Red Hat OpenShift Data Foundation 4.9

Managing and allocating storage resources

Instructions on how to allocate storage to core services and hosted applications in OpenShift Data Foundation, including snapshot and clone.

Last Updated: 2022-05-16

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Legal Notice

Abstract

This document explains how to allocate storage to core services and hosted applications in Red Hat OpenShift Data Foundation.

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MAKING OPEN SOURCE MORE INCLUSIVE

Red Hat is committed to replacing problematic language in our code, documentation, and web properties. We are beginning with these four terms: master, slave, blacklist, and whitelist. Because of the enormity of this endeavor, these changes will be implemented gradually over several upcoming releases. For more details, see our CTO Chris Wright's message.

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CHAPTER 1. OVERVIEW

Read this document to understand how to create, configure, and allocate storage to core services or hosted applications in Red Hat OpenShift Data Foundation.

- Chapter 2, *Storage classes* shows you how to create custom storage classes.
- Chapter 3, *Block pools* provides you with information on how to create, update and delete block pools.
- Chapter 4, *Configure storage for OpenShift Container Platform services* shows you how to use OpenShift Data Foundation for core OpenShift Container Platform services.
- Chapter 5, *Backing OpenShift Container Platform applications with OpenShift Data Foundation* provides information about how to configure OpenShift Container Platform applications to use OpenShift Data Foundation.
- Adding file and object storage to an existing external OpenShift Data Foundation cluster
- Chapter 7, *How to use dedicated worker nodes for Red Hat OpenShift Data Foundation* provides information about how to use dedicated worker nodes for Red Hat OpenShift Data Foundation.
- Chapter 8, *Managing Persistent Volume Claims* provides information about managing Persistent Volume Claim requests, and automating the fulfillment of those requests.
- Chapter 9, *Volume Snapshots* shows you how to create, restore, and delete volume snapshots.
- Chapter 10, *Volume cloning* shows you how to create volume clones.
- Chapter 11, *Managing container storage interface (CSI) component placements* provides information about setting tolerations to bring up container storage interface component on the nodes.

CHAPTER 2. STORAGE CLASSES

The OpenShift Data Foundation operator installs a default storage class depending on the platform in use. This default storage class is owned and controlled by the operator and it cannot be deleted or modified. However, you can create custom storage classes to use other storage resources or to offer a different behavior to applications.

NOTE

Custom storage classes are not supported for *external mode* OpenShift Data Foundation clusters.

2.1. CREATING STORAGE CLASSES AND POOLS

You can create a storage class using an existing pool or you can create a new pool for the storage class while creating it.

Prerequisites

- Ensure that you are logged into the OpenShift Container Platform web console and OpenShift Data Foundation cluster is in **Ready** state.

Procedure

1. Click **Storage → StorageClasses**.
2. Click **Create Storage Class**
3. Enter the storage class **Name** and **Description**.
4. Select either **Delete** or **Retain** for the Reclaim Policy. By default, **Delete** is selected.
5. Select RBD Provisioner which is the plugin used for provisioning the persistent volumes.
6. Select an existing **Storage Pool** from the list or create a new pool.

   Create new pool

   a. Click **Create New Pool**.

   b. Enter **Pool name**.

   c. Choose **2-way-Replication** or **3-way-Replication** as the Data Protection Policy.

   d. Select **Enable compression** if you need to compress the data.
   Enabling compression can impact application performance and might prove ineffective when data to be written is already compressed or encrypted. Data written before enabling compression will not be compressed.

   e. Click **Create** to create the new storage pool.

   f. Click **Finish** after the pool is created.

7. Optional: Select **Enable Encryption** checkbox.

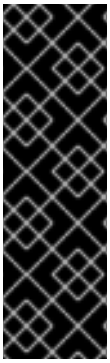
8. Click **Create** to create the storage class.

2.2. CREATING A STORAGE CLASS FOR PERSISTENT VOLUME ENCRYPTION

Persistent volume (PV) encryption guarantees isolation and confidentiality between tenants (applications). Before you can use PV encryption, you must create a storage class for PV encryption.

OpenShift Data Foundation supports storing encryption passphrases in HashiCorp Vault. Use the following procedure to create an encryption enabled storage class using an external key management system (KMS) for persistent volume encryption. Persistent volume encryption is only available for RBD PVs. You can configure access to the KMS in two different ways:

- Using **vaulttokens**: allows users to authenticate using a token
- Using **vaulttenantsa** (technology preview): allows users to use serviceaccounts to authenticate with Vault



IMPORTANT

Accessing the KMS using **vaulttenantsa** is a Technology Preview feature. Technology Preview features are not supported with Red Hat production service level agreements (SLAs) and might not be functionally complete. Red Hat does not recommend using them in production. These features provide early access to upcoming product features, enabling customers to test functionality and provide feedback during the development process.

For more information, see Technology Preview Features Support Scope .

See the relevant prerequisites section for your use case before following the procedure for creating the storage class:

- Section 2.2.1, "Prerequisites for using **vaulttokens**"
- Section 2.2.2, "Prerequisites for using **vaulttenantsa**"

2.2.1. Prerequisites for using vaulttokens

- The OpenShift Data Foundation cluster is in **Ready** state.
- On the external key management system (KMS),
  - Ensure that a policy with a token exists and the key value backend path in Vault is enabled. For more information, see Enabling key value and policy in Vault .
  - Ensure that you are using signed certificates on your Vault servers.
- Create a secret in the tenant's namespace as follows:
  - On the OpenShift Container Platform web console, navigate to **Workloads → Secrets**
  - Click **Create → Key/value secret**
  - Enter **Secret Name** as **ceph-csi-kms-token**.

- Enter **Key** as **token**.
- Enter **Value**. It is the token from Vault. You can either click **Browse** to select and upload the file containing the token or enter the token directly in the text box.
- Click **Create**.

NOTE

The token can be deleted only after all the encrypted PVCs using the **ceph-csi-kms-token** have been deleted.

Next, follow the steps in Section 2.2.3, "Procedure for creating a storage class for PV encryption" .

2.2.2. Prerequisites for using vaulttenantsa

- The OpenShift Data Foundation cluster is in **Ready** state.
- On the external key management system (KMS),
  - Ensure that a policy exists and the key value backend path in Vault is enabled. For more information, see Enabling key value and policy in Vault .
  - Ensure that you are using signed certificates on your Vault servers.
- Create the following serviceaccount in the tenant namespace as shown below:

```
$ cat <<EOF | oc create -f -
apiVersion: v1
kind: ServiceAccount
metadata:
   name: ceph-csi-vault-sa
EOF
```

- The Kubernetes authentication method must be configured before OpenShift Data Foundation can authenticate with and start using Vault. The instructions below create and configure **serviceAccount**, **ClusterRole**, and **ClusterRoleBinding** required to allow OpenShift Data Foundation to authenticate with Vault.
  1. Apply the following YAML to your Openshift cluster:

```
apiVersion: v1
kind: ServiceAccount
metadata:
  name: rbd-csi-vault-token-review
---
kind: ClusterRole
apiVersion: rbac.authorization.k8s.io/v1
metadata:
  name: rbd-csi-vault-token-review
rules:
  - apiGroups: ["authentication.k8s.io"]
    resources: ["tokenreviews"]
    verbs: ["create", "get", "list"]
```

```
---
kind: ClusterRoleBinding
apiVersion: rbac.authorization.k8s.io/v1
metadata:
  name: rbd-csi-vault-token-review
subjects:
  - kind: ServiceAccount
    name: rbd-csi-vault-token-review
    namespace: openshift-storage
roleRef:
  kind: ClusterRole
  name: rbd-csi-vault-token-review
  apiGroup: rbac.authorization.k8s.io
```

2. Identify the secret name associated with the serviceaccount (SA) created above:

```
$ oc -n openshift-storage get sa rbd-csi-vault-token-review -o jsonpath="{.secrets[*]
['name']}"
```

3. Get the token and the CA certificate from the secret:

```
$ oc get secret <secret associated with SA> -o jsonpath="{.data['token']}" | base64 --
decode; echo
$ oc get secret <secret associated with SA> -o jsonpath="{.data['ca\.crt']}" | base64 --
decode; echo
```

4. Retrieve the OCP cluster endpoint:

```
$ oc config view --minify --flatten -o jsonpath="{.clusters[0].cluster.server}"
```

5. Use the information collected in the steps above to setup the kubernetes authentication method in Vault as shown below:

```
$ vault auth enable kubernetes
$ vault write auth/kubernetes/config token_reviewer_jwt=<SA token> kubernetes_host=
<OCP cluster endpoint> kubernetes_ca_cert=<SA CA certificate>
```

6. Create a role in Vault for the tenant namespace:

```
$ vault write "auth/kubernetes/role/csi-kubernetes"
bound_service_account_names="ceph-csi-vault-sa"
bound_service_account_namespaces=<tenant_namespace> policies=
<policy_name_in_vault>
```

csi-kubernetes is the default role name that OpenShift Data Foundation looks for in Vault. The default service account name in the tenant namespace in the Openshift Data Foundation cluster is **ceph-csi-vault-sa**. These default values can be overridden by creating a ConfigMap in the tenant namespace.

For more information about overriding the default names, see Overriding Vault connection details using tenant ConfigMap.

- In order to create a storageclass that uses the **vaulttenantsa** method for PV encrytpion, you must either edit the existing ConfigMap or create a ConfigMap named **csi-kms-connection-details** that will hold all the information needed to establish the connection with Vault.
  The sample yaml given below can be used to update or create the **csi-kms-connection-detail** ConfigMap:

```
apiVersion: v1
data:
  vault-tenant-sa: |-
    {
      "encryptionKMSType": "vaulttenantsa",
      "vaultAddress": "<https://hostname_or_ip_of_vault_server:port>",
      "vaultTLSServerName": "<vault TLS server name>",
      "vaultAuthPath": "/v1/auth/kubernetes/login",
      "vaultAuthNamespace": "<vault auth namespace name>"
      "vaultNamespace": "<vault namespace name>",
      "vaultBackendPath": "<vault backend path name>",
      "vaultCAFromSecret": "<secret containing CA cert>",
      "vaultClientCertFromSecret": "<secret containing client cert>",
      "vaultClientCertKeyFromSecret": "<secret containing client private key>",
      "tenantSAName": "<service account name in the tenant namespace>"
    }
metadata:
  name: csi-kms-connection-details
```

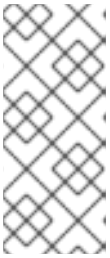
  - **encryptionKMSType**: should be set to **vaulttenantsa** to use service accounts for authentication with vault.
  - **vaultAddress**: The hostname or IP address of the vault server with the port number.
  - **vaultTLSServerName**: (Optional) The vault TLS server name
  - **vaultAuthPath**: (Optional) The path where kubernetes auth method is enabled in Vault. The default path is **kubernetes**. If the auth method is enabled in a different path other than **kubernetes**, this variable needs to be set as **"/v1/auth/<path>/login"**.
  - **vaultAuthNamespace**: (Optional) The Vault namespace where kubernetes auth method is enabled.
  - **vaultNamespace**: (Optional) The Vault namespace where the backend path being used to store the keys exists
  - **vaultBackendPath**: The backend path in Vault where the encryption keys will be stored
  - **vaultCAFromSecret**: The secret in the OpenShift Data Foundation cluster containing the CA certificate from Vault
  - **vaultClientCertFromSecret**: The secret in the OpenShift Data Foundation cluster containing the client certificate from Vault
  - **vaultClientCertKeyFromSecret**: The secret in the OpenShift Data Foundation cluster containing the client private key from Vault
  - **tenantSAName**: (Optional) The service account name in the tenant namespace. The default value is **ceph-csi-vault-sa**. If a different name is to be used, this variable has to be set accordingly.

Next, follow the steps in Section 2.2.3, "Procedure for creating a storage class for PV encryption" .

2.2.3. Procedure for creating a storage class for PV encryption

After performing the required prerequisites for either **vaulttokens** or **vaulttenantsa**, perform the steps below to create a storageclass with encryption enabled.

1. Navigate to **Storage → StorageClasses**.
2. Click **Create Storage Class**
3. Enter the storage class **Name** and **Description**.
4. Select either **Delete** or **Retain** for the **Reclaim Policy**. By default, **Delete** is selected.
5. Select either **Immediate** or **WaitForFirstConsumer** as the **Volume binding mode**. **WaitForConsumer** is set as the default option.
6. Select **RBD Provisioner openshift-storage.rbd.csi.ceph.com** which is the plugin used for provisioning the persistent volumes.
7. Select **Storage Pool** where the volume data is stored from the list or create a new pool.
8. Select the **Enable encryption** checkbox. There are two options available to set the KMS connection details:
   - **Choose existing KMS connection**: Select an existing KMS connection from the drop-down list. The list is populated from the the connection details available in the **csi-kms-connection-details** ConfigMap.
   - **Create new KMS connection**: This is applicable for **vaulttokens** only.
     a. **Key Management Service Provider** is set to Vault by default.
     b. Enter a unique Vault **Service Name**, host **Address** of the Vault server (**https://<hostname or ip>**), and **Port** number.
     c. Expand **Advanced Settings** to enter additional settings and certificate details based on your Vault configuration.
        i. Enter the key value secret path in **Backend Path** that is dedicated and unique to OpenShift Data Foundation.
        ii. **Optional**: Enter **TLS Server Name** and **Vault Enterprise Namespace**.
        iii. Provide **CA Certificate**, **Client Certificate** and **Client Private Key** by uploading the respective PEM encoded certificate file.
        iv. Click **Save**.
     d. Click **Save**.
9. Click **Create**.
10. Edit the ConfigMap to add the **VAULT_BACKEND** or **vaultBackend** parameter if the HashiCorp Vault setup does not allow automatic detection of the Key/Value (KV) secret engine API version used by the backend path.



NOTE

VAULT_BACKEND or **vaultBackend** are optional parameters that has added to the configmap to specify the version of the KV secret engine API associated with the backend path. Ensure that the value matches the KV secret engine API version that is set for the backend path, otherwise it might result in a failure during persistent volume claim (PVC) creation.

a. Identify the encryptionKMSID being used by the newly created storage class.

   i. On the OpenShift Web Console, navigate to **Storage → Storage Classes**.

   ii. Click the **Storage class** name → **YAML** tab.

   iii. Capture the **encryptionKMSID** being used by the storage class.
   Example:

```
encryptionKMSID: 1-vault
```

b. On the OpenShift Web Console, navigate to **Workloads → ConfigMaps**.

c. To view the KMS connection details, click **csi-kms-connection-details**.

d. Edit the ConfigMap.

   i. Click Action menu **(⋮) → Edit ConfigMap**.

   ii. Add the **VAULT_BACKEND** or **vaultBackend** parameter depending on the backend that is configured for the previously identified encryptionKMSID.
   You can assign kv for KV secret engine API, version 1 and **kv-v2** for KV secret engine API, version 2.

   Example:

```
kind: ConfigMap
apiVersion: v1
metadata:
  name: csi-kms-connection-details
[...]
data:
  1-vault: |-
    {
      "KMS_PROVIDER": "vaulttokens",
      "KMS_SERVICE_NAME": "1-vault",
      [...]
      "VAULT_BACKEND": "kv-v2"
    }
  2-vault: |-
    {
      "encryptionKMSType": "vaulttenantsa",
      [...]
      "vaultBackend": "kv-v2"
    }
```

   iii. Click Save

Next steps

- The storage class can be used to create encrypted persistent volumes. For more information, see managing persistent volume claims.

IMPORTANT

Red Hat works with the technology partners to provide this documentation as a service to the customers. However, Red Hat does not provide support for the HashiCorp product. For technical assistance with this product, contact HashiCorp.

2.2.3.1. Overriding Vault connection details using tenant ConfigMap

The Vault connections details can be reconfigured per tenant by creating a ConfigMap in the Openshift namespace with configuration options that differ from the values set in the **csi-kms-connection-details** ConfigMap in the **openshift-storage** namespace. The ConfigMap needs to be located in the tenant namespace. The values in the ConfigMap in the tenant namespace will override the values set in the **csi-kms-connection-details** ConfigMap for the encrypted Persistent Volumes created in that namespace.

Procedure

1. Ensure that you are in the tenant namespace.
2. Click on **Workloads → ConfigMaps**.
3. Click on **Create ConfigMap**.
4. The following is a sample yaml. The values to be overidden for the given tenant namespace can be specified under the **data** section as shown below:

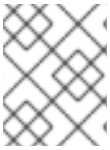
```
---
apiVersion: v1
kind: ConfigMap
metadata:
  name: ceph-csi-kms-config
data:
  vaultAddress: "<vault_address:port>"
  vaultBackendPath: "<backend_path>"
  vaultTLSServerName: "<vault_tls_server_name>"
  vaultNamespace: "<vault_namespace>"
```

5. Once the yaml is edited, click on **Create**.

CHAPTER 3. BLOCK POOLS

The OpenShift Data Foundation operator installs a default set of storage pools depending on the platform in use. These default storage pools are owned and controlled by the operator and it cannot be deleted or modified. With OpenShift Container Platform, you can create multiple custom storage pools which map to storage classes that provide the following features:

- Enable applications with their own high availability to use persistent volumes with two replicas, potentially improving application performance.
- Save space for persistent volume claims using storage classes with compression enabled.



NOTE

Multiple multiple pools are not supported for *external mode* OpenShift Data Foundation clusters.

3.1. CREATING A BLOCK POOL

Prerequisites

- You must be logged into the OpenShift Container Platform web console as an administrator.

Procedure

1. Click **Storage → OpenShift Data Foundation**
2. In the **Storage systems** tab, select the storage system and then click the **BlockPools** tab.
3. Click **Create Block Pool**
4. Enter **Pool name**.
5. Select **Data protection policy** as either **2-way Replication** or **3-way Replication**.
6. Select **Volume Type**.
7. Optional: Select **Enable compression** checkbox if you need to compress the data. Enabling compression can impact application performance and might prove ineffective when data to be written is already compressed or encrypted. Data written before enabling compression will not be compressed.
8. Click **Create**.

3.2. UPDATING AN EXISTING POOL

Prerequisites

- You must be logged into the OpenShift Container Platform web console as an administrator.

Procedure

1. Click **Storage → OpenShift Data Foundation**

2. In the **Storage systems** tab, select the storage system and then click **BlockPools**.
3. Click the Action Menu (⋮) at the end the pool you want to update.
4. Click **Edit Block Pool**.
5. Modify the form details as follows:
    a. Change the **Data protection policy** to either 2-way Replication or 3-way Replication.
    b. Enable or disable the compression option.
    Enabling compression can impact application performance and might prove ineffective when data to be written is already compressed or encrypted. Data written before enabling compression will not be compressed.
6. Click **Save**.

3.3. DELETING A POOL

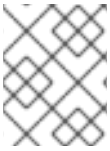
Use this procedure to delete a pool in OpenShift Data Foundation.

Prerequisites

- You must be logged into the OpenShift Container Platform web console as an administrator.

Procedure

1. . Click **Storage → OpenShift Data Foundation**
2. In the **Storage systems** tab, select the storage system and then click the **BlockPools** tab.
3. Click the Action Menu (⋮) at the end the pool you want to delete.
4. Click **Delete Block Pool**.
5. Click **Delete** to confirm the removal of the Pool.



NOTE

A pool cannot be deleted when it is bound to a PVC. You must detach all the resources before performing this activity.

CHAPTER 4. CONFIGURE STORAGE FOR OPENSHIFT CONTAINER PLATFORM SERVICES

You can use OpenShift Data Foundation to provide storage for OpenShift Container Platform services such as image registry, monitoring, and logging.

The process for configuring storage for these services depends on the infrastructure used in your OpenShift Data Foundation deployment.

WARNING

Always ensure that you have plenty of storage capacity for these services. If the storage for these critical services runs out of space, the cluster becomes inoperable and very difficult to recover.

Red Hat recommends configuring shorter curation and retention intervals for these services. See Configuring the Curator schedule and the Modifying retention time for Prometheus metrics data of *Monitoring* guide in the OpenShift Container Platform documentation for details.

If you do run out of storage space for these services, contact Red Hat Customer Support.

4.1. CONFIGURING IMAGE REGISTRY TO USE OPENSHIFT DATA FOUNDATION

OpenShift Container Platform provides a built in Container Image Registry which runs as a standard workload on the cluster. A registry is typically used as a publication target for images built on the cluster as well as a source of images for workloads running on the cluster.

Follow the instructions in this section to configure OpenShift Data Foundation as storage for the Container Image Registry. On AWS, it is not required to change the storage for the registry. However, it is recommended to change the storage to OpenShift Data Foundation Persistent Volume for vSphere and Bare metal platforms.

WARNING

This process does not migrate data from an existing image registry to the new image registry. If you already have container images in your existing registry, back up your registry before you complete this process, and re-register your images when this process is complete.

Prerequisites

- You have administrative access to OpenShift Web Console.

- OpenShift Data Foundation Operator is installed and running in the **openshift-storage** namespace. In OpenShift Web Console, click **Operators → Installed Operators** to view installed operators.
- Image Registry Operator is installed and running in the **openshift-image-registry** namespace. In OpenShift Web Console, click **Administration → Cluster Settings → Cluster Operators** to view cluster operators.
- A storage class with provisioner **openshift-storage.cephfs.csi.ceph.com** is available. In OpenShift Web Console, click **Storage → StorageClasses** to view available storage classes.

Procedure

1. **Create a Persistent Volume Claim for the Image Registry to use.**
   a. In the OpenShift Web Console, click **Storage → Persistent Volume Claims**
   b. Set the **Project** to **openshift-image-registry**.
   c. Click **Create Persistent Volume Claim**
      i. From the list of available storage classes retrieved above, specify the **Storage Class** with the provisioner **openshift-storage.cephfs.csi.ceph.com**.
      ii. Specify the Persistent Volume Claim **Name**, for example, **ocs4registry**.
      iii. Specify an **Access Mode** of **Shared Access (RWX)**.
      iv. Specify a **Size** of at least 100 GB.
      v. Click **Create**.
      Wait until the status of the new Persistent Volume Claim is listed as **Bound**.
2. **Configure the cluster's Image Registry to use the new Persistent Volume Claim.**
   a. Click **Administration → Custom Resource Definitions**
   b. Click the **Config** custom resource definition associated with the **imageregistry.operator.openshift.io** group.
   c. Click the **Instances** tab.
   d. Beside the cluster instance, click the **Action Menu (⋮) → Edit Config**.
   e. Add the new Persistent Volume Claim as persistent storage for the Image Registry.
      i. Add the following under **spec:**, replacing the existing **storage:** section if necessary.

```
storage:
  pvc:
    claim: <new-pvc-name>
```

For example:

```
storage:
  pvc:
    claim: ocs4registry
```

ii. Click **Save**.

3. **Verify that the new configuration is being used.**

   a. Click **Workloads → Pods**.

   b. Set the **Project** to **openshift-image-registry**.

   c. Verify that the new **image-registry-*** pod appears with a status of **Running**, and that the previous **image-registry-*** pod terminates.

   d. Click the new **image-registry-*** pod to view pod details.

   e. Scroll down to **Volumes** and verify that the **registry-storage** volume has a **Type** that matches your new Persistent Volume Claim, for example, **ocs4registry**.

4.2. CONFIGURING MONITORING TO USE OPENSHIFT DATA FOUNDATION

OpenShift Data Foundation provides a monitoring stack that comprises of Prometheus and Alert Manager.

Follow the instructions in this section to configure OpenShift Data Foundation as storage for the monitoring stack.

IMPORTANT

Monitoring will not function if it runs out of storage space. Always ensure that you have plenty of storage capacity for monitoring.

Red Hat recommends configuring a short retention interval for this service. See the Modifying retention time for Prometheus metrics data of Monitoring guide in the OpenShift Container Platform documentation for details.

Prerequisites

- You have administrative access to OpenShift Web Console.
- OpenShift Data Foundation Operator is installed and running in the **openshift-storage** namespace. In the OpenShift Web Console, click **Operators → Installed Operators** to view installed operators.
- Monitoring Operator is installed and running in the **openshift-monitoring** namespace. In the OpenShift Web Console, click **Administration → Cluster Settings → Cluster Operators** to view cluster operators.
- A storage class with provisioner **openshift-storage.rbd.csi.ceph.com** is available. In the OpenShift Web Console, click **Storage → StorageClasses** to view available storage classes.

Procedure

1. In the OpenShift Web Console, go to **Workloads → Config Maps**.
2. Set the **Project** dropdown to **openshift-monitoring**.

3. Click **Create Config Map**.

4. Define a new **cluster-monitoring-config** Config Map using the following example. Replace the content in angle brackets (**<**, **>**) with your own values, for example, **retention: 24h** or **storage: 40Gi**.

   Replace the **storageClassName** with the **storageclass** that uses the provisioner **openshift-storage.rbd.csi.ceph.com**. In the example given below the name of the **storageclass** is **ocs-storagecluster-ceph-rbd**.

   Example cluster-monitoring-config Config Map

```
apiVersion: v1
kind: ConfigMap
metadata:
  name: cluster-monitoring-config
  namespace: openshift-monitoring
data:
  config.yaml: |
    prometheusK8s:
      retention: <time to retain monitoring files, e.g. 24h>
      volumeClaimTemplate:
        metadata:
          name: ocs-prometheus-claim
        spec:
          storageClassName: ocs-storagecluster-ceph-rbd
          resources:
            requests:
              storage: <size of claim, e.g. 40Gi>
    alertmanagerMain:
      volumeClaimTemplate:
        metadata:
          name: ocs-alertmanager-claim
        spec:
          storageClassName: ocs-storagecluster-ceph-rbd
          resources:
            requests:
              storage: <size of claim, e.g. 40Gi>
```

5. Click **Create** to save and create the Config Map.

Verification steps

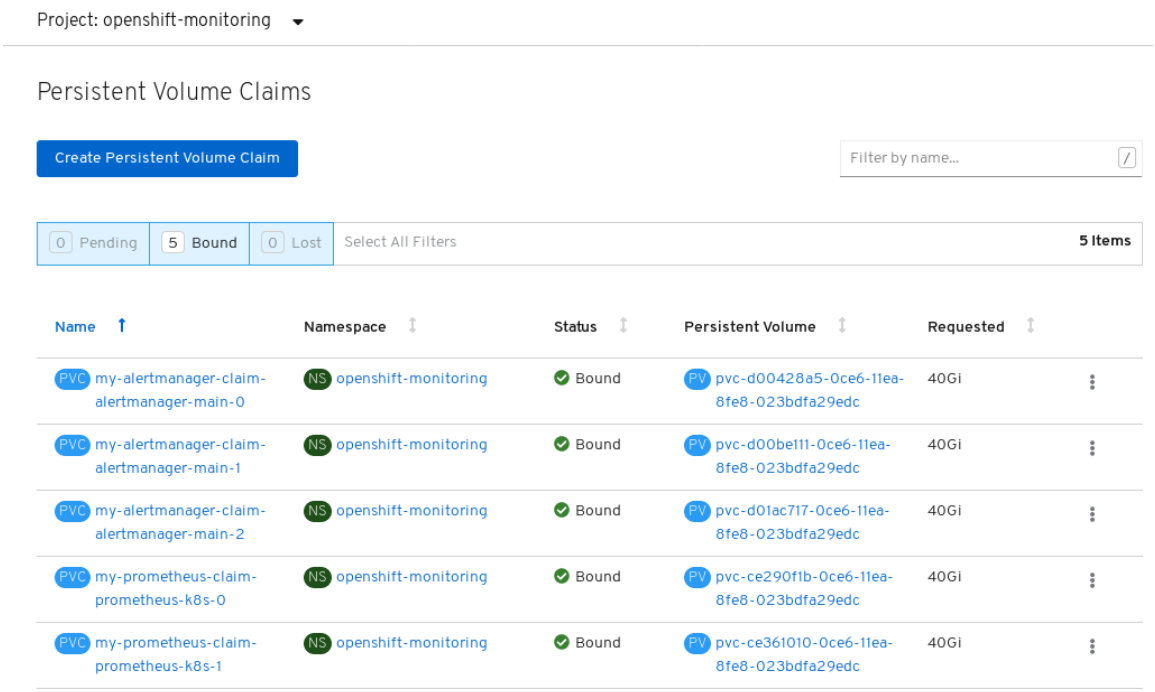
1. Verify that the Persistent Volume Claims are bound to the pods.

   a. Go to **Storage → Persistent Volume Claims**

   b. Set the **Project** dropdown to **openshift-monitoring**.

   c. Verify that 5 Persistent Volume Claims are visible with a state of **Bound**, attached to three **alertmanager-main-*** pods, and two **prometheus-k8s-*** pods.

Figure 4.1. Monitoring storage created and bound



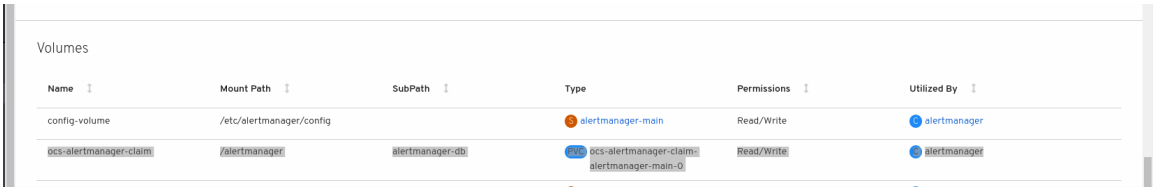
2. Verify that the new **alertmanager-main-*** pods appear with a state of **Running**.

   a. Go to **Workloads → Pods**.

   b. Click the new **alertmanager-main-*** pods to view the pod details.

   c. Scroll down to **Volumes** and verify that the volume has a **Type**, **ocs-alertmanager-claim** that matches one of your new Persistent Volume Claims, for example, **ocs-alertmanager-claim-alertmanager-main-0**.

   Figure 4.2. Persistent Volume Claims attached to alertmanager-main-* pod

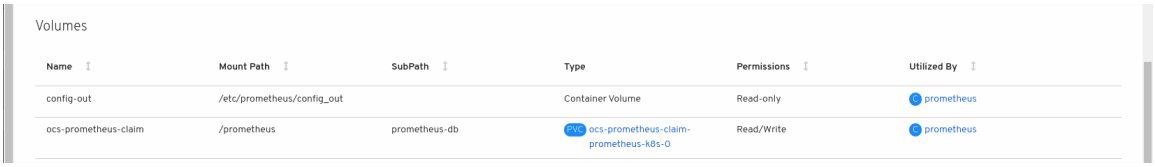


3. Verify that the new **prometheus-k8s-*** pods appear with a state of **Running**.

   a. Click the new **prometheus-k8s-*** pods to view the pod details.

   b. Scroll down to **Volumes** and verify that the volume has a **Type**, **ocs-prometheus-claim** that matches one of your new Persistent Volume Claims, for example, **ocs-prometheus-claim-prometheus-k8s-0**.

   Figure 4.3. Persistent Volume Claims attached to prometheus-k8s-* pod



4.3. CLUSTER LOGGING FOR OPENSHIFT DATA FOUNDATION

You can deploy cluster logging to aggregate logs for a range of OpenShift Container Platform services. For information about how to deploy cluster logging, see Deploying cluster logging.

Upon initial OpenShift Container Platform deployment, OpenShift Data Foundation is not configured by default and the OpenShift Container Platform cluster will solely rely on default storage available from the nodes. You can edit the default configuration of OpenShift logging (ElasticSearch) to be backed by OpenShift Data Foundation to have OpenShift Data Foundation backed logging (Elasticsearch).

IMPORTANT

Always ensure that you have plenty of storage capacity for these services. If you run out of storage space for these critical services, the logging application becomes inoperable and very difficult to recover.

Red Hat recommends configuring shorter curation and retention intervals for these services. See Cluster logging curator in the OpenShift Container Platform documentation for details.

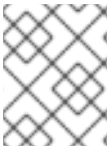
If you run out of storage space for these services, contact Red Hat Customer Support.

4.3.1. Configuring persistent storage

You can configure a persistent storage class and size for the Elasticsearch cluster using the storage class name and size parameters. The Cluster Logging Operator creates a Persistent Volume Claim for each data node in the Elasticsearch cluster based on these parameters. For example:

```
spec:
   logStore:
     type: "elasticsearch"
     elasticsearch:
       nodeCount: 3
       storage:
         storageClassName: "ocs-storagecluster-ceph-rbd”
         size: "200G"
```

This example specifies that each data node in the cluster will be bound to a Persistent Volume Claim that requests **200GiB** of **ocs-storagecluster-ceph-rbd** storage. Each primary shard will be backed by a single replica. A copy of the shard is replicated across all the nodes and are always available and the copy can be recovered if at least two nodes exist due to the single redundancy policy. For information about Elasticsearch replication policies, see *Elasticsearch replication policy* in About deploying and configuring cluster logging.



NOTE

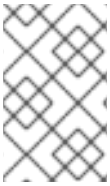
Omission of the storage block will result in a deployment backed by default storage. For example:

```
spec:
   logStore:
     type: "elasticsearch"
     elasticsearch:
       nodeCount: 3
       storage: {}
```

For more information, see Configuring cluster logging.

4.3.2. Configuring cluster logging to use OpenShift data Foundation

Follow the instructions in this section to configure OpenShift Data Foundation as storage for the OpenShift cluster logging.



NOTE

You can obtain all the logs when you configure logging for the first time in OpenShift Data Foundation. However, after you uninstall and reinstall logging, the old logs are removed and only the new logs are processed.

Prerequisites

- You have administrative access to OpenShift Web Console.
- OpenShift Data Foundation Operator is installed and running in the **openshift-storage** namespace.
- Cluster logging Operator is installed and running in the **openshift-logging** namespace.

Procedure

1. Click **Administration → Custom Resource Definitions**from the left pane of the OpenShift Web Console.
2. On the Custom Resource Definitions page, click **ClusterLogging**.
3. On the Custom Resource Definition Overview page, select **View Instances** from the Actions menu or click the **Instances** Tab.
4. On the Cluster Logging page, click **Create Cluster Logging**.
   You might have to refresh the page to load the data.
5. In the YAML, replace the **storageClassName** with the **storageclass** that uses the provisioner **openshift-storage.rbd.csi.ceph.com**. In the example given below the name of the **storageclass** is **ocs-storagecluster-ceph-rbd**:

```
apiVersion: "logging.openshift.io/v1"
kind: "ClusterLogging"
metadata:
  name: "instance"
  namespace: "openshift-logging"
spec:
  managementState: "Managed"
  logStore:
    type: "elasticsearch"
    elasticsearch:
      nodeCount: 3
      storage:
        storageClassName: ocs-storagecluster-ceph-rbd
        size: 200G # Change as per your requirement
      redundancyPolicy: "SingleRedundancy"
  visualization:
```

```
    type: "kibana"
    kibana:
      replicas: 1
  curation:
    type: "curator"
    curator:
      schedule: "30 3 * * *"
  collection:
    logs:
      type: "fluentd"
      fluentd: {}
```

If you have tainted the OpenShift Data Foundation nodes, you must add toleration to enable scheduling of the daemonset pods for logging.

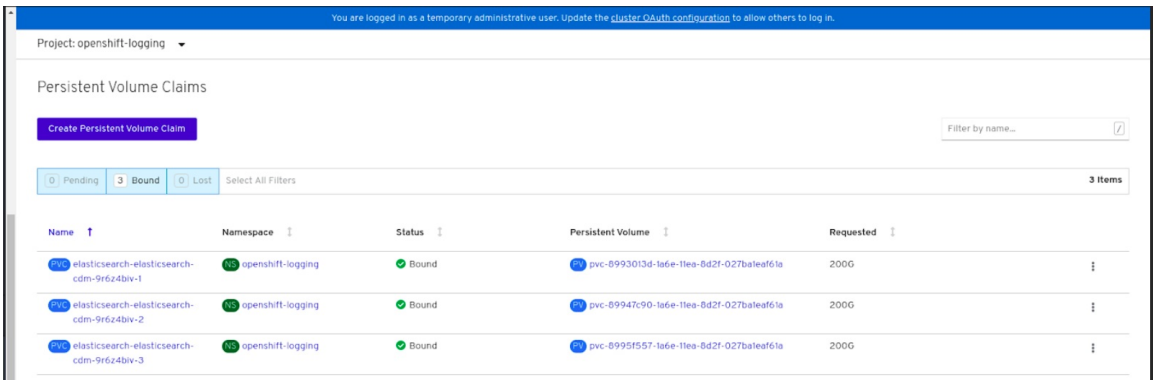
```
spec:
[...]
  collection:
    logs:
      fluentd:
        tolerations:
        - effect: NoSchedule
          key: node.ocs.openshift.io/storage
          value: 'true'
      type: fluentd
```

6. Click **Save**.

Verification steps

1. Verify that the Persistent Volume Claims are bound to the **elasticsearch** pods.
   a. Go to **Storage → Persistent Volume Claims**
   b. Set the **Project** dropdown to **openshift-logging**.
   c. Verify that Persistent Volume Claims are visible with a state of **Bound**, attached to **elasticsearch-*** pods.

   Figure 4.4. Cluster logging created and bound



2. Verify that the new cluster logging is being used.
   a. Click **Workload → Pods**.

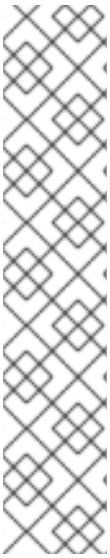
b. Set the Project to **openshift-logging**.

c. Verify that the new **elasticsearch-*** pods appear with a state of **Running**.

d. Click the new **elasticsearch-*** pod to view pod details.

e. Scroll down to **Volumes** and verify that the elasticsearch volume has a **Type** that matches your new Persistent Volume Claim, for example, **elasticsearch-elasticsearch-cdm-9r624biv-3**.

f. Click the Persistent Volume Claim name and verify the storage class name in the PersistentVolumeClaim Overview page.



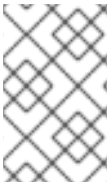
NOTE

Make sure to use a shorter curator time to avoid PV full scenario on PVs attached to Elasticsearch pods.

You can configure Curator to delete Elasticsearch data based on retention settings. It is recommended that you set the following default index data retention of 5 days as a default.

```
config.yaml: |
  openshift-storage:
    delete:
      days: 5
```

For more details, see Curation of Elasticsearch Data .



NOTE

To uninstall the cluster logging backed by Persistent Volume Claim, use the procedure removing the cluster logging operator from OpenShift Data Foundation in the uninstall chapter of the respective deployment guide.

CHAPTER 5. BACKING OPENSHIFT CONTAINER PLATFORM APPLICATIONS WITH OPENSHIFT DATA FOUNDATION

You cannot directly install OpenShift Data Foundation during the OpenShift Container Platform installation. However, you can install OpenShift Data Foundation on an existing OpenShift Container Platform by using the Operator Hub and then configure the OpenShift Container Platform applications to be backed by OpenShift Data Foundation.

Prerequisites

- OpenShift Container Platform is installed and you have administrative access to OpenShift Web Console.
- OpenShift Data Foundation is installed and running in the **openshift-storage** namespace.

Procedure

1. In the OpenShift Web Console, perform one of the following:
   - Click **Workloads → Deployments**.
     In the Deployments page, you can do one of the following:
     - Select any existing deployment and click **Add Storage** option from the **Action** menu (⋮).
     - Create a new deployment and then add storage.
       i. Click **Create Deployment** to create a new deployment.
       ii. Edit the **YAML** based on your requirement to create a deployment.
       iii. Click **Create**.
       iv. Select **Add Storage** from the **Actions** drop-down menu on the top right of the page.
   - Click **Workloads → Deployment Configs**
     In the Deployment Configs page, you can do one of the following:
     - Select any existing deployment and click **Add Storage** option from the **Action** menu (⋮).
     - Create a new deployment and then add storage.
       i. Click **Create Deployment Config** to create a new deployment.
       ii. Edit the **YAML** based on your requirement to create a deployment.
       iii. Click **Create**.
       iv. Select **Add Storage** from the **Actions** drop-down menu on the top right of the page.
2. In the Add Storage page, you can choose one of the following options:
   - Click the **Use existing claim** option and select a suitable PVC from the drop-down list.

- Click the **Create new claim** option.

  a. Select the appropriate **CephFS** or **RBD** storage class from the **Storage Class** drop-down list.

  b. Provide a name for the Persistent Volume Claim.

  c. Select ReadWriteOnce (RWO) or ReadWriteMany (RWX) access mode.

  NOTE

  ReadOnlyMany (ROX) is deactivated as it is not supported.

  d. Select the size of the desired storage capacity.

  NOTE

  You can expand the block PVs but cannot reduce the storage capacity after the creation of Persistent Volume Claim.

3. Specify the mount path and subpath (if required) for the mount path volume inside the container.

4. Click **Save**.

Verification steps

1. Depending on your configuration, perform one of the following:

   - Click **Workloads → Deployments**.
   - Click **Workloads → Deployment Configs**

2. Set the Project as required.

3. Click the deployment for which you added storage to display the deployment details.

4. Scroll down to **Volumes** and verify that your deployment has a **Type** that matches the Persistent Volume Claim that you assigned.

5. Click the Persistent Volume Claim name and verify the storage class name in the Persistent Volume Claim Overview page.

CHAPTER 6. ADDING FILE AND OBJECT STORAGE TO AN EXISTING EXTERNAL OPENSHIFT DATA FOUNDATION CLUSTER

When OpenShift Data Foundation is configured in external mode, there are several ways to provide storage for persistent volume claims and object bucket claims.

- Persistent volume claims for block storage are provided directly from the external Red Hat Ceph Storage cluster.
- Persistent volume claims for file storage can be provided by adding a Metadata Server (MDS) to the external Red Hat Ceph Storage cluster.
- Object bucket claims for object storage can be provided either by using the Multicloud Object Gateway or by adding the Ceph Object Gateway to the external Red Hat Ceph Storage cluster.

Use the following process to add file storage (using Metadata Servers) or object storage (using Ceph Object Gateway) or both to an external OpenShift Data Foundation cluster that was initially deployed to provide only block storage.

Prerequisites

- You have OpenShift Data Foundation 4.9 installed and running on the OpenShift Container Platform version 4.9 or above. Also, the OpenShift Data Foundation Cluster in external mode is in **Ready** state.
- Your external Red Hat Ceph Storage cluster is configured with one or both of the following:
  - a Ceph Object Gateway (RGW) endpoint that can be accessed by the OpenShift Container Platform cluster for object storage
  - a Metadata Server (MDS) pool for file storage
- Ensure that you know the parameters used with the **ceph-external-cluster-details-exporter.py** script during external OpenShift Data Foundation cluster deployment.

Procedure

1. Download the OpenShift Data Foundation version of the **ceph-external-cluster-details-exporter.py** python script using the following command:

```
oc get csv $(oc get csv -n openshift-storage | grep ocs-operator | awk '{print $1}') -n openshift-storage -o jsonpath='{.metadata.annotations.external\.features\.ocs\.openshift\.io/export-script}' | base64 --decode > ceph-external-cluster-details-exporter.py
```

2. Update permission caps on the external Red Hat Ceph Storage cluster by running **ceph-external-cluster-details-exporter.py** on any client node in the external Red Hat Ceph Storage cluster. You may need to ask your Red Hat Ceph Storage administrator to do this.

```
# python3 ceph-external-cluster-details-exporter.py --upgrade \
--run-as-user=ocs-client-name \
--rgw-pool-prefix rgw-pool-prefix
```

--run-as-user

The client name used during OpenShift Data Foundation cluster deployment. Use the default client name **client.healthchecker** if a different client name was not set.

--rgw-pool-prefix

The prefix used for the Ceph Object Gateway pool. This can be omitted if the default prefix is used.

3. Generate and save configuration details from the external Red Hat Ceph Storage cluster.

   a. Generate configuration details by running **ceph-external-cluster-details-exporter.py** on any client node in the external Red Hat Ceph Storage cluster.

   ```
   # python3 ceph-external-cluster-details-exporter.py --rbd-data-pool-name rbd-block-pool-name --monitoring-endpoint ceph-mgr-prometheus-exporter-endpoint --monitoring-endpoint-port ceph-mgr-prometheus-exporter-port --run-as-user ocs-client-name  --rgw-endpoint rgw-endpoint --rgw-pool-prefix rgw-pool-prefix
   ```

   --monitoring-endpoint

   Is optional. It accepts comma separated list of IP addresses of active and standby mgrs reachable from the OpenShift Container Platform cluster. If not provided, the value is automatically populated.

   --monitoring-endpoint-port

   Is optional. It is the port associated with the ceph-mgr Prometheus exporter specified by **--monitoring-endpoint**. If not provided, the value is automatically populated.

   --run-as-user

   The client name used during OpenShift Data Foundation cluster deployment. Use the default client name client.healthchecker if a different client name was not set.

   --rgw-endpoint

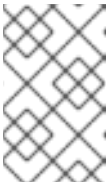
   Provide this parameter to provision object storage through Ceph Object Gateway for OpenShift Data Foundation. (optional parameter)

   --rgw-pool-prefix

   The prefix used for the Ceph Object Gateway pool. This can be omitted if the default prefix is used.

   User permissions are updated as shown:

   ```
   caps: [mgr] allow command config
   caps: [mon] allow r, allow command quorum_status, allow command version
   caps: [osd] allow rwx pool=default.rgw.meta, allow r pool=.rgw.root, allow rw pool=default.rgw.control, allow rx pool=default.rgw.log, allow x pool=default.rgw.buckets.index
   ```

   NOTE

   Ensure that all the parameters (including the optional arguments) except the Ceph Object Gateway details (if provided), are the same as what was used during the deployment of OpenShift Data Foundation in external mode.

   b. Save the output of the script in an **external-cluster-config.json** file.
   The following example output shows the generated configuration changes in bold text.

[{"name": "rook-ceph-mon-endpoints", "kind": "ConfigMap", "data": {"data": "xxx.xxx.xxx.xxx:xxxx", "maxMonId": "0", "mapping": "{}"}}, {"name": "rook-ceph-mon", "kind": "Secret", "data": {"admin-secret": "admin-secret", "fsid": "<fs-id>", "mon-secret": "mon-secret"}}, {"name": "rook-ceph-operator-creds", "kind": "Secret", "data": {"userID": "<user-id>", "userKey": "<user-key>"}}, {"name": "rook-csi-rbd-node", "kind": "Secret", "data": {"userID": "csi-rbd-node", "userKey": "<user-key>"}}, {"name": "ceph-rbd", "kind": "StorageClass", "data": {"pool": "<pool>"}}, {"name": "monitoring-endpoint", "kind": "CephCluster", "data": {"MonitoringEndpoint": "xxx.xxx.xxx.xxx", "MonitoringPort": "xxxx"}}, {"name": "rook-ceph-dashboard-link", "kind": "Secret", "data": {"userID": "ceph-dashboard-link", "userKey": "<user-key>"}}, {"name": "rook-csi-rbd-provisioner", "kind": "Secret", "data": {"userID": "csi-rbd-provisioner", "userKey": "<user-key>"}}, {"name": "rook-csi-cephfs-provisioner", "kind": "Secret", "data": {"adminID": "csi-cephfs-provisioner", "adminKey": "<admin-key>"}}, {"name": "rook-csi-cephfs-node", "kind": "Secret", "data": {"adminID": "csi-cephfs-node", "adminKey": "<admin-key>"}}, {"name": "cephfs", "kind": "StorageClass", "data": {"fsName": "cephfs", "pool": "cephfs_data"}}, {"name": "ceph-rgw", "kind": "StorageClass", "data": {"endpoint": "xxx.xxx.xxx.xxx:xxxx", "poolPrefix": "default"}}, {"name": "rgw-admin-ops-user", "kind": "Secret", "data": {"accessKey": "<access-key>", "secretKey": "<secret-key>"}}]

4. Upload the generated JSON file.

   a. Log in to the OpenShift web console.

   b. Click **Workloads → Secrets**.

   c. Set **project** to **openshift-storage**.

   d. Click on **rook-ceph-external-cluster-details**.

   e. Click **Actions** (⋮) → **Edit Secret**

   f. Click **Browse** and upload the **external-cluster-config.json** file.

   g. Click **Save**.

Verification steps

- To verify that the OpenShift Data Foundation cluster is healthy and data is resilient, navigate to **Storage → OpenShift Data foundation → Storage Systems** tab and then click on the storage system name.
  - On the **Overview → Block and File** tab, check the Status card to confirm that the *Storage Cluster* has a green tick indicating it is healthy.

- If you added a Metadata Server for file storage:

  a. Click **Workloads → Pods** and verify that **csi-cephfsplugin-*** pods are created new and are in the **Running** state.

  b. Click **Storage → Storage Classes** and verify that the **ocs-external-storagecluster-cephfs** storage class is created.

- If you added the Ceph Object Gateway for object storage:

  a. Click **Storage → Storage Classes** and verify that the **ocs-external-storagecluster-ceph-rgw** storage class is created.

b. To verify that the OpenShift Data Foundation cluster is healthy and data is resilient, navigate to **Storage → OpenShift Data foundation → Storage Systems** tab and then click on the storage system name.

c. Click the **Object** tab and confirm *Object Service* and *Data resiliency* has a green tick indicating it is healthy.

CHAPTER 7. HOW TO USE DEDICATED WORKER NODES FOR RED HAT OPENSHIFT DATA FOUNDATION

Any Red Hat OpenShift Container Platform subscription requires an OpenShift Data Foundation subscription. However, you can save on the OpenShift Container Platform subscription costs if you are using infrastructure nodes to schedule OpenShift Data Foundation resources.

It is important to maintain consistency across environments with or without Machine API support. Because of this, it is highly recommended in all cases to have a special category of nodes labeled as either worker or infra or have both roles. See the Section 7.3, "Manual creation of infrastructure nodes" section for more information.

7.1. ANATOMY OF AN INFRASTRUCTURE NODE

Infrastructure nodes for use with OpenShift Data Foundation have a few attributes. The **infra** node-role label is required to ensure the node does not consume RHOCP entitlements. The **infra** node-role label is responsible for ensuring only OpenShift Data Foundation entitlements are necessary for the nodes running OpenShift Data Foundation.

- Labeled with **node-role.kubernetes.io/infra**

Adding an OpenShift Data Foundation taint with a **NoSchedule** effect is also required so that the **infra** node will only schedule OpenShift Data Foundation resources.

- Tainted with **node.ocs.openshift.io/storage="true"**

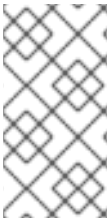
The label identifies the RHOCP node as an **infra** node so that RHOCP subscription cost is not applied. The taint prevents non OpenShift Data Foundation resources to be scheduled on the tainted nodes.

Example of the taint and labels required on infrastructure node that will be used to run OpenShift Data Foundation services:

```
spec:
  taints:
  - effect: NoSchedule
    key: node.ocs.openshift.io/storage
    value: "true"
  metadata:
    creationTimestamp: null
    labels:
      node-role.kubernetes.io/worker: ""
      node-role.kubernetes.io/infra: ""
      cluster.ocs.openshift.io/openshift-storage: ""
```

7.2. MACHINE SETS FOR CREATING INFRASTRUCTURE NODES

If the Machine API is supported in the environment, then labels should be added to the templates for the Machine Sets that will be provisioning the infrastructure nodes. Avoid the anti-pattern of adding labels manually to nodes created by the machine API. Doing so is analogous to adding labels to pods created by a deployment. In both cases, when the pod/node fails, the replacement pod/node will not have the appropriate labels.



NOTE

In EC2 environments, you will need three machine sets, each configured to provision infrastructure nodes in a distinct availability zone (such as us-east-2a, us-east-2b, us-east-2c). Currently, OpenShift Data Foundation does not support deploying in more than three availability zones.

The following Machine Set template example creates nodes with the appropriate taint and labels required for infrastructure nodes. This will be used to run OpenShift Data Foundation services.

```
template:
  metadata:
    creationTimestamp: null
    labels:
      machine.openshift.io/cluster-api-cluster: kb-s25vf
      machine.openshift.io/cluster-api-machine-role: worker
      machine.openshift.io/cluster-api-machine-type: worker
      machine.openshift.io/cluster-api-machineset: kb-s25vf-infra-us-west-2a
  spec:
    taints:
    - effect: NoSchedule
      key: node.ocs.openshift.io/storage
      value: "true"
    metadata:
      creationTimestamp: null
      labels:
        node-role.kubernetes.io/infra: ""
        cluster.ocs.openshift.io/openshift-storage: ""
```

7.3. MANUAL CREATION OF INFRASTRUCTURE NODES

Only when the Machine API is not supported in the environment should labels be directly applied to nodes. Manual creation requires that at least 3 RHOCP worker nodes are available to schedule OpenShift Data Foundation services, and that these nodes have sufficient CPU and memory resources. To avoid the RHOCP subscription cost, the following is required:

```
oc label node <node> node-role.kubernetes.io/infra=""
oc label node <node> cluster.ocs.openshift.io/openshift-storage=""
```

Adding a **NoSchedule** OpenShift Data Foundation taint is also required so that the **infra** node will only schedule OpenShift Data Foundation resources and repel any other non-OpenShift Data Foundation workloads.

```
oc adm taint node <node> node.ocs.openshift.io/storage="true":NoSchedule
```

WARNING

Do not remove the node-role**node-role.kubernetes.io/worker=""**

The removal of the **node-role.kubernetes.io/worker=""** can cause issues unless changes are made both to the OpenShift scheduler and to MachineConfig resources.

If already removed, it should be added again to each **infra** node. Adding node-role **node-role.kubernetes.io/infra=""** and OpenShift Data Foundation taint is sufficient to conform to entitlement exemption requirements.

CHAPTER 8. MANAGING PERSISTENT VOLUME CLAIMS

8.1. CONFIGURING APPLICATION PODS TO USE OPENSHIFT DATA FOUNDATION

Follow the instructions in this section to configure OpenShift Data Foundation as storage for an application pod.

Prerequisites

- You have administrative access to OpenShift Web Console.
- OpenShift Data Foundation Operator is installed and running in the **openshift-storage** namespace. In OpenShift Web Console, click **Operators → Installed Operators** to view installed operators.
- The default storage classes provided by OpenShift Data Foundation are available. In OpenShift Web Console, click **Storage → StorageClasses** to view default storage classes.

Procedure

1. **Create a Persistent Volume Claim (PVC) for the application to use.**
   a. In OpenShift Web Console, click **Storage → Persistent Volume Claims**
   b. Set the **Project** for the application pod.
   c. Click **Create Persistent Volume Claim**
      i. Specify a **Storage Class** provided by OpenShift Data Foundation.
      ii. Specify the PVC **Name**, for example, **myclaim**.
      iii. Select the required **Access Mode**.

NOTE

The **Access Mode**, **Shared access (RWX)** is not supported in IBM FlashSystem.

      iv. For Rados Block Device (RBD), if the **Access mode** is ReadWriteOnce (**RWO**), select the required **Volume mode**. The default volume mode is **Filesystem**.
      v. For Rados Block Device (RBD), if the **Access mode** is ReadWriteOnce (**RWO**), select the required **Volume mode**. The default volume mode is **Filesystem**.
      vi. Specify a **Size** as per application requirement.
      vii. Click **Create** and wait until the PVC is in **Bound** status.
2. **Configure a new or existing application pod to use the new PVC.**
   - For a new application pod, perform the following steps:
      i. Click **Workloads →Pods**.

ii. Create a new application pod.

iii. Under the **spec:** section, add **volume:** section to add the new PVC as a volume for the application pod.

```
volumes:
  - name: <volume_name>
    persistentVolumeClaim:
      claimName: <pvc_name>
```

For example:

```
volumes:
  - name: mypd
    persistentVolumeClaim:
      claimName: myclaim
```

- For an existing application pod, perform the following steps:

i. Click **Workloads →Deployment Configs**.

ii. Search for the required deployment config associated with the application pod.

iii. Click on its **Action menu (⋮) → Edit Deployment Config**.

iv. Under the **spec:** section, add **volume:** section to add the new PVC as a volume for the application pod and click **Save**.

```
volumes:
  - name: <volume_name>
    persistentVolumeClaim:
      claimName: <pvc_name>
```

For example:

```
volumes:
  - name: mypd
    persistentVolumeClaim:
      claimName: myclaim
```

3. **Verify that the new configuration is being used.**

a. Click **Workloads → Pods**.

b. Set the **Project** for the application pod.

c. Verify that the application pod appears with a status of **Running**.

d. Click the application pod name to view pod details.

e. Scroll down to **Volumes** section and verify that the volume has a **Type** that matches your new Persistent Volume Claim, for example, **myclaim**.

8.2. VIEWING PERSISTENT VOLUME CLAIM REQUEST STATUS

Use this procedure to view the status of a PVC request.

Prerequisites

- Administrator access to OpenShift Data Foundation.

Procedure

1. Log in to OpenShift Web Console.
2. Click **Storage → Persistent Volume Claims**
3. Search for the required PVC name by using the **Filter** textbox. You can also filter the list of PVCs by Name or Label to narrow down the list
4. Check the **Status** column corresponding to the required PVC.
5. Click the required **Name** to view the PVC details.

8.3. REVIEWING PERSISTENT VOLUME CLAIM REQUEST EVENTS

Use this procedure to review and address Persistent Volume Claim (PVC) request events.

Prerequisites

- Administrator access to OpenShift Web Console.

Procedure

1. In the OpenShift Web Console, click **Storage → OpenShift Data Foundation**
2. In the **Storage systems** tab, select the storage system and then click **Overview → Block and File**.
3. Locate the **Inventory** card to see the number of PVCs with errors.
4. Click **Storage → Persistent Volume Claims**
5. Search for the required PVC using the **Filter** textbox.
6. Click on the PVC name and navigate to **Events**
7. Address the events as required or as directed.

8.4. EXPANDING PERSISTENT VOLUME CLAIMS

OpenShift Data Foundation 4.6 onwards has the ability to expand Persistent Volume Claims providing more flexibility in the management of persistent storage resources.

Expansion is supported for the following Persistent Volumes:

- PVC with ReadWriteOnce (RWO) and ReadWriteMany (RWX) access that is based on Ceph File System (CephFS) for volume mode **Filesystem**.

- PVC with ReadWriteOnce (RWO) access that is based on Ceph RADOS Block Devices (RBDs) with volume mode **Filesystem**.
- PVC with ReadWriteOnce (RWO) access that is based on Ceph RADOS Block Devices (RBDs) with volume mode **Block**.

NOTE

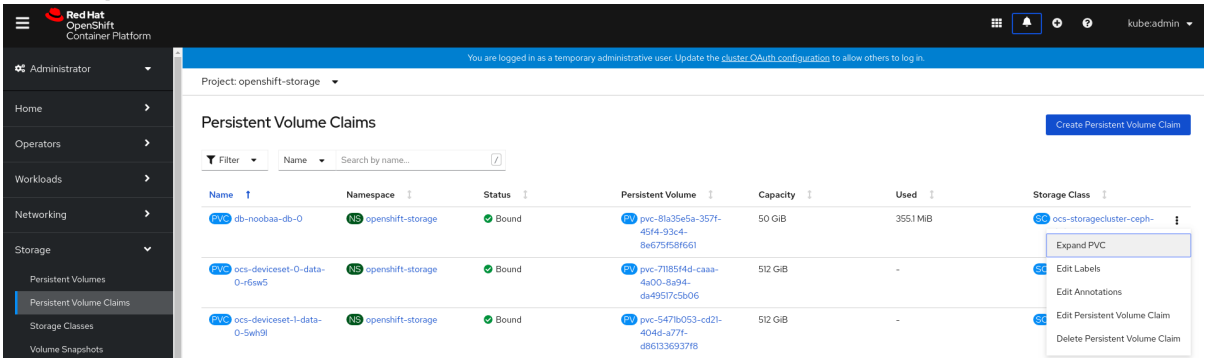
PVC expansion is not supported for OSD, MON and encrypted PVCs.

Prerequisites

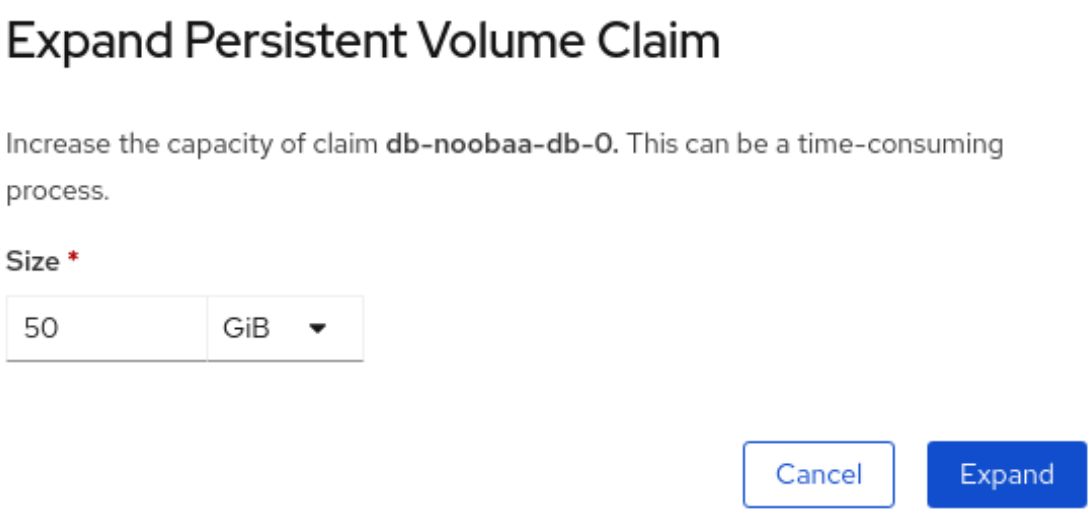
- Administrator access to OpenShift Web Console.

Procedure

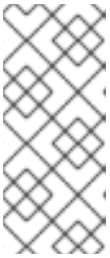
1. In OpenShift Web Console, navigate to **Storage → Persistent Volume Claims**.
2. Click the Action Menu (⋮) next to the Persistent Volume Claim you want to expand.
3. Click **Expand PVC**:



4. Select the new size of the Persistent Volume Claim, then click **Expand**:



5. To verify the expansion, navigate to the PVC's details page and verify the **Capacity** field has the correct size requested.



NOTE

When expanding PVCs based on Ceph RADOS Block Devices (RBDs), if the PVC is not already attached to a pod the **Condition type** is **FileSystemResizePending** in the PVC's details page. Once the volume is mounted, filesystem resize succeeds and the new size is reflected in the **Capacity** field.

8.5. DYNAMIC PROVISIONING

8.5.1. About dynamic provisioning

The StorageClass resource object describes and classifies storage that can be requested, as well as provides a means for passing parameters for dynamically provisioned storage on demand. StorageClass objects can also serve as a management mechanism for controlling different levels of storage and access to the storage. Cluster Administrators (**cluster-admin**) or Storage Administrators (**storage-admin**) define and create the StorageClass objects that users can request without needing any intimate knowledge about the underlying storage volume sources.

The OpenShift Container Platform persistent volume framework enables this functionality and allows administrators to provision a cluster with persistent storage. The framework also gives users a way to request those resources without having any knowledge of the underlying infrastructure.

Many storage types are available for use as persistent volumes in OpenShift Container Platform. While all of them can be statically provisioned by an administrator, some types of storage are created dynamically using the built-in provider and plug-in APIs.

8.5.2. Dynamic provisioning in OpenShift Data Foundation

Red Hat OpenShift Data Foundation is software-defined storage that is optimised for container environments. It runs as an operator on OpenShift Container Platform to provide highly integrated and simplified persistent storage management for containers.

OpenShift Data Foundation supports a variety of storage types, including:

- Block storage for databases
- Shared file storage for continuous integration, messaging, and data aggregation
- Object storage for archival, backup, and media storage

Version 4 uses Red Hat Ceph Storage to provide the file, block, and object storage that backs persistent volumes, and Rook.io to manage and orchestrate provisioning of persistent volumes and claims. NooBaa provides object storage, and its Multicloud Gateway allows object federation across multiple cloud environments (available as a Technology Preview).

In OpenShift Data Foundation 4, the Red Hat Ceph Storage Container Storage Interface (CSI) driver for RADOS Block Device (RBD) and Ceph File System (CephFS) handles the dynamic provisioning requests. When a PVC request comes in dynamically, the CSI driver has the following options:

- Create a PVC with ReadWriteOnce (RWO) and ReadWriteMany (RWX) access that is based on Ceph RBDs with volume mode **Block**
- Create a PVC with ReadWriteOnce (RWO) access that is based on Ceph RBDs with volume mode **Filesystem**

- Create a PVC with ReadWriteOnce (RWO) and ReadWriteMany (RWX) access that is based on CephFS for volume mode **Filesystem**

The judgment of which driver (RBD or CephFS) to use is based on the entry in the **storageclass.yaml** file.

8.5.3. Available dynamic provisioning plug-ins

OpenShift Container Platform provides the following provisioner plug-ins, which have generic implementations for dynamic provisioning that use the cluster's configured provider's API to create new storage resources:

Storage type	Provisioner plug-in name	Notes
OpenStack Cinder	**kubernetes.io/cinder**	
AWS Elastic Block Store (EBS)	**kubernetes.io/aws-ebs**	For dynamic provisioning when using multiple clusters in different zones, tag each node with **Key=kubernetes.io/cluster/<cluster_name>,Value=<cluster_id>** where **<cluster_name>** and **<cluster_id>** are unique per cluster.
AWS Elastic File System (EFS)		Dynamic provisioning is accomplished through the EFS provisioner pod and not through a provisioner plug-in.
Azure Disk	**kubernetes.io/azure-disk**	
Azure File	**kubernetes.io/azure-file**	The **persistent-volume-binder** ServiceAccount requires permissions to create and get Secrets to store the Azure storage account and keys.
GCE Persistent Disk (gcePD)	**kubernetes.io/gce-pd**	In multi-zone configurations, it is advisable to run one OpenShift Container Platform cluster per GCE project to avoid PVs from being created in zones where no node in the current cluster exists.
VMware vSphere	**kubernetes.io/vsphere-volume**	
Red Hat Virtualization	**csi.ovirt.org**	

IMPORTANT

Any chosen provisioner plug-in also requires configuration for the relevant cloud, host, or third-party provider as per the relevant documentation.

CHAPTER 9. VOLUME SNAPSHOTS

A volume snapshot is the state of the storage volume in a cluster at a particular point in time. These snapshots help to use storage more efficiently by not having to make a full copy each time and can be used as building blocks for developing an application.

Volume snapshot class allows an administrator to specify different attributes belonging to a volume snapshot object. The OpenShift Data Foundation operator installs default volume snapshot classes depending on the platform in use. The operator owns and controls these default volume snapshot classes and they cannot be deleted or modified.

You can create many snapshots of the same persistent volume claim (PVC) but cannot schedule periodic creation of snapshots.

- For CephFS, you can create up to 100 snapshots per PVC.
- For RADOS Block Device (RBD), you can create up to 512 snapshots per PVC.

NOTE

Persistent Volume encryption now supports volume snapshots.

9.1. CREATING VOLUME SNAPSHOTS

You can create a volume snapshot either from the Persistent Volume Claim (PVC) page or the Volume Snapshots page.

Prerequisites

- For a consistent snapshot, the PVC should be in **Bound** state and not be in use. Ensure to stop all IO before taking the snapshot.

NOTE

OpenShift Data Foundation only provides crash consistency for a volume snapshot of a PVC if a pod is using it. For application consistency, be sure to first tear down a running pod to ensure consistent snapshots or use any quiesce mechanism provided by the application to ensure it.

Procedure

From the Persistent Volume Claims page

1. Click **Storage → Persistent Volume Claims** from the OpenShift Web Console.
2. To create a volume snapshot, do one of the following:
   - Beside the desired PVC, click Action menu **(⋮) → Create Snapshot**.
   - Click on the PVC for which you want to create the snapshot and click **Actions → Create Snapshot**.
3. Enter a **Name** for the volume snapshot.
4. Choose the **Snapshot Class** from the drop-down list.

5. Click **Create**. You will be redirected to the Details page of the volume snapshot that is created.

From the Volume Snapshots page

1. Click **Storage → Volume Snapshots** from the OpenShift Web Console.
2. In the **Volume Snapshots** page, click **Create Volume Snapshot**
3. Choose the required **Project** from the drop-down list.
4. Choose the **Persistent Volume Claim** from the drop-down list.
5. Enter a **Name** for the snapshot.
6. Choose the **Snapshot Class** from the drop-down list.
7. Click **Create**. You will be redirected to the Details page of the volume snapshot that is created.

Verification steps

- Go to the **Details** page of the PVC and click the **Volume Snapshots** tab to see the list of volume snapshots. Verify that the new volume snapshot is listed.
- Click **Storage → Volume Snapshots** from the OpenShift Web Console. Verify that the new volume snapshot is listed.
- Wait for the volume snapshot to be in **Ready** state.

9.2. RESTORING VOLUME SNAPSHOTS

When you restore a volume snapshot, a new Persistent Volume Claim (PVC) gets created. The restored PVC is independent of the volume snapshot and the parent PVC.

You can restore a volume snapshot from either the Persistent Volume Claim page or the Volume Snapshots page.

Procedure

From the Persistent Volume Claims page

You can restore volume snapshot from the Persistent Volume Claims page only if the parent PVC is present.

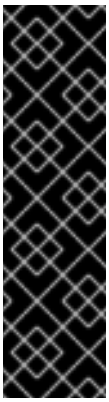
1. Click **Storage → Persistent Volume Claims** from the OpenShift Web Console.
2. Click on the PVC name with the volume snapshot to restore a volume snapshot as a new PVC.
3. In the **Volume Snapshots** tab, click the Action menu (⋮) next to the volume snapshot you want to restore.
4. Click **Restore as new PVC**.
5. Enter a name for the new PVC.

6. Select the **Storage Class** name.

NOTE

For Rados Block Device (RBD), you must select a storage class with the same pool as that of the parent PVC. Restoring the snapshot of an encrypted PVC using a storage class where encryption is not enabled and vice versa is not supported.

7. Select the **Access Mode** of your choice.



IMPORTANT

The ReadOnlyMany (ROX) access mode is a Developer Preview feature and is subject to Developer Preview support limitations. Developer Preview releases are not intended to be run in production environments and are not supported through the Red Hat Customer Portal case management system. If you need assistance with ReadOnlyMany feature, reach out to the ocs-devpreview@redhat.com mailing list and a member of the Red Hat Development Team will assist you as quickly as possible based on availability and work schedules. See Creating a clone or restoring a snapshot with the new readonly access mode to use the ROX access mode.

8. Optional: For RBD, select **Volume mode**.

9. Click **Restore**. You are redirected to the new PVC details page.

From the Volume Snapshots page

1. Click **Storage → Volume Snapshots** from the OpenShift Web Console.

2. In the **Volume Snapshots** tab, click the Action menu (⋮) next to the volume snapshot you want to restore.

3. Click **Restore as new PVC**.

4. Enter a name for the new PVC.

5. Select the **Storage Class** name.

NOTE

For Rados Block Device (RBD), you must select a storage class with the same pool as that of the parent PVC. Restoring the snapshot of an encrypted PVC using a storage class where encryption is not enabled and vice versa is not supported.

6. Select the **Access Mode** of your choice.

IMPORTANT

The ReadOnlyMany (ROX) access mode is a Developer Preview feature and is subject to Developer Preview support limitations. Developer Preview releases are not intended to be run in production environments and are not supported through the Red Hat Customer Portal case management system. If you need assistance with ReadOnlyMany feature, reach out to the ocs-devpreview@redhat.com mailing list and a member of the Red Hat Development Team will assist you as quickly as possible based on availability and work schedules. See Creating a clone or restoring a snapshot with the new readonly access mode to use the ROX access mode.

7. Optional: For RBD, select **Volume mode**.
8. Click **Restore**. You are redirected to the new PVC details page.

Verification steps

- Click **Storage → Persistent Volume Claims** from the OpenShift Web Console and confirm that the new PVC is listed in the **Persistent Volume Claims** page.
- Wait for the new PVC to reach **Bound** state.

9.3. DELETING VOLUME SNAPSHOTS

Prerequisites

- For deleting a volume snapshot, the volume snapshot class which is used in that particular volume snapshot should be present.

Procedure

From Persistent Volume Claims page

1. Click **Storage → Persistent Volume Claims** from the OpenShift Web Console.
2. Click on the PVC name which has the volume snapshot that needs to be deleted.
3. In the **Volume Snapshots** tab, beside the desired volume snapshot, click Action menu **(⋮) → Delete Volume Snapshot**

From Volume Snapshots page

1. Click **Storage → Volume Snapshots** from the OpenShift Web Console.
2. In the **Volume Snapshots** page, beside the desired volume snapshot click Action menu **(⋮) → Delete Volume Snapshot**

Verfication steps

- Ensure that the deleted volume snapshot is not present in the **Volume Snapshots** tab of the PVC details page.

- Click **Storage → Volume Snapshots** and ensure that the deleted volume snapshot is not listed.

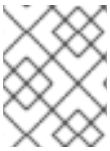
CHAPTER 10. VOLUME CLONING

A clone is a duplicate of an existing storage volume that is used as any standard volume. You create a clone of a volume to make a point in time copy of the data. A persistent volume claim (PVC) cannot be cloned with a different size. You can create up to 512 clones per PVC for both CephFS and RADOS Block Device (RBD).

10.1. CREATING A CLONE

Prerequisites

- Source PVC must be in **Bound** state and must not be in use.

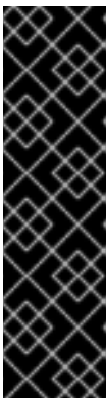


NOTE

Do not create a clone of a PVC if a Pod is using it. Doing so might cause data corruption because the PVC is not quiesced (paused).

Procedure

1. Click **Storage → Persistent Volume Claims** from the OpenShift Web Console.
2. To create a clone, do one of the following:
   - Beside the desired PVC, click Action menu **(⋮) → Clone PVC**.
   - Click on the PVC that you want to clone and click **Actions → Clone PVC**.
3. Enter a **Name** for the clone.
4. Select the access mode of your choice.



IMPORTANT

The ReadOnlyMany (ROX) access mode is a Developer Preview feature and is subject to Developer Preview support limitations. Developer Preview releases are not intended to be run in production environments and are not supported through the Red Hat Customer Portal case management system. If you need assistance with ReadOnlyMany feature, reach out to the ocs-devpreview@redhat.com mailing list and a member of the Red Hat Development Team will assist you as quickly as possible based on availability and work schedules. See Creating a clone or restoring a snapshot with the new readonly access mode to use the ROX access mode.

5. Click **Clone**. You are redirected to the new PVC details page.
6. Wait for the cloned PVC status to become **Bound**.
   The cloned PVC is now available to be consumed by the pods. This cloned PVC is independent of its dataSource PVC.

CHAPTER 11. MANAGING CONTAINER STORAGE INTERFACE (CSI) COMPONENT PLACEMENTS

Each cluster consists of a number of dedicated nodes such as **infra** and **storage** nodes. However, an **infra** node with a custom taint will not be able to use OpenShift Data Foundation Persistent Volume Claims (PVCs) on the node. So, if you want to use such nodes, you can set tolerations to bring up **csi-plugins** on the nodes. For more information, see https://access.redhat.com/solutions/4827161.

Procedure

1. Edit the configmap to add the toleration for the custom taint. Remember to save before exiting the editor.

```
$ oc edit configmap rook-ceph-operator-config -n openshift-storage
```

2. Display the **configmap** to check the added toleration.

```
$ oc get configmap rook-ceph-operator-config -n openshift-storage -o yaml
```

Example output of the added toleration for the taint, **nodetype=infra:NoSchedule** :

```
apiVersion: v1
data:
[...]
  CSI_PLUGIN_TOLERATIONS: |
    - key: nodetype
      operator: Equal
      value: infra
      effect: NoSchedule
    - key: node.ocs.openshift.io/storage
      operator: Equal
      value: "true"
      effect: NoSchedule
[...]
kind: ConfigMap
metadata:
[...]
```

3. Restart the **rook-ceph-operator** if the **csi-cephfsplugin-*** and **csi-rbdplugin-*** pods fail to come up on their own on the infra nodes.

```
$ oc delete -n openshift-storage pod <name of the rook_ceph_operator pod>
```

Example :

```
$ oc delete -n openshift-storage pod rook-ceph-operator-5446f9b95b-jrn2j

pod "rook-ceph-operator-5446f9b95b-jrn2j" deleted
```

Verification step

Verify that the **csi-cephfsplugin-*** and **csi-rbdplugin-*** pods are running on the **infra** nodes.