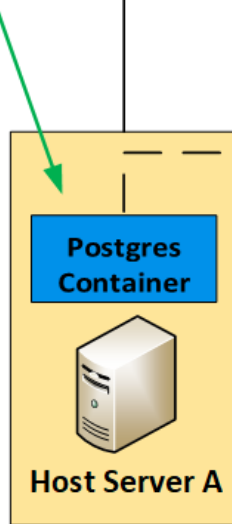
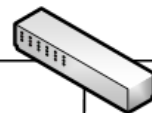
S3 Bucket

Upload
Backup Files

Download
Backup Files



Secondary Kubernetes
Cluster

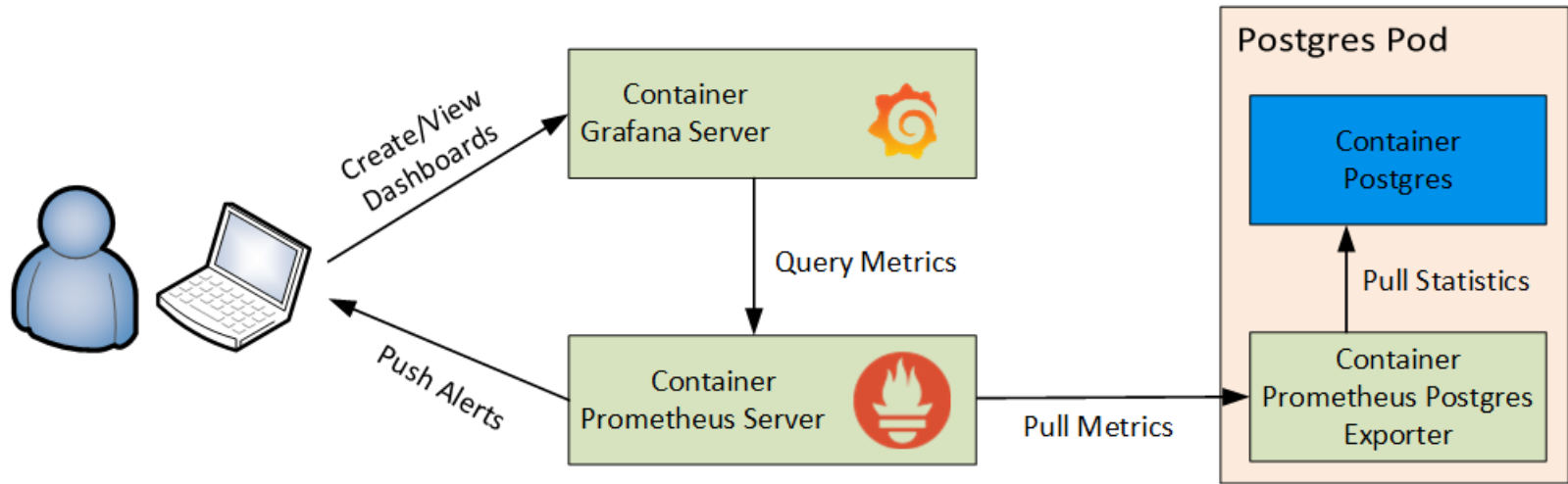


Standby Patroni Cluster

Monitoring and Observability

- ◎ Deploy a “sidecar” container.
- ◎ For ex: Prometheus postgres exporter

Monitoring and Observability





Should We Migrate Our Postgres to Kubernetes?

The ultimate question

Reasons to Love Postgres on Kubernetes



- ◎ Self-healing
- ◎ Database As A Service (DBaaS)
- ◎ Offload some DBA tasks to Postgres Operators

Reasons to Dislike Postgres on Kubernetes



Prepare for more Postgres switchovers:

- ◎ Kubernetes maintenance
- ◎ OOM killer and node evictions
- ◎ Kubernetes issues

Reasons to Dislike Postgres on Kubernetes



Challenges For DBAs:

- ◎ Learning container and Kubernetes concepts.
- ◎ Learning curve is steep.

Final Words



We'll Probably Have to Migrate Postgres to Kubernetes

- ◎ Paradigm in virtualization technologies has shifted to containers. Databases cannot stay out of this.
- ◎ Communities/vendors are constantly developing projects for better database experience on Kubernetes. It will be difficult to provide arguments against using them.
- ◎ Your company/clients may want to quit hypervisors or at least keep them at minimum due to licensing and maintenance costs.

Thank You!

Any questions?

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