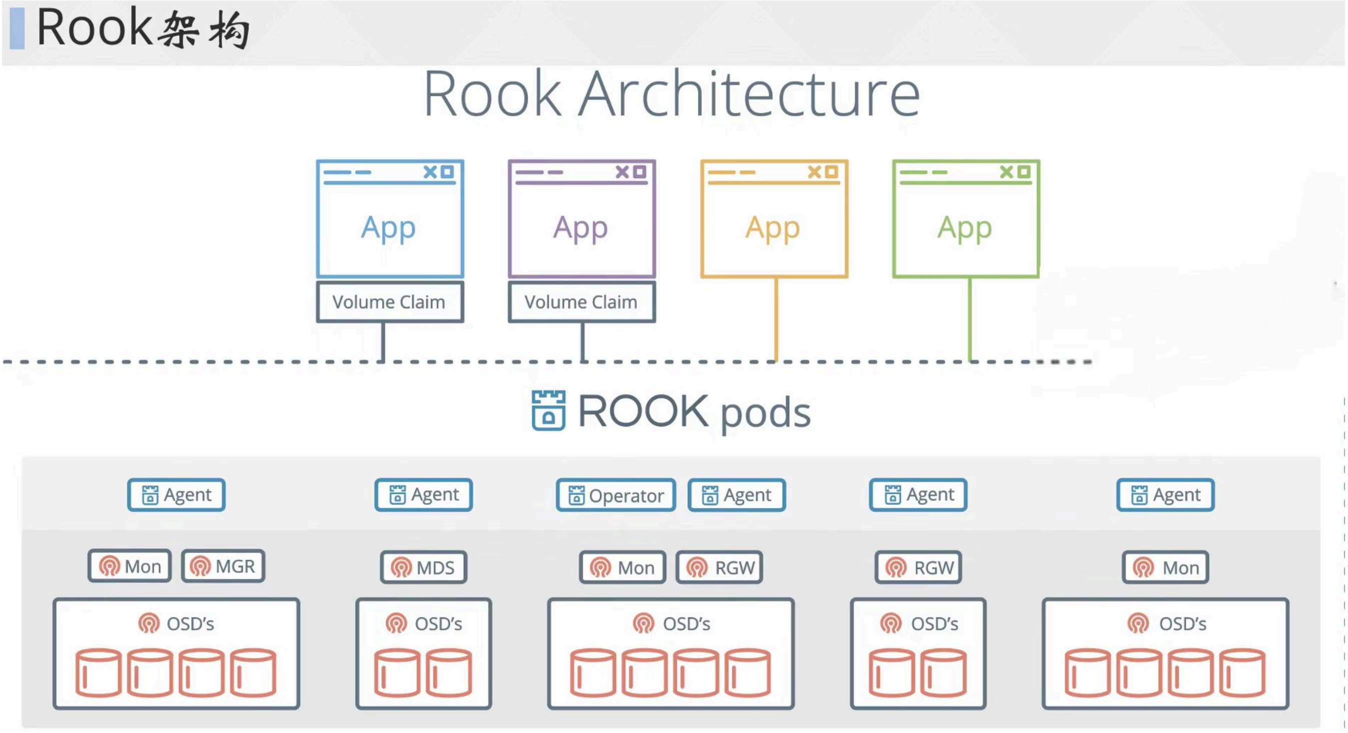
Rook

📖前言

Rook是一个自我管理的分布式存储编排系统，它本身并不是存储系统，在存储和 k8s之前搭建了一个桥梁，使存储系统的搭建或者维护变得特别简单，Rook将分布式存储系 统转变为自我管理、自我扩展、自我修复的存储服务。它让一些存储的操作，比如部署、 配置、扩容、升级、迁移、灾难恢复、监视和资源管理变得自动化，无需人工处理。并且 Rook支持CSI，可以利用CSI做一些PVC的快照、扩容、克隆等操作。

`我们不生产水，我们只是大自然的搬运工`

Rook 架构



组件介绍:

核心Pod功能说明

- `rook-discover`：Rook设备发现守护进程，**自动扫描节点上的存储设备**（如磁盘、SSD），并将信息上报给Operator。
- `rook-ceph-mon`：Ceph Monitor服务，**维护集群元数据**（如OSD映射、PG状态），**确保集群一致性。**
- `rook-ceph-mgr`：Ceph Manager服务，**提供管理接口和监控指标**（Dashboard、Prometheus指标）。
- `rook-ceph-osd`：Ceph OSD服务，**实际存储数据的守护进程**，每个OSD对应一个物理设备。
- `rook-ceph-crashcollector`：崩溃日志收集器，**自动收集OSD/Mon故障时的诊断信息。**
- `rook-ceph-exporter`：指标导出器，**将Ceph集群性能数据导出给Prometheus。**

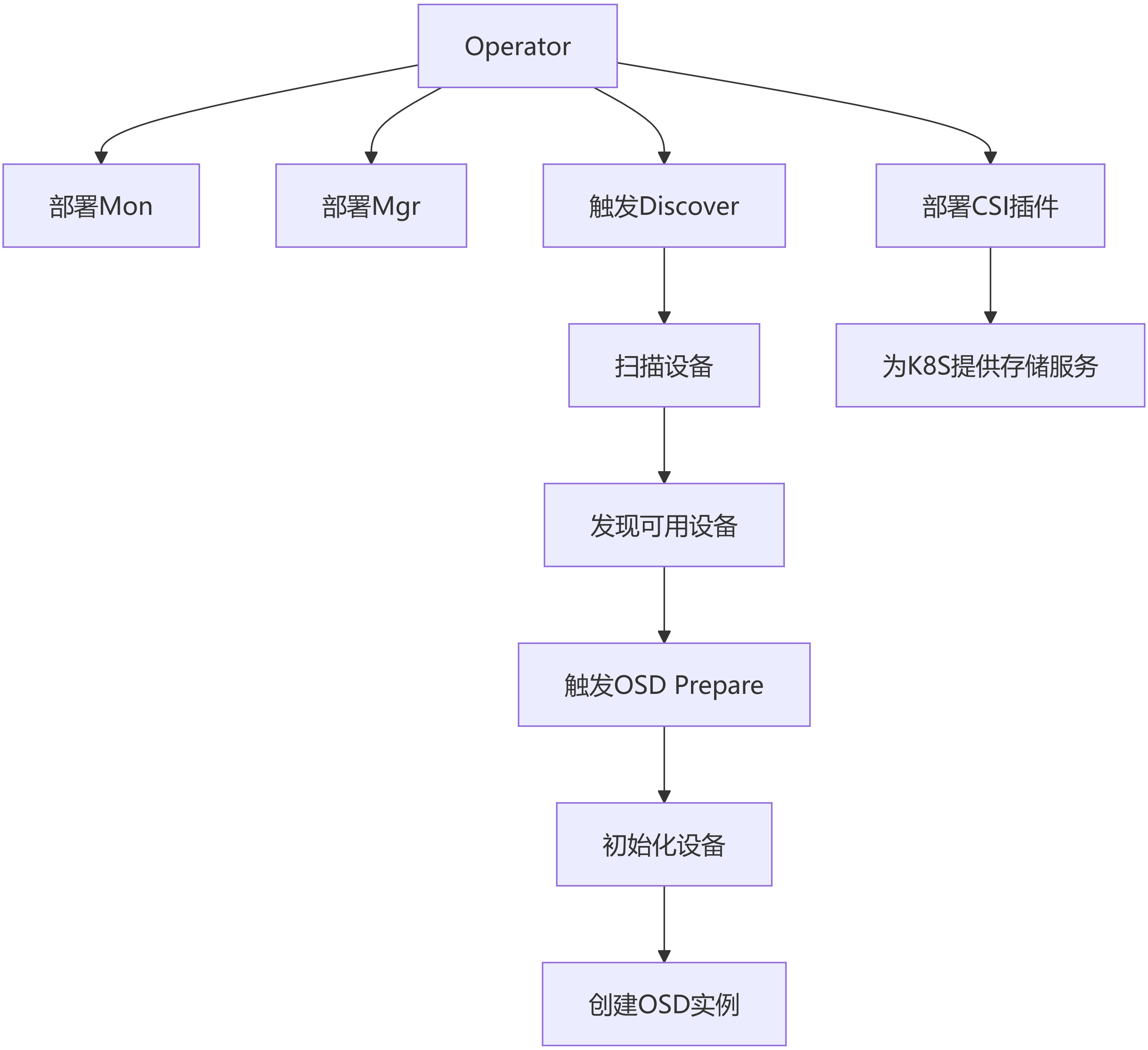
CSI相关组件说明

- `csi-rbdplugin`：RBD块存储插件，**支持动态创建/挂载Ceph RBD卷**（适用于数据库等场景）。
- `csi-cephfsplugin`：CephFS文件存储插件，**支持动态创建/挂载CephFS卷**（适用于共享文件存储）。
- `csi-*-provisioner`：存储供应控制器，**处理存储卷的生命周期管理**（创建/扩容/删除）。

运维工具类说明

- `rook-ceph-operator`：集群管理核心，**协调所有资源部署和配置更新。**

- `rook-ceph-tools`：工具Pod（需手动创建），**提供`ceph`命令行工具**，用于集群调试。



基础环境

name	IP	磁盘	ceph
k8s-master01	192.168.0.105	nvme0n1	
k8s-master02	192.168.0.106	nvme0n1	
k8s-master03	192.168.0.107	nvme0n1、nvme0n2	ceph安装所在节点
k8s-work01	192.168.0.115	nvme0n1、nvme0n2	ceph安装所在节点
k8s-work02	192.168.0.116	nvme0n1、nvme0n2	ceph安装所在节点

Rook 部署

集群运行后，应用程序可以**使用块、对象或文件存储。**

1）克隆 Rook 仓库

```
git clone --single-branch --branch v1.16.5 https://github.com/rook/rook.git
```

2）下载镜像

按照利用阿里云下载国外镜像文档进行下载

```
ctr images pull registry.cn-hangzhou.aliyuncs.com/xusx/images:3.13.0
ctr images tag registry.cn-hangzhou.aliyuncs.com/xusx/images:3.13.0 quay.io/cephcsi/cephcsi:v3.13.0


ctr images pull registry.cn-hangzhou.aliyuncs.com/xusx/images:2.13.0
ctr images tag registry.cn-hangzhou.aliyuncs.com/xusx/images:2.13.0 registry.k8s.io/sig-storage/csi-node-driver-registrar:v2.13.0


ctr images pull registry.cn-hangzhou.aliyuncs.com/xusx/images:1.13.1
ctr images tag registry.cn-hangzhou.aliyuncs.com/xusx/images:1.13.1 registry.k8s.io/sig-storage/csi-resizer:v1.13.1


ctr images pull registry.cn-hangzhou.aliyuncs.com/xusx/images:5.1.0
ctr images tag registry.cn-hangzhou.aliyuncs.com/xusx/images:5.1.0 registry.k8s.io/sig-storage/csi-provisioner:v5.1.0


ctr images pull registry.cn-hangzhou.aliyuncs.com/xusx/images:8.2.0
ctr images tag registry.cn-hangzhou.aliyuncs.com/xusx/images:8.2.0 registry.k8s.io/sig-storage/csi-snapshotter:v8.2.0


ctr images pull registry.cn-hangzhou.aliyuncs.com/xusx/images:4.8.0
ctr images tag registry.cn-hangzhou.aliyuncs.com/xusx/images:4.8.0 registry.k8s.io/sig-storage/csi-attacher:v4.8.0


ctr images pull registry.cn-hangzhou.aliyuncs.com/xusx/images:1.16.5
ctr images tag registry.cn-hangzhou.aliyuncs.com/xusx/images:1.16.5 docker.io/rook/ceph:v1.16.5

ctr images pull registry.cn-hangzhou.aliyuncs.com/xusx/images:2.13.0
ctr images tag registry.cn-hangzhou.aliyuncs.com/xusx/images:2.13.0 registry.k8s.io/sig-storage/csi-node-driver-registrar:v2.13.0
```

3）修改配置文件

修改 Rook CSI 镜像地址，原本的地址可能是 k8s.io 的镜像，但是 无法被国内访问，所以需要同步gcr的镜像到阿里云镜像仓库

operator 文件，新版本 rook 默认关闭了自动发现容器的部署，可以找到 ROOK_ENABLE_DISCOVERY_DAEMON 改成 true

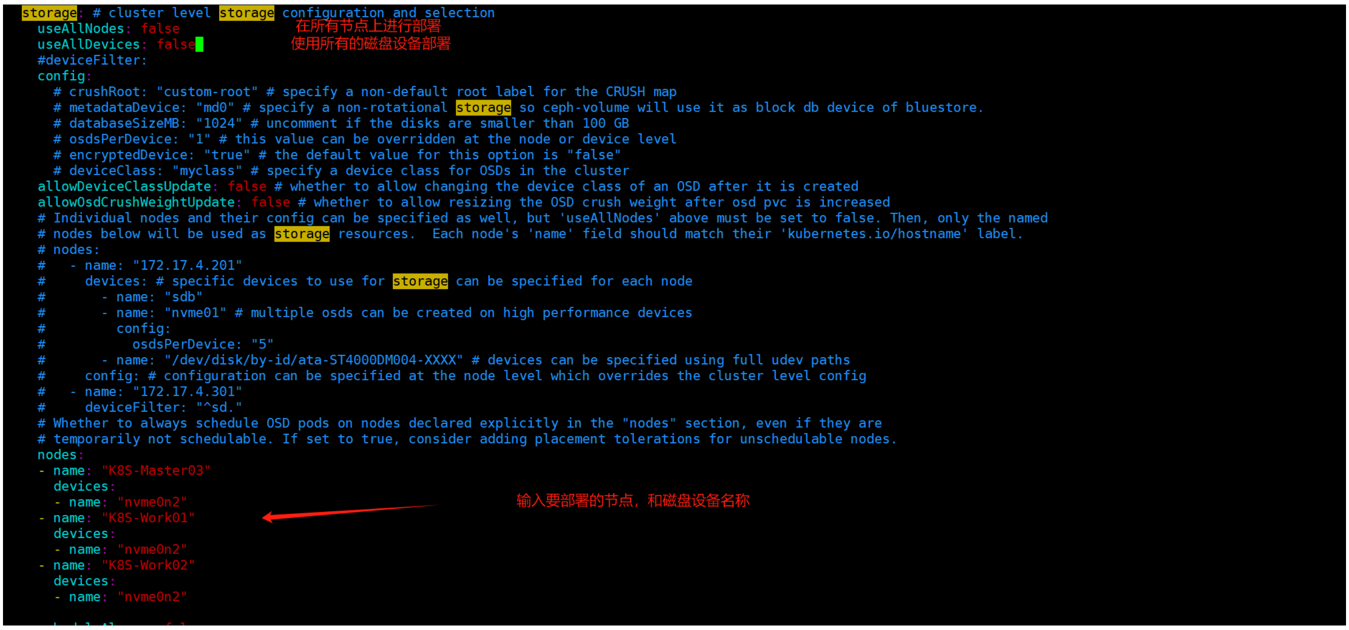
```
sed -i -E 's/(ROOK_ENABLE_DISCOVERY_DAEMON:\s*)"false"/\1"true"/g' operator.yaml
#   -E：启用扩展正则表达式（支持 \s* 匹配任意数量空格）
#   \s*：匹配键值之间的任意数量空格。
#   \1：保留原键名和冒号后的格式，仅替换值部分

cd rook/deploy/examples
kubectl create namespace rook-ceph
kubectl create -f crds.yaml -f common.yaml -f operator.yaml

[root@K8S-Master01 examples]# kubectl -n rook-ceph get pod
NAME                                  READY   STATUS    RESTARTS   AGE
rook-ceph-operator-67944bdfcc-b7r79   1/1     Running   0          35s
rook-discover-l4cw8                   1/1     Running   0          33s
rook-discover-qf5z8                   1/1     Running   0          33s
[root@K8S-Master01 examples]# kubectl get crd  |grep rook
cephblockpoolradosnamespaces.ceph.rook.io             2025-03-17T09:03:29Z
cephblockpools.ceph.rook.io                           2025-03-17T09:03:29Z
cephbucketnotifications.ceph.rook.io                  2025-03-17T09:03:29Z
cephbuckettopics.ceph.rook.io                         2025-03-17T09:03:29Z
cephclients.ceph.rook.io                              2025-03-17T09:03:29Z
cephclusters.ceph.rook.io                             2025-03-17T09:03:29Z
cephcosidrivers.ceph.rook.io                          2025-03-17T09:03:29Z
cephfilesystemmirrors.ceph.rook.io                    2025-03-17T09:03:29Z
cephfilesystems.ceph.rook.io                          2025-03-17T09:03:29Z
cephfilesystemsubvolumegroups.ceph.rook.io            2025-03-17T09:03:29Z
cephnfses.ceph.rook.io                                2025-03-17T09:03:30Z
cephobjectrealms.ceph.rook.io                         2025-03-17T09:03:30Z
cephobjectstores.ceph.rook.io                         2025-03-17T09:03:30Z
cephobjectstoreusers.ceph.rook.io                     2025-03-17T09:03:30Z
cephobjectzonegroups.ceph.rook.io                     2025-03-17T09:03:30Z
cephobjectzones.ceph.rook.io                          2025-03-17T09:03:30Z
cephrbdmirrors.ceph.rook.io                           2025-03-17T09:03:30Z
```

ceph 部署集群

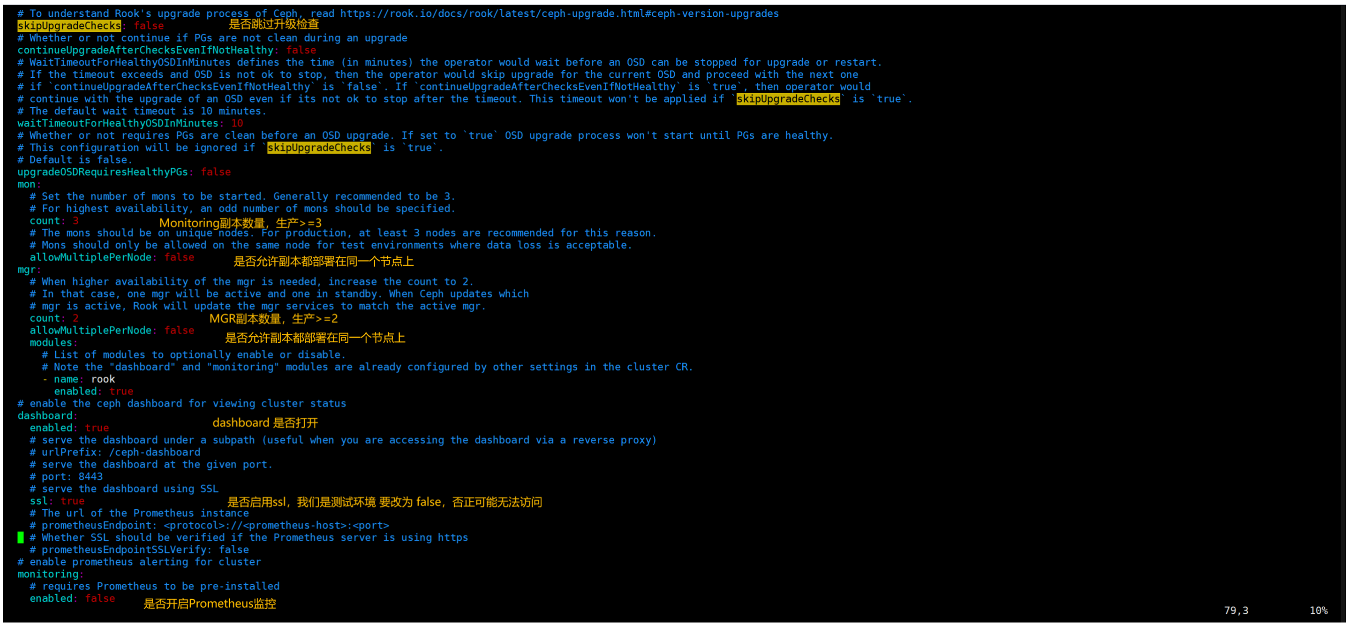
注意：新版必须采用裸盘，即未格式化的磁盘。其中 k8s-master03 k8s-node01 node02 有新加的一个磁盘，可以通过 `lsblk -f`查看新添加的磁盘名称。**建议最少三个节点，否则后面的试验可能会出现问题**

```
[root@K8S-Master03 ~]# lsblk
NAME          MAJ:MIN  RM   SIZE  RO  TYPE  MOUNTPOINT
sr0            11:0     1  1024M   0  rom
nvme0n1       259:0     0   100G   0  disk
├─nvme0n1p1   259:1     0     1G   0  part  /boot
└─nvme0n1p2   259:2     0    99G   0  part
  └─rl-root   253:0     0    99G   0  lvm   /
nvme0n2       259:3     0    10G   0  disk                    #新加磁盘，用作ceph OSD
```

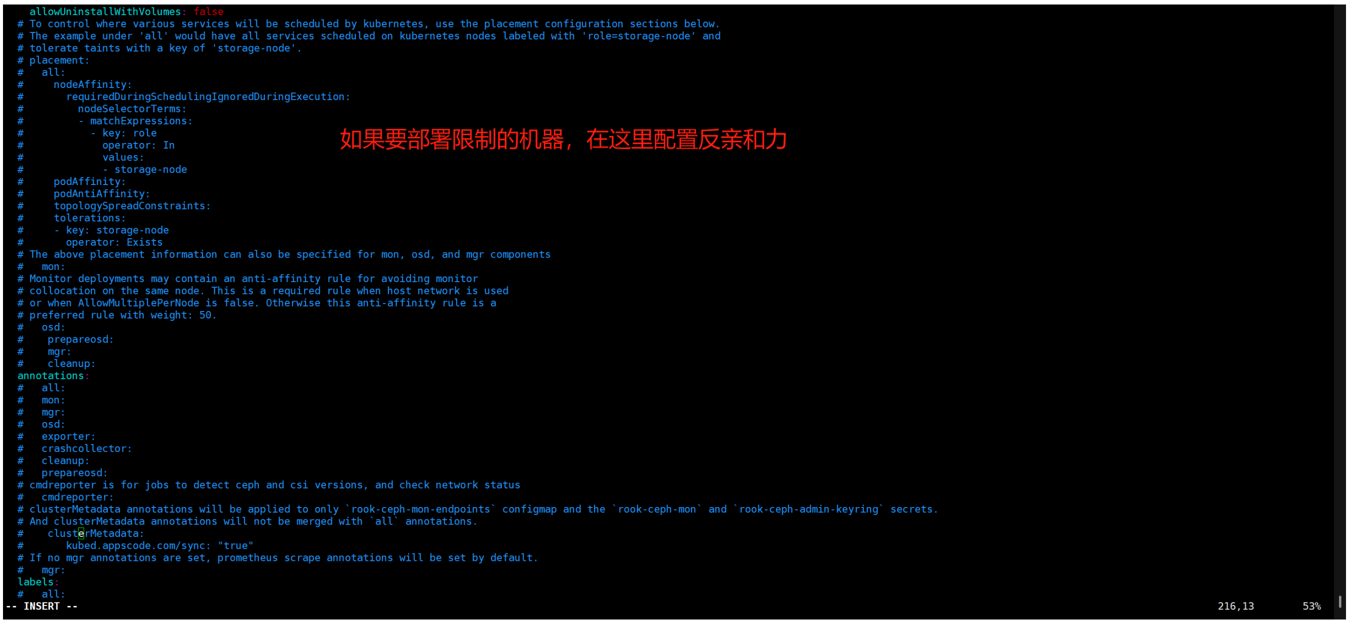
1）创建Ceph集群



```
storage: # cluster level storage configuration and selection
  useAllNodes: false                      在所有节点上进行部署
  useAllDevices: false                    使用所有的磁盘设备部署
  #deviceFilter:
  config:
    # crushRoot: "custom-root" # specify a non-default root label for the CRUSH map
    # metadataDevice: "md0" # specify a non-rotational storage so ceph-volume will use it as block db device of bluestore.
    # databaseSizeMB: "1024" # uncomment if the disks are smaller than 100 GB
    # osdsPerDevice: "1" # this value can be overridden at the node or device level
    # encryptedDevice: "true" # the default value for this option is "false"
    # deviceClass: "myclass" # specify a device class for OSDs in the cluster
  allowDeviceClassUpdate: false # whether to allow changing the device class of an OSD after it is created
  allowOsdCrushWeightUpdate: false # whether to allow resizing the OSD crush weight after osd pvc is increased
  # Individual nodes and their config can be specified as well, but 'useAllNodes' above must be set to false. Then, only the named
  # nodes below will be used as storage resources.  Each node's 'name' field should match their 'kubernetes.io/hostname' label.
  # nodes:
  #   - name: "172.17.4.201"
  #     devices: # specific devices to use for storage can be specified for each node
  #       - name: "sdb"
  #       - name: "nvme01" # multiple osds can be created on high performance devices
  #         config:
  #           osdsPerDevice: "5"
  #       - name: "/dev/disk/by-id/ata-ST4000DM004-XXXX" # devices can be specified using full udev paths
  #     config: # configuration can be specified at the node level which overrides the cluster level config
  #   - name: "172.17.4.301"
  #     deviceFilter: "^sd."
  # Whether to always schedule OSD pods on nodes declared explicitly in the "nodes" section, even if they are
  # temporarily not schedulable. If set to true, consider adding placement tolerations for unschedulable nodes.
  nodes:
  - name: "K8S-Master03"
    devices:
    - name: "nvme0n2"                                             输入要部署的节点，和磁盘设备名称
  - name: "K8S-Work01"
    devices:
    - name: "nvme0n2"
  - name: "K8S-Work02"
    devices:
    - name: "nvme0n2"
```



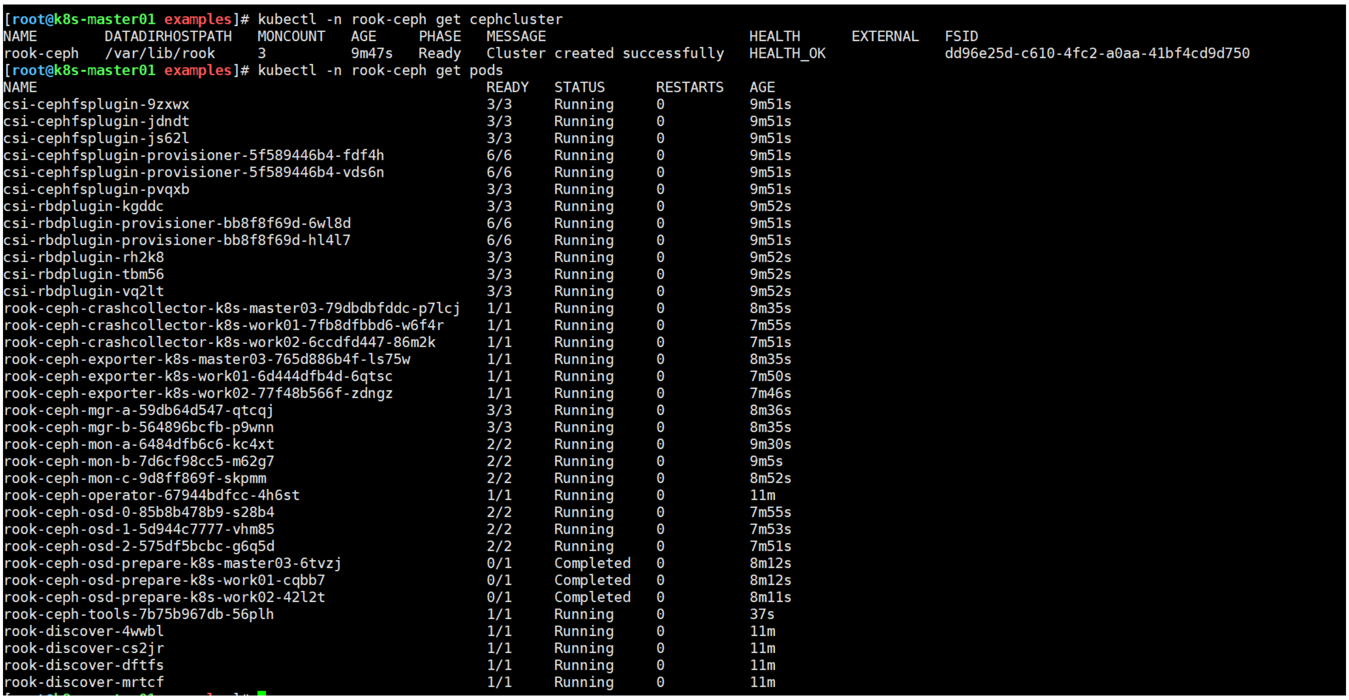
```
# To understand Rook's upgrade process of Ceph, read https://rook.io/docs/rook/latest/ceph-upgrade.html#ceph-version-upgrades
skipUpgradeChecks: false             是否跳过升级检查
# Whether or not continue if PGs are not clean during an upgrade
continueUpgradeAfterChecksEvenIfNotHealthy: false
# WaitTimeoutForHealthyOSDInMinutes defines the time (in minutes) the operator would wait before an OSD can be stopped for upgrade or restart.
# If the timeout exceeds and OSD is not ok to stop, then the operator would skip upgrade for the current OSD and proceed with the next one
# if `continueUpgradeAfterChecksEvenIfNotHealthy` is `false`. If `continueUpgradeAfterChecksEvenIfNotHealthy` is `true`, then operator would
# continue with the upgrade of an OSD even if its not ok to stop after the timeout. This timeout won't be applied if `skipUpgradeChecks` is `true`.
# The default wait timeout is 10 minutes.
waitTimeoutForHealthyOSDInMinutes: 10
# Whether or not requires PGs are clean before an OSD upgrade. If set to `true` OSD upgrade process won't start until PGs are healthy.
# This configuration will be ignored if `skipUpgradeChecks` is `true`.
# Default is false.
upgradeOSDRequiresHealthyPGs: false
mon:
  # Set the number of mons to be started. Generally recommended to be 3.
  # For highest availability, an odd number of mons should be specified.
  count: 3              Monitoring副本数量，生产>=3
  # The mons should be on unique nodes. For production, at least 3 nodes are recommended for this reason.
  # Mons should only be allowed on the same node for test environments where data loss is acceptable.
  allowMultiplePerNode: false          是否允许副本都部署在同一个节点上
mgr:
  # When higher availability of the mgr is needed, increase the count to 2.
  # In that case, one mgr will be active and one in standby. When Ceph updates which
  # mgr is active, Rook will update the mgr services to match the active mgr.
  count: 2                      MGR副本数量，生产>=2
  allowMultiplePerNode: false         是否允许副本都部署在同一个节点上
  modules:
    # List of modules to optionally enable or disable.
    # Note the "dashboard" and "monitoring" modules are already configured by other settings in the cluster CR.
    - name: rook
      enabled: true
# enable the ceph dashboard for viewing cluster status
dashboard:
  enabled: true                 dashboard 是否打开
  # serve the dashboard under a subpath (useful when you are accessing the dashboard via a reverse proxy)
  # urlPrefix: /ceph-dashboard
  # serve the dashboard at the given port.
  # port: 8443
  # serve the dashboard using SSL
  ssl: true                           是否启用ssl，我们是测试环境 要改为 false，否正可能无法访问
  # The url of the Prometheus instance
  # prometheusEndpoint: <protocol>://<prometheus-host>:<port>
  # Whether SSL should be verified if the Prometheus server is using https
  # prometheusEndpointSSLVerify: false
# enable prometheus alerting for cluster
monitoring:
  # requires Prometheus to be pre-installed
  enabled: false          是否开启Prometheus监控
                                                                                           79,3          10%
```



```
    allowUninstallWithVolumes: false
  # To control where various services will be scheduled by kubernetes, use the placement configuration sections below.
  # The example under 'all' would have all services scheduled on kubernetes nodes labeled with 'role=storage-node' and
  # tolerate taints with a key of 'storage-node'.
  # placement:
  #   all:
  #     nodeAffinity:
  #       requiredDuringSchedulingIgnoredDuringExecution:
  #         nodeSelectorTerms:
  #         - matchExpressions:
  #           - key: role
  #             operator: In
  #             values:
  #             - storage-node
  #     podAffinity:
  #     podAntiAffinity:
  #     topologySpreadConstraints:
  #     tolerations:
  #     - key: storage-node
  #       operator: Exists
  # The above placement information can also be specified for mon, osd, and mgr components
  #   mon:
  # Monitor deployments may contain an anti-affinity rule for avoiding monitor
  # collocation on the same node. This is a required rule when host network is used
  # or when AllowMultiplePerNode is false. Otherwise this anti-affinity rule is a
  # preferred rule with weight: 50.
  #   osd:
  #    prepareosd:
  #    mgr:
  #    cleanup:
  annotations:
  #   all:
  #   mon:
  #   mgr:
  #   osd:
  #   exporter:
  #   crashcollector:
  #   cleanup:
  #   prepareosd:
  # cmdreporter is for jobs to detect ceph and csi versions, and check network status
  #   cmdreporter:
  # clusterMetadata annotations will be applied to only `rook-ceph-mon-endpoints` configmap and the `rook-ceph-mon` and `rook-ceph-admin-keyring` secrets.
  # And clusterMetadata annotations will not be merged with `all` annotations.
  #    clusterMetadata:
  #       kubed.appscode.com/sync: "true"
  # If no mgr annotations are set, prometheus scrape annotations will be set by default.
  #   mgr:
  labels:
  #   all:
-- INSERT --                                                                                       216,13        53%
```

如果要部署限制的机器，在这里配置反亲和力

```
# 修改上述配置
vim rook/deploy/examples/cluster.yaml

# 按照使用阿里云下载外网镜像方法下载：quay.io/ceph/ceph:v19.2.1
ctr images pull registry.cn-hangzhou.aliyuncs.com/xusx/images:19.2.1
ctr images tag registry.cn-hangzhou.aliyuncs.com/xusx/images:19.2.1 quay.io/ceph/ceph:v19.2.1

kubectl create  -f cluster.yaml
kubectl -n rook-ceph get pod
# 查看集群健康
kubectl -n rook-ceph get cephcluster
```



```
[root@k8s-master01 examples]# kubectl -n rook-ceph get cephcluster
NAME        DATADIRHOSTPATH   MONCOUNT   AGE     PHASE   MESSAGE                        HEALTH      EXTERNAL   FSID
rook-ceph   /var/lib/rook     3          9m47s   Ready   Cluster created successfully   HEALTH_OK              dd96e25d-c610-4fc2-a0aa-41bf4cd9d750
[root@k8s-master01 examples]# kubectl -n rook-ceph get pods
NAME                                                  READY   STATUS      RESTARTS   AGE
csi-cephfsplugin-9zxwx                                3/3     Running     0          9m51s
csi-cephfsplugin-jdndt                                3/3     Running     0          9m51s
csi-cephfsplugin-js62l                                3/3     Running     0          9m51s
csi-cephfsplugin-provisioner-5f589446b4-fdf4h         6/6     Running     0          9m51s
csi-cephfsplugin-provisioner-5f589446b4-vds6n         6/6     Running     0          9m51s
csi-cephfsplugin-pvqxb                                3/3     Running     0          9m51s
csi-rbdplugin-kgddc                                   3/3     Running     0          9m52s
csi-rbdplugin-provisioner-bb8f8f69d-6wl8d             6/6     Running     0          9m51s
csi-rbdplugin-provisioner-bb8f8f69d-hl4l7             6/6     Running     0          9m51s
csi-rbdplugin-rh2k8                                   3/3     Running     0          9m52s
csi-rbdplugin-tbm56                                   3/3     Running     0          9m52s
csi-rbdplugin-vq2lt                                   3/3     Running     0          9m52s
rook-ceph-crashcollector-k8s-master03-79dbdbfddc-p7lcj   1/1     Running     0          8m35s
rook-ceph-crashcollector-k8s-work01-7fb8dfbbd6-w6f4r  1/1     Running     0          7m55s
rook-ceph-crashcollector-k8s-work02-6ccdfd447-86m2k   1/1     Running     0          7m51s
rook-ceph-exporter-k8s-master03-765d886b4f-ls75w      1/1     Running     0          8m35s
rook-ceph-exporter-k8s-work01-6d444dfb4d-6qtsc        1/1     Running     0          7m50s
rook-ceph-exporter-k8s-work02-77f48b566f-zdngz        1/1     Running     0          7m46s
rook-ceph-mgr-a-59db64d547-qtcqj                      3/3     Running     0          8m36s
rook-ceph-mgr-b-564896bcfb-p9wnn                      3/3     Running     0          8m35s
rook-ceph-mon-a-6484dfb6c6-kc4xt                      2/2     Running     0          9m30s
rook-ceph-mon-b-7d6cf98cc5-m62g7                      2/2     Running     0          9m5s
rook-ceph-mon-c-9d8ff869f-skpmm                       2/2     Running     0          8m52s
rook-ceph-operator-67944bdfcc-4h6st                   1/1     Running     0          11m
rook-ceph-osd-0-85b8b478b9-s28b4                      2/2     Running     0          7m55s
rook-ceph-osd-1-5d944c7777-vhm85                      2/2     Running     0          7m53s
rook-ceph-osd-2-575df5bcbc-g6q5d                      2/2     Running     0          7m51s
rook-ceph-osd-prepare-k8s-master03-6tvzj              0/1     Completed   0          8m12s
rook-ceph-osd-prepare-k8s-work01-cqbb7                0/1     Completed   0          8m12s
rook-ceph-osd-prepare-k8s-work02-42l2t                0/1     Completed   0          8m11s
rook-ceph-tools-7b75b967db-56plh                      1/1     Running     0          37s
rook-discover-4wwbl                                   1/1     Running     0          11m
rook-discover-cs2jr                                   1/1     Running     0          11m
rook-discover-dftfs                                   1/1     Running     0          11m
rook-discover-mrtcf                                   1/1     Running     0          11m
```

如果第一次没有创建成功OSD，可清理重新尝试

```
# 停止当前集群的OSD服务（避免干扰）
```

```
kubectl -n rook-ceph delete --all pods -l app=rook-ceph-osd
#删除之前创建的crd
kubectl get crds | grep "ceph.rook.io" | awk '{print $1}' | xargs kubectl delete crd
kubectl get clusterroles | grep "rook" | awk '{print $1}' | xargs kubectl delete clusterrole
kubectl get clusterrolebindings | grep "rook" | awk '{print $1}' | xargs kubectl delete clusterrolebinding
kubectl get roles -n rook-ceph | awk '{print $1}' | xargs kubectl delete role -n rook-ceph
kubectl get rolebindings -n rook-ceph | awk '{print $1}' | xargs kubectl delete rolebinding -n rook-ceph
kubectl get serviceaccounts -n rook-ceph | awk '{print $1}' | xargs kubectl delete serviceaccount -n rook-ceph

# 在每个节点执行以下命令
sudo rm -rf /var/lib/rook/*
sudo wipefs -a /dev/nvme0n2
sudo dd if=/dev/zero of=/dev/nvme0n2 bs=1M count=1000

sudo reboot  # 可选：重启确保设备状态刷新
```

> ⓘ **Note**
>
> 需要注意的是，**osd-x 的容器必须是存在的**，且是正常的。如果上述 Pod 均正常，则认为集群安装成功。
> **更多配置：**https://rook.io/docs/rook/v1.6/ceph-cluster-crd.html

2）安装 ceph snapshot 控制器

snapshot 控制器的部署在集群安装时的 k8s-ha-install 项目中，需要切换到 1.20.x 分支：

```
cd /root/k8s-ha-install/
git checkout manual-installation-v1.20.x
```

创建 snapshot controller：

```
kubectl create -f /root/k8s-ha-install/snapshotter/ -n kube-system
kubectl get po -n kube-system -l app=snapshot-controller


[root@K8S-Master01 examples]# kubectl get po -n kube-system -l app=snapshot-controller
NAME                    READY   STATUS    RESTARTS   AGE
snapshot-controller-0   1/1     Running   0          6m16s
```

3）安装 ceph 客户端工具

```
cd /root/rook/deploy/examples/
kubectl  create -f /root/rook/deploy/examples/toolbox.yaml -n rook-ceph
kubectl get po -n rook-ceph -l app=rook-ceph-tools


[root@K8S-Master01 examples]# kubectl get po -n rook-ceph -l app=rook-ceph-tools
NAME                                READY   STATUS    RESTARTS   AGE
rook-ceph-tools-7b75b967db-ls9t4    1/1     Running   0          6m51s
```

容器启动后，即可进入容器内部执行服务命令

```
[root@k8s-master01 examples]# kubectl -n rook-ceph exec deploy/rook-ceph-tools -- ceph osd stat
3 osds: 3 up (since 7m), 3 in (since 7m); epoch: e16
[root@k8s-master01 examples]# kubectl -n rook-ceph exec deploy/rook-ceph-tools -- ceph -s
  cluster:
    id:     dd96e25d-c610-4fc2-a0aa-41bf4cd9d750
    health: HEALTH_OK

  services:
    mon: 3 daemons, quorum a,b,c (age 5m)
    mgr: b(active, since 6m), standbys: a
    osd: 3 osds: 3 up (since 7m), 3 in (since 7m)

  data:
    pools:   1 pools, 1 pgs
    objects: 2 objects, 449 KiB
    usage:   82 MiB used, 30 GiB / 30 GiB avail
    pgs:     1 active+clean

如果觉得执行命令过长，可以设置别名
```

具体文档：https://rook.io/docs/rook/v1.6/ceph-csi-snapshot.html

4）安装Ceph dashboard

默认情况下，ceph dashboard是打开的，可以创建一个nodePort类型的Service暴露服务 （新版本该文件默认存在可以直接创建）：

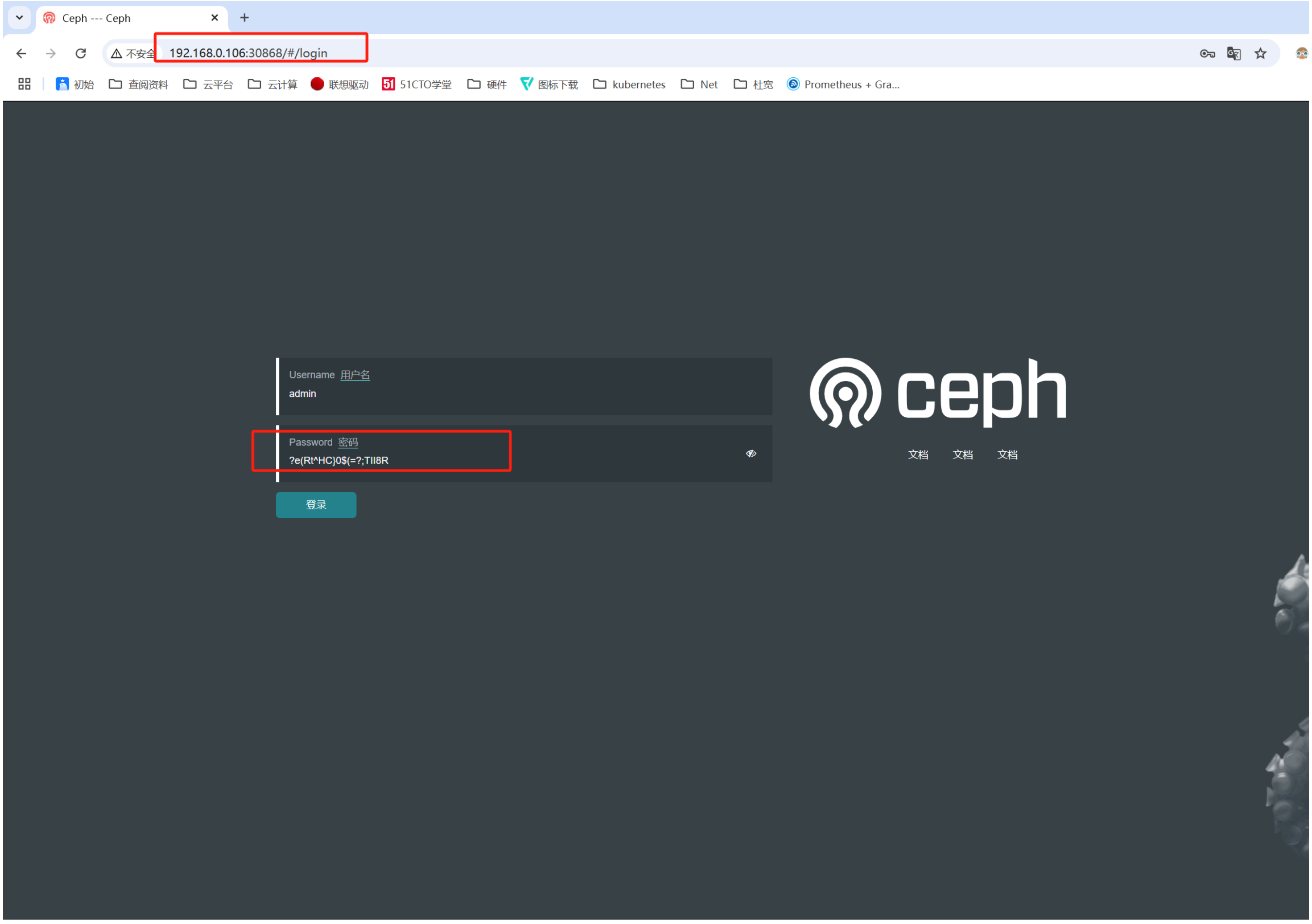
有存在以下四个类型的 SVC 文件，如果dashboard 之前设置的是ssl: true 那么根据实际情况去进行创建

```
[root@k8s-master01 examples]# ls dashboard-*
dashboard-external-https.yaml  dashboard-external-http.yaml  dashboard-ingress-https.yaml  dashboard-loadbalancer.yaml
```

创建

```
kubectl create -f dashboard-external-http.yaml

[root@k8s-master01 examples]#  kubectl get svc  -n rook-ceph rook-ceph-mgr-dashboard-external-https
NAME                                    TYPE        CLUSTER-IP       EXTERNAL-IP   PORT(S)          AGE
rook-ceph-mgr-dashboard-external-https   NodePort   10.96.211.249    <none>        8443:31983/TCP   80s


#获取登陆密码
kubectl -n rook-ceph get secret rook-ceph-dashboard-password -o jsonpath="{['data']['password']}" | base64 --decode && echo

[root@k8s-master01 examples]# kubectl -n rook-ceph get secret rook-ceph-dashboard-password -o jsonpath="{['data']['password']}" | base64 --decode && echo
?e(Rt^HC}0$(=?;TII8R
```

WEB 访问



192.168.0.106:30868/#/login

Username 用户名: admin

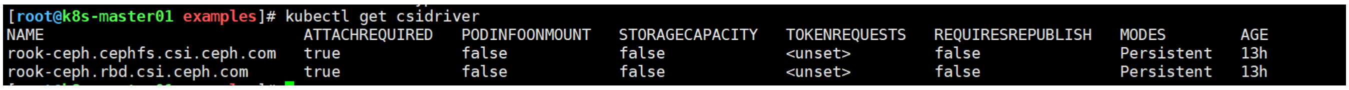
Password 密码: ?e(Rt^HC}0$(=?;TII8R

ceph 块存储的使用

块存储一般用于一个 Pod 挂载一块存储使用，相当于一个服务器新挂了一个盘，只给一个应用使用。
参考文档：https://rook.io/docs/rook/v1.6/ceph-block.html

1）创建 StorageClass 和 ceph 的存储池

```
cd /root/rook/deploy/examples
kubectl create -f csi/rbd/storageclass.yaml -n rook-ceph


[root@k8s-master01 examples]# kubectl get cephblockpool -n rook-ceph
NAME          PHASE   TYPE         FAILUREDOMAIN   AGE
replicapool   Ready   Replicated   host            2m7s
[root@k8s-master01 examples]# kubectl get sc
NAME              PROVISIONER                  RECLAIMPOLICY   VOLUMEBINDINGMODE   ALLOWVOLUMEEXPANSION   AGE
rook-ceph-block   rook-ceph.rbd.csi.ceph.com   Delete          Immediate           true                   2m15s

# 查看ceph提供的存储驱动
kubectl get csidriver
```

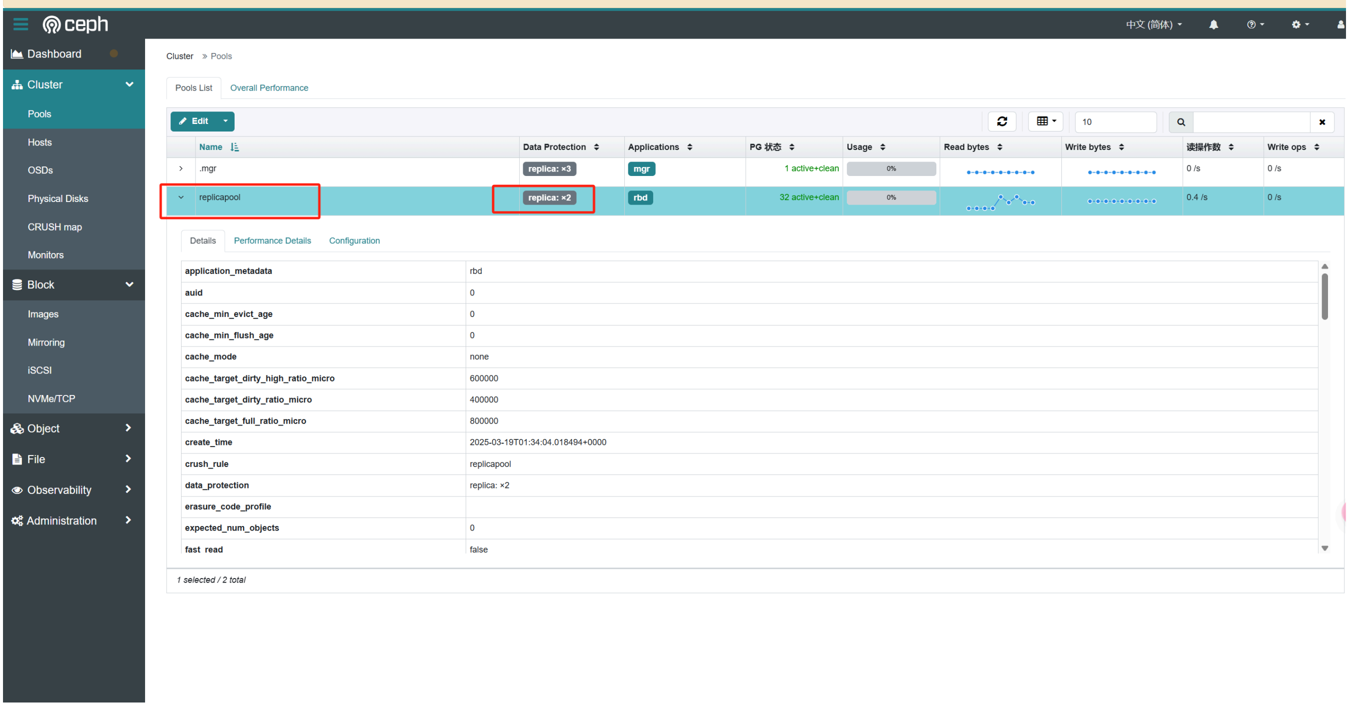


```
[root@k8s-master01 examples]# kubectl get csidriver
NAME                          ATTACHREQUIRED   PODINFOONMOUNT   STORAGECAPACITY   TOKENREQUESTS   REQUIRESREPUBLISH   MODES        AGE
rook-ceph.cephfs.csi.ceph.com true             false            false             <unset>         false               Persistent   13h
rook-ceph.rbd.csi.ceph.com    true             false            false             <unset>         false               Persistent   13h
```

Yaml 配置文件解释

```
apiVersion: ceph.rook.io/v1
kind: CephBlockPool
metadata:
  name: replicapool           # 存储池名称
  namespace: rook-ceph        # 所属命名空间（必须与CephCluster一致）
spec:
  failureDomain: host         # 数据副本分布策略（故障域级别）其他可选值：osd（不同OSD磁盘）、rack（不同机架）。
  replicated:
    size: 3                   # 数据副本数量，每个数据块保存 3个副本（即同一份数据在集群中有3份拷贝）。
    requireSafeReplicaSize: true  # 强制副本数必须满足最小安全要求
---
apiVersion: storage.k8s.io/v1
kind: StorageClass
metadata:
  name: rook-ceph-block       # 存储类名称（创建PVC时需指定）
provisioner: rook-ceph.rbd.csi.ceph.com  # CSI驱动名称
parameters:
  clusterID: rook-ceph        # Ceph集群ID（必须与CephCluster名称一致）
  pool: replicapool           # 使用的Ceph存储池（即上述定义的replicapool）
  imageFormat: "2"            # RBD镜像格式版本，使用 第2版RBD格式（支持更多功能如动态调整大小）。
  imageFeatures: layering     # RBD镜像支持的特性，支持 分层克隆（用于快照和克隆功能）。
  csi.storage.k8s.io/provisioner-secret-name: rook-csi-rbd-provisioner  # 供应者密钥名称
  csi.storage.k8s.io/provisioner-secret-namespace: rook-ceph  # 密钥所在命名空间
  csi.storage.k8s.io/controller-expand-secret-name: rook-csi-rbd-provisioner  # 扩容存储卷时使用的认证信息名称
  csi.storage.k8s.io/controller-expand-secret-namespace: rook-ceph  # 密钥命名空间
  csi.storage.k8s.io/node-stage-secret-name: rook-csi-rbd-node  # 节点挂载密钥名称
  csi.storage.k8s.io/node-stage-secret-namespace: rook-ceph  # 密钥命名空间
  csi.storage.k8s.io/fstype: ext4  # 文件系统类型,存储卷格式化时使用 ext4文件系统（可选：xfs、ext3等）。
allowVolumeExpansion: true   # 允许通过Kubernetes动态扩展存储卷大小。
reclaimPolicy: Delete        # 回收策略,删除PVC时自动删除底层RBD镜像（可选：Retain 保留数据）
```

从Dashboard上可以看到刚刚所创建的Pool，并且副本数量是我们设置的 size: 2



	Name	Data Protection	Applications	PG 状态	Usage	Read bytes	Write bytes	读操作数	Write ops
›	.mgr	replica: ×3	mgr	1 active+clean	0%			0 /s	0 /s
⌄	replicapool	replica: ×2	rbd	32 active+clean	0%			0.4 /s	0 /s

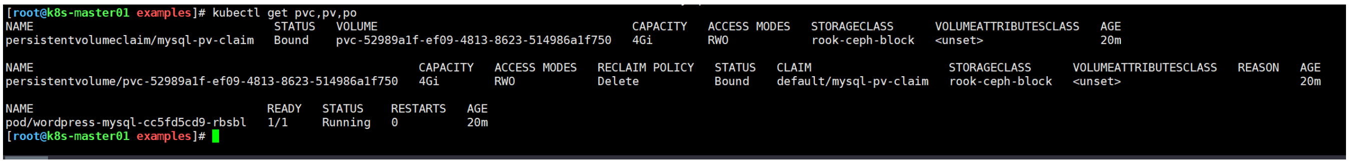
application_metadata	rbd
auid	0
cache_min_evict_age	0
cache_min_flush_age	0
cache_mode	none
cache_target_dirty_high_ratio_micro	600000
cache_target_dirty_ratio_micro	400000
cache_target_full_ratio_micro	800000
create_time	2025-03-19T01:34:04.018494+0000
crush_rule	replicapool
data_protection	replica: ×2
erasure_code_profile	
expected_num_objects	0
fast_read	false

1 selected / 2 total

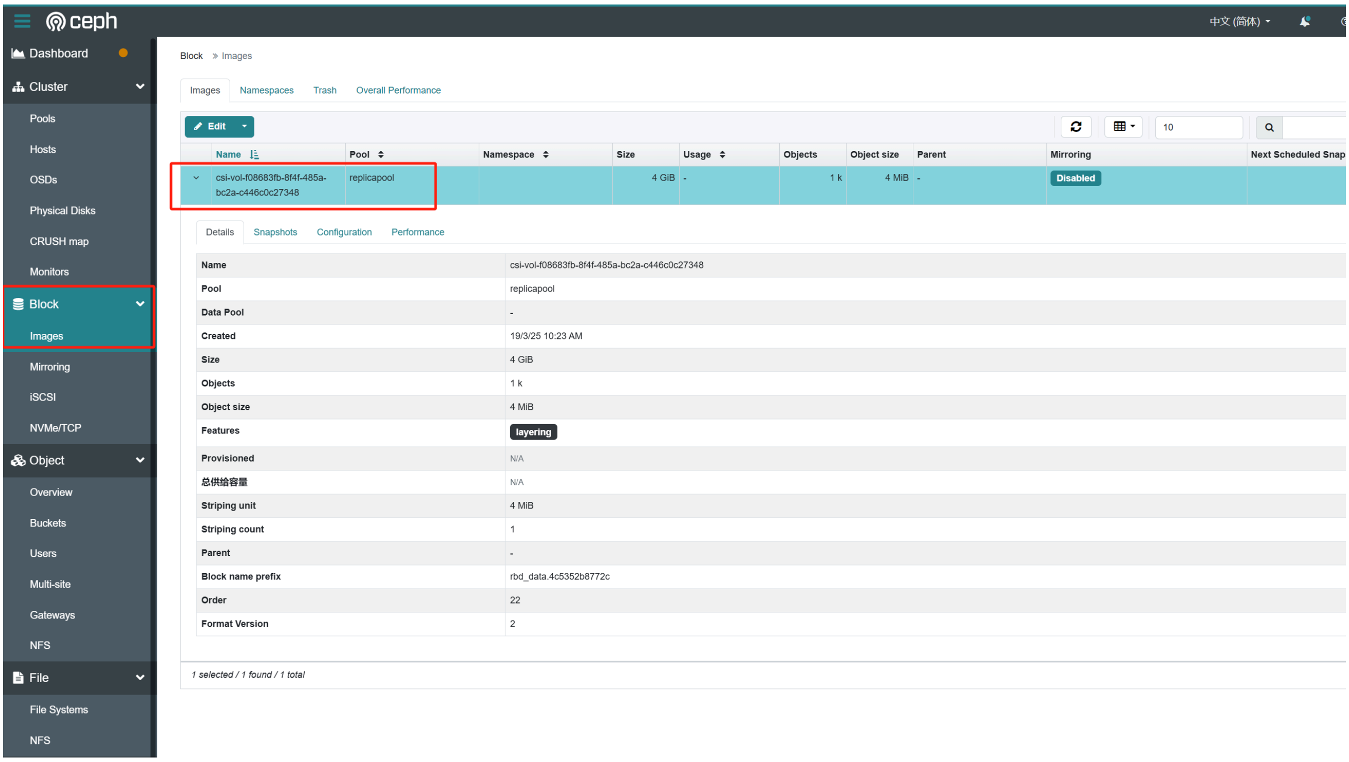
2）挂载测试

创建一个 MySQL 服务

```
cd /root/rook/deploy/examples
kubectl create -f mysql.yaml

kubectl get pvc,pv,po
```



```
[root@k8s-master01 examples]# kubectl get pvc,pv,po
NAME                                 STATUS   VOLUME                                     CAPACITY   ACCESS MODES   STORAGECLASS      VOLUMEATTRIBUTESCLASS   AGE
persistentvolumeclaim/mysql-pv-claim  Bound    pvc-52989a1f-ef09-4813-8623-514986a1f750   4Gi        RWO            rook-ceph-block   <unset>                 20m

NAME                                                       CAPACITY   ACCESS MODES   RECLAIM POLICY   STATUS   CLAIM                    STORAGECLASS      VOLUMEATTRIBUTESCLASS   REASON   AGE
persistentvolume/pvc-52989a1f-ef09-4813-8623-514986a1f750   4Gi        RWO            Delete           Bound    default/mysql-pv-claim   rook-ceph-block   <unset>                          20m

NAME                                READY   STATUS    RESTARTS   AGE
pod/wordpress-mysql-cc5fd5cd9-rbsbl   1/1     Running   0          20m
[root@k8s-master01 examples]# 
```



Name	Pool	Namespace	Size	Usage	Objects	Object size	Parent	Mirroring	Next Scheduled Snap
csi-vol-f08683fb-8f4f-485a-bc2a-c446c0c27348	replicapool		4 GiB	-	1 k	4 MiB	-	Disabled	

Name	csi-vol-f08683fb-8f4f-485a-bc2a-c446c0c27348
Pool	replicapool
Data Pool	-
Created	19/3/25 10:23 AM
Size	4 GiB
Objects	1 k
Object size	4 MiB
Features	layering
Provisioned	N/A
总供给容量	N/A
Striping unit	4 MiB
Striping count	1
Parent	-
Block name prefix	rbd_data.4c5352b8772c
Order	22
Format Version	2

1 selected / 1 found / 1 total

Yaml 配置文件解释

> **Note**
>
> Volume 通过主要配置参数：claimName：mysql-pv-claim 指定PVC
>
> PVC 通过主要配置参数：storageClassName: rook-ceph-block 指定SC

```yaml
apiVersion: v1
kind: Service
metadata:
  name: wordpress-mysql      # 服务名称
  labels:
    app: wordpress           # 服务标签（用于关联应用）
spec:
  ports:
    - port: 3306             # 暴露的端口号（MySQL默认端口）
  selector:
    app: wordpress           # 选择器：匹配Pod的标签
    tier: mysql
  clusterIP: None            # 使用Headless Service（无集群IP）

---
apiVersion: v1
kind: PersistentVolumeClaim
metadata:
  name: mysql-pv-claim        # PVC名称
  labels:
    app: wordpress
spec:
  storageClassName: rook-ceph-block  # 指定使用的存储类（需提前创建）
  accessModes:
    - ReadWriteOnce           # 访问模式：单节点读写
  resources:
    requests:
      storage: 5Gi           # 请求5Gi存储空间
---
apiVersion: apps/v1
kind: Deployment
metadata:
  name: wordpress-mysql        # 部署名称
  labels:
    app: wordpress
    tier: mysql
spec:
  selector:
    matchLabels:              # 选择器：匹配Pod标签
      app: wordpress
      tier: mysql
  strategy:
    type: Recreate           # 更新策略：先终止旧Pod再创建新Pod（防止数据冲突）
  template:
    metadata:
      labels:
        app: wordpress
        tier: mysql
    spec:
      containers:
        - image: mysql:5.6    # 使用MySQL 5.6镜像
          name: mysql
          env:
            - name: MYSQL_ROOT_PASSWORD  # 设置MySQL root密码
              value: changeme            # 实际环境应使用Secret管理
          ports:
            - containerPort: 3306        # 容器暴露端口
              name: mysql
          volumeMounts:
            - name: mysql-persistent-storage
              mountPath: /var/lib/mysql  # MySQL数据存储路径
      volumes:
        - name: mysql-persistent-storage
          persistentVolumeClaim:
            claimName: mysql-pv-claim    # 绑定到上述PVC
```

pvc 会连接刚才创建的 `storageClass`，动态的创建 `pv`，然后连接到 ceph 创建对应的存储之后创建。 `pvc` 只需要指定 `storageClassName` 为刚才创建的 `StorageClass` 名称即可连接到 rook 的ceph。如果是 statefulset，只需要将 `volumeTemplateClaim` 里面的 `Claim` 名称改为 `StorageClass` 名称即可动态创建 Pod

完整流程说明

1.存储分配：

- 当PVC `mysql-pv-claim` 被创建时，Rook-Ceph会根据 `rook-ceph-block` 存储类动态创建PV（RBD镜像）。
- PVC与PV绑定后，MySQL Pod才能挂载存储卷。

2.服务访问：

- 其他Pod（如WordPress）可通过DNS名称 `wordpress-mysql` 访问MySQL服务。
- Headless Service的DNS记录直接指向MySQL Pod IP，适用于需要直接访问Pod的场景。

3.数据持久化：

- MySQL数据保存在 `/var/lib/mysql` 目录，底层由Ceph RBD提供高可用存储。
- 即使Pod重启或迁移，数据不会丢失。

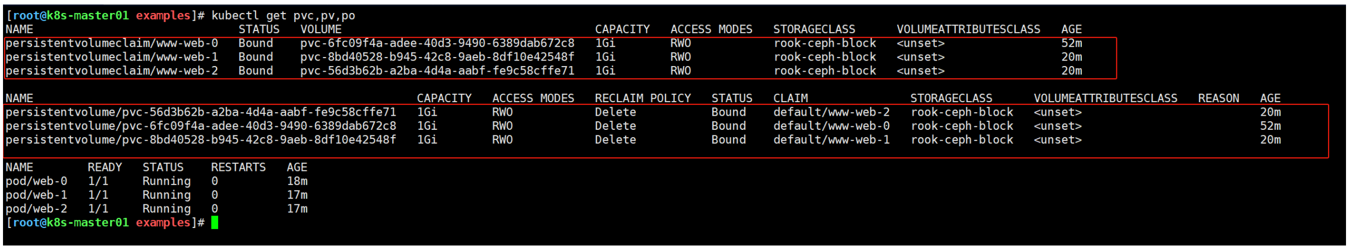
卸载pv

```
[root@k8s-master01 examples]# kubectl delete -f mysql.yaml
service "wordpress-mysql" deleted
persistentvolumeclaim "mysql-pv-claim" deleted
deployment.apps "wordpress-mysql" deleted


[root@k8s-master01 examples]# kubectl get pvc,pv,po
No resources found
```

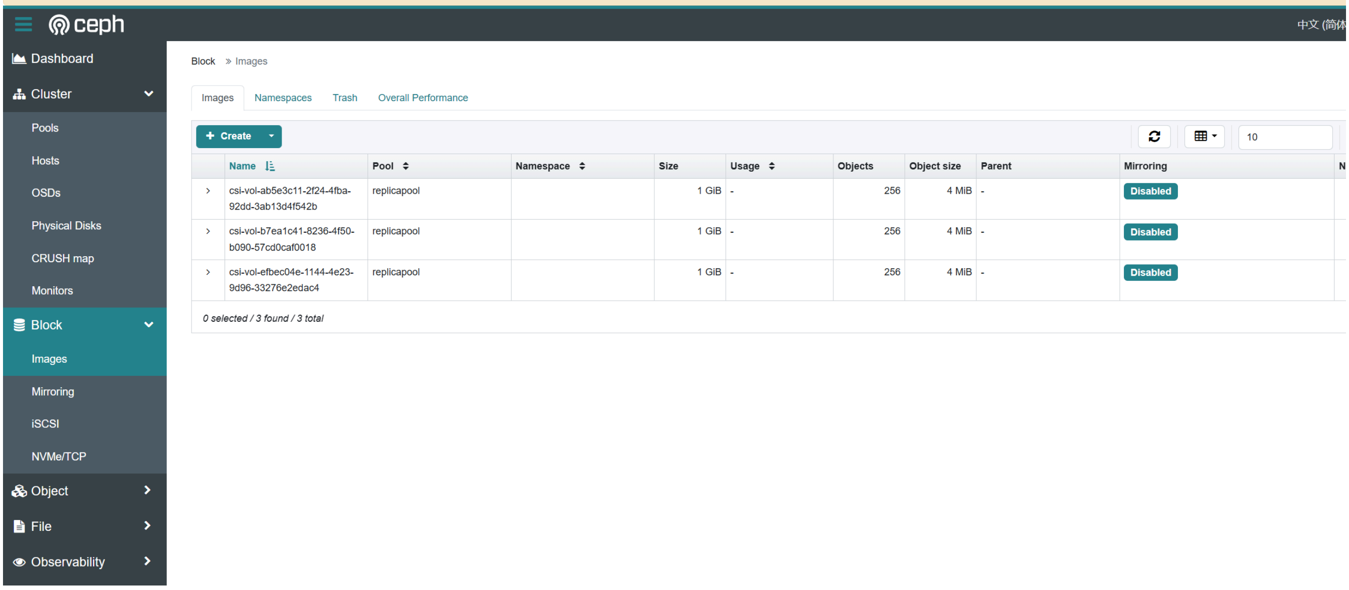
3）StatefulSet 动态存储

普通情况 PVC通过 StorageClass 一次只能创一个PV，但是 StatefulSet 有状态的服务不适用于共享存储数据，否则可能会导致服务异常，所以每个po需要一个pv。可以通过volumeClaimTemplates：来实现

```
#部署
vim sts-sc.yaml
kubectl create -f sts-sc.yaml

kubectl get pvc,pv,po


#卸载
kubectl delete -f sts-sc.yaml
kubectl delete pvc www-web-0,www-web-1,www-web-2
```



```
[root@k8s-master01 examples]# kubectl get pvc,pv,po
NAME                              STATUS   VOLUME                                     CAPACITY   ACCESS MODES   STORAGECLASS      VOLUMEATTRIBUTESCLASS   AGE
persistentvolumeclaim/www-web-0   Bound    pvc-6fc09f4a-adee-40d3-9490-6389dab672c8   1Gi        RWO            rook-ceph-block   <unset>                 52m
persistentvolumeclaim/www-web-1   Bound    pvc-8bd40528-b945-42c8-9aeb-8df10e42548f   1Gi        RWO            rook-ceph-block   <unset>                 20m
persistentvolumeclaim/www-web-2   Bound    pvc-56d3b62b-a2ba-4d4a-aabf-fe9c58cffe71   1Gi        RWO            rook-ceph-block   <unset>                 20m

NAME                                                        CAPACITY   ACCESS MODES   RECLAIM POLICY   STATUS   CLAIM               STORAGECLASS      VOLUMEATTRIBUTESCLASS   REASON   AGE
persistentvolume/pvc-56d3b62b-a2ba-4d4a-aabf-fe9c58cffe71   1Gi        RWO            Delete           Bound    default/www-web-2   rook-ceph-block   <unset>                          20m
persistentvolume/pvc-6fc09f4a-adee-40d3-9490-6389dab672c8   1Gi        RWO            Delete           Bound    default/www-web-0   rook-ceph-block   <unset>                          52m
persistentvolume/pvc-8bd40528-b945-42c8-9aeb-8df10e42548f   1Gi        RWO            Delete           Bound    default/www-web-1   rook-ceph-block   <unset>                          20m

NAME        READY   STATUS    RESTARTS   AGE
pod/web-0   1/1     Running   0          18m
pod/web-1   1/1     Running   0          17m
pod/web-2   1/1     Running   0          17m
[root@k8s-master01 examples]# 
```



	Name	Pool	Namespace	Size	Usage	Objects	Object size	Parent	Mirroring	N
›	csi-vol-ab5e3c11-2f24-4fba-92dd-3ab13d4f542b	replicapool		1 GiB	-	256	4 MiB	-	Disabled	
›	csi-vol-b7ea1c41-8236-4f50-b090-57cd0caf0018	replicapool		1 GiB	-	256	4 MiB	-	Disabled	
›	csi-vol-efbec04e-1144-4e23-9d96-33276e2edac4	replicapool		1 GiB	-	256	4 MiB	-	Disabled	

0 selected / 3 found / 3 total

```yaml
# 定义一个 Service 资源
apiVersion: v1
kind: Service
metadata:
  name: nginx                 # 服务名称
  labels:
    app: nginx                # 服务标签（用于关联应用）
spec:
  ports:
  - port: 80                  # 服务暴露端口
    name: web                 # 端口名称标识
  clusterIP: None             # 使用Headless Service（无集群IP）
  selector:
    app: nginx                # 选择器：匹配Pod的标签

---
# 定义一个 StatefulSet 资源
apiVersion: apps/v1
kind: StatefulSet
metadata:
  name: web                   # StatefulSet名称
spec:
  selector:
    matchLabels:
      app: nginx              # 必须与Pod模板中的标签一致
  serviceName: "nginx"        # 关联的Headless Service名称
  replicas: 3                 # 副本数量（创建3个Pod：web-0，web-1，web-2）
  minReadySeconds: 10         # 新Pod就绪后等待10秒才视为可用
  template:
    metadata:
      labels:
        app: nginx            # Pod标签（必须与selector.matchLabels一致）
    spec:
      terminationGracePeriodSeconds: 10   # 删除Pod时的优雅终止等待时间
      containers:
      - name: nginx
```

```
        image: m.daocloud.io/docker.io/library/nginx:latest  # 使用Nginx镜像
        ports:
        - containerPort: 80   # 容器监听端口
          name: web           # 端口名称标识
        volumeMounts:
        - name: www           # 挂载的卷名称（与volumeClaimTemplates匹配）
          mountPath: /usr/share/nginx/html  # 挂载路径（Nginx默认静态文件目录）
  volumeClaimTemplates:       # 动态创建PVC的模板（每个Pod自动生成独立PVC）
  - metadata:
      name: www               # PVC名称模板（最终名称：www-web-0, www-web-1等）
    spec:
      accessModes: [ "ReadWriteOnce" ]  # 访问模式：单节点读写
      storageClassName: "rook-ceph-block"  # 使用的存储类（需提前创建）
      resources:
        requests:
          storage: 1Gi        # 每个PVC请求1Gi存储空间
```

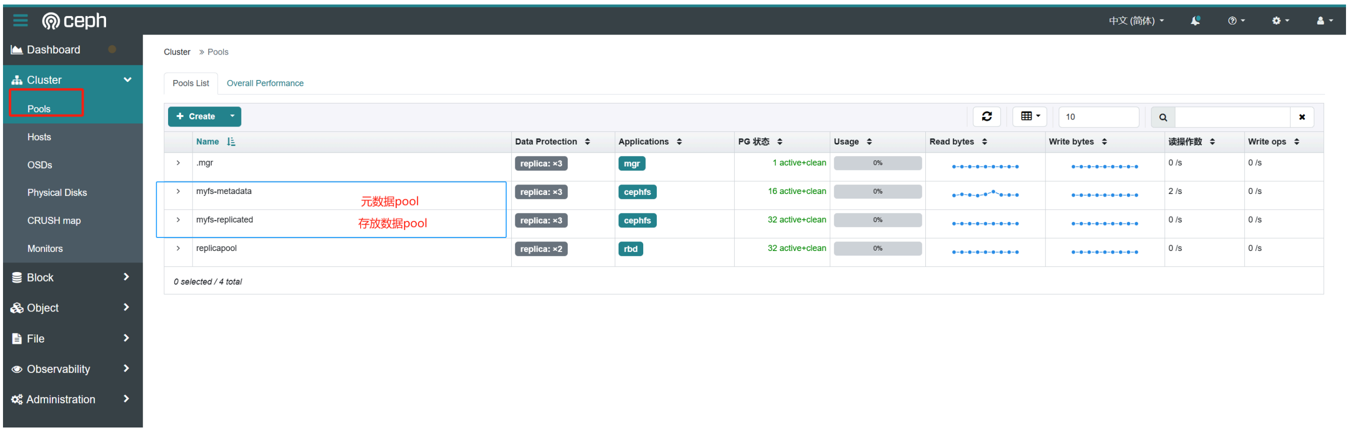
共享文件系统的使用

共享文件系统一般用于多个 Pod 共享一个存储
官方文档：https://rook.io/docs/rook/v1.6/ceph-filesystem.html

1）创建共享类型的文件系统和 StorageClass

> ⓘ **Note**
>
> 文件存储会有创建MDS 用来存放元数据，多个 MDS 节点共享元数据，通过动态子树分区实现负载均衡

```
cd /root/rook/deploy/examples
kubectl create -f filesystem.yaml
kubectl -n rook-ceph get pod -l app=rook-ceph-mds


kubectl create -f csi/cephfs/storageclass.yaml

[root@k8s-master01 examples]# kubectl get sc
NAME              PROVISIONER                     RECLAIMPOLICY   VOLUMEBINDINGMODE
ALLOWVOLUMEEXPANSION   AGE
rook-ceph-block   rook-ceph.rbd.csi.ceph.com      Delete          Immediate
true                   24h
rook-cephfs       rook-ceph.cephfs.csi.ceph.com   Delete          Immediate
true                   5s
```

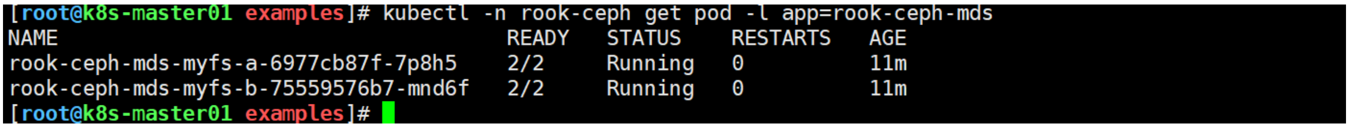


	Name	Data Protection	Applications	PG 状态	Usage	Read bytes	Write bytes	读操作数	Write ops
›	.mgr	replica: ×3	mgr	1 active+clean	0%			0 /s	0 /s
›	myfs-metadata	replica: ×3	cephfs	16 active+clean	0%			2 /s	0 /s
›	myfs-replicated	replica: ×3	cephfs	32 active+clean	0%			0 /s	0 /s
›	replicapool	replica: ×2	rbd	32 active+clean	0%			0 /s	0 /s

0 selected / 4 total

元数据pool

存放数据pool



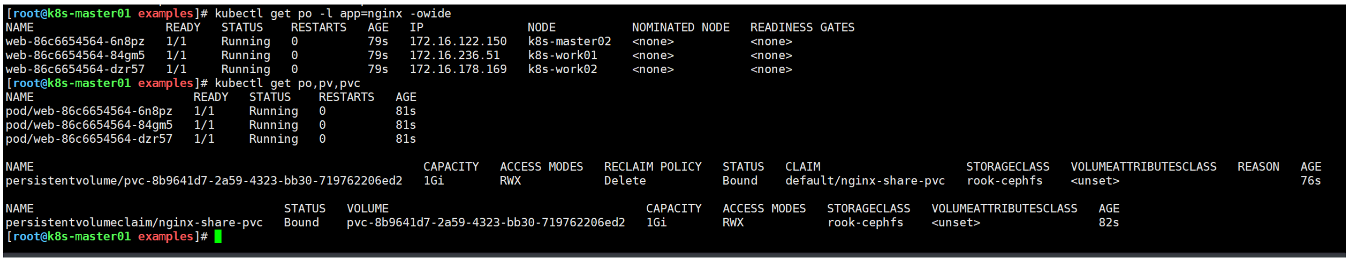
```
[root@k8s-master01 examples]# kubectl -n rook-ceph get pod -l app=rook-ceph-mds
NAME                                   READY   STATUS    RESTARTS   AGE
rook-ceph-mds-myfs-a-6977cb87f-7p8h5   2/2     Running   0          11m
rook-ceph-mds-myfs-b-75559576b7-mnd6f  2/2     Running   0          11m
[root@k8s-master01 examples]# 
```

2）nginx 挂载测试

```
kubectl create -f nginx.yaml
kubectl get po -l app=nginx

kubectl get pvc,pv,po

vim nginx.yaml
```

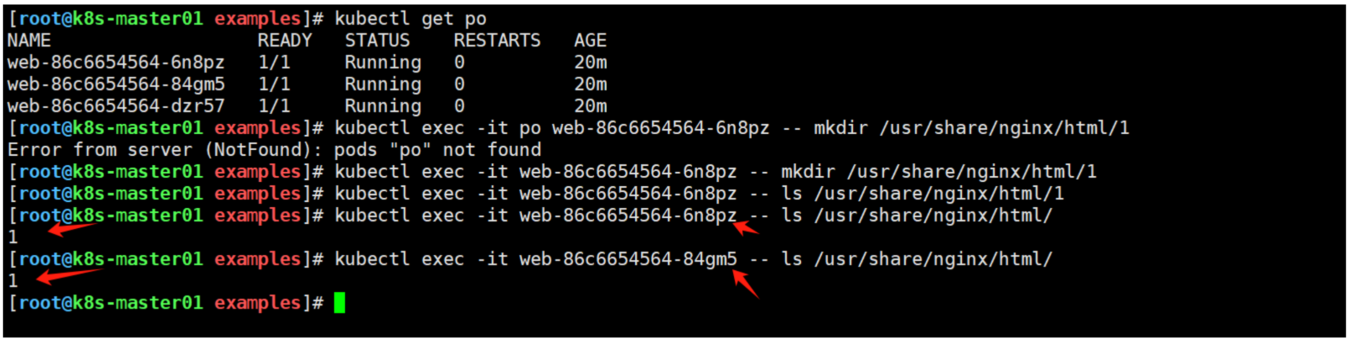
```
apiVersion: v1
kind: Service
metadata:
  name: nginx                     # 服务名称
  labels:
    app: nginx                    # 服务标签（用于关联应用）
spec:
  ports:
  - port: 80                      # 服务暴露端口
    name: web                     # 端口名称标识
  selector:
    app: nginx                    # 选择器：匹配Pod的标签,将流量路由到标签为 app: nginx 的Pod。
  type: ClusterIP                 # 服务类型（默认ClusterIP，仅集群内访问）
---
kind: PersistentVolumeClaim
apiVersion: v1
metadata:
  name: nginx-share-pvc           # PVC名称
spec:
  storageClassName: rook-cephfs   # 使用的存储类（需提前创建CephFS存储类）
  accessModes:
  - ReadWriteMany                # 访问模式：多节点读写,允许多个Pod同时读写同一个存储卷（适合共享存储场景）
  resources:
    requests:
      storage: 1Gi               # 请求1Gi存储空间
---
```

```yaml
apiVersion: apps/v1
kind: Deployment
metadata:
  name: web                     # 部署名称
spec:
  selector:
    matchLabels:
      app: nginx                # 选择器：匹配Pod标签
  replicas: 3                   # 副本数量（部署3个Pod）
  template:
    metadata:
      labels:
        app: nginx              # Pod标签（必须与selector.matchLabels一致）
    spec:
      containers:
      - name: nginx
        image: m.daocloud.io/docker.io/library/nginx:latest          # 使用Nginx镜像
        imagePullPolicy: IfNotPresent  # 镜像拉取策略（本地存在则不拉取）
        ports:
        - containerPort: 80    # 容器监听端口
          name: web
        volumeMounts:
        - name: www             # 挂载的卷名称
          mountPath: /usr/share/nginx/html  # Nginx静态文件目录
      volumes:
      - name: www               # 卷名称（与volumeMounts匹配）
        persistentVolumeClaim:
          claimName: nginx-share-pvc  # 绑定到上述PVC
```



```
[root@k8s-master01 examples]# kubectl get po -l app=nginx -owide
NAME                   READY   STATUS    RESTARTS   AGE   IP               NODE           NOMINATED NODE   READINESS GATES
web-86c6654564-6n8pz   1/1     Running   0          79s   172.16.122.150   k8s-master02   <none>           <none>
web-86c6654564-84gm5   1/1     Running   0          79s   172.16.236.51    k8s-work01     <none>           <none>
web-86c6654564-dzr57   1/1     Running   0          79s   172.16.178.169   k8s-work02     <none>           <none>
[root@k8s-master01 examples]# kubectl get po,pv,pvc
NAME                       READY   STATUS    RESTARTS   AGE
pod/web-86c6654564-6n8pz   1/1     Running   0          81s
pod/web-86c6654564-84gm5   1/1     Running   0          81s
pod/web-86c6654564-dzr57   1/1     Running   0          81s

NAME                                                        CAPACITY   ACCESS MODES   RECLAIM POLICY   STATUS   CLAIM                     STORAGECLASS   VOLUMEATTRIBUTESCLASS   REASON   AGE
persistentvolume/pvc-8b9641d7-2a59-4323-bb30-719762206ed2   1Gi        RWX            Delete           Bound    default/nginx-share-pvc   rook-cephfs    <unset>                          76s

NAME                                    STATUS   VOLUME                                     CAPACITY   ACCESS MODES   STORAGECLASS   VOLUMEATTRIBUTESCLASS   AGE
persistentvolumeclaim/nginx-share-pvc   Bound    pvc-8b9641d7-2a59-4323-bb30-719762206ed2   1Gi        RWX            rook-cephfs    <unset>                 82s
[root@k8s-master01 examples]# 
```

3）验证效果



```
[root@k8s-master01 examples]# kubectl get po
NAME                   READY   STATUS    RESTARTS   AGE
web-86c6654564-6n8pz   1/1     Running   0          20m
web-86c6654564-84gm5   1/1     Running   0          20m
web-86c6654564-dzr57   1/1     Running   0          20m
[root@k8s-master01 examples]# kubectl exec -it po web-86c6654564-6n8pz -- mkdir /usr/share/nginx/html/1
Error from server (NotFound): pods "po" not found
[root@k8s-master01 examples]# kubectl exec -it web-86c6654564-6n8pz -- mkdir /usr/share/nginx/html/1
[root@k8s-master01 examples]# kubectl exec -it web-86c6654564-6n8pz -- ls /usr/share/nginx/html/1
[root@k8s-master01 examples]# kubectl exec -it web-86c6654564-6n8pz -- ls /usr/share/nginx/html/
1
[root@k8s-master01 examples]# kubectl exec -it web-86c6654564-84gm5 -- ls /usr/share/nginx/html/
1
[root@k8s-master01 examples]# 
```

PVC 扩容

> **Caution**
>
> 文件共享类型的 PVC 扩容需要 k8s 1.15+
> 块存储类型的 PVC 扩容需要 k8s 1.16+
>
> **在 Kubernetes 中，PVC 的缩容功能是受限制的。大多数存储提供商不支持 PVC 的缩容操作。即使某些存储提供商支持缩容，也需要手动干预，并且可能会导致数据丢失。因此，Kubernetes 默认不允许 PVC 的缩容操作。**

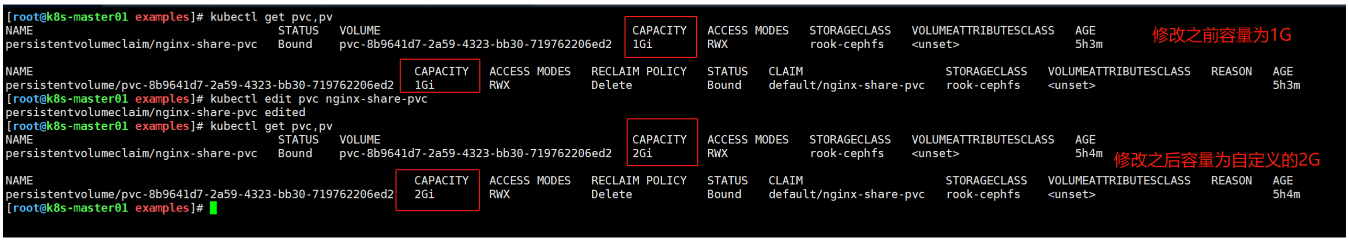
1）扩容文件共享型 PVC

前置条件：需确保SC 开启了参数 allowVolumeExpansion: true

```
[root@k8s-master01 examples]# awk '/allowVolumeExpansion/' csi/cephfs/storageclass.yaml
allowVolumeExpansion: true
```

修改扩容

```
kubectl get pvc,pvc
kubectl edit pvc cephfs-pvc -n kube-system


# 查看修改过后的容量大小
kubectl get pvc,pvc
```



```
[root@k8s-master01 examples]# kubectl get pvc,pv
NAME                                   STATUS   VOLUME                                     CAPACITY   ACCESS MODES   STORAGECLASS   VOLUMEATTRIBUTESCLASS   AGE
persistentvolumeclaim/nginx-share-pvc  Bound    pvc-8b9641d7-2a59-4323-bb30-719762206ed2   1Gi        RWX            rook-cephfs    <unset>                 5h3m

NAME                                                      CAPACITY   ACCESS MODES   RECLAIM POLICY   STATUS   CLAIM                     STORAGECLASS   VOLUMEATTRIBUTESCLASS   REASON   AGE
persistentvolume/pvc-8b9641d7-2a59-4323-bb30-719762206ed2  1Gi       RWX            Delete           Bound    default/nginx-share-pvc   rook-cephfs    <unset>                          5h3m
[root@k8s-master01 examples]# kubectl edit pvc nginx-share-pvc
persistentvolumeclaim/nginx-share-pvc edited
[root@k8s-master01 examples]# kubectl get pvc,pv
NAME                                   STATUS   VOLUME                                     CAPACITY   ACCESS MODES   STORAGECLASS   VOLUMEATTRIBUTESCLASS   AGE
persistentvolumeclaim/nginx-share-pvc  Bound    pvc-8b9641d7-2a59-4323-bb30-719762206ed2   2Gi        RWX            rook-cephfs    <unset>                 5h4m

NAME                                                      CAPACITY   ACCESS MODES   RECLAIM POLICY   STATUS   CLAIM                     STORAGECLASS   VOLUMEATTRIBUTESCLASS   REASON   AGE
persistentvolume/pvc-8b9641d7-2a59-4323-bb30-719762206ed2  2Gi       RWX            Delete           Bound    default/nginx-share-pvc   rook-cephfs    <unset>                          5h4m
[root@k8s-master01 examples]# 
```

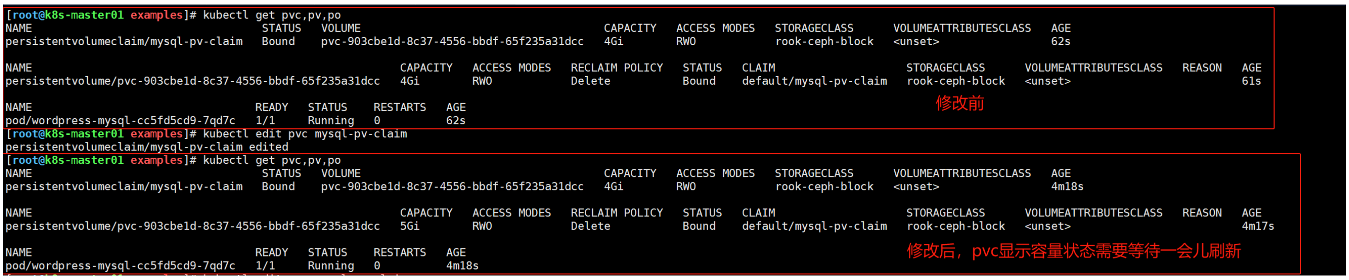
修改之前容量为1G

修改之后容量为自定义的2G

2）扩容块存储

与文件系统扩容一样，先确认sc有没有开启允许动态扩容,然后直接 edit pv进行容量修改

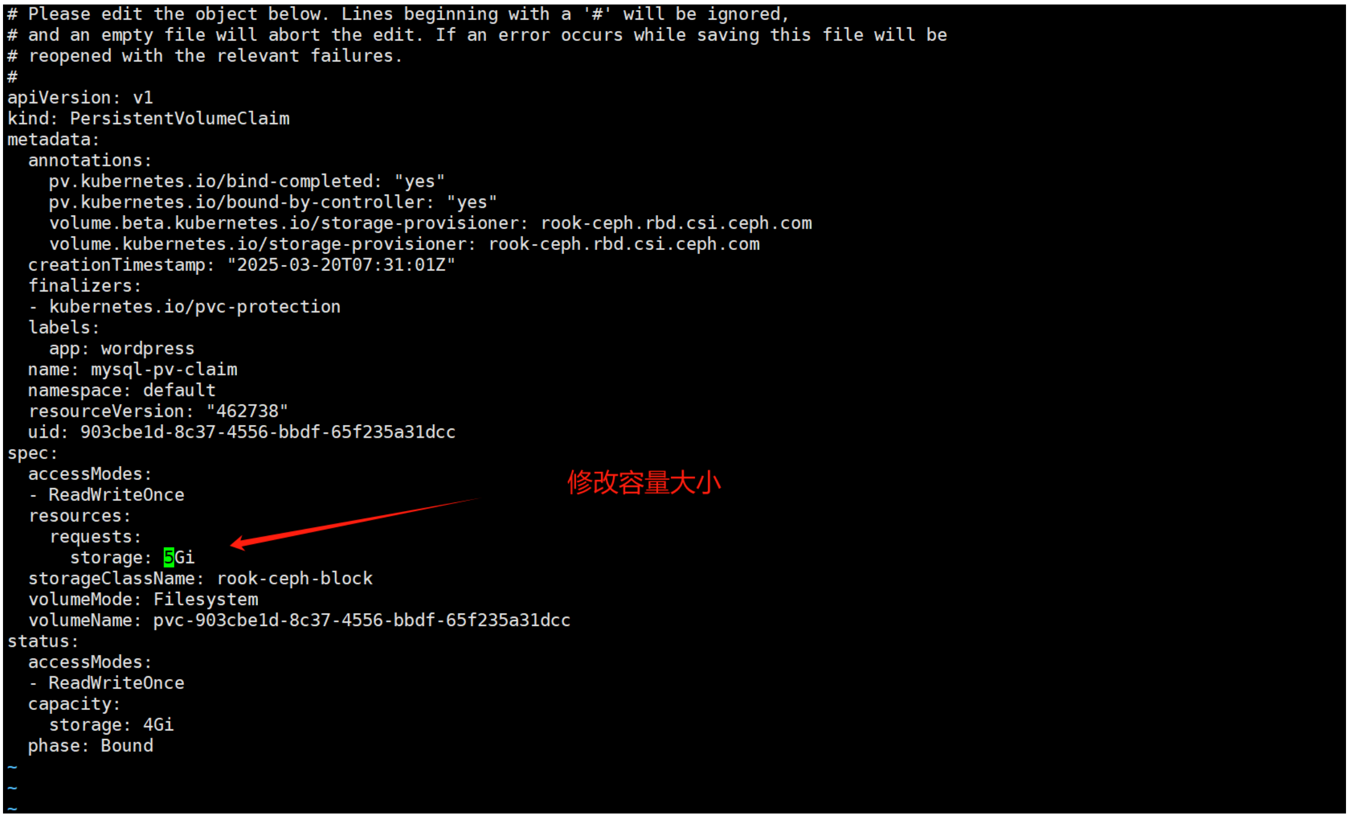
```
kubectl get pvc,pv,po
kubectl edit pvc mysql-pv-claim
```



```
[root@k8s-master01 examples]# kubectl get pvc,pv,po
NAME                                  STATUS   VOLUME                                     CAPACITY   ACCESS MODES   STORAGECLASS      VOLUMEATTRIBUTESCLASS   AGE
persistentvolumeclaim/mysql-pv-claim  Bound    pvc-903cbe1d-8c37-4556-bbdf-65f235a31dcc   4Gi        RWO            rook-ceph-block   <unset>                 62s

NAME                                                      CAPACITY   ACCESS MODES   RECLAIM POLICY   STATUS   CLAIM                    STORAGECLASS      VOLUMEATTRIBUTESCLASS   REASON   AGE
persistentvolume/pvc-903cbe1d-8c37-4556-bbdf-65f235a31dcc  4Gi       RWO            Delete           Bound    default/mysql-pv-claim   rook-ceph-block   <unset>                          61s

NAME                                 READY   STATUS    RESTARTS   AGE
pod/wordpress-mysql-cc5fd5cd9-7qd7c  1/1     Running   0          62s
[root@k8s-master01 examples]# kubectl edit pvc mysql-pv-claim
persistentvolumeclaim/mysql-pv-claim edited
[root@k8s-master01 examples]# kubectl get pvc,pv,po
NAME                                  STATUS   VOLUME                                     CAPACITY   ACCESS MODES   STORAGECLASS      VOLUMEATTRIBUTESCLASS   AGE
persistentvolumeclaim/mysql-pv-claim  Bound    pvc-903cbe1d-8c37-4556-bbdf-65f235a31dcc   4Gi        RWO            rook-ceph-block   <unset>                 4m18s

NAME                                                      CAPACITY   ACCESS MODES   RECLAIM POLICY   STATUS   CLAIM                    STORAGECLASS      VOLUMEATTRIBUTESCLASS   REASON   AGE
persistentvolume/pvc-903cbe1d-8c37-4556-bbdf-65f235a31dcc  5Gi       RWO            Delete           Bound    default/mysql-pv-claim   rook-ceph-block   <unset>                          4m17s

NAME                                 READY   STATUS    RESTARTS   AGE
pod/wordpress-mysql-cc5fd5cd9-7qd7c  1/1     Running   0          4m18s
```

修改前

修改后，pvc显示容量状态需要等待一会儿刷新



```
# Please edit the object below. Lines beginning with a '#' will be ignored,
# and an empty file will abort the edit. If an error occurs while saving this file will be
# reopened with the relevant failures.
#
apiVersion: v1
kind: PersistentVolumeClaim
metadata:
  annotations:
    pv.kubernetes.io/bind-completed: "yes"
    pv.kubernetes.io/bound-by-controller: "yes"
    volume.beta.kubernetes.io/storage-provisioner: rook-ceph.rbd.csi.ceph.com
    volume.kubernetes.io/storage-provisioner: rook-ceph.rbd.csi.ceph.com
  creationTimestamp: "2025-03-20T07:31:01Z"
  finalizers:
  - kubernetes.io/pvc-protection
  labels:
    app: wordpress
  name: mysql-pv-claim
  namespace: default
  resourceVersion: "462738"
  uid: 903cbe1d-8c37-4556-bbdf-65f235a31dcc
spec:
  accessModes:
  - ReadWriteOnce
  resources:
    requests:
      storage: 5Gi
  storageClassName: rook-ceph-block
  volumeMode: Filesystem
  volumeName: pvc-903cbe1d-8c37-4556-bbdf-65f235a31dcc
status:
  accessModes:
  - ReadWriteOnce
  capacity:
    storage: 4Gi
  phase: Bound
~
~
~
```

修改容量大小

PVC 快照

1）创建 snapshotClass

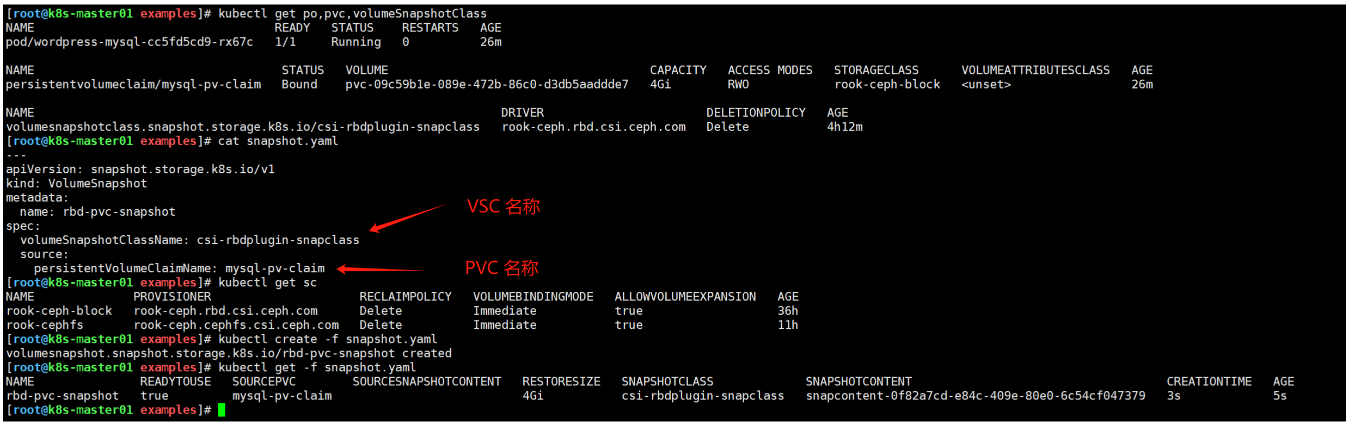
```
kubectl create -f csi/rbd/snapshotclass.yaml

[root@k8s-master01 examples]# cat csi/rbd/snapshotclass.yaml
---
apiVersion: snapshot.storage.k8s.io/v1
kind: VolumeSnapshotClass
metadata:
  name: csi-rbdplugin-snapclass
driver: rook-ceph.rbd.csi.ceph.com # csi-provisioner-name
parameters:
  # Specify a string that identifies your cluster. Ceph CSI supports any
  # unique string. When Ceph CSI is deployed by Rook use the Rook namespace,
  # for example "rook-ceph".
  clusterID: rook-ceph # namespace:cluster
  csi.storage.k8s.io/snapshotter-secret-name: rook-csi-rbd-provisioner
  csi.storage.k8s.io/snapshotter-secret-namespace: rook-ceph # namespace:cluster
deletionPolicy: Delete
```

2）创建快照

创建一些数据模拟环境

```
kubectl exec -it  wordpress-mysql-cc5fd5cd9-7qd7c -- mkdir /var/lib/mysql/demo{1..3}
kubectl get po,pvc,volumeSnapshotClass
```

```


[root@k8s-master01 examples]# vim snapshot.yaml
---
apiVersion: snapshot.storage.k8s.io/v1
kind: VolumeSnapshot
metadata:
  name: rbd-pvc-snapshot
spec:
  volumeSnapshotClassName: csi-rbdplugin-snapclass
  source:
    persistentVolumeClaimName: rbd-pvc


kubectl create -f  snapshot.yaml
```



```
[root@k8s-master01 examples]# kubectl get po,pvc,volumeSnapshotClass
NAME                                READY   STATUS    RESTARTS   AGE
pod/wordpress-mysql-cc5fd5cd9-rx67c   1/1     Running   0          26m

NAME                                   STATUS   VOLUME                                     CAPACITY   ACCESS MODES   STORAGECLASS      VOLUMEATTRIBUTESCLASS   AGE
persistentvolumeclaim/mysql-pv-claim   Bound    pvc-09c59b1e-089e-472b-86c0-d3db5aaddde7   4Gi        RWO            rook-ceph-block   <unset>                 26m

NAME                                                             DRIVER                       DELETIONPOLICY   AGE
volumesnapshotclass.snapshot.storage.k8s.io/csi-rbdplugin-snapclass   rook-ceph.rbd.csi.ceph.com   Delete           4h12m
[root@k8s-master01 examples]# cat snapshot.yaml
---
apiVersion: snapshot.storage.k8s.io/v1
kind: VolumeSnapshot
metadata:
  name: rbd-pvc-snapshot
spec:
  volumeSnapshotClassName: csi-rbdplugin-snapclass
  source:
    persistentVolumeClaimName: mysql-pv-claim
[root@k8s-master01 examples]# kubectl get sc
NAME              PROVISIONER                     RECLAIMPOLICY   VOLUMEBINDINGMODE   ALLOWVOLUMEEXPANSION   AGE
rook-ceph-block   rook-ceph.rbd.csi.ceph.com      Delete          Immediate           true                   36h
rook-cephfs       rook-ceph.cephfs.csi.ceph.com   Delete          Immediate           true                   11h
[root@k8s-master01 examples]# kubectl create -f snapshot.yaml
volumesnapshot.snapshot.storage.k8s.io/rbd-pvc-snapshot created
[root@k8s-master01 examples]# kubectl get -f snapshot.yaml
NAME               READYTOUSE   SOURCEPVC        SOURCESNAPSHOTCONTENT   RESTORESIZE   SNAPSHOTCLASS             SNAPSHOTCONTENT                                    CREATIONTIME   AGE
rbd-pvc-snapshot   true         mysql-pv-claim                           4Gi           csi-rbdplugin-snapclass   snapcontent-0f82a7cd-e84c-409e-80e0-6c54cf047379   3s             5s
[root@k8s-master01 examples]# 
```

VSC 名称

PVC 名称

查看快照

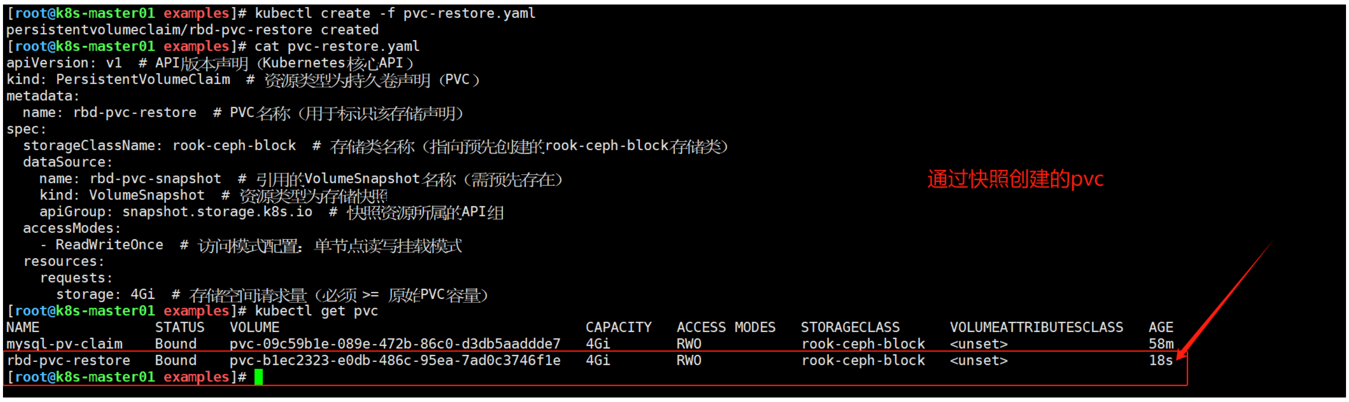
```
[root@k8s-master01 examples]# kubectl get -f  snapshot.yaml
NAME               READYTOUSE   SOURCEPVC        SOURCESNAPSHOTCONTENT   RESTORESIZE   SNAPSHOTCLASS             SNAPSHOTCONTENT                                    CREATIONTIME   AGE
rbd-pvc-snapshot   true         mysql-pv-claim                           4Gi           csi-rbdplugin-snapclass   snapcontent-0f82a7cd-e84c-409e-80e0-6c54cf047379   4m7s           4m9s
```

3）通过快照创建 PVC

如果想要创建一个具有某个数据的 PVC，可以从某个快照恢复

```
cat pvc-restore.yaml
apiVersion: v1  # API版本声明（Kubernetes核心API）
kind: PersistentVolumeClaim  # 资源类型为持久卷声明（PVC）
metadata:
  name: rbd-pvc-restore  # PVC名称（用于标识该存储声明）
spec:
  storageClassName: rook-ceph-block  # 存储类名称（指向预先创建的rook-ceph-block存储类）
  dataSource:
    name: rbd-pvc-snapshot  # 引用的VolumeSnapshot名称（需预先存在）
    kind: VolumeSnapshot  # 资源类型为存储快照
```

```yaml
      apiGroup: snapshot.storage.k8s.io  # 快照资源所属的API组
    accessModes:
      - ReadWriteOnce  # 访问模式配置：单节点读写挂载模式
    resources:
      requests:
        storage: 4Gi  # 存储空间请求量（必须 >= 原始PVC容量）

  kubectl create -f pvc-restore.yam
```



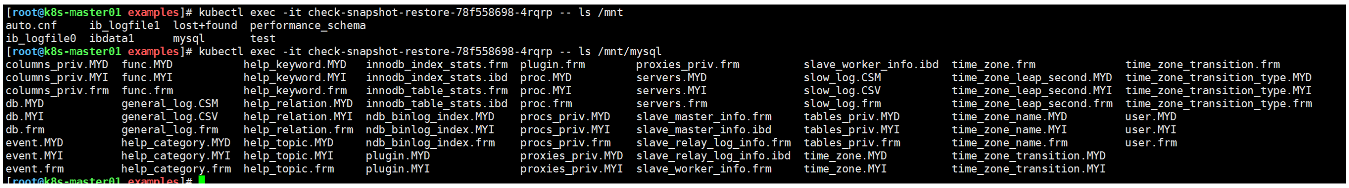
```
[root@k8s-master01 examples]# kubectl create -f pvc-restore.yaml
persistentvolumeclaim/rbd-pvc-restore created
[root@k8s-master01 examples]# cat pvc-restore.yaml
apiVersion: v1  # API版本声明（Kubernetes核心API）
kind: PersistentVolumeClaim  # 资源类型为持久卷声明（PVC）
metadata:
  name: rbd-pvc-restore  # PVC名称（用于标识该存储声明）
spec:
  storageClassName: rook-ceph-block  # 存储类名称（指向预先创建的rook-ceph-block存储类）
  dataSource:
    name: rbd-pvc-snapshot  # 引用的VolumeSnapshot名称（需预先存在）
    kind: VolumeSnapshot  # 资源类型为存储快照
    apiGroup: snapshot.storage.k8s.io  # 快照资源所属的API组
  accessModes:
    - ReadWriteOnce  # 访问模式配置：单节点读写挂载模式
  resources:
    requests:
      storage: 4Gi  # 存储空间请求量（必须 >= 原始PVC容量）
[root@k8s-master01 examples]# kubectl get pvc
NAME              STATUS   VOLUME                                     CAPACITY   ACCESS MODES   STORAGECLASS      VOLUMEATTRIBUTESCLASS   AGE
mysql-pv-claim    Bound    pvc-09c59b1e-089e-472b-86c0-d3db5aaddde7   4Gi        RWO            rook-ceph-block   <unset>                 58m
rbd-pvc-restore   Bound    pvc-b1ec2323-e0db-486c-95ea-7ad0c3746f1e   4Gi        RWO            rook-ceph-block   <unset>                 18s
[root@k8s-master01 examples]# 
```

通过快照创建的pvc

4）数据校验

创建pod绑定pvc验证校验数据

```yaml
vim restore-check-snapshot-rbd.yaml
---
apiVersion: apps/v1  # API版本声明（适用于Deployment资源）
kind: Deployment  # 资源类型为Deployment
metadata:
  name: check-snapshot-restore  # Deployment的名称
spec:
  selector:
    matchLabels:
      app: check  # 匹配Pod的标签，用于关联Deployment和Pod
  strategy:
    type: Recreate  # 部署策略：先删除旧Pod，再创建新Pod
  template:          # pod 的模板
    metadata:
      labels:
        app: check  # Pod的标签，与selector中的标签匹配
    spec:
      containers:
        - image: m.daocloud.io/docker.io/library/nginx:latest  # 使用的容器镜像
          name: check  # 容器的名称
          command:
            - sh
            - -c
            - sleep 36000  # 容器启动后执行的命令：休眠36000秒（10小时）
          volumeMounts:
            - name: check-mysql-persistent-storage  # 挂载的卷名称
              mountPath: /mnt  # 卷挂载到容器内的路径
      volumes:
        - name: check-mysql-persistent-storage  # 卷的名称
          persistentVolumeClaim:
            claimName: rbd-pvc-restore  # 使用的PVC名称（从快照恢复的PVC）

 kubectl  create -f restore-check-snapshot-rbd.yaml
 kubectl get -f restore-check-snapshot-rbd.yaml
```



```
[root@k8s-master01 examples]# kubectl exec -it check-snapshot-restore-78f558698-4rqrp -- ls /mnt
auto.cnf     ib_logfile1  lost+found  performance_schema
ib_logfile0  ibdata1      mysql       test
[root@k8s-master01 examples]# kubectl exec -it check-snapshot-restore-78f558698-4rqrp -- ls /mnt/mysql
columns_priv.MYD  func.MYD           help_keyword.MYD   innodb_index_stats.frm  plugin.frm        proxies_priv.frm          slave_worker_info.ibd  time_zone.frm              time_zone_transition.frm
columns_priv.MYI  func.MYI           help_keyword.MYI   innodb_index_stats.ibd  proc.MYD          servers.MYD               slow_log.CSM           time_zone_leap_second.MYD  time_zone_transition_type.MYD
columns_priv.frm  func.frm           help_keyword.frm   innodb_table_stats.frm  proc.MYI          servers.MYI               slow_log.CSV           time_zone_leap_second.MYI  time_zone_transition_type.MYI
db.MYD            general_log.CSM    help_relation.MYD  innodb_table_stats.ibd  proc.frm          servers.frm               slow_log.frm           time_zone_leap_second.frm  time_zone_transition_type.frm
db.MYI            general_log.CSV    help_relation.MYI  ndb_binlog_index.MYD    procs_priv.MYD    slave_master_info.frm     tables_priv.MYD        time_zone_name.MYD         user.MYD
db.frm            general_log.frm    help_relation.frm  ndb_binlog_index.MYI    procs_priv.MYI    slave_master_info.ibd     tables_priv.MYI        time_zone_name.MYI         user.MYI
event.MYD         help_category.MYD  help_topic.MYD     ndb_binlog_index.frm    procs_priv.frm    slave_relay_log_info.frm  tables_priv.frm        time_zone_name.frm         user.frm
event.MYI         help_category.MYI  help_topic.MYI     plugin.MYD              proxies_priv.MYD  slave_relay_log_info.ibd  time_zone.MYD          time_zone_transition.MYD
event.frm         help_category.frm  help_topic.frm     plugin.MYI              proxies_priv.MYI  slave_worker_info.frm     time_zone.MYI          time_zone_transition.MYI
[root@k8s-master01 examples]#
```

5）文件共享类型快照

操作步骤和块存储类型无区别，可以参考：
https://rook.io/docs/rook/v1.6/ceph-csi-snapshot.html#cephfs-snapshots

PVC 克隆

需要注意的是 pvc-clone.yaml 的 dataSource 的 name 是被克隆的 pvc 名称，在此是 mysql-pvclaim，storageClassName 为新建 pvc 的 storageClass 名称，storage 不能小于之前 pvc 的大小。

```
vim pvc-clone.yaml
---
apiVersion: v1  # API版本声明（Kubernetes核心API）
kind: PersistentVolumeClaim  # 资源类型为持久卷声明（PVC）
metadata:
  name: rbd-pvc-clone  # PVC的名称（用于标识该克隆PVC）
spec:
  storageClassName: rook-ceph-block  # 存储类名称（指向预先创建的rook-ceph-block存储类）
  dataSource:
    name: mysql-pv-claim  # 数据源名称（引用的原始PVC名称）
    kind: PersistentVolumeClaim  # 数据源类型为PVC（表示从现有PVC克隆）
  accessModes:
    - ReadWriteOnce  # 访问模式配置：单节点读写挂载模式
  resources:
    requests:
      storage: 3Gi  # 存储空间请求量（必须 >= 原始PVC容量）

kubectl create -f pvc-clone.yaml
```

🚀 测试数据清理

参考链接：https://rook.io/docs/rook/v1.6/ceph-teardown.html

如果 Rook 要继续使用，可以只清理创建的 `deploy、pod、pvc` 即可。

清理步骤:

1.清理挂载了 PVC 的 Pod 和 Deployment

- 删除所有挂载了 PVC 的 Pod、Deployment 或其他高级资源。

```
kubectl delete pod <pod-name>
kubectl delete deployment <deployment-name>

[root@k8s-master01 examples]# kubectl get deploy
NAME                     READY   UP-TO-DATE   AVAILABLE   AGE
check-snapshot-restore   1/1     1            1           92m
wordpress-mysql          1/1     1            1           95m
[root@k8s-master01 examples]# kubectl delete deploy check-snapshot-restore wordpress-mysql
deployment.apps "check-snapshot-restore" deleted
deployment.apps "wordpress-mysql" deleted
[root@k8s-master01 examples]# kubectl get po
NAME                                      READY   STATUS        RESTARTS   AGE
check-snapshot-restore-78f558698-4rqrp    1/1     Terminating   0          89m
[root@k8s-master01 examples]# kubectl delete po check-snapshot-restore-78f558698-4rqrp
```

2.清理 PVC

- 删除所有通过 Ceph StorageClass 创建的 PVC。
- 检查 PV 是否被自动清理。

```
Bashkubectl delete pvc <pvc-name>
kubectl get pv  # 确认 PV 是否已清理



[root@k8s-master01 examples]# kubectl get pvc
NAME                STATUS   VOLUME                                     CAPACITY   ACCESS MODES   STORAGECLASS      VOLUMEATTRIBUTESCLASS   AGE
mysql-pv-claim      Bound    pvc-dbea43d6-3991-4434-86f7-28707b55f2cb   4Gi        RWO            rook-ceph-block   <unset>                 96m
rbd-pvc-restore     Bound    pvc-b1ec2323-e0db-486c-95ea-7ad0c3746f1e   4Gi        RWO            rook-ceph-block   <unset>                 100m
[root@k8s-master01 examples]# kubectl delete pvc mysql-pv-claim rbd-pvc-restore
persistentvolumeclaim "mysql-pv-claim" deleted
persistentvolumeclaim "rbd-pvc-restore" deleted
[root@k8s-master01 examples]# kubectl get pv
No resources found
```

3.清理快照

- 删除所有 VolumeSnapshot 资源。

```
kubectl delete volumesnapshot <snapshot-name>


[root@k8s-master01 examples]# kubectl get volumesnapshot
NAME                READYTOUSE   SOURCEPVC        SOURCESNAPSHOTCONTENT
RESTORESIZE   SNAPSHOTCLASS             SNAPSHOTCONTENT
       CREATIONTIME   AGE
rbd-pvc-snapshot   true         mysql-pv-claim                          4Gi
    csi-rbdplugin-snapclass   snapcontent-0f82a7cd-e84c-409e-80e0-6c54cf047379
131m           131m
[root@k8s-master01 examples]# kubectl delete volumesnapshot rbd-pvc-snapshot
volumesnapshot.snapshot.storage.k8s.io "rbd-pvc-snapshot" deleted

# 删除快照控制器
kubectl delete -f /root/k8s-ha-install/snapshotter/ -n kube-system
```

4.清理存储池

- 删除块存储池和文件存储池。

```
#  查看所有存储池
kubectl -n rook-ceph exec deploy/rook-ceph-tools -- ceph osd pool ls


kubectl delete -n rook-ceph cephblockpool replicapool
kubectl delete -n rook-ceph cephfilesystem myfs
```

5.清理 StorageClass

- 删除 Rook 创建的 StorageClass。

```
kubectl delete sc rook-ceph-block rook-cephfs

[root@k8s-master01 examples]# kubectl get sc
NAME              PROVISIONER                     RECLAIMPOLICY   VOLUMEBINDINGMODE
  ALLOWVOLUMEEXPANSION   AGE
rook-ceph-block   rook-ceph.rbd.csi.ceph.com      Delete          Immediate
  true                   38h
rook-cephfs       rook-ceph.cephfs.csi.ceph.com   Delete          Immediate
  true                   14h
[root@k8s-master01 examples]# kubectl delete sc rook-ceph-block rook-cephfs
storageclass.storage.k8s.io "rook-ceph-block" deleted
storageclass.storage.k8s.io "rook-cephfs" deleted
```

6.清理 Ceph 集群

- 删除 CephCluster 资源。

```
kubectl delete -f cluster.yaml
```

7.删除 Rook 资源

- 删除 Rook 的 Operator、Common 和 CRD 资源。

```
kubectl delete -f operator.yaml
kubectl delete -f common.yaml
kubectl delete -f crds.yaml
```

8.处理卡住资源（如有）

- 若资源删除卡住，参考 Rook 官方文档进行故障排除。如果由于某些原因操作员无法移除终结器（例如，操作员不再运行），您可以使用以下命令手动删除终结器：

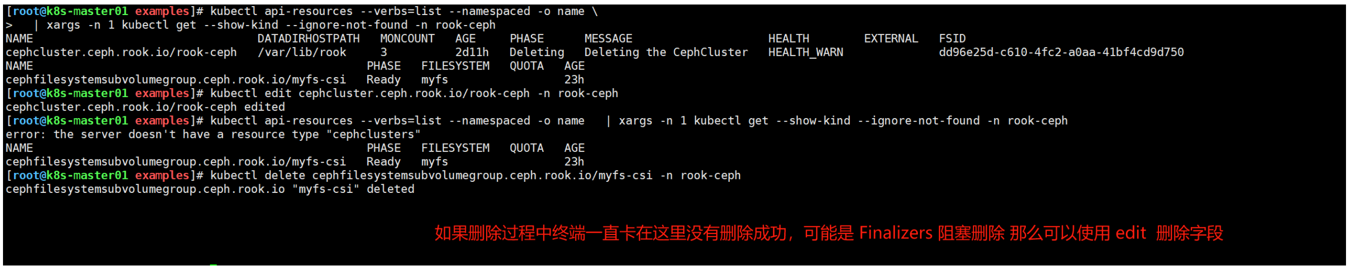
```
for CRD in $(kubectl get crd -n rook-ceph | awk '/ceph.rook.io/ {print $1}'); do
    kubectl get -n rook-ceph "$CRD" -o name | \
    xargs -I {} kubectl patch {} --type merge -p '{"metadata":{"finalizers":[null]}}'
done
```

几秒钟内，你应该能看到集群 CRD 已被删除，将不再阻止其他清理操作，例如删除 `rook-ceph` 命名空间。

如果命名空间仍然处于终止状态，您可以检查哪些资源正在阻止删除，并移除最终 izers 并删除这些资源，

```
kubectl api-resources --verbs=list --namespaced -o name \
  | xargs -n 1 kubectl get --show-kind --ignore-not-found -n rook-ceph
```

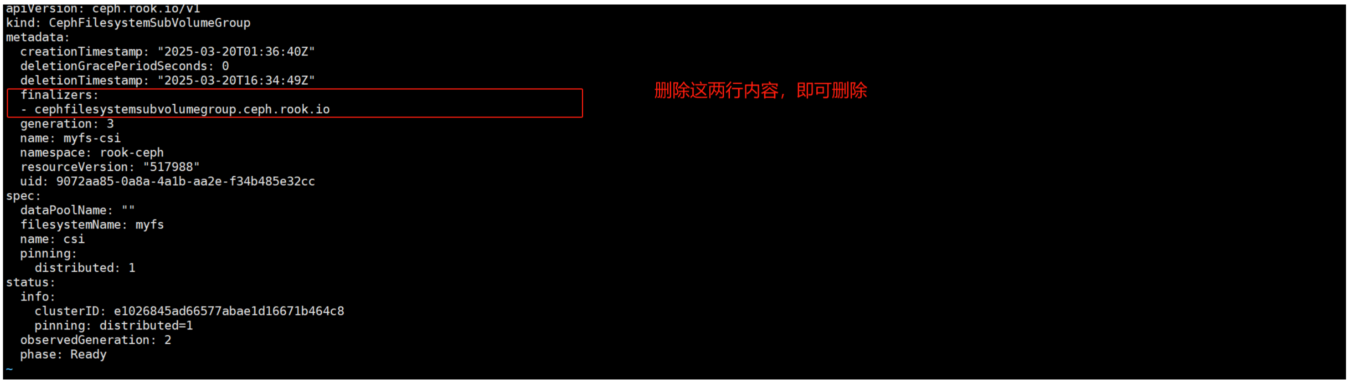
如果删除失败，终端一直卡在删除中那么应该是配置有 Finalizers 阻塞删除，Finalizer 是 Kubernetes 中一种机制，用于在资源删除前执行清理逻辑。如果 finalizer 未被释放，资源会处于删除挂起状态。可以通过 `kubectl get configmap rook-ceph-mon-endpoints -n rook-ceph -o yaml | grep finalizers` 确认了该 ConfigMap 存在 `finalizers`



```
[root@k8s-master01 examples]# kubectl api-resources --verbs=list --namespaced -o name \
>   | xargs -n 1 kubectl get --show-kind --ignore-not-found -n rook-ceph
NAME                                DATADIRHOSTPATH   MONCOUNT   AGE     PHASE      MESSAGE                    HEALTH        EXTERNAL   FSID
cephcluster.ceph.rook.io/rook-ceph   /var/lib/rook     3          2d11h   Deleting   Deleting the CephCluster   HEALTH_WARN              dd96e25d-c610-4fc2-a0aa-41bf4cd9d750
NAME                                             PHASE   FILESYSTEM   QUOTA   AGE
cephfilesystemsubvolumegroup.ceph.rook.io/myfs-csi   Ready   myfs                 23h
[root@k8s-master01 examples]# kubectl edit cephcluster.ceph.rook.io/rook-ceph -n rook-ceph
cephcluster.ceph.rook.io/rook-ceph edited
[root@k8s-master01 examples]# kubectl api-resources --verbs=list --namespaced -o name   | xargs -n 1 kubectl get --show-kind --ignore-not-found -n rook-ceph
error: the server doesn't have a resource type "cephclusters"
NAME                                             PHASE   FILESYSTEM   QUOTA   AGE
cephfilesystemsubvolumegroup.ceph.rook.io/myfs-csi   Ready   myfs                 23h
[root@k8s-master01 examples]# kubectl delete cephfilesystemsubvolumegroup.ceph.rook.io/myfs-csi -n rook-ceph
cephfilesystemsubvolumegroup.ceph.rook.io "myfs-csi" deleted
```

如果删除过程中终端一直卡在这里没有删除成功，可能是 Finalizers 阻塞删除 那么可以使用 edit 删除字段

```
[root@k8s-master01 examples]# kubectl get cephfilesystemsubvolumegroup.ceph.rook.io myfs-csi -n rook-ceph -o yaml | grep finalizers
  finalizers:


kubectl edit cephfilesystemsubvolumegroup.ceph.rook.io myfs-csi -n rook-ceph
```



```
apiVersion: ceph.rook.io/v1
kind: CephFilesystemSubVolumeGroup
metadata:
  creationTimestamp: "2025-03-20T01:36:40Z"
  deletionGracePeriodSeconds: 0
  deletionTimestamp: "2025-03-20T16:34:49Z"
  finalizers:
  - cephfilesystemsubvolumegroup.ceph.rook.io
  generation: 3
  name: myfs-csi
  namespace: rook-ceph
  resourceVersion: "517988"
  uid: 9072aa85-0a8a-4a1b-aa2e-f34b485e32cc
spec:
  dataPoolName: ""
  filesystemName: myfs
  name: csi
  pinning:
    distributed: 1
status:
  info:
    clusterID: e1026845ad66577abae1d16671b464c8
    pinning: distributed=1
  observedGeneration: 2
  phase: Ready
~
```

删除这两行内容，即可删除

9.清理数据目录和磁盘

```
rm -rf /var/lib/rook/*
```

10.清理OSD 所使用磁盘

```
#!/usr/bin/env bash
DISK="/dev/sdb"

# Zap the disk to a fresh, usable state (zap-all is important, b/c MBR has to be clean)

# You will have to run this step for all disks.
sgdisk --zap-all $DISK

# Clean hdds with dd
dd if=/dev/zero of="$DISK" bs=1M count=100 oflag=direct,dsync

# Clean disks such as ssd with blkdiscard instead of dd
blkdiscard $DISK

# These steps only have to be run once on each node
# If rook sets up osds using ceph-volume, teardown leaves some devices mapped that lock the disks.
ls /dev/mapper/ceph-* | xargs -I% -- dmsetup remove %

# ceph-volume setup can leave ceph-<UUID> directories in /dev and /dev/mapper (unnecessary clutter)
rm -rf /dev/ceph-*
rm -rf /dev/mapper/ceph--*

# Inform the OS of partition table changes
partprobe $DISK
```

参考链接：https://rook.io/docs/rook/v1.6/ceph-teardown.html#delete-the-dataon-hosts