Develop Cloud-Native Apps on K8s with Postgres

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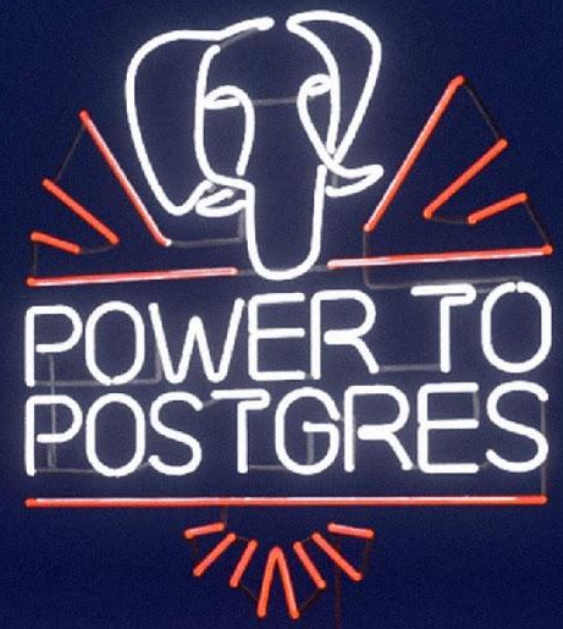
Wed Jun 30



EDB

Agenda

- Why EDB?
- PostgreSQL + K8s
- Declarative Cluster Configuration
- Deploy Anywhere
- Kubernetes Services
- Advanced database features, no DBA required
- Conclusions and recommended next steps

Why EDB?

The Largest PostgreSQL Company

5,300+
lifetime customers

Over 300
dedicated PostgreSQL technologists

91%
customer satisfaction rating

28%
of Fortune 500 companies are customers

40%
of customers deploying in cloud

2
Founders of Postgres Community

The most PostgreSQL experts

EDB team includes:

300+ PostgreSQL technologists

26 PostgreSQL community contributors and committers

Including founders and leaders like

Michael Stonebraker
"Father of Postgres"
and EDB Advisor

Bruce Momjian
Co-founder, PostgreSQL
Development Corp and
PostgreSQL Core Team

Peter Eisentraut
PostgreSQL
Core Team member

Robert Haas
PostgreSQL Major
Contributor and Committer

Simon Riggs
PostgreSQL Major Contributor,
Founder
of 2ndQuadrant

EDB and Kubernetes

- Kubernetes Certified Service Provider (KCSP)
  - First PostgreSQL Company to reach this status

- Silver Member of CNCF & Linux Foundation

- Red Hat Certified Kubernetes Operators
  - Cloud Native PostgreSQL (aka PostgreSQL Operator)
  - Cloud Native BDR (aka BDR Operator)

What makes up Cloud Native PostgreSQL?

Downloadable software solution that includes [1] a Kubernetes Operator and [2] PostgreSQL/EPAS container images

Cloud Native PostgreSQL

PostgreSQL and EDB Postgres Advanced Container images

Docker container images containing the Database server with only the Postgres service exposed

Kubernetes Operator

Responsible for deploying and managing PostgreSQL and EDB Postgres Advanced containers and maintaining the desired state

What makes up Cloud Native PostgreSQL? NEW!!

Tools with working with Cloud Native PostgreSQL in an Operations environment [3] Kubectl plugin [4] Cloud Native benchmarking tool

Cloud Native PostgreSQL

kubectl-cnp

Plugin for kubectl to manage a Cloud Native PostgreSQL cluster in Kubernetes

cnp-bench

Helm charts for benchmarking both storage and the database itself for pre-production readiness testing.

Cloud Native Postgres capabilities

Deploy anywhere

Lightweight, immutable PostgreSQL containers

Automate DBA Tasks

Failover, switchover, backup, recovery, and rolling updates

Avoid lock-in

Operator and images are portable to any cloud

What makes EDB unique?

EDB Technology

Unique products - EDB Postgres Advanced & Bi-Directional Replication (BDR)

No external dependencies - backups and HA management all EDB developed technologies

Largest dedicated PostgreSQL company

5,000 lifetime customers

25% of Fortune 500

300+ PostgreSQL technologists

26 PostgreSQL community contributors and committers

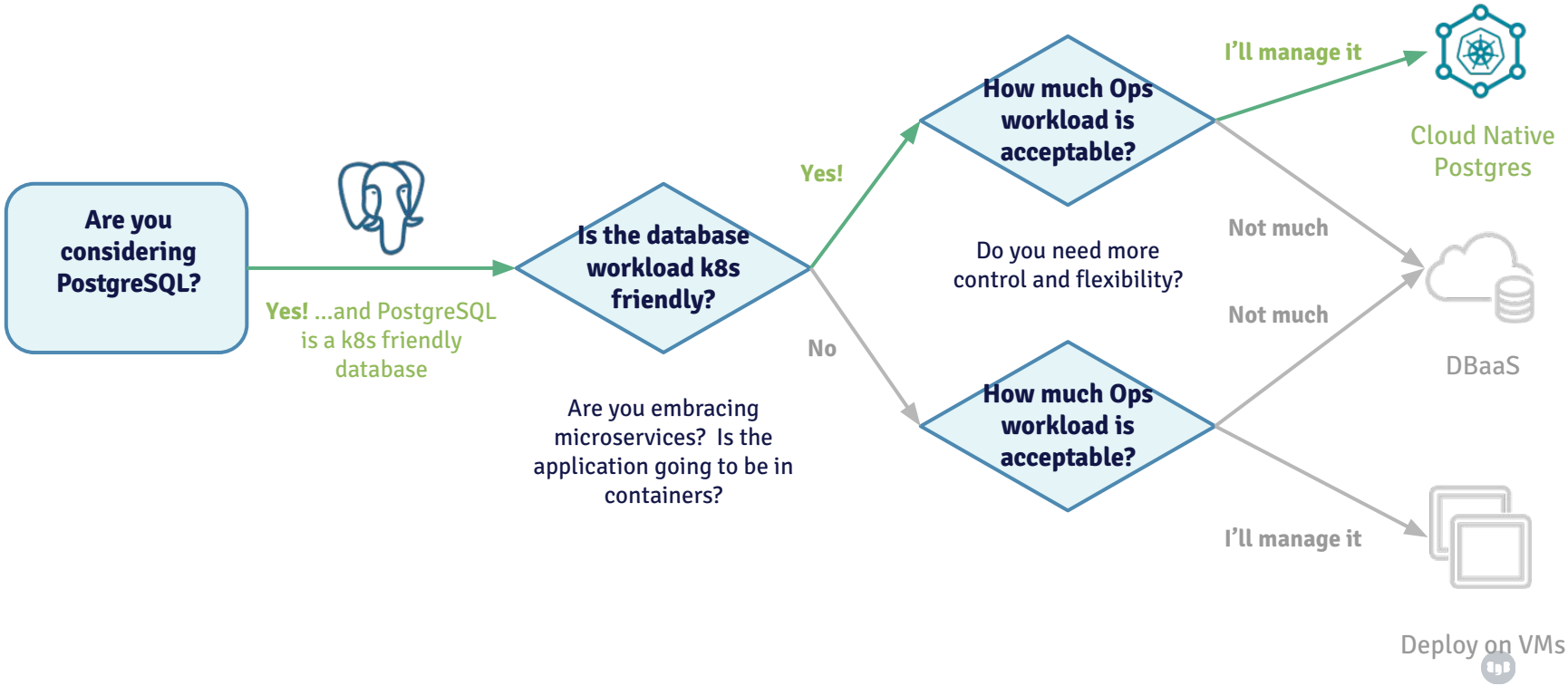
Kubernetes experience

CNCF Kubernetes Certified Services Provider (KCSP)

Red Hat Certified Kubernetes Operators

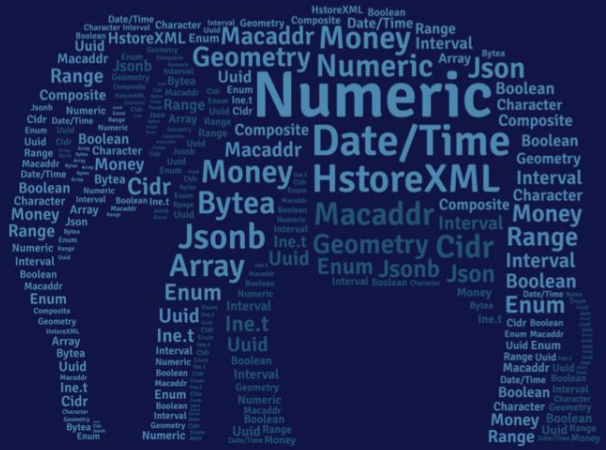
PostgreSQL + K8s

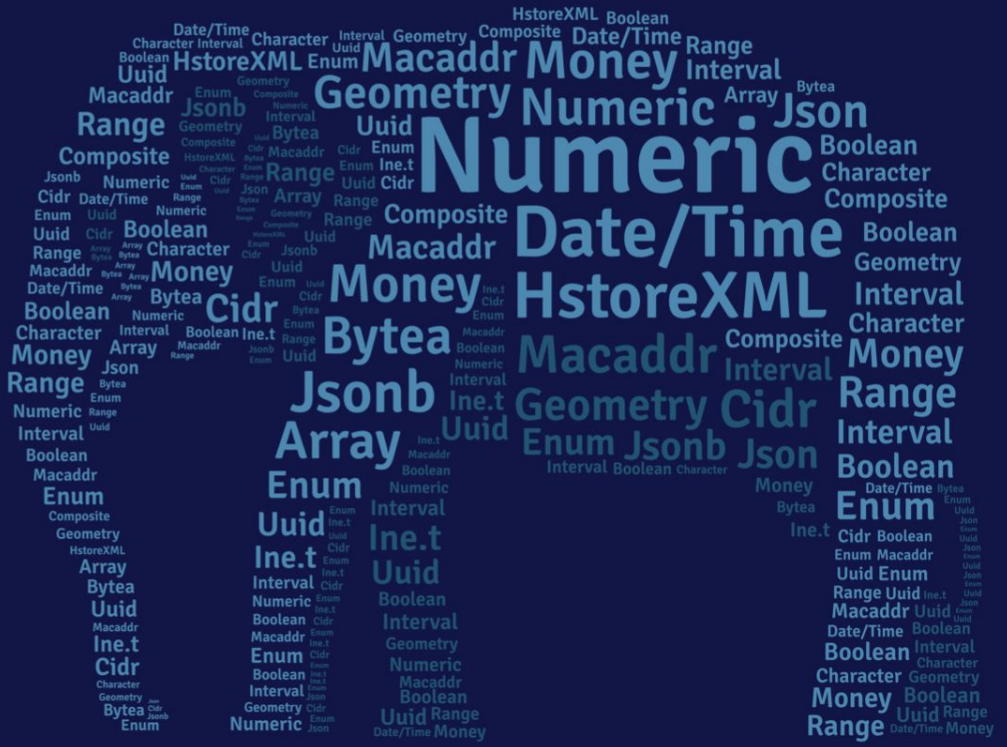
When Cloud Native Postgres is a fit



PostgreSQL Flexible Data Types

for your application





PostgreSQL Flexibility

All Document

```
create table customers(
 customer_document jsonb not null);
```

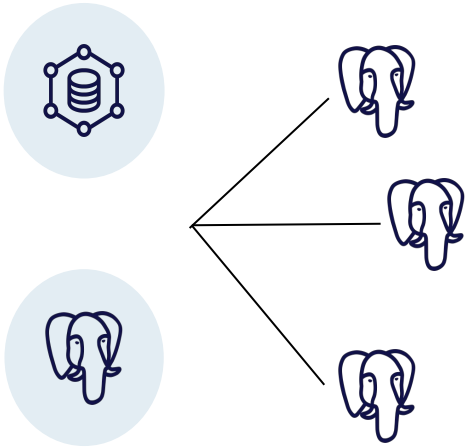
All Relational

```
create table customers (
 customer_id bigserial primary key,
 customer_name text not null,
 age int,
 address text,
 city char(50),
 state char(2),
 zip_code char(10),
    CONSTRAINT fk_state
     FOREIGN KEY(state)
   REFERENCES state(name));
```

Mix of Document and Relational

```
create table customers(
 customer_id bigserial primary key,
 customer_data jsonb not null);
```

Postgres Foreign Data Wrappers (FDWs)



- Communicate with other Postgres databases
- Communicate with the data store of other microservices without pulling data into the application layer
- Query optimizations
- {join, predicate, aggregate} push-down

EDB Postgres Advanced - Database compatibility support

SQL extension support
Decode, NVL, Substr, NVL2, Date/time functions
DDL syntax support

PL/SQL support – native language
REF Cursors, Implicit and explicit cursors
Looping, variable declarations, conditional statements
Collections: Associative Arrays, Varrays, Nested tables
Pragmas
Named parameters
User Defined Exceptions
Explicit Transaction Control (within sp)

Tools
EDB*Plus – SQL*Plus look-a-like
EDB*Loader – SQL*Loader equivalent

Oracle-like Data Dictionary
ALL_, DBA_, USER_ views

Wait Events
System and session waits
Statspack-like reporting

PL/SQL supplied packages
18 DBMS
7 UTL

Data types
Blobs, Clobs, XMLTYPE, VARCHAR2, NUMBER, CHAR, Integer

Drivers
JDBC, ODBC, .NET with Oracle extensions
OCI & ProC compatible drivers

Features
Packages
Stored procedures
Functions
Triggers
Hints
Hierarchical Queries
Synonyms – Public and Private
Sequences
Rownum
Users/Roles
Dynamic SQL
Materialized Views
Partitioning

EDB Postgres Advanced Server 11:
Pragma Autonomous Transaction and DBMS_REDACT

EDB Postgres Advanced Server 12:
Interval partition; MEDIAN, LISTAGG, COMPOUND TRIGGER

Declarative Cluster Configuration

Cloud Native Postgres and BDR

Extends Kubernetes controller and defines how a complex application works

- A Kubernetes operator automates actions of a human being, in a programmatic way
- **A PostgreSQL cluster is a complex application**
  - Deployment and configuration
  - Failure detection and Failover
  - Updates and switchovers
  - Backup and Recovery
- Relies on Kubernetes' native components and capabilities:
  - Self-healing, high availability, scalability, resource control, access, …
  - Declarative and fully automated

Imperative vs Declarative

Imperative

- Create a PostgreSQL 13 instance
- Configure for replication
- Clone a second one
- Set it as a replica
- Clone a third one
- Set it as a replica

Declarative

There’s a PostgreSQL 13 cluster with 2 replicas

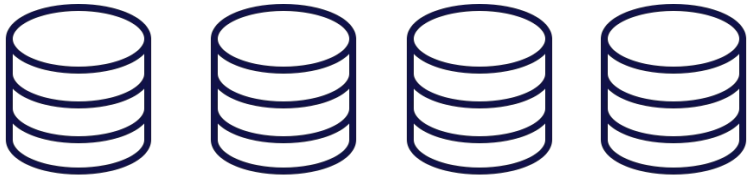
(At any time)

States in Kubernetes

The role of the Kubernetes controller

- Definition of the **desired state** of an object and the overall infrastructure as **configuration**
- **Reconciliation loops:**
  - Current state of the infrastructure matches the desired one
    - If not, the operator reacts to restore the desired state
- Foundation of **self-healing**

Desired state



Actual state

Convention over configuration

```
apiVersion: postgresql.k8s.enterprisedb.io/v1
kind: Cluster
metadata:
  name: myapp-db
spec:
  instances: 3
  imageName: quay.io/enterprisedb/postgresql:13.3-4

  storage:
    size: 10Gi
```


Declarative deployment

```
# Install the operator in the cluster
kubectl apply -f <OPERATOR_MANIFEST_URL>

# Deploy the cluster (declarative)
kubectl apply -f myapp-cluster.yaml
```


Deploy Anywhere

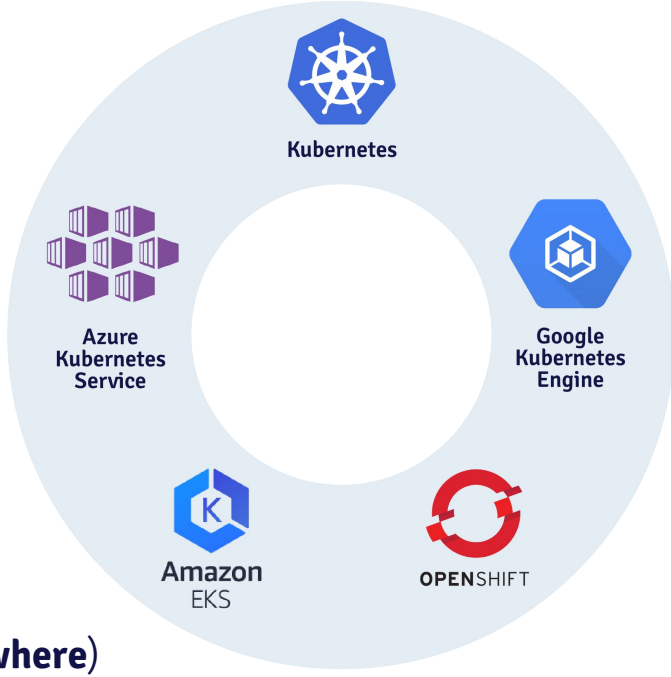
EDB

Story time

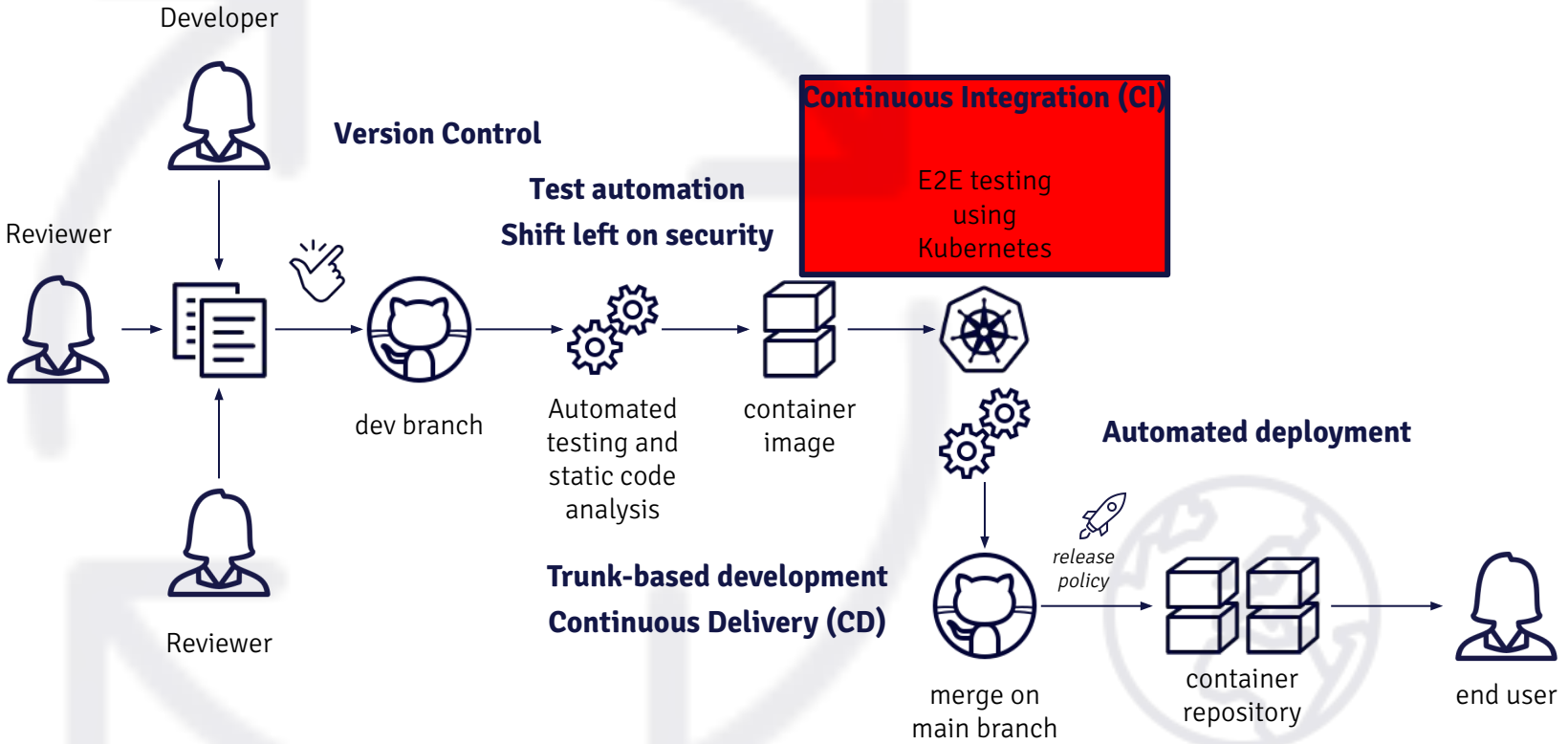
Deploy anywhere

On Premises, Multi/Hybrid Cloud

- Use the same container images from EDB
- Use the same Deployment files
- Only requires K8s 1.16 or higher
  - Tested on AWS, Google, Azure, and OpenShift
- Risk mitigation for vendor lock-in of the cloud platform
  - Standard PostgreSQL backups you own (restore **anywhere**)



CNP - Deploy anywhere (including pipelines)
Real world EDB example



End-To-End tests

Part of the automated CI/CD pipelines with Github actions

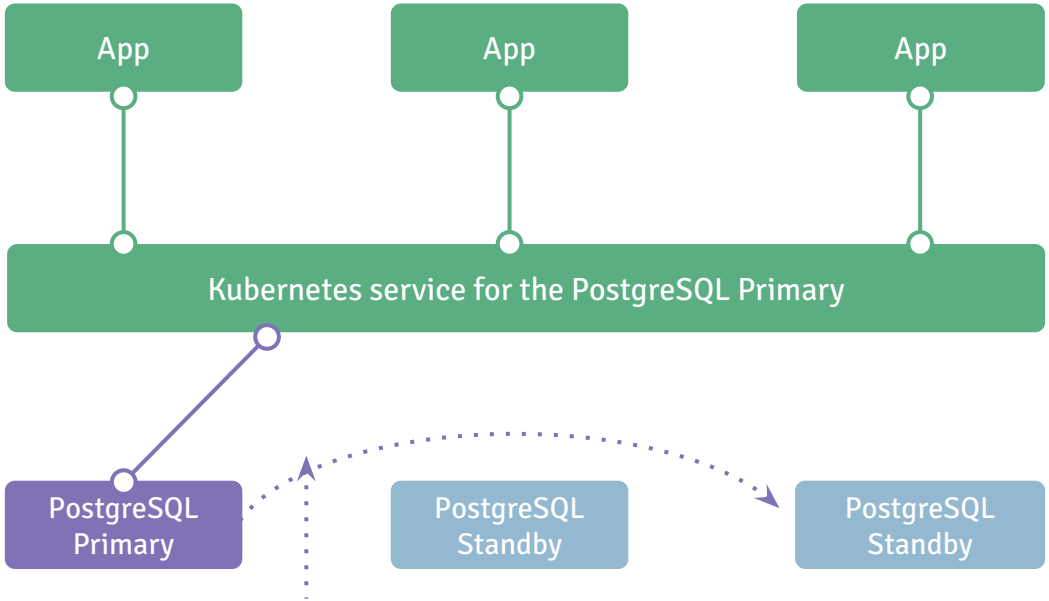
- Rely on Kind (Kubernetes IN Docker) and K3d
  - Tested K8s versions: 1.16, 1.16, 1.17, 1.18, 1.20
    - Including OpenShift and, once a day, major Public Clouds
  - Tested Postgres versions: 10, 11, 12, 13
- Relevant set of tests:
  - Installation and creation of a cluster
  - Scale-up/down of a cluster
  - Failover and Switchover - including performance tests
  - Continuous backup and recovery

Services

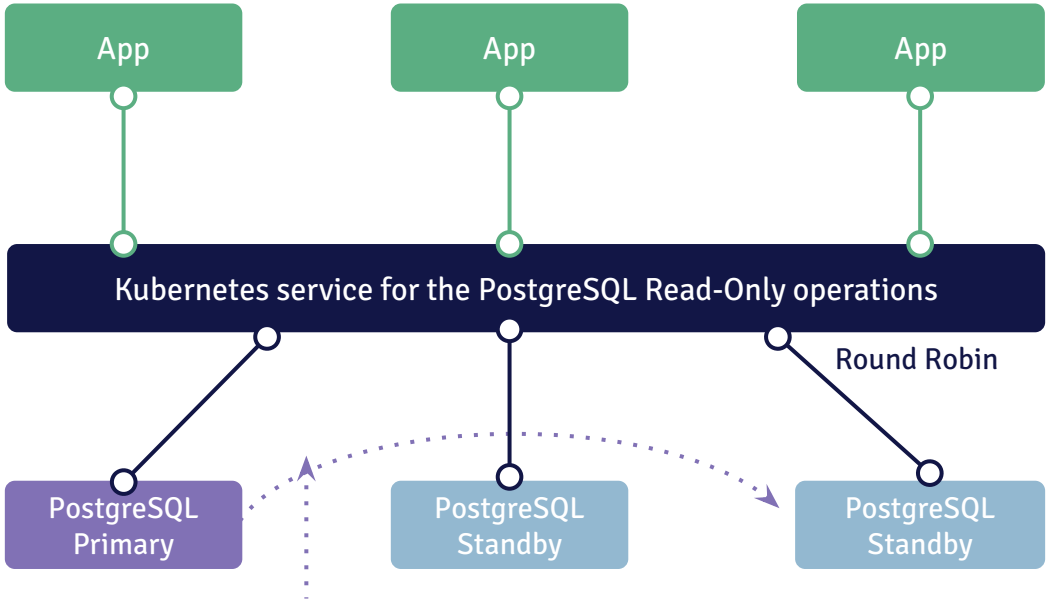
PostgreSQL cluster architecture

- One PostgreSQL primary
- Zero or more hot standby servers
  - PostgreSQL native streaming replication
    - Async (default) and Sync (quorum-based)
  - Required for HA
  - Transparent support for pg_rewind
- Provides apps with three K8s Services:
  - -rw suffix (read-write workloads)
  - -r suffix (read workloads)
  - -ro suffix (read-only workloads)

Read-write workloads (“-rw” service)



Read workloads (“-r” service)



Reliable DNS endpoints
for your application

```
apiVersion: postgresql.k8s.enterprisedb.io/v1
kind: Cluster
metadata:
   name: pg-ha-dolores
spec:
   instances:  3
```

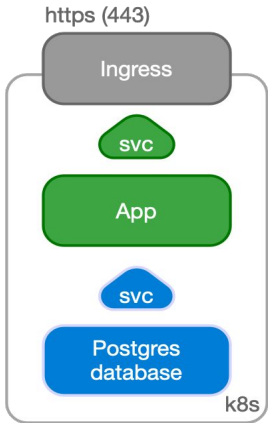
```
#  kubectl apply -f myapp-db.yaml
```

```
#  kubectl get services -o wide
NAME                TYPE        CLUSTER-IP      EXTERNAL-IP   PORT(S)    SELECTOR
pg-ha-dolores-any   ClusterIP   10.96.184.65    ######        5432/TCP   postgresql=pg-ha-dolores
pg-ha-dolores-r     ClusterIP   10.96.225.137   ######        5432/TCP   postgresql=pg-ha-dolores
pg-ha-dolores-ro    ClusterIP   10.96.129.1     ######        5432/TCP   postgresql=pg-ha-dolores, role=replica
pg-ha-dolores-rw    ClusterIP   10.96.168.65    ######        5432/TCP   postgresql=pg-ha-dolores, role=primary
```

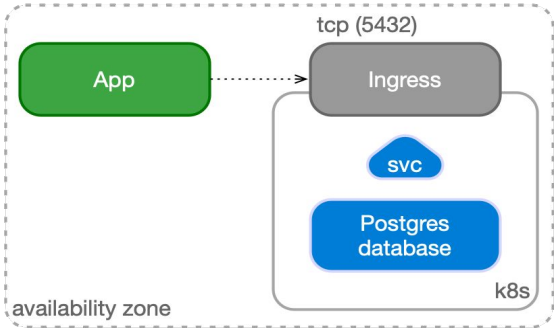
System architectures

Main classification is based on where the application reside

Use case 1: Application and Database in K8s

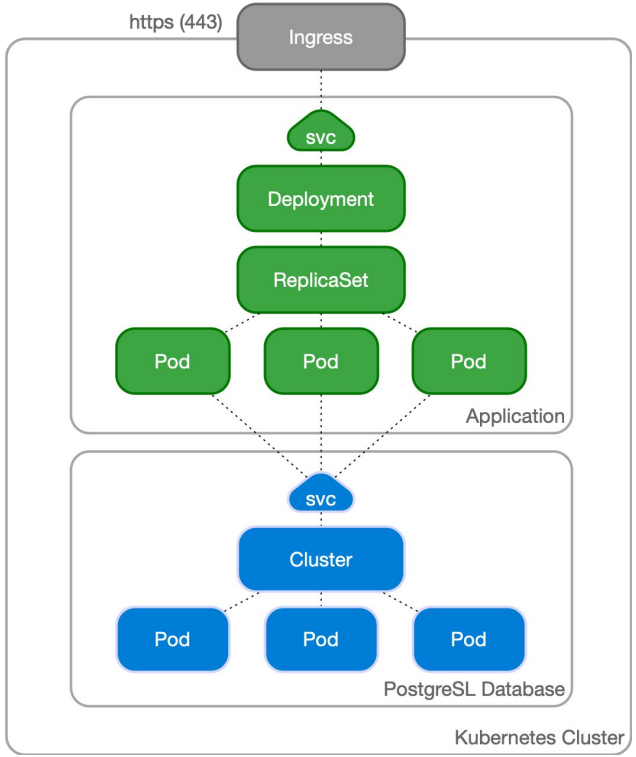


Use case 2: Application outside K8s



Application and Database in K8s

- Stateless application as a deployment
  - Rolling upgrades
  - ReplicaSet for scaling and HA
  - Custom application images (Go, Django, Java, Python, C, C++, …)
- Stateful database using our operator
  - Embeds primary/standby logic
  - Service for RW and Read operations
  - Rolling upgrades, scaling, HA, …
  - “Cluster” CRD



Connecting to the Service

```
1    const (
2    host    =”pg-ha-dolores-rw”
3    port    =5432
4    user    =”dolores”
5    password = “#######”
6    )
7    ...
8    dbWrite := fmt.Sprintf(...)
```

```
1    const (
2    host    =”pg-ha-dolores-ro”
3    port    =5432
4    user    =”dolores-ro”
5    password = “#######”
6    )
7    ...
8    dbRead := fmt.Sprintf(...)
```

Advanced database features, no DBA required

Default pg_hba.conf settings

```
# Grant local access
local all all peer
# TLS for replication
hostssl postgres streaming_replica all cert clientcert=1
hostssl replication streaming_replica all cert clientcert=1

# CUSTOM SETTINGS GO HERE

# Require md5 authentication elsewhere
host all all all md5
```

Refer to “How to Issue a TLS Certificate for Cloud Native PostgreSQL” for details

Synchronous replication

```
apiVersion: postgresql.k8s.enterprisedb.io/v1
kind: Cluster
metadata:
  name: cluster-example
spec:
  instances: 3
  minSyncReplicas: 1
  maxSyncReplicas: 2
  storage:
    size: 1Gi
```

Refer to “Streaming replication overview” for details

PostgreSQL configuration

```
apiVersion: postgresql.k8s.enterprisedb.io/v1
kind: Cluster
metadata:
  name: cluster-example
spec:
  instances: 3
  postgresql:
    parameters:
      work_mem: "8MB"
      # …
  # ...
```

Refer to “PostgreSQL configuration” for details

Enabling EDB Postgres Server

```
apiVersion: postgresql.k8s.enterprisedb.io/v1
kind: Cluster
metadata:
  name: cluster-example
spec:
 instances: 3
 imageName: quay.io/enterprisedb/edb-postgres-advanced:13.3.6-2
 licenseKey: <PASTE_YOUR_LICENSE_KEY_HERE>

 # ...
```

Refer to “Evaluation of EDB Postgres Advanced” for details

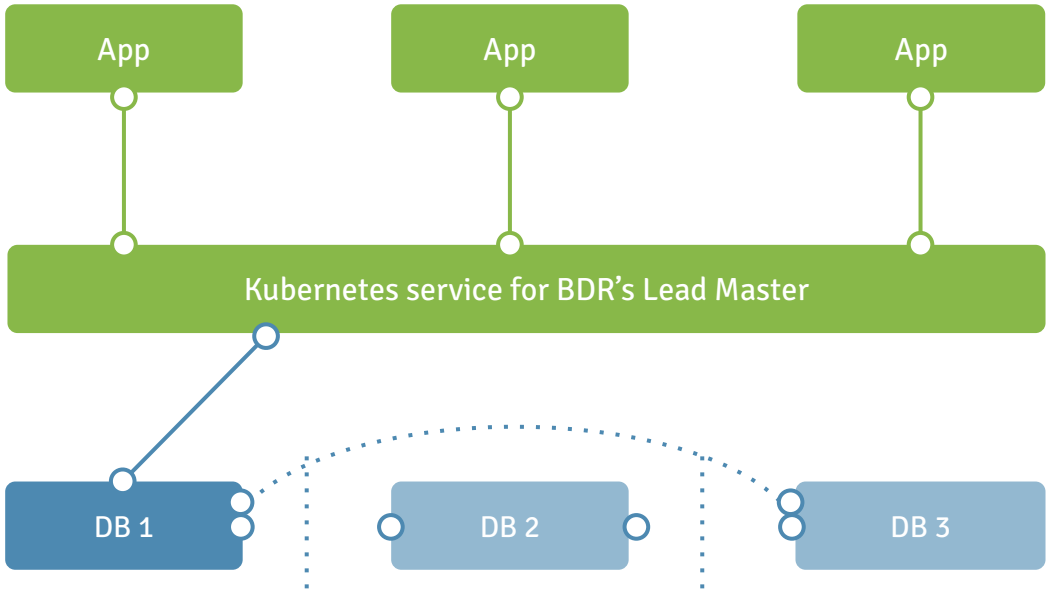
Cloud Native BDR (Q4 2021)

Cloud Native BDR

Kubernetes operator that manages multi-master architectures with BDR

- First EDB rebranded version expected in Q4/2021
- Multi-Master technology
  - Full mesh replication solution
  - Including DDL and DML statements
  - BDR is an extension for PostgreSQL
- Based on Cloud Native PostgreSQL
  - All concepts explained earlier apply here as well
  - “BdrGroup” CRD implementing the **WriteAnywhere** architecture

Lead-master workloads (HA)



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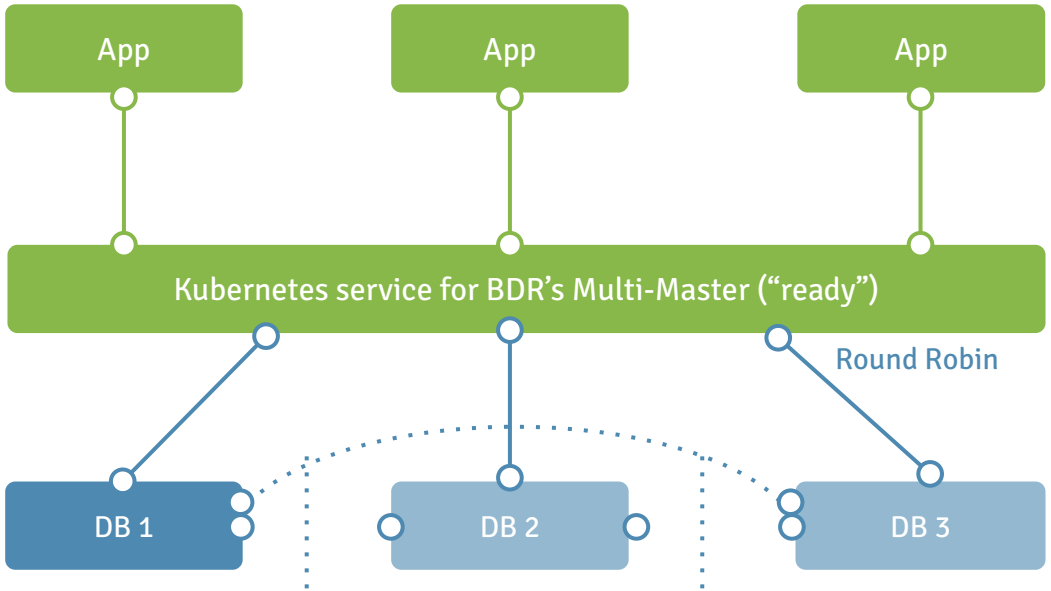
Multi-master workloads (“ready” service)



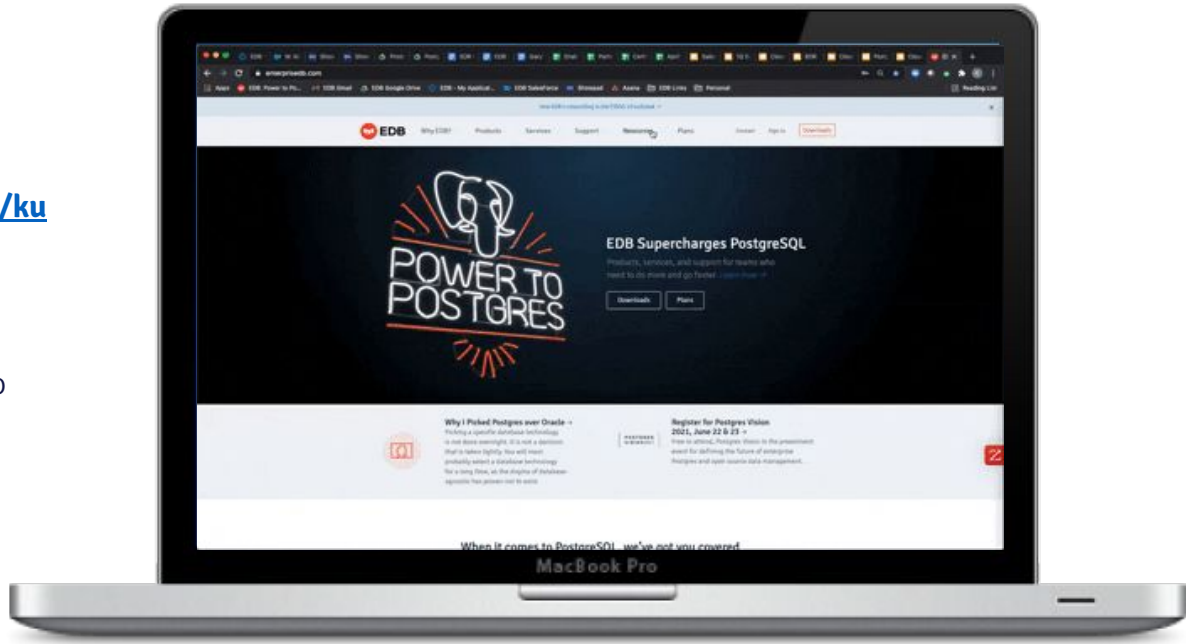
Recommended Next Steps

EDB docs

Don’t forget about the rich experience for Cloud Native Postgres in EDB Docs!

Visit the Cloud Native Postgres docs site:
https://www.enterprisedb.com/docs/kubernetes/cloud_native_postgresql/

- Detailed documentation
- Trial guidance
- Interactive demo (as visualized to the right!)



Evaluation/Trial

Operator with PostgreSQL

- No trial license key required
- No reconciliation attempt after 30d
  - From the creation of each Postgres cluster

Operator with EDB Postgres Advanced

- A trial license key is required
- Expiry date = 60d from license request
- No reconciliation attempt after expiry date

Recommended Next Steps

Proof of Concept

- Plan to deploy and test on YOUR K8s cluster
- How can EDB help ensure success?