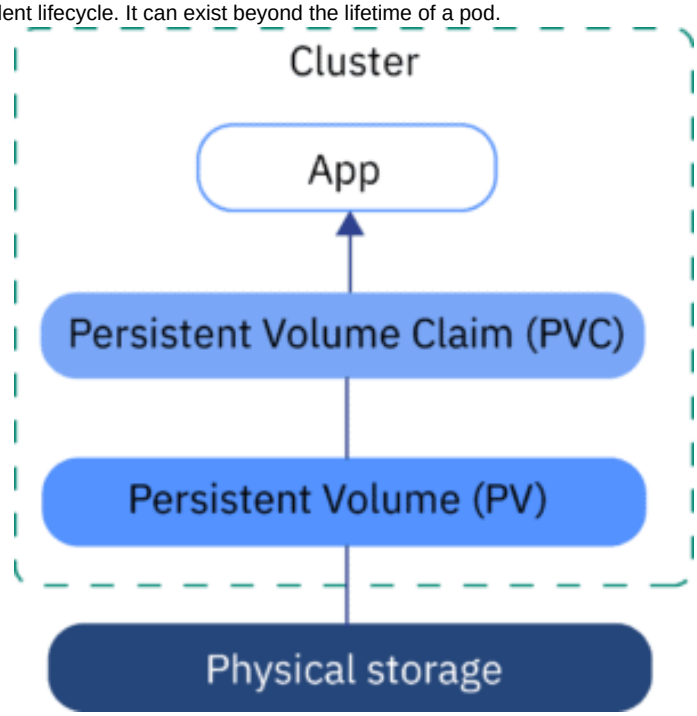
Kubernetes Persistent Storage: PV, PVC and Storage Class

Kubernetes is a complete containerization orchestration, which provides the ability to run dynamically scaling, management of containerized applications. **Persistent Storage** in Kubernetes offers applications in K8s a handy way to request, and consume storage resources. In this blog, We will cover Kubernetes persistent storage concepts.

What is Kubernetes Volume

Containers are immutable means they don't write data permanently to any **storage location** meaning that when a container is deleted, all the data generated during its lifetime also gets deleted. This gives rise to two problems. One loss of files when the container crashes and second files can't be shared between containers. That's where Kubernetes Volume comes into the picture. At its core, a volume is just a directory, possibly with some data in it, which is accessible to the containers in a pod. It solves both of these problems.

Difference between K8s Volume and Persistent Volume: Volume lifecycle is linked to a pod. It gets deleted when the pod gets deleted. While Persistent Volume has an independent lifecycle. It can exist beyond the lifetime of a pod.



Types of Volumes

Kubernetes supports various types of volumes.

Kubernetes hostPath

A Kubernetes hostPath volume mounts a file or directory from the host node's filesystem into your Pod. This is not something that the majority of Pods will need, but it offers a strong hatchway for a few applications.

configMap

A ConfigMap provides a way to inject configuration data into pods. The data stored during a ConfigMap are often referenced during a volume of type configMap then consumed by containerized applications running within a pod.

Kubernetes Persistency concepts

There are three foremost concepts you should understand as you start working with Kubernetes persistent storage:

PersistentVolume (PV)

In Kubernetes Persistent Storage a ***PersistentVolume* (PV)** is a piece of storage within the cluster that has been provisioned by an administrator or dynamically provisioned using **Storage Classes**. PV is an abstraction for the physical storage device (such as NFS or iSCSI communication) that you have attached to the cluster. The main feature of a PV is that it has an independent life cycle which is managed by Kubernetes, and it continues to live when the pods accessing it gets deleted.

A typical YAML file of PV using hostPath PersistentVolume looks like this:

```
apiVersion: v1
kind: PersistentVolume
metadata:
  name: task-pv-volume
  labels:
    type: local
spec:
  storageClassName: manual
  capacity:
    storage: 10Gi
  accessModes:
    - ReadWriteOnce
  hostPath:
    path: "/mnt/data"
```

PersistentVolumeClaim (PVC)

A *PersistentVolumeClaim* (PVC) is a request for storage by a user. The claim can include specific storage parameters required by the application. For example, an amount of storage, or a specific type of access (RWO – ReadWriteOnce, ROX – ReadOnlyMany, RWX – ReadWriteMany, etc.).

- **ReadWriteOnce** — the volume can be mounted as read-write by a single node
- **ReadOnlyMany** — the volume can be mounted read-only by many nodes
- **ReadWriteMany** — the volume can be mounted as read-write by many nodes

Kubernetes looks for a PV that meets the criteria defined in the user's PVC, and if there is one, it matches the claim to PV then it binds the PV to that PVC.

A typical YAML file of PVC looks like this:

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

You can attach the storage to a pod by adding a volume section in the pod config file:

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

StorageClass

Storage Class allows the provision of Kubernetes persistent storage dynamically. With a storage class, **administrators need not create a persistent volume separately before claiming it**. Administrators can define several **StorageClasses** that give users multiple options for performance. For example, one can be on a fast SSD drive, it also supports Cloud Storage Services like **AWS EBS**, AzureDisk, GCEPersistentDisk, etc.

A typical YAML file of storage class using AWS EBS storage looks like this:

```
apiVersion: storage.k8s.io/v1
kind: StorageClass
metadata:
  name: standard
provisioner: kubernetes.io/aws-ebs
parameters:
  type: gp2
reclaimPolicy: Retain
allowVolumeExpansion: true
mountOptions:
  - debug
volumeBindingMode: Immediate
```

Types of Persistent Volumes

Using the Kubernetes Persistent Storage the PersistentVolume types are implemented as plugins. Kubernetes currently supports the following plugins:

Cloud Storage and Virtualization	Proprietary Storage Platforms	Physical Drives / Storage Protocols
GCEPersistentDisk	Flocker	NFS
AWSElasticBlockStore	RBD (Ceph Block Device)	iSCSI
AzureFile	Cinder (OpenStack block storage)	FC (Fibre Channel)

AzureDisk	Glusterfs	
VsphereVolume	Flexvolume	
	Quobyte Volumes	
	Portworx Volumes	
	ScaleIO Volumes	
	StorageOS	

Persistent Storage – Phase

- **Available** – A free resource that's not yet sure to a claim
- **Bound** – The Volume is bound to a claim
- **Released** – The claim has been deleted, but the resource isn't yet reclaimed by the cluster
- **Failed** – The volume has failed its automatic reclamation.

Lifecycle of Volume and Claim

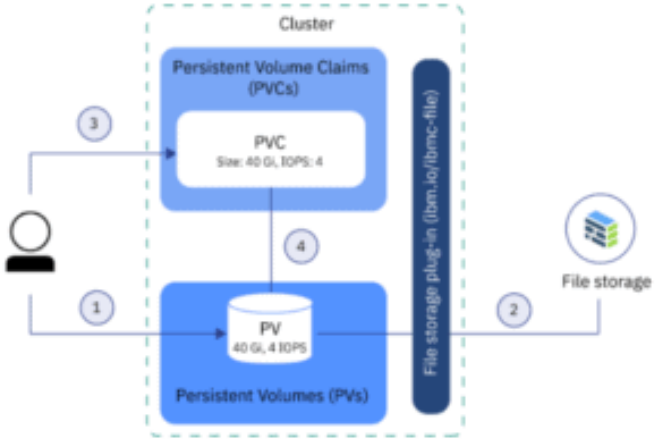
Persistent Volumes are the resources within the cluster. PVCs are requests for those resources and also act as claim checks to the resource. The interaction between PVs and PVCs follows the following lifecycle:

Provisioning

There are two ways PVs could be provisioned: statically or dynamically.

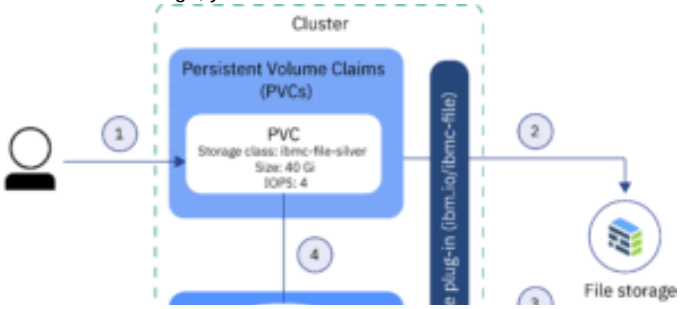
1. Static

In static provisioning of the Kubernetes persistent Storage, the administrator has to make existing storage devices available to a cluster. To make existing storage available to a cluster, the administrator has to manually create a persistent volume after that only user can claim the storage for the pod by creating PVCs.



2. Dynamic

Dynamic provisioning is used when we want to give developers the liberty to provision storage when they need it. This provisioning is based on StorageClasses: the PVC must request a storage class and thus the administrator must have created and configured that storage class for dynamic provisioning to occur. In order to demand storage, you must create a PVC.



Binding

When a user creates a PVC with a specific amount of storage requested and with certain access modes. The control loop within the master watches newly created PVCs finds an identical PV (if possible), and binds them together. If a PV was dynamically provisioned for a new PVC, the loop will always bind that PV to the PVC.

Reclaiming

When the user no longer needs a volume, they can delete the PVC. The reclaim policy for a PersistentVolume tells the cluster what to do with the volume after it has been released of its claim. Currently, volumes can either be Retained, Recycled, or Deleted.

Retain

The Retain reclaim policy allows the manual reclamation of the resource. Deleting the PVCs does not delete PV. it can still exist in the cluster and is considered to be “released”. But it’s not yet available for an additional claim because the previous claimant’s data remains on the volume.

Delete

The volume plugins support the Delete reclaim policy. Deletion removes both the PV from the K8s cluster as well as the external storage asset like AWS EBS, GCE PD, Azure Disk, or Cinder volume.

To know more about **Kubernetes deployment strategy**. Click here

Recycle

Volume plugins that support the Recycle reclaim policy perform a basic scrub on the volume and make it available again for a fresh claim.

Note: The Recycle reclaim policy is outdated. Instead, the recommended approach is to use dynamic provisioning.