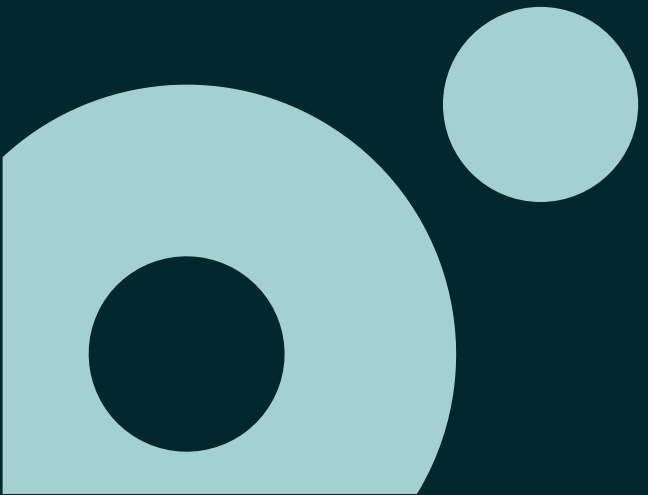
Containers & Kubernetes

Session #08



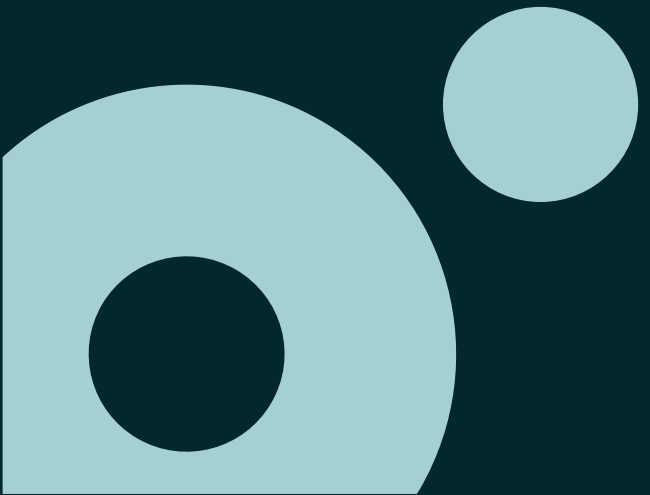
Storage

ConfigMaps

Secrets

Lab

Storage



Motivation

Storage

- On-disk files in a container are ephemeral, which presents some problems for non-trivial applications when running in containers
- One problem is the loss of files when a container crashes. The kubelet restarts the container but with a clean state
- A second problem occurs when sharing files between containers running together in a Pod.
- The Kubernetes volume abstraction solves both of these problems.

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Kubernetes Volumes

Storage

- Kubernetes supports many types of volumes and a Pod can use any number of volume types simultaneously
- Ephemeral volume types have a lifetime of a pod
- Persistent volumes exist beyond the lifetime of a pod
- When a pod ceases to exist, Kubernetes destroys ephemeral volumes; however, Kubernetes does not destroy persistent volumes

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Ephemeral Volumes

Storage

- Some application need additional storage but don't care whether that data is stored persistently across restarts, like caching services
- Other applications expect some read-only input data to be present in files, like configuration data or secret keys
- Ephemeral volume are designed for these use cases. Because volumes follow the Pod's lifetime and get created and deleted along with the Pod
- Volumes are defined on Pod Spec along containers
- Mount concept follows Docker volume mount strategy

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Types of Ephemeral Volumes

Storage

- Empty Dir – A temporary folder for all containers within a Pod to read/write to.
- Host Path – Mounts a file or directory from the host node's filesystem into your Pod. Not practical in a multi-node cluster.
- Config Map/Secret – A Read-only folder that provides a way to inject configuration data into pods.

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Ephemeral Volumes

Storage

redis container only mounts **emptyDir** volume

nginx container mounts both volumes

emptyDir volume definition

hostPath volume definition

```yaml
spec:
  containers:
    - name: redis
      image: redis
      ports:
        - containerPort: 80
      volumeMounts:
      - name: tempVol
        mountPath: /share
    - name: nginx
      image: nginx:1.17
      ports:
        - containerPort: 80
      volumeMounts:
      - name: tempVol
        mountPath: /usr/share/nginx/html
      - mountPath: /share/somefile
        name: hostFolder
        readOnly: true
  volumes:
  - name: tempVol
    emptyDir: {}
  - name: hostFolder
    hostPath:
      path: /var/local/aaa/1.txt
      type: FileOrCreate
```

Demo: Ephemeral Volumes

Persistent Volumes

Storage

- Persistent volumes exist beyond the lifetime of a pod
- PersistentVolume subsystem provides an API for users and administrators that abstracts details of how storage is provided from how it is consumed using PersistentVolume and PersistentVolumeClaim
- PersistentVolume (PV) is a piece of storage in the cluster that has been provisioned by an administrator or dynamically provisioned using Storage Classes
- PersistentVolumeClaim (PVC) is a request for storage by a user. It is similar to a Pod. Pods consume node resources and PVCs consume PV resources

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Persistent Volumes Types

Storage

- awsElasticBlockStore - AWS Elastic Block Store (EBS)
- azureDisk - Azure Disk
- azureFile - Azure File
- cephfs - CephFS volume
- csi - Container Storage Interface (CSI)
- fc - Fibre Channel (FC) storage
- gcePersistentDisk - GCE Persistent Disk
- glusterfs - Glusterfs volume
- hostPath - HostPath volume (for single node testing only; WILL NOT WORK in a multi-node cluster; consider using local volume instead)
- iscsi - iSCSI (SCSI over IP) storage
- local - local storage devices mounted on nodes.
- nfs - Network File System (NFS) storage
- portworxVolume - Portworx volume
- rbd - Rados Block Device (RBD) volume
- vsphereVolume - vSphere VMDK volume

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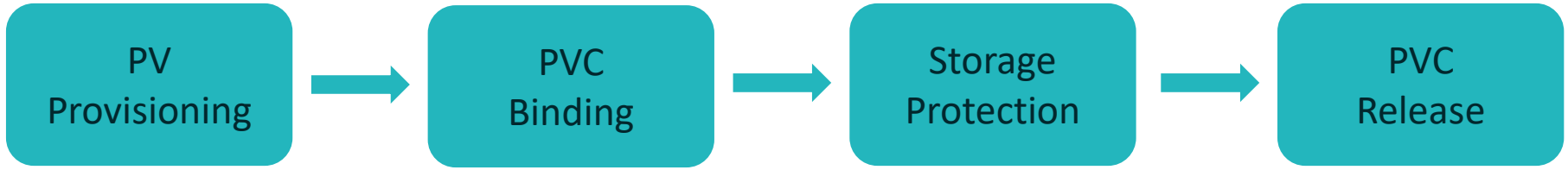
Persistent Volumes Lifecycle

Storage



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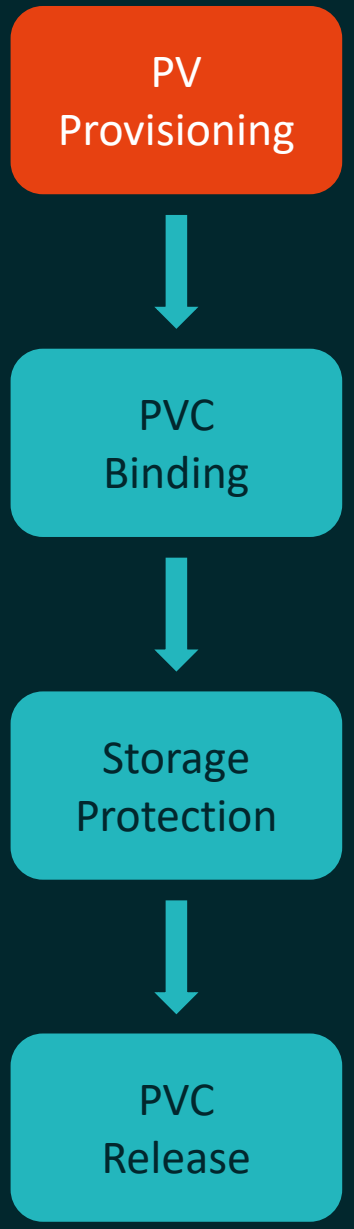

PV Provisioning

PV Lifecycle

- There are two ways PVs may be provisioned: statically or dynamically.
- Static: A cluster administrator creates a number of PVs. They carry the details of the real storage, which is available for use by cluster users
- Dynamic: When none of the static PVs the administrator created match a user's PersistentVolumeClaim, the cluster may try to dynamically provision a volume specially for the PVC. This provisioning is based on StorageClasses

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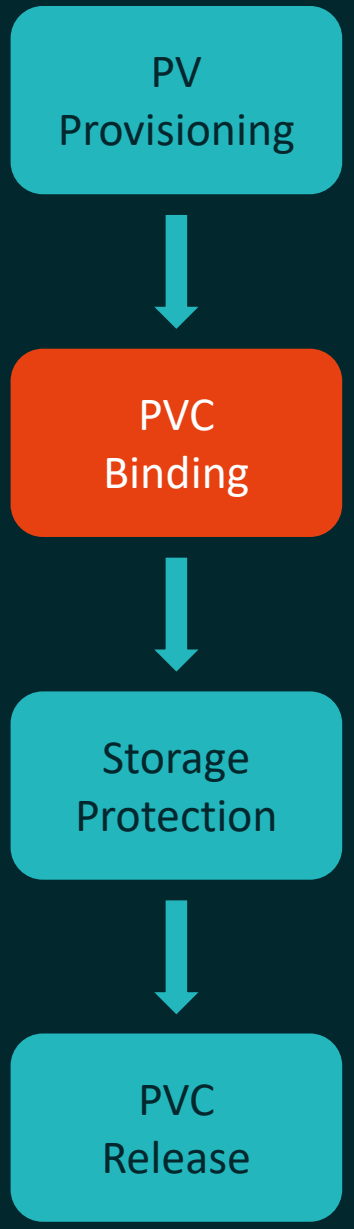

PVC Binding

PV Lifecycle

- A user creates a PersistentVolumeClaim with a specific amount of storage requested and with certain access modes
- Claims will remain unbound indefinitely if a matching volume does not exist
  - For example, a cluster provisioned with many 50Gi PVs would not match a PVC requesting 100Gi
- Access Modes
  - ReadWriteOnce (RWO): RW on single node for all pods on node
  - ReadOnlyMany (ROX): RO on multiple nodes
  - ReadWriteMany (RWX): RW on multiple nodes and pods
  - ReadWriteOncePod (RWOP): RW to a single pod

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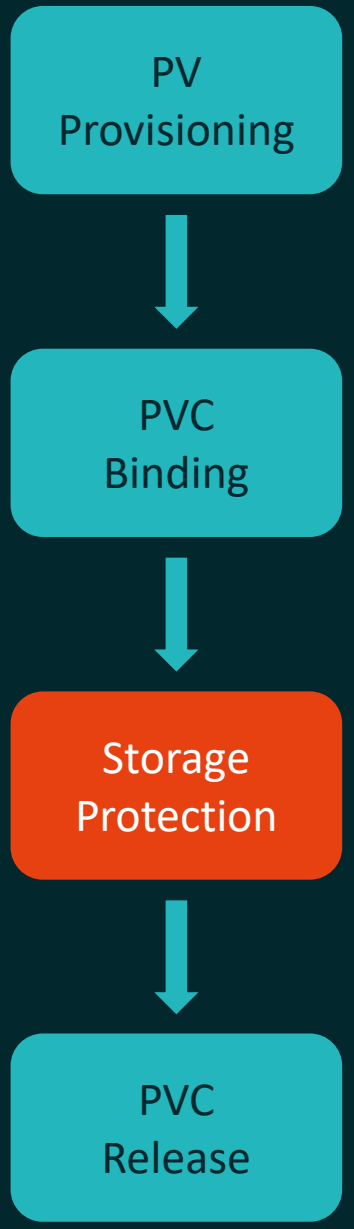

Storage Protection

PV Lifecycle

- The purpose of the Storage Object in Use Protection feature is to ensure that PersistentVolumeClaims (PVCs) in active use by a Pod and PersistentVolume (PVs) that are bound to PVCs are not removed from the system
- If a user deletes a PVC in active use by a Pod, the PVC is not removed immediately. PVC removal is postponed until the PVC is no longer actively used by any Pods
- If an admin deletes a PV that is bound to a PVC, the PV is not removed immediately. PV removal is postponed until the PV is no longer bound to a PVC

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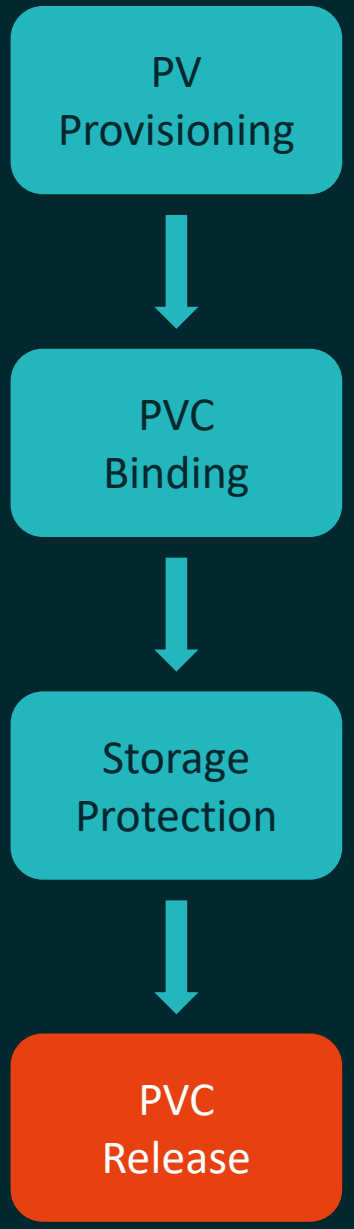

PVC Release

PV Lifecycle

- When a user is done with their volume, they can delete the PVC objects from the API that allows reclamation of the resource
- The reclaim policy for a PersistentVolume tells the cluster what to do with the volume after it has been released of its claim: Retain, Recycle or Delete
- Retain: Volume is available but data written remains on storage
- Recycle: Data written is delete and volume as all free space again
- Delete: Volume is deleted. Depends on Storage Class

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Persistent Volume

Storage

`capacity` defines storage size

`accessModes` defines allowed modes

`storageClassName` defines storage class

Specific properties for local storage

`nodeAffinity` defines where volume will be located to work properly on multi-node cluster

```yaml
apiVersion: v1
kind: PersistentVolume
metadata:
  name: sample-pv
spec:
  capacity:
    storage: 10Gi
  volumeMode: Filesystem
  accessModes:
  - ReadWriteOnce
  persistentVolumeReclaimPolicy: Retain
  storageClassName: local-storage
  local:
    path: /tmp
  nodeAffinity:
    required:
      nodeSelectorTerms:
      - matchExpressions:
        - key: kubernetes.io/hostname
          operator: In
          values:
          - docker-desktop
```

Persistent Volume Claim

Storage

`storageClassName` defines type of volume that Claim wants to use

`accessModes` needed on volume

`resources` defines amount of storage

To have a binding, all configs needs to be filled by an individual volume

```yaml
apiVersion: v1
kind: PersistentVolumeClaim
metadata:
  name: sample-pv-claim
spec:
  storageClassName: local-storage
  accessModes:
    - ReadWriteOnce
  resources:
    requests:
      storage: 3Gi
```


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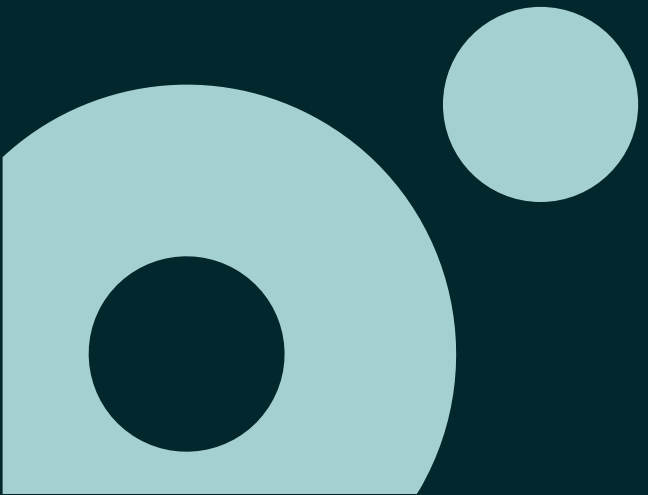
Demo: Persistent Volumes

ConfigMaps



Motivation

ConfigMaps

- When running pods you may need to add some configuration to make it work properly
- For example, set database host that can be different depending the environment you are running it
- At same time, there are configurations that may be shared by different pods, like an external service
- Finally, having a way to update some configuration that don't need Pods restart
- Kubernetes have a ConfigMap object to handle configurations

What is a ConfigMap

ConfigMaps

- ConfigMap is an object used to store non-confidential data in key-value pairs
- ConfigMap allows you to decouple environment-specific configuration from your container images, so that your applications are easily portable
- Pods can consume ConfigMaps as environment variables, command-line arguments, or as configuration files in a volume
- ConfigMaps as volumes are updated automatically when ConfigMap is updated
- ConfigMaps as environment variables are not updated automatically. A Pod restart is needed

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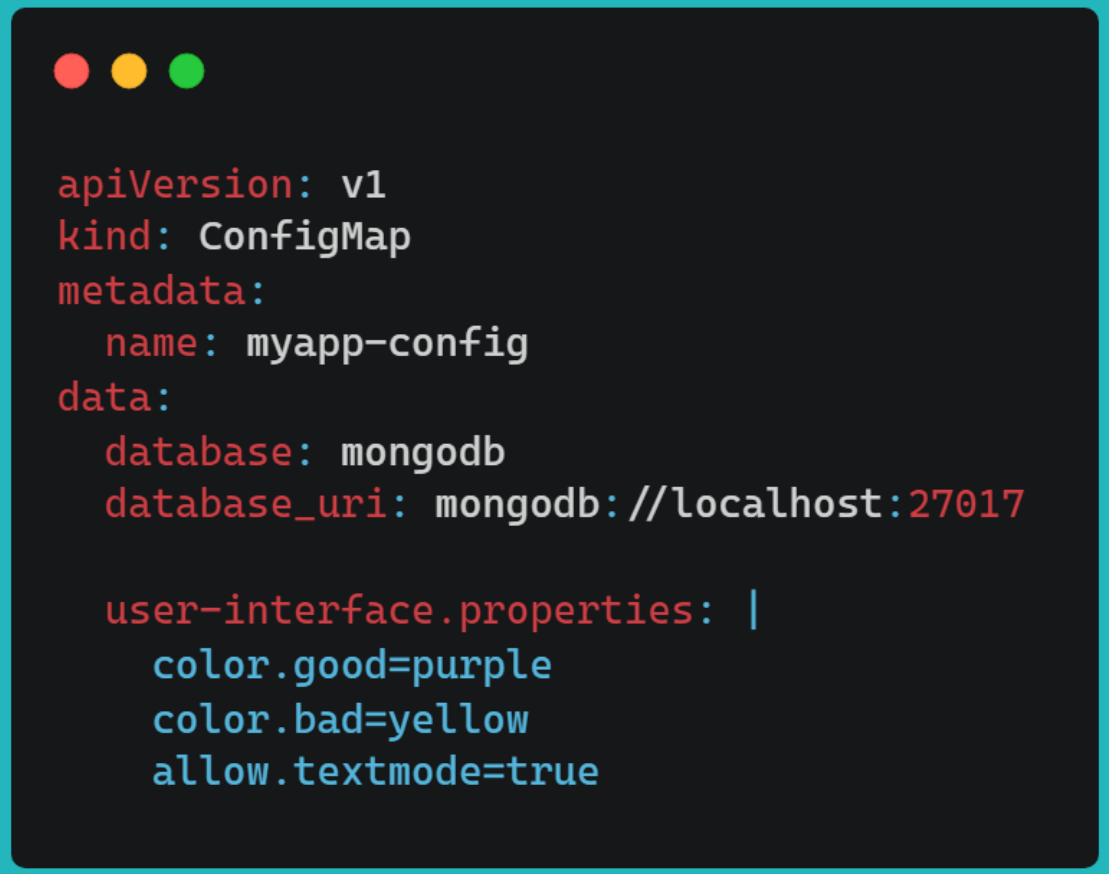
ConfigMap Manifest

ConfigMaps

ConfigMap name. Used for matching

Property-like keys. One key, one value

File-like keys. One key, a list of values



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Pod Spec
ConfigMaps

ConfigMap as environment variable

Pod Volume mount using ConfigMap

ConfigMap as Volume

```yaml
apiVersion: apps/v1
kind: Deployment
...
    spec:
      containers:
      - name: nginx
        image: nginx
        ports:
        - containerPort: 80
        env:
        - name: DATABASE_URL
          valueFrom:
            configMapKeyRef:
              name: myapp-config
              key: database_uri
        volumeMounts:
        - name: config
          mountPath: "/config"
          readOnly: true
      volumes:
        - name: config
          configMap:
            name: myapp-config
            items:
            - key: "user-interface.properties"
              path: "user-interface.properties"
```

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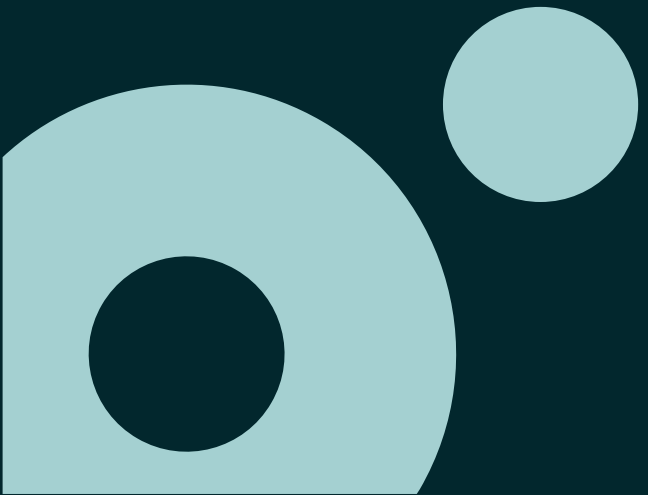
Secrets



Motivation

Secrets

- Your pods need to have access to sensitive data, like password, token, etc.
- You may define that sensitive data on Pod specification or container image but that can arise some security concerns
- Additionally having sensitive data configured apart from the pods can bring more agility
- Secrets are Kubernetes objects to reach these goals

What is a Secret

Secrets

- Secrets allow to store and manage sensitive information, such as passwords, OAuth tokens, ssh keys and TLS certificates
- Storing confidential information in a Secret is safer and more flexible than putting it in a Pod definition or in a container image
- Pods can consume Secrets as environment variables, command-line arguments, or as configuration files in a volume
- Secrets as volumes are updated automatically when Secrets is updated
- Secrets as environment variables are not updated automatically. A Pod restart is needed

Types of Secret

Secrets

Default ->

Builtin Type	Usage
`Opaque`	arbitrary user-defined data
`kubernetes.io/service-account-token`	service account token
`kubernetes.io/dockercfg`	serialized `~/.dockercfg` file
`kubernetes.io/dockerconfigjson`	serialized `~/.docker/config.json` file
`kubernetes.io/basic-auth`	credentials for basic authentication
`kubernetes.io/ssh-auth`	credentials for SSH authentication
`kubernetes.io/tls`	data for a TLS client or server
`bootstrap.kubernetes.io/token`	bootstrap token data

https://kubernetes.io/docs/concepts/configuration/secret/#secret-types

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Encoded, NOT Encrypted

Secrets

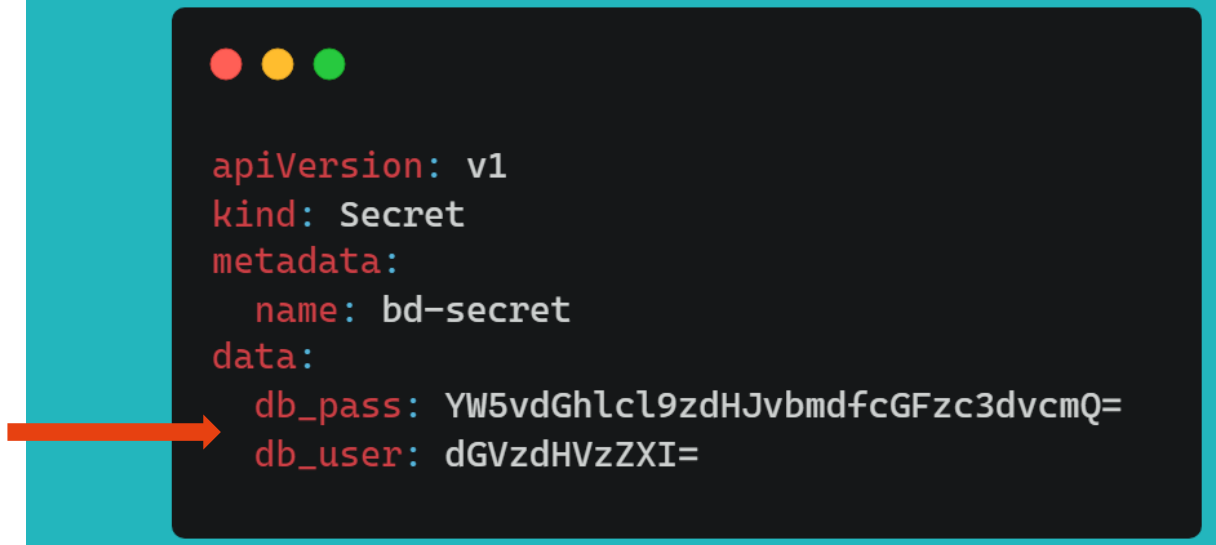
- Secrets are stored unencrypted inside the cluster!
- Secrets are only encoded using base64 algorithm which can be easily reverted
- AS being a regular object on Kubernetes, can be retrieved as plain text by someone with API access
- Some options to handle this security concern
  - Using Kubernetes RBAC to restrict reading and writing of Secrets
  - Using 3rd-party services to store secrets and integrate with Kubernetes (like Azure Key Vault, Hashicorp Vault, etc.)

Secret Manifest

Secrets

Pair Key-Value with secret

Secret value encoded on base64



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Pod Spec

Secret

Secret as environment variable

Pod Volume mount using Secret

Secret as Volume

```yaml
apiVersion: apps/v1
kind: Deployment
...
    spec:
      containers:
      - name: nginx
        image: nginx
        ports:
        - containerPort: 80
        env:
        - name: DB_USERNAME
          valueFrom:
            secretKeyRef:
              name: bd-secret
              key: db_user
        - name: DB_PASSWORD
          valueFrom:
            secretKeyRef:
              name: bd-secret
              key: db_pass
        volumeMounts:
        - name: secret-vol
          mountPath: "/config"
          readOnly: true
      volumes:
      - name: secret-vol
        secret:
          secretName: file-secret
```

Using Kubectl Commands

Secrets

- Create from literal (command line value)

```
kubectl create secret generic mysecret --dry-run=client \
--from-literal=secret=secretValue
```

- Create from file (encoding content)

```
kubectl create secret generic test-secret \
--dry-run=client --from-file=secret-file.json
```

- Using kubectl to encode content to base64

```
kubectl create secret generic test-secret \
--dry-run=client --from-file=secret-file.json -o yaml
```


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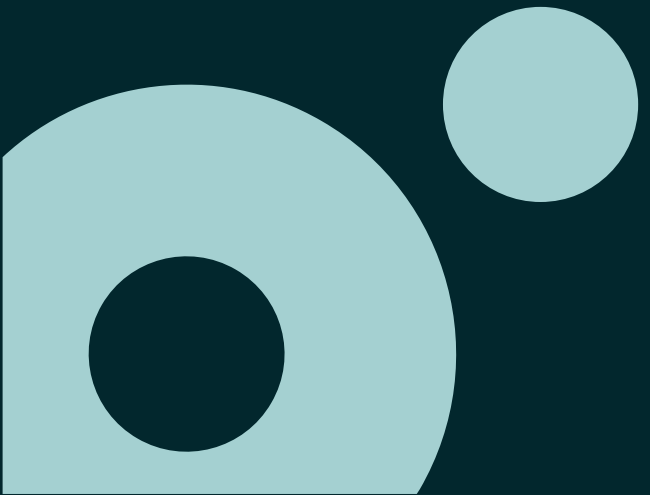
Lab



Lab 8: Storage in Kubernetes

Github

[Lab 08 - Storage in Kubernetes | docker-kubernetes-training (tasb.github.io)]

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Minds on the move

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