

Create PersistentVolumes (PV) and PersistentVolumeClaims (PVC) for Data Storage

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Introduction

In Kubernetes, **PersistentVolumes (PV)** and **PersistentVolumeClaims (PVC)** provide a way to manage storage resources for your applications. Persistent storage allows data to be retained even if the pod is terminated or restarted. This is critical for stateful applications like databases or any app that requires data persistence across pod restarts.

- **PersistentVolume (PV)**: A storage resource in the cluster that can be provisioned dynamically or manually by an administrator. It abstracts the underlying storage from the application.
- **PersistentVolumeClaim (PVC)**: A request by a user for storage. PVCs are used by pods to request specific storage resources from available PVs.

In this lab, we will create a PersistentVolume and a PersistentVolumeClaim, and then use the PVC in a Kubernetes pod.

Problem Statement

Many applications require persistent data storage that survives pod restarts and scaling events. To solve this, Kubernetes provides PersistentVolumes (PVs) and PersistentVolumeClaims (PVCs) as a means to allocate and consume storage resources within the cluster. This lab will guide you through the steps required to configure persistent storage for an NGINX application.

Prerequisites

Completion of all previous lab guides (up to Lab Guide-04) is required before proceeding with Lab Guide-05.

- A running Kubernetes cluster on Minikube.
 - `kubectl` installed and configured to interact with your Minikube cluster.
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Setup Instructions

Step 1: Create a PersistentVolume (PV)

A **PersistentVolume** represents a piece of storage in the cluster. This storage can be provided by cloud services, local disk, NFS, or other means.

1. Create a PV YAML File

Create a file named `pv.yaml` with the following content:

```
apiVersion: v1
kind: PersistentVolume
metadata:
  name: nginx-pv
spec:
  capacity:
    storage: 1Gi
  accessModes:
    - ReadWriteOnce
  hostPath:
    path: "/mnt/data"
```

Key points:

- **capacity**: The size of the persistent storage (1Gi).
- **accessModes**: Specifies how the storage can be accessed. `ReadWriteOnce` means it can be mounted as read-write by a single node.
- **hostPath**: The path to the storage location on the host machine. For this lab, we use a directory on the Minikube node.

2. Apply the PV

Run the following command to create the PersistentVolume:

```
kubectl apply -f pv.yaml
```

3. Verify the PersistentVolume

Check the status of the PV to ensure it's available:

```
kubectl get pv
```

```
PS C:\Users\Administrator> kubectl apply -f pv.yaml
persistentvolume/nginx-pv created
PS C:\Users\Administrator> kubectl get pv
```

NAME	CAPACITY	ACCESS MODES	RECLAIM POLICY	STATUS	CLAIM	STORAGECLASS	VOLUMEATTRIBUTESCLASS	REASON	AGE
nginx-pv	1Gi	RWO	Retain	Available					14s

Step 2: Create a PersistentVolumeClaim (PVC)

A **PersistentVolumeClaim** is a request for storage by a user. The PVC must match the properties of the PV, such as storage size and access modes.

1. Create a PVC YAML File

Create a file named `pvc.yaml` with the following content:

```
apiVersion: v1
kind: PersistentVolumeClaim
metadata:
  name: nginx-pvc
spec:
  accessModes:
    - ReadWriteOnce
  resources:
    requests:
      storage: 1Gi
```

Key points:

- **accessModes:** Matches the access mode of the PV (`ReadWriteOnce`).
- **resources.requests.storage:** Requests 1Gi of storage.

2. Apply the PVC

Run the following command to create the PersistentVolumeClaim:

```
kubectl apply -f pvc.yaml
```

3. Verify the PVC

Check that the PVC is successfully bound to the PV:

```
kubectl get pvc
```

```
PS C:\Users\Administrator> kubectl apply -f pvc.yaml
persistentvolumeclaim/nginx-pvc created
PS C:\Users\Administrator> kubectl get pvc
```

NAME	STATUS	VOLUME	CAPACITY	ACCESS MODES	STORAGECLASS	VOLUMEATTRIBUTESCLASS	AGE
nginx-pvc	Bound	pvc-d5d49de1-7c5c-49d0-810b-43051468a933	1Gi	RWO	standard	<unset>	10s

The status should show `Bound`, meaning the PVC has successfully claimed the PV.

Step 3: Use the PVC in a Pod

Now that the PVC is created and bound to the PV, we can use it in a pod to provide persistent storage for the application.

1. Create the Pod YAML File

Create a file named `nginx-pv-pod.yaml` with the following content:

```
apiVersion: v1
kind: Pod
metadata:
  name: nginx-pv-pod
spec:
  containers:
    - name: nginx
      image: nginx:latest
      ports:
        - containerPort: 80
      volumeMounts:
        - mountPath: "/usr/share/nginx/html"
          name: nginx-storage
  volumes:
    - name: nginx-storage
      persistentVolumeClaim:
        claimName: nginx-pvc
```

Key points:

- **volumeMounts:** The PVC is mounted to `/usr/share/nginx/html` in the container, which is the default directory for serving content in NGINX.
- **volumes:** The volume is backed by the PersistentVolumeClaim (`nginx-pvc`).

2. Apply the Pod Configuration

Run the following command to create the pod:

```
kubectl apply -f nginx-pv-pod.yaml
```

3. Verify the Pod

Check the status of the pod to ensure it's running:

```
kubectl get pods
```

```
PS C:\Users\Administrator> kubectl apply -f nginx-pv-pod.yaml
pod/nginx-pv-pod created
PS C:\Users\Administrator> kubectl get pods
NAME                READY   STATUS    RESTARTS   AGE
nginx-pod            1/1     Running   0           43m
nginx-pv-pod         1/1     Running   0           18s
```

4. Test the Persistent Storage

You can now write files to the `/mnt/data` directory on the Minikube node, and they will persist even if the pod is deleted or restarted.

To test, exec into the pod and create a file:

```
kubectl exec -it nginx-pv-pod -- /bin/bash
echo "Hello, Kubernetes!" > /usr/share/nginx/html/index.html
```

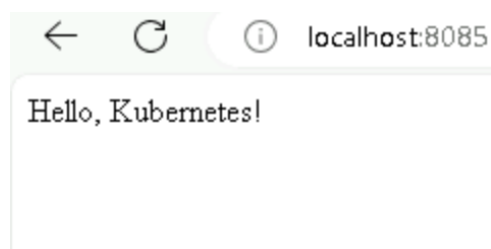
```
PS C:\Users\Administrator> kubectl exec -it nginx-pv-pod -- /bin/bash
root@nginx-pv-pod:/# echo "Hello, Kubernetes!" > /usr/share/nginx/html/index.html
root@nginx-pv-pod:/# exit
exit
```

Now, access the NGINX pod using port-forwarding to see the content you just created:

```
kubectl port-forward nginx-pv-pod 8085:80
```

```
PS C:\Users\Administrator> kubectl port-forward nginx-pv-pod 8085:80
Forwarding from 127.0.0.1:8085 -> 80
Forwarding from [::1]:8085 -> 80
Handling connection for 8085
Handling connection for 8085
```

Open your browser and navigate to `http://localhost:8085`. You should see "Hello, Kubernetes!" displayed.



References

- [Kubernetes Persistent Volumes Documentation](#)
 - [Kubernetes Persistent Volume Claims Documentation](#)
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