



How to put a Database in K8s

Jeff Carpenter – Software Engineer @ DataStax

October 14, 2021

How to put a Database in K8s

The idea of running a stateful workload in Kubernetes can be intimidating, especially if you haven't done it before. How do you deploy a database? Where is the actual storage? How is the storage mapped to the database or application that uses it? In this talk, we'll demystify the deployment of databases and stateful workloads in K8s by showing that databases are just applications composed of compute, network and storage. We can deploy them like any other Kubernetes application and take advantage of resources that K8s provides including Storage Classes, Persistent Volumes, Persistent Volume Claims, and Stateful Sets. We will demonstrate how to make it all work by deploying a relational database (MySQL) and a NoSQL database (Apache Cassandra).



Who am I?

- Developer
- Architect
- Author
- Advocate
- Defense
- Hospitality
- R&D
- Distributed Systems
- Large Scale
- Cassandra

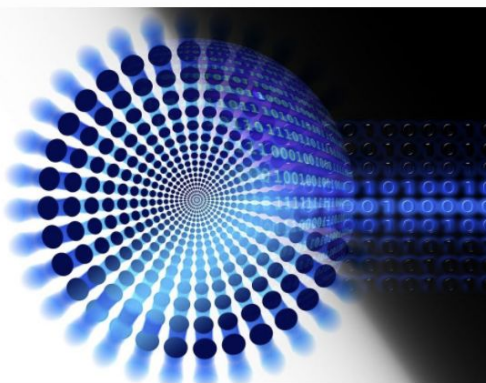
Wait, you can run databases on K8s?



DATA / KUBERNETES / SPONSORED / CONTRIBUTED

A Case for Databases on Kubernetes from a Former Skeptic

5 Apr 2021 9:00am, by Christopher Bradford



Kubernetes is everywhere. Transactional apps, video streaming services and machine learning workloads are finding a home on this ever-growing platform. But what about databases? If you had asked me this question five years ago, the answer would have been a resounding “No!” — based on my experience in development and operations. In the following years, as more resources emerged for stateful applications, my answer would have changed to “Maybe,” but always with a qualifier: “It’s fine for development or test environments...” or “If the rest of your tooling is Kubernetes-based, and you have extensive experience...”

But how about today? Should you run a database on Kubernetes? With complex operations and the requirements of persistent, consistent data, let’s retrace the stages in the journey to my current answer: “In a cloud native environment? Yes!”

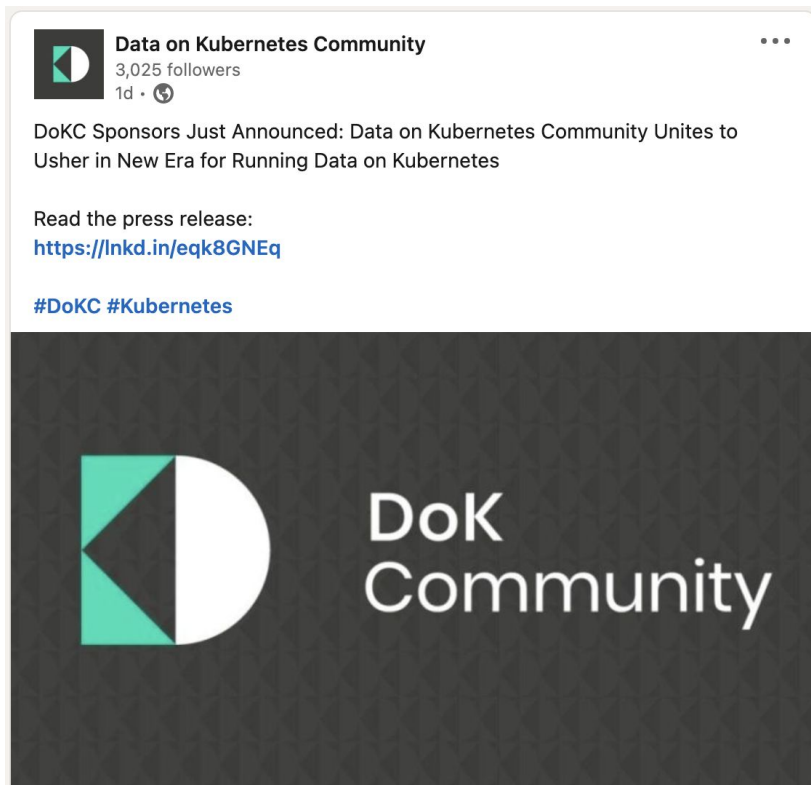
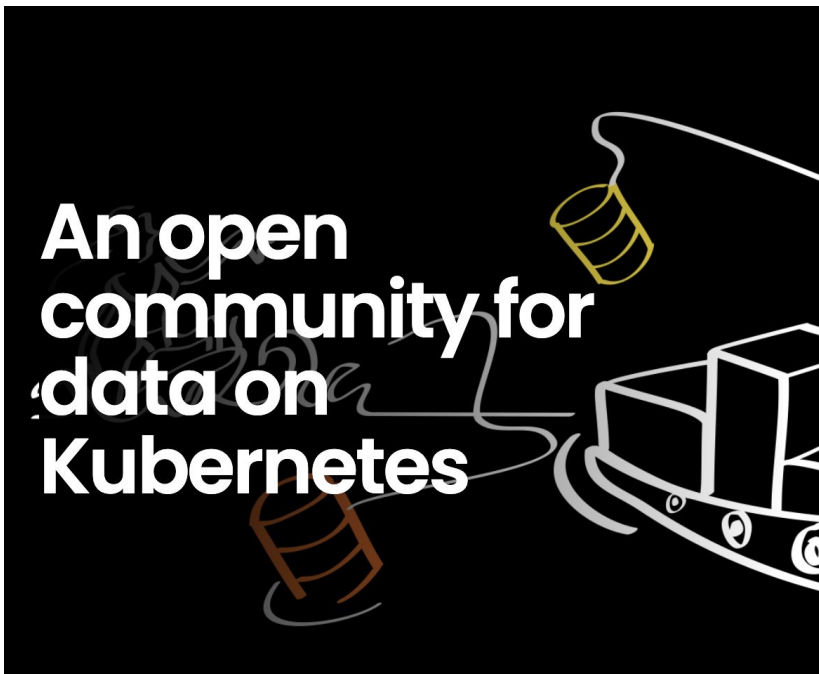


Christopher
Bradford

Christopher has a passion for enabling efficiency through automation. From promoting effortless scaling via Cassandra to DevOps pipelines with infrastructure automation and containers, he is here to get work done and enable operators to rest easy.

<https://thenewstack.io/a-case-for-databases-on-kubernetes-from-a-former-skeptic/>

Data on Kubernetes Community – <https://dok.community>



“90% of respondents believe K8s is ready for stateful workloads, and a large majority (70%) are running them in production with databases topping the list. ”

Data on Kubernetes 2021 Research Report

https://dok.community/wp-content/uploads/2021/10/DoK_Report_2021.pdf

How to put a database on Kubernetes

(in 4 easy
steps?)

01

Learn the Kubernetes
primitives

02

Pick a storage
provider

03

Pick a database

04

Pick an operator

How to put a database on Kubernetes

01

Learn the Kubernetes primitives

02

Pick a storage provider

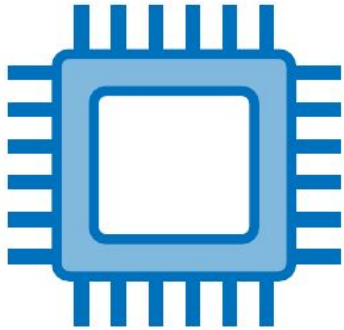
03

Pick a database

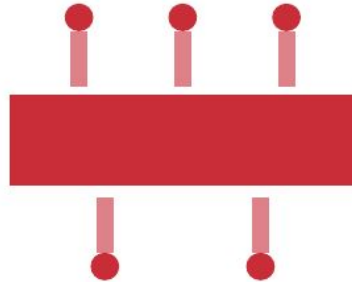
04

Pick an operator

Fundamental Resources



Compute

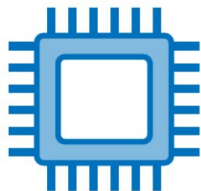


Network



Storage

Kubernetes Primitives



Compute



Network



Storage



Node



Pod



Namespace



Service



Volume



PersistentVolume



Deployment



ReplicaSet



StatefulSet



DaemonSet



Ingress

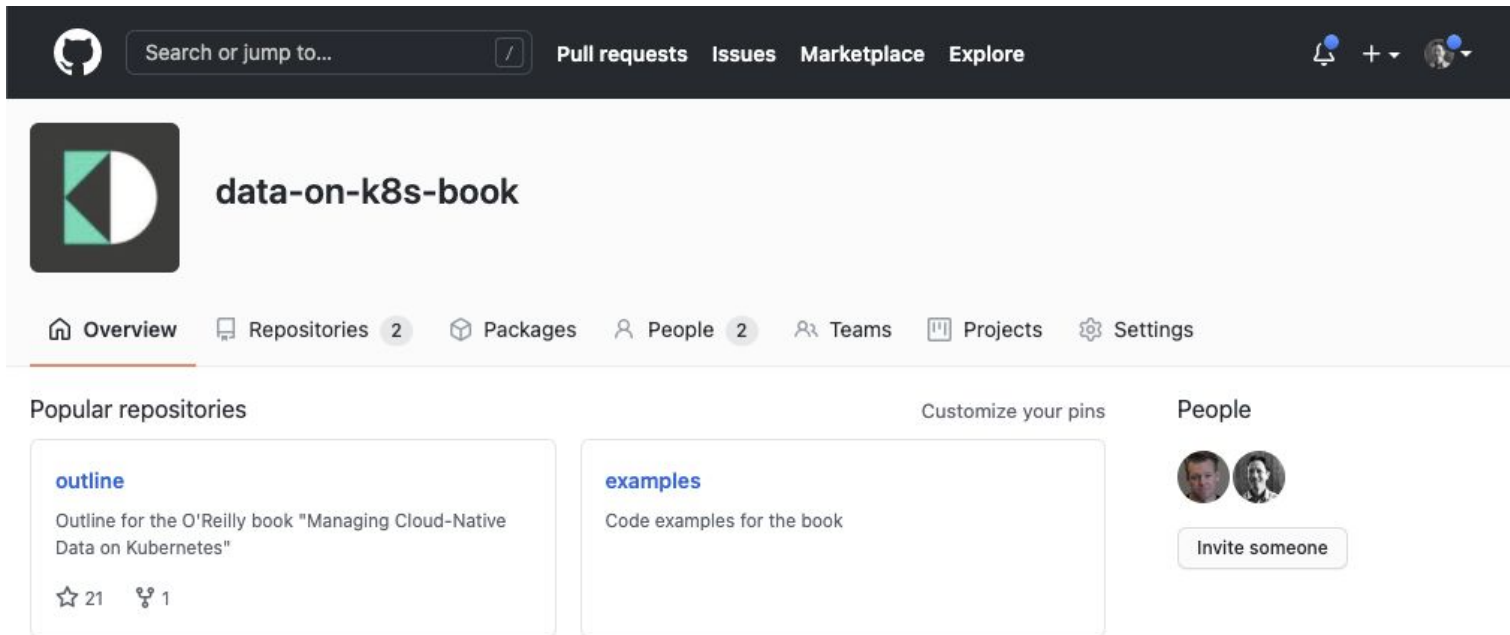


PersistentVolumeClaim



StorageClass

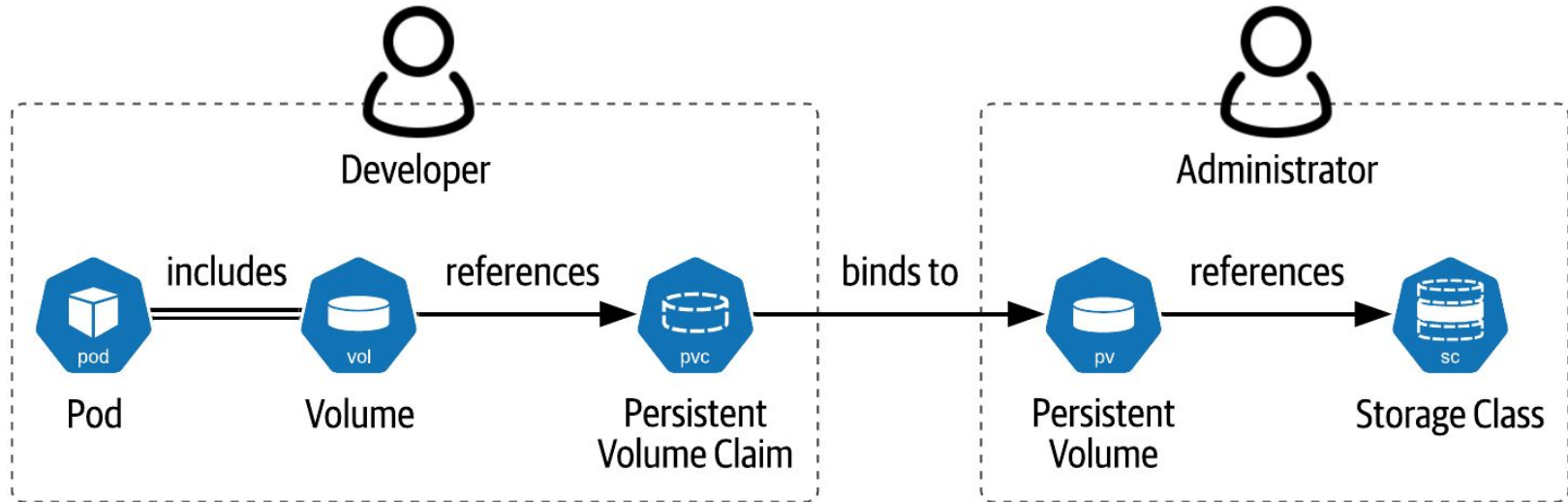
Example code



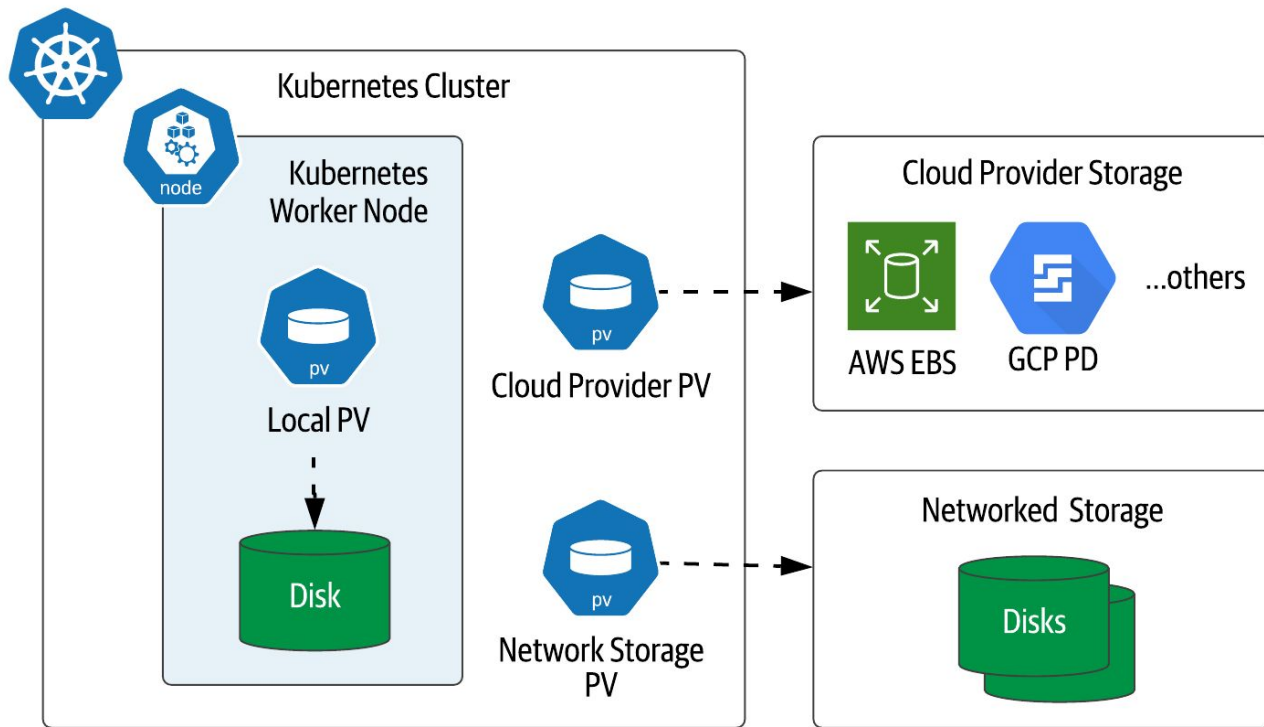
The screenshot shows the GitHub interface for the repository 'data-on-k8s-book'. The repository owner's profile picture is a green and white 'D' logo. The repository name is 'data-on-k8s-book'. Below the repository name, there are tabs for 'Overview', 'Repositories' (with a count of 2), 'Packages', 'People' (with a count of 2), 'Teams', 'Projects', and 'Settings'. The 'Overview' tab is selected. Under the 'Popular repositories' section, there are two pinned repositories: 'outline' (with 21 stars and 1 fork) and 'examples' (with the description 'Code examples for the book'). To the right of the pinned repositories, there is a 'Customize your pins' link and a 'People' section showing two profile pictures and an 'Invite someone' button.

<https://github.com/data-on-k8s-book/examples>

Kubernetes Persistent Volume Subsystem



Persistent Volumes



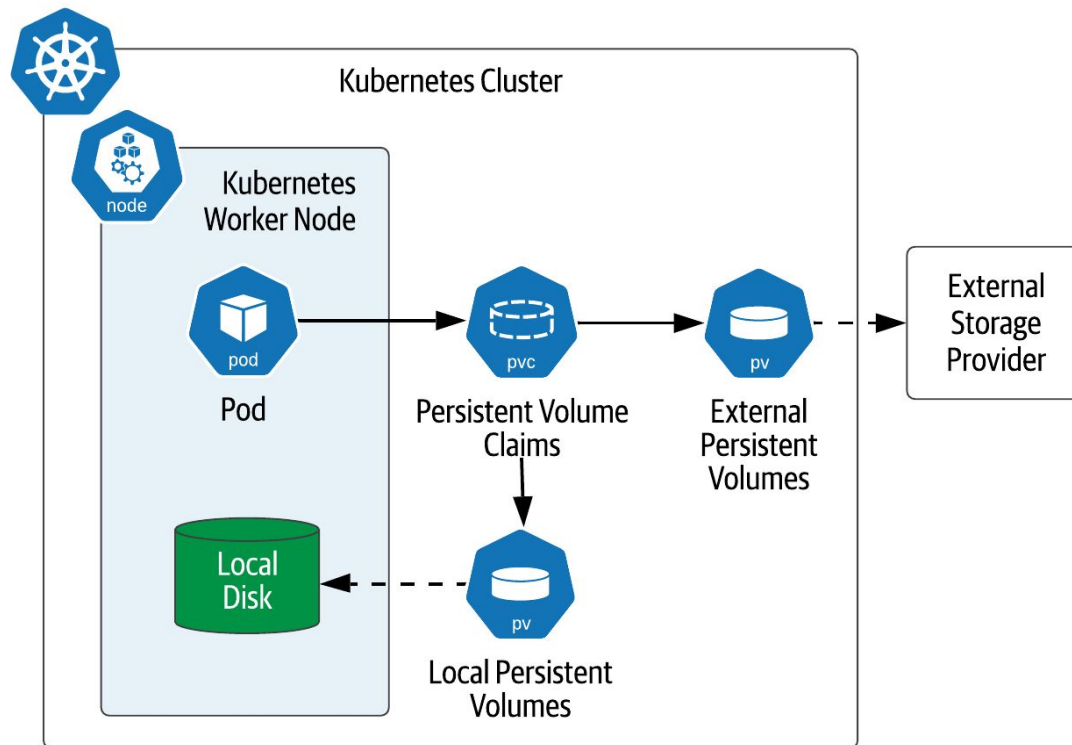
Persistent Volumes

Example local volume using node affinity

Default storage class

```
apiVersion: v1
kind: PersistentVolume
metadata:
  name: my-volume
spec:
  capacity:
    storage: 3Gi
  accessModes:
    - ReadWriteOnce
  local:
    path: /app/data
  nodeAffinity:
    required:
      nodeSelectorTerms:
        - matchExpressions:
            - key: kubernetes.io/hostname
              operator: In
              values:
                - node1
```

Persistent Volume Claims



Persistent Volume Claims

```
apiVersion: v1
kind: PersistentVolumeClaim
metadata:
  name: my-claim
spec:
  storageClassName: ""
  accessModes:
    - ReadWriteOnce
  resources:
    requests:
      storage: 1Gi
```

```
apiVersion: v1
kind: Pod
metadata:
  name: my-pod
spec:
  containers:
    - name: nginx
      image: nginx
      volumeMounts:
        - mountPath: "/app/data"
          name: my-volume
  volumes:
    - name: my-volume
      persistentVolumeClaim:
        claimName: my-claim
```


How to put a database on Kubernetes

01

Learn the Kubernetes primitives

02

Pick a storage provider

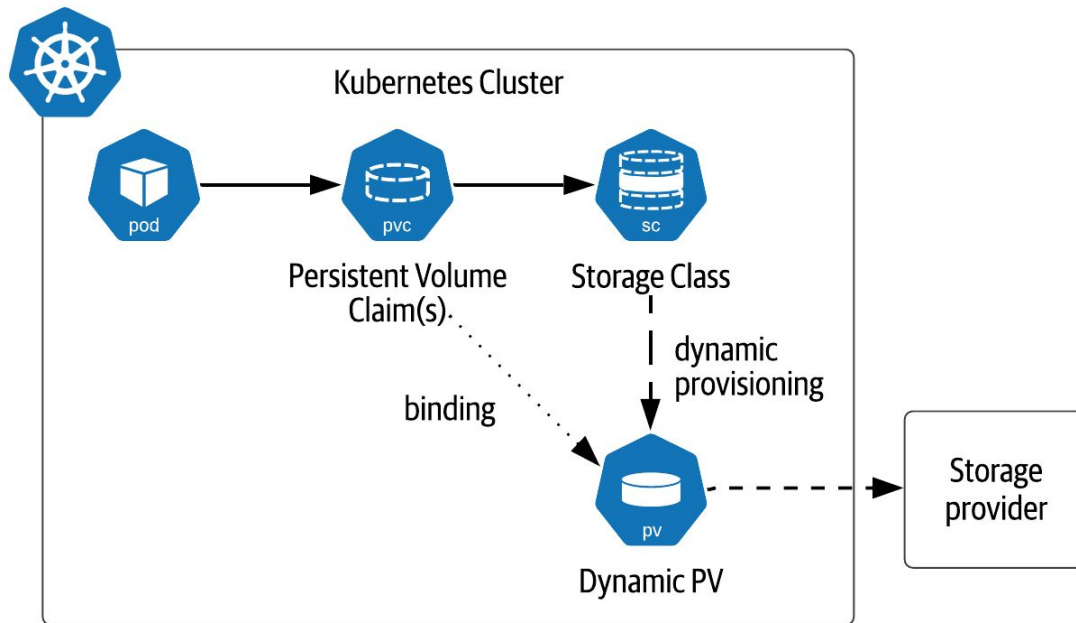
03

Pick a database

04

Pick an operator

Storage Class



Storage Classes

Many options available

- Local Storage
- Networked Storage
- Object Storage

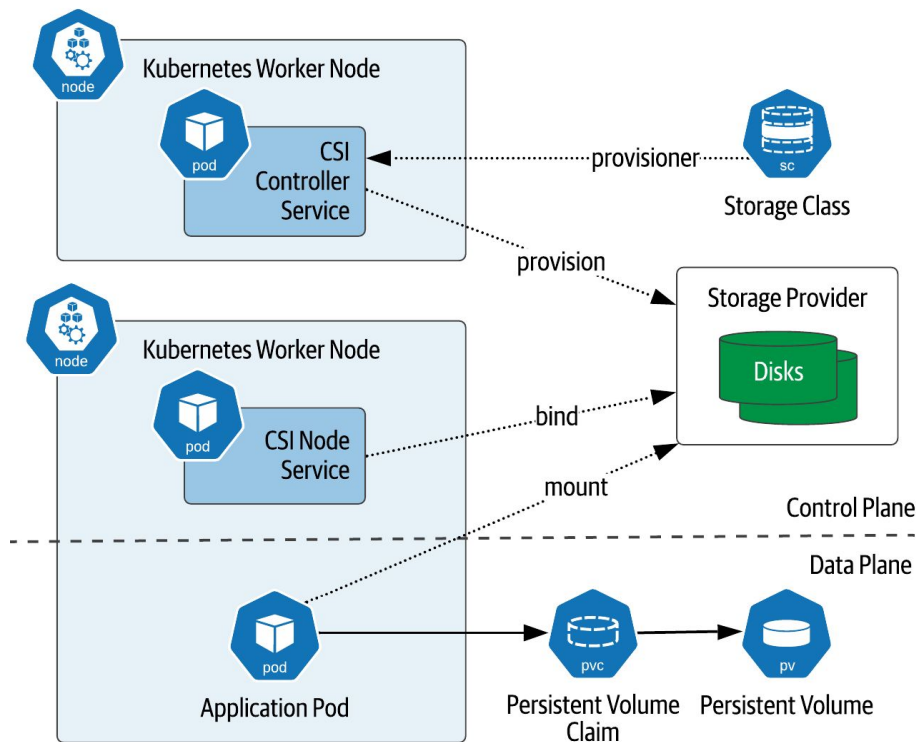
Many providers

- Public clouds
- CSI-compliant vendors

<https://kubestr.io/>

```
apiVersion: storage.k8s.io/v1
kind: StorageClass
metadata:
  name: local-path
provisioner: rancher.io/local-path
volumeBindingMode: WaitForFirstConsumer
reclaimPolicy: Delete
```

Container Storage Interface (CSI)



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Let's try a database

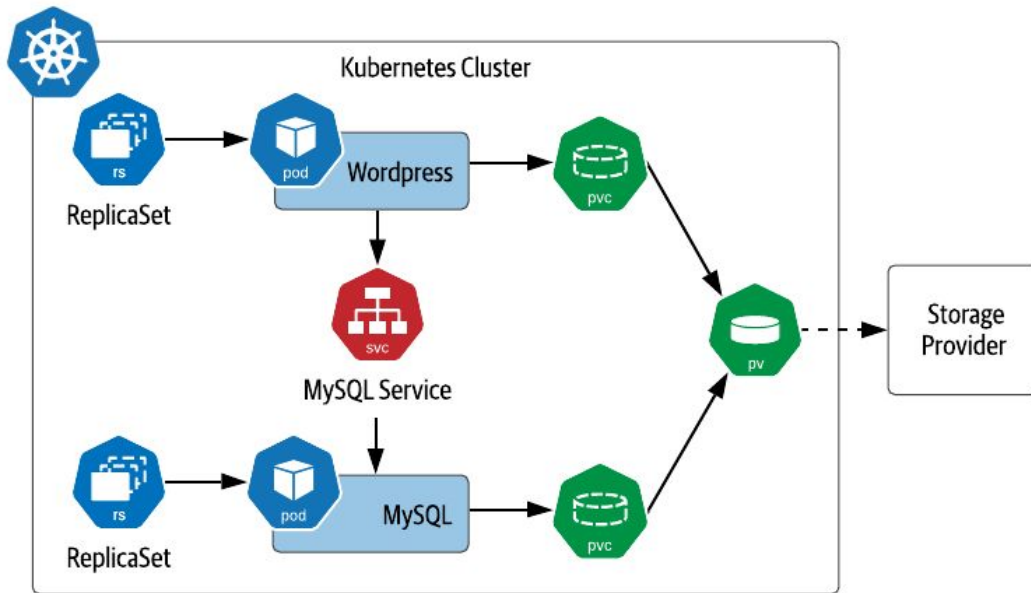
Relational, Single Node



NoSQL, Multiple Nodes



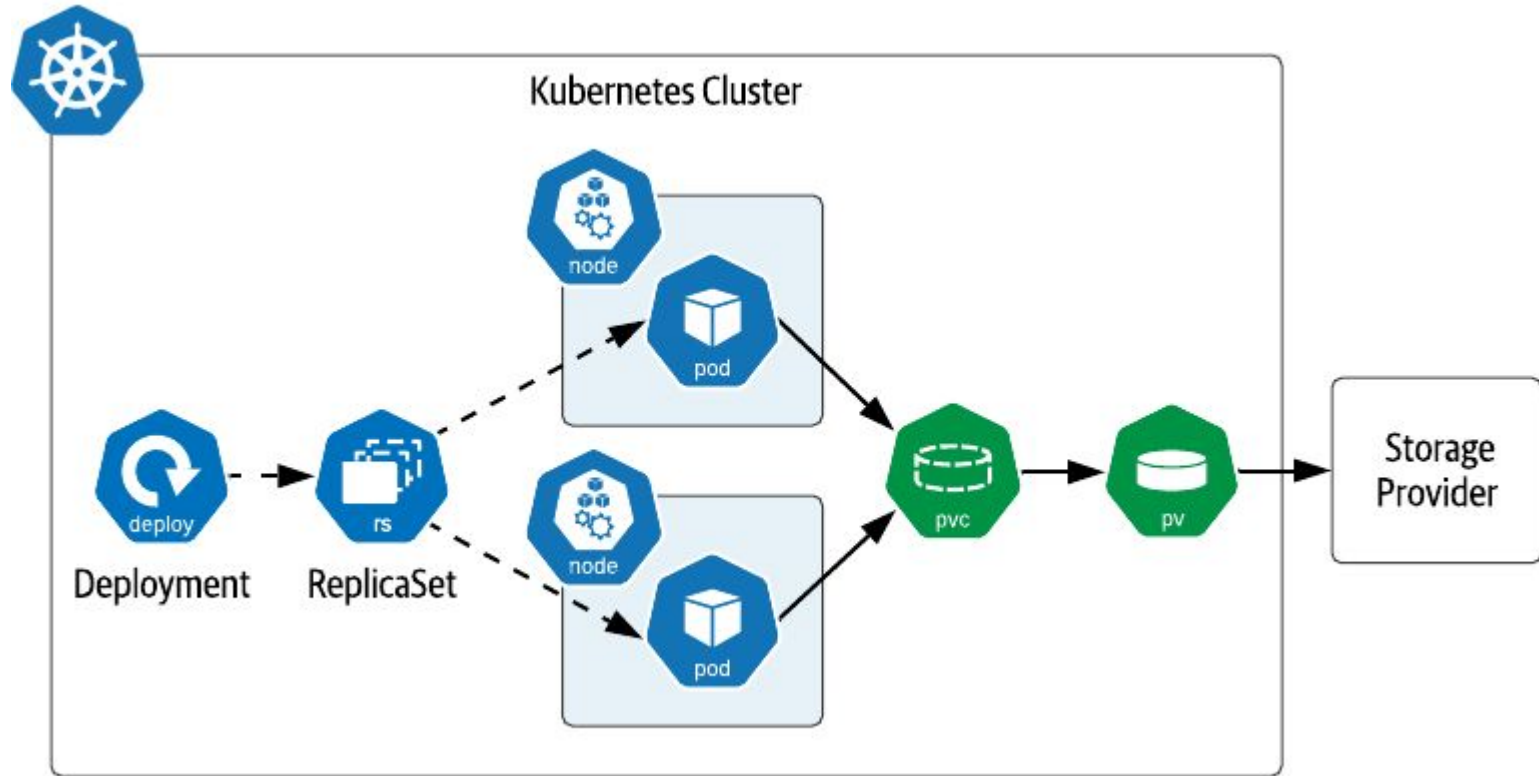
Deploying MySQL on K8s



Inspiration: <https://kubernetes.io/docs/tutorials/stateful-application/mysql-wordpress-persistent-volume/>

Update: <https://github.com/data-on-k8s-book/examples/tree/main/ch3-mysql>

Deployments and Replica Sets



Secret and PVC - MySQL

```
kubectl create secret generic  
mysql-root-password  
--from-literal=password=<your password>
```

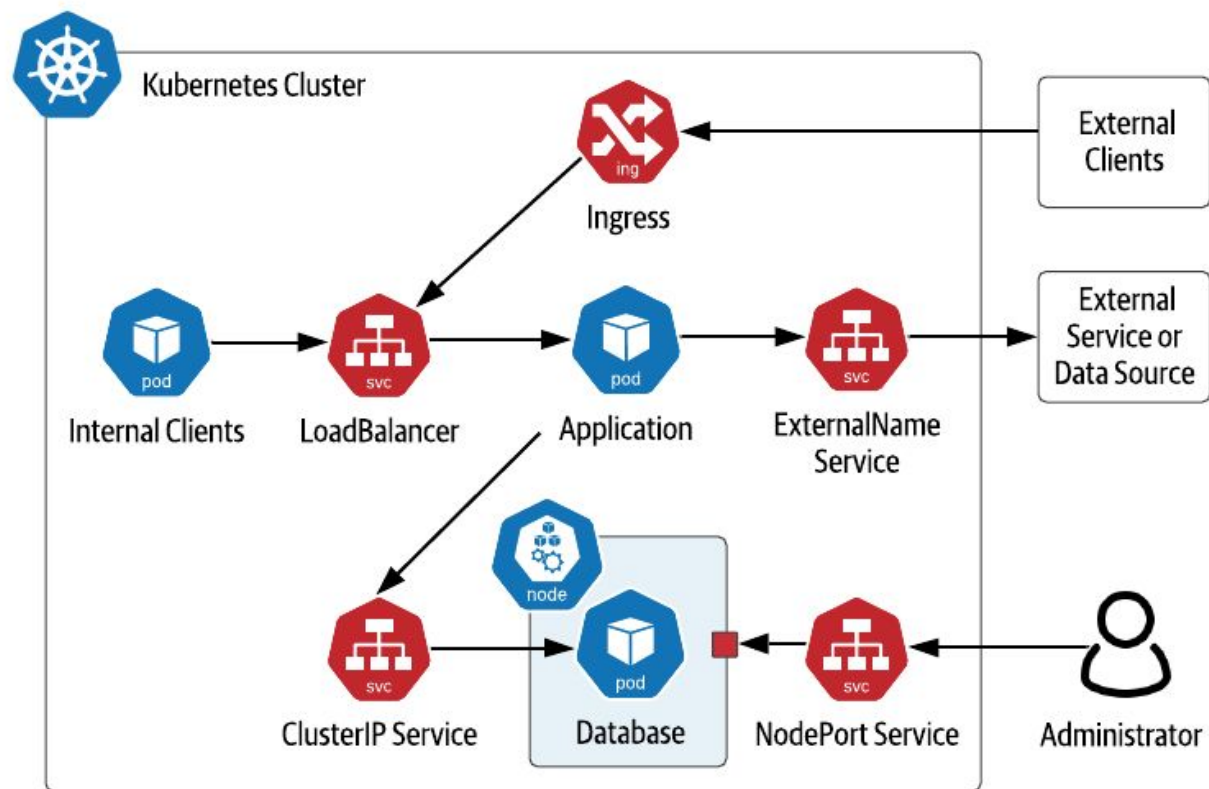
```
apiVersion: v1  
kind: PersistentVolumeClaim  
metadata:  
  name: mysql-pv-claim  
  labels:  
    app: wordpress  
spec:  
  accessModes:  
    - ReadWriteOnce  
  resources:  
    requests:  
      storage: 1Gi
```

Deployment – MySQL

```
apiVersion: apps/v1
kind: Deployment
metadata:
  name: wordpress-mysql
  labels:
    app: wordpress
spec:
  selector:
    matchLabels:
      app: wordpress
      tier: mysql
  strategy:
    type: Recreate
  template:
    metadata:
      labels:
        app: wordpress
        tier: mysql
```

```
spec:
  containers:
    - image: mysql:5.7
      name: mysql
      env:
        - name: MYSQL_ROOT_PASSWORD
          valueFrom:
            secretKeyRef:
              name: mysql-root-password
              key: password
      ports:
        - containerPort: 3306
          name: mysql
      volumeMounts:
        - name: mysql-persistent-storage
          mountPath: /var/lib/mysql
  volumes:
    - name: mysql-persistent-storage
      persistentVolumeClaim:
        claimName: mysql-pv-claim
```

Services

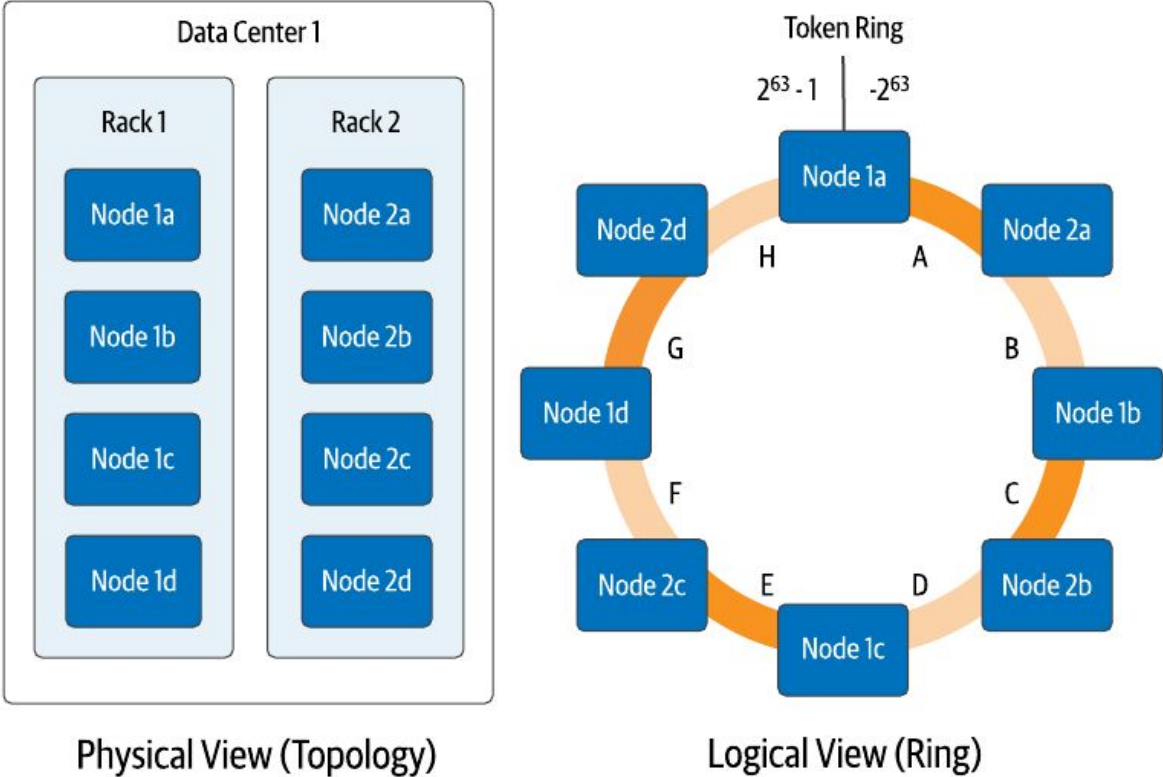


Service – MySQL

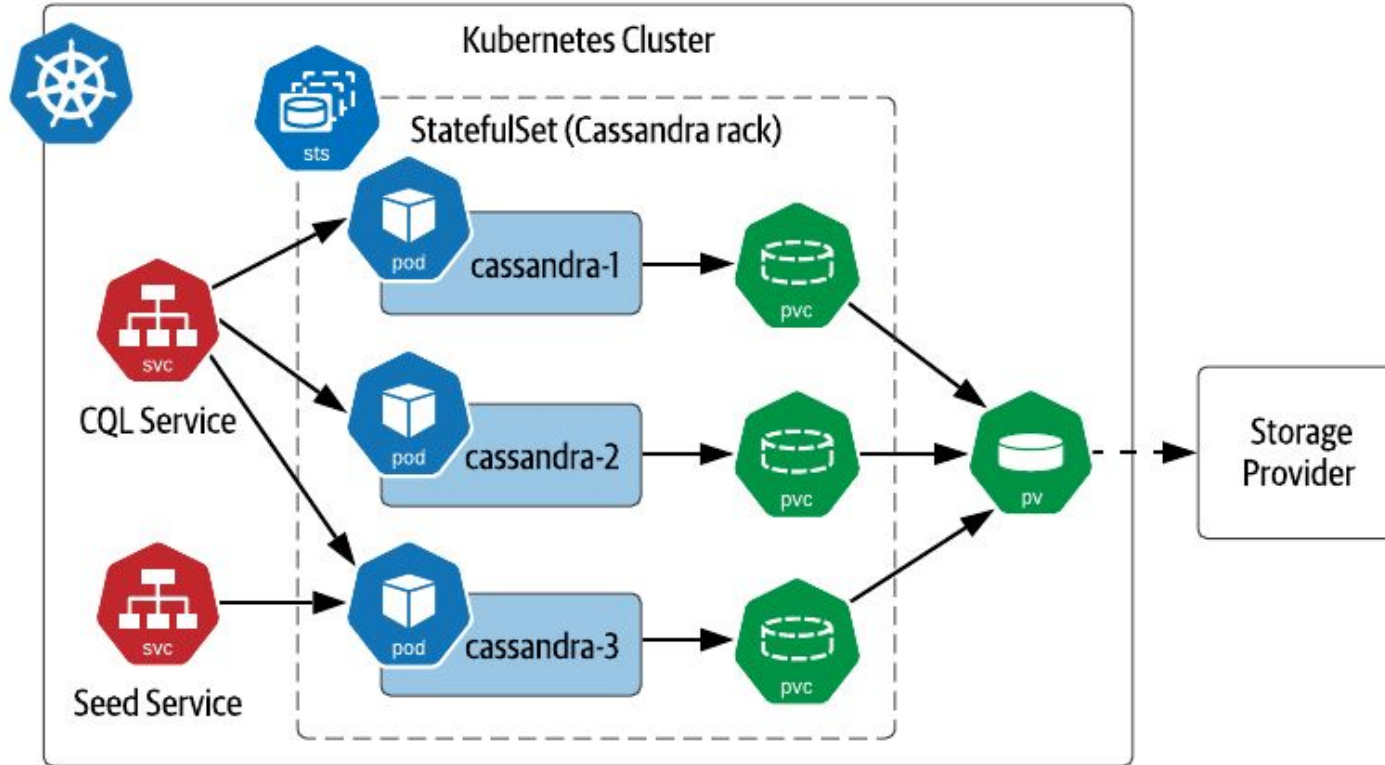
Headless service for access within cluster

```
apiVersion: v1
kind: Service
metadata:
  name: wordpress-mysql
  labels:
    app: wordpress
spec:
  ports:
    - port: 3306
  selector:
    app: wordpress
    tier: mysql
  clusterIP: None
```

Cassandra - Logical and Physical Views



Deploying Cassandra on K8s



Service – Cassandra

Headless service for access within cluster

```
apiVersion: v1
kind: Service
metadata:
  labels:
    app: cassandra
  name: cassandra
spec:
  clusterIP: None
  ports:
    - port: 9042
  selector:
    app: cassandra
```

StatefulSet – Cassandra

```
apiVersion: apps/v1
kind: StatefulSet
metadata:
  name: cassandra
  labels:
    app: cassandra
spec:
  serviceName: cassandra
  replicas: 3
  podManagementPolicy: OrderedReady
  updateStrategy: RollingUpdate
  selector:
    matchLabels:
      app: cassandra
  template:
    metadata:
      labels:
        app: cassandra
```

```
spec:
  containers:
    - name: cassandra
      image: cassandra
      ports:
        - containerPort: 7000
          name: intra-node
        - containerPort: 7001
          name: tls-intra-node
        - containerPort: 7199
          name: jmx
        - containerPort: 9042
          name: cql
      lifecycle:
        preStop:
          exec:
            command:
              - /bin/sh
              - -c
              - nodetool drain
```


StatefulSet – Cassandra (cont.)

```
env:
  - name: CASSANDRA_CLUSTER_NAME
    value: "cluster1"
  - name: CASSANDRA_DC
    value: "dc1"
  - name: CASSANDRA_RACK
    value: "rack1"
  - name: CASSANDRA_SEEDS
    value:
      "cassandra-0.cassandra.default.svc.cluster.local"

volumeMounts:
  - name: cassandra-data
    mountPath: /var/lib/cassandra
```

```
volumeClaimTemplates:
  - metadata:
      name: cassandra-data
    spec:
      accessModes: [ "ReadWriteOnce" ]
      storageClassName: standard-rwo
      resources:
        requests:
          storage: 1Gi
```

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“If you’re running a database on K8s, you should be using an operator.”

Rick Vasquez, Western Digital

DoK Community Day - Kubecon NA 2021

Cass-operator – <https://github.com/k8ssandra/cass-operator>

Search or jump to... Pull requests Issues Marketplace Explore

k8ssandra / cass-operator Public

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master cass-operator / README.md Go to file

jdonenine Fossa Integration (#112) Latest commit eb5042f on Jun 15 History

10 contributors

368 lines (274 sloc) 15.3 KB

Cass Operator

license Apache-2.0

The DataStax Kubernetes Operator for Apache Cassandra®. This repository replaces the old [datastax/cass-operator](#) for use-cases in the k8ssandra project. Some documentation is still out of date and will be modified in the future. Check [k8ssandra/k8ssandra](#) for more up to date information.

Deploying Cassandra on K8s – What's Missing?

Affinity / Anti-Affinity

Resource requests

Availability / PodDisruptionBudgets

Backup and Restore

Secure provisioning of access credentials

Expanding volumes



K8SSANDRA

Cloud native, scalable data tier with administration tools and easy data access

K8ssandra – A Complete Cassandra Ecosystem for K8s



Data Gateway providing REST, GraphQL, Document APIs



Scalable cloud-native database managed via cass-operator



Cassandra utilities for repair and backup/restore



Prometheus



Grafana

Metrics aggregation and visualization



Packaged and delivered via Helm charts

Jeff Carpenter, Software Engineer, DataStax | @jscarp | jscarp.medium.com

Kubecon Talk on Thursday, October 14

2:30 PM - 3:05 PM

Investigating multi-cluster
deployments for data
(Intermediate level)

<https://sched.co/IV2m>



**Taking Your Database
Beyond the Border of a
Single Kubernetes Cluster**

Christopher Bradford, DataStax / Ty Morton, Google
Thursday, October 14 / 2:30pm - 3:05pm

KubeCon | CloudNativeCon
North America 2021

**RESILIENCE
REALIZED**

The poster features a teal background with a stylized sun rising over waves on the right side. The sun is a red semi-circle, and the waves are light blue. The text is white and red. The KubeCon and CloudNativeCon logos are at the bottom left, and the 'RESILIENCE REALIZED' text is on the right.

New Book!

Early release now available at: <https://learning.oreilly.com>
and
<https://portworx.com/resource/ebook-managing-cloud-native-data-on-kubernetes/>

Chapter 1: Introduction to Cloud Native Data Infrastructure

Chapter 2: Managing Data Storage on Kubernetes

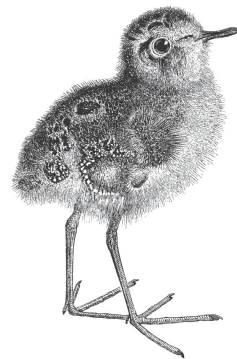
Chapter 3: Running Databases on Kubernetes (the hard way)

More info: <https://github.com/data-on-k8s-book>

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