



Red Hat OpenShift Data Foundation 4.10

Deploying OpenShift Data Foundation in external mode

Instructions for deploying OpenShift Data Foundation to use an external Red Hat Ceph Storage cluster and IBM FlashSystem.

Red Hat OpenShift Data Foundation 4.10 Deploying OpenShift Data Foundation in external mode

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Abstract

Read this document for instructions on installing Red Hat OpenShift Data Foundation 4.10 to use an external Red Hat Ceph Storage cluster or IBM FlashSystem.

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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](#).

PROVIDING FEEDBACK ON RED HAT DOCUMENTATION

We appreciate your input on our documentation. Do let us know how we can make it better. To give feedback:

- For simple comments on specific passages:
 1. Make sure you are viewing the documentation in the *Multi-page HTML* format. In addition, ensure you see the **Feedback** button in the upper right corner of the document.
 2. Use your mouse cursor to highlight the part of text that you want to comment on.
 3. Click the **Add Feedback** pop-up that appears below the highlighted text.
 4. Follow the displayed instructions.
- For submitting more complex feedback, create a Bugzilla ticket:
 1. Go to the [Bugzilla](#) website.
 2. In the **Component** section, choose **documentation**.
 3. Fill in the **Description** field with your suggestion for improvement. Include a link to the relevant part(s) of documentation.
 4. Click **Submit Bug**.

CHAPTER 1. OVERVIEW OF DEPLOYING IN EXTERNAL MODE

Red Hat OpenShift Data Foundation can make services from an external Red Hat Ceph Storage cluster or use IBM FlashSystems available for consumption through OpenShift Container Platform clusters running on the following platforms:

- VMware vSphere
- Bare metal
- Red Hat OpenStack platform (Technology Preview)
- IBM Power
- IBM Z infrastructure



IMPORTANT

Connecting and monitoring IBM FlashSystem® storage using OpenShift Data Foundation is a Developer Preview feature. Developer Preview features are subject to Developer Preview support limitations. Developer Preview releases are not intended to be run in production environments. The clusters deployed with the Developer Preview features are considered to be development clusters and are not supported through the Red Hat Customer Portal case management system. If you need assistance with Developer Preview features, 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 [Planning your deployment](#) for more information.

For instructions regarding how to install a RHCS 4 cluster, see [Installation guide](#).

Follow these steps to deploy OpenShift Data Foundation in external mode:

- [Deploy OpenShift Data Foundation using Red Hat Ceph Storage](#) .
- [Deploy OpenShift Data Foundation using IBM FlashSystem](#) .

Regional-DR requirements [Developer preview]

Disaster Recovery features supported by Red Hat OpenShift Data Foundation require all of the following prerequisites in order to successfully implement a Disaster Recovery solution:

- A valid Red Hat OpenShift Data Foundation Advanced subscription
- A valid Red Hat Advanced Cluster Management for Kubernetes subscription

To know how subscriptions for OpenShift Data Foundation work, see [knowledgebase article on OpenShift Data Foundation subscriptions](#).

For detailed requirements, see [Regional-DR requirements](#) and [RHACM requirements](#).

CHAPTER 2. DEPLOY OPENSHIFT DATA FOUNDATION USING RED HAT CEPH STORAGE

Red Hat OpenShift Data Foundation can make services from an external Red Hat Ceph Storage cluster available for consumption through OpenShift Container Platform clusters. You need to install the OpenShift Data Foundation operator and then create OpenShift Data Foundation cluster for external Ceph storage system.

2.1. INSTALLING RED HAT OPENSHIFT DATA FOUNDATION OPERATOR

You can install Red Hat OpenShift Data Foundation Operator using the Red Hat OpenShift Container Platform Operator Hub.

Prerequisites

- Access to an OpenShift Container Platform cluster using an account with **cluster-admin** and Operator installation permissions.
- For additional resource requirements, see the [Planning your deployment](#) guide.



IMPORTANT

- When you need to override the cluster-wide default node selector for OpenShift Data Foundation, you can use the following command in the command line interface to specify a blank node selector for the **openshift-storage** namespace (create `openshift-storage` namespace in this case):

```
$ oc annotate namespace openshift-storage openshift.io/node-selector=
```

Procedure

1. Log in to the OpenShift Web Console.
2. Click **Operators** → **OperatorHub**.
3. Scroll or type **OpenShift Data Foundation** into the **Filter by keyword** box to find the **OpenShift Data Foundation** Operator.
4. Click **Install**.
5. Set the following options on the **Install Operator** page:
 - a. Update Channel as **stable-4.10**.
 - b. Installation Mode as **A specific namespace on the cluster**
 - c. Installed Namespace as **Operator recommended namespace openshift-storage**. If Namespace **openshift-storage** does not exist, it is created during the operator installation.
 - d. Select Approval Strategy as **Automatic** or **Manual**.
If you select **Automatic** updates, then the Operator Lifecycle Manager (OLM) automatically upgrades the running instance of your Operator without any intervention.

If you select **Manual** updates, then the OLM creates an update request. As a cluster administrator, you must then manually approve that update request to update the Operator to a newer version.

- e. Ensure that the **Enable** option is selected for the **Console plugin**.
- f. Click **Install**.

Verification steps

- Verify that the **OpenShift Data Foundation** Operator shows a green tick indicating successful installation.
- After the operator is successfully installed, a pop-up with a message, **Web console update is available** appears on the user interface. Click **Refresh web console** from this pop-up for the console changes to reflect.
 - In the Web Console, navigate to **Operators** and verify if **OpenShift Data Foundation** is available.

2.2. CREATING AN OPENSIFT DATA FOUNDATION CLUSTER FOR EXTERNAL CEPH STORAGE SYSTEM

You need to create a new OpenShift Data Foundation cluster after you install OpenShift Data Foundation operator on OpenShift Container Platform deployed on VMware vSphere or user-provisioned bare metal infrastructures.

Prerequisites

- Ensure the OpenShift Container Platform version is 4.10 or above before deploying OpenShift Data Foundation 4.10.
- OpenShift Data Foundation operator must be installed. For more information, see [Installing OpenShift Data Foundation Operator using the Operator Hub](#).
- Red Hat Ceph Storage version 4.2z1 or later is required for the external cluster. For more information, see this [knowledge base article on Red Hat Ceph Storage releases and corresponding Ceph package versions](#).

If you have updated the Red Hat Ceph Storage cluster from a version lower than 4.1.1 to the latest release and is not a freshly deployed cluster, you must manually set the application type for CephFS pool on the Red Hat Ceph Storage cluster to enable CephFS PVC creation in external mode.

For more details, see [Troubleshooting CephFS PVC creation in external mode](#).

- Red Hat Ceph Storage must have Ceph Dashboard installed and configured. For more information, see [Ceph Dashboard installation and access](#).
- It is recommended that the external Red Hat Ceph Storage cluster has the PG Autoscaler enabled. For more information, see [The placement group autoscaler](#) section in the Red Hat Ceph Storage documentation.
- The external Ceph cluster should have an existing RBD pool pre-configured for use. If it does not exist, contact your Red Hat Ceph Storage administrator to create one before you move ahead with OpenShift Data Foundation deployment. Red Hat recommends to use a separate pool for each OpenShift Data Foundation cluster.

- Optional: If there is a zonegroup created apart from the default zonegroup, you need to add the hostname, **rook-ceph-rgw-ocs-external-storagecluster-cephobjectstore.openshift-storage.svc** to the zonegroup as OpenShift Data Foundation sends S3 requests to the RADOS Object Gateways (RGWs) with this hostname. For more information, see the Red Hat Knowledgebase solution [Ceph - How to add hostnames in RGW zonegroup?](#) .

Procedure

- Click **Operators → Installed Operators** to view all the installed operators. Ensure that the **Project** selected is **openshift-storage**.
- Click **OpenShift Data Foundation** and then click **Create StorageSystem**.
- In the Backing storage page, select the following options:
 - Select **Full deployment** for the **Deployment type** option.
 - Select **Connect an external storage platform** from the available options.
 - Select **Red Hat Ceph Storage** for **Storage platform**.
 - Click **Next**.
- In the Connection details page, provide the necessary information:
 - Click on the **Download Script** link to download the python script for extracting Ceph cluster details.
 - For extracting the Red Hat Ceph Storage (RHCS) cluster details, contact the RHCS administrator to run the downloaded python script on a Red Hat Ceph Storage node with **admin key**.
 - Run the following command on the RHCS node to view the list of available arguments:

```
# python3 ceph-external-cluster-details-exporter.py --help
```



IMPORTANT

Use **python** instead of **python3** if the Red Hat Ceph Storage 4.x cluster is deployed on Red Hat Enterprise Linux 7.x (RHEL 7.x) cluster.



NOTE

You can also run the script from inside a MON container (containerized deployment) or from a MON node (rpm deployment).

- To retrieve the external cluster details from the RHCS cluster, run the following command:

```
# python3 ceph-external-cluster-details-exporter.py \
--rbd-data-pool-name <rbd block pool name> [optional arguments]
```

For example:

```
# python3 ceph-external-cluster-details-exporter.py --rbd-data-pool-name ceph-rbd --
monitoring-endpoint xxx.xxx.xxx.xxx --monitoring-endpoint-port xxxx --rgw-endpoint
xxx.xxx.xxx.xxx:xxxx --run-as-user client.ocs
```

In this example,

--rbd-data-pool-name

A mandatory parameter that is used for providing block storage in OpenShift Data Foundation.

--rgw-endpoint

An optional parameter, which needs to be provided only if the object storage is to be provisioned through Ceph Rados Gateway for OpenShift Data Foundation. Provide the endpoint in the following format: **<ip_address>:<port>**

--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

This 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

This is an optional parameter used for providing name for the Ceph user which is created by the script. If this parameter is not specified, a default user name **client.healthchecker** is created. The permissions for the new user is set as:

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

Example of JSON output generated using the python script:

```
{
  "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:xxx", "poolPrefix": "default"}}, {"name": "rgw-admin-ops-user", "kind": "Secret", "data": {"accessKey": "<access-key>", "secretKey": "<secret-key>"}}
```

- iii. Save the JSON output to a file with **.json** extension



NOTE

For OpenShift Data Foundation to work seamlessly, ensure that the parameters (RGW endpoint, CephFS details, RBD pool, and so on) to be uploaded using the JSON file remains unchanged on the RHCS external cluster after the storage cluster creation.

- iv. Run the command when there is a multi-tenant deployment in which RHCS cluster is already connected to OpenShift Data Foundation deployment with a lower version.

```
``` # python3 ceph-external-cluster-details-exporter.py --upgrade ```
```

- c. Click **Browse** to select and upload the JSON file.  
The content of the JSON file is populated and displayed in the text box.
  - d. Click **Next**  
The **Next** button is enabled only after you upload the **.json** file.
5. In the Review and create page, review if all the details are correct:
    - To modify any configuration settings, click **Back** to go back to the previous configuration page.
  6. Click **Create StorageSystem**.

### Verification steps

To verify the final Status of the installed storage cluster:

1. In the OpenShift Web Console, navigate to **Installed Operators → OpenShift Data Foundation → Storage System → ocs-external-storagecluster-storage-system → Resources**.
2. Verify that **Status** of **StorageCluster** is **Ready** and has a green tick.
3. To verify that OpenShift Data Foundation, pods and StorageClass are successfully installed, see [Verifying your external mode OpenShift Data Foundation installation for external Ceph storage system](#).

## 2.3. VERIFYING YOUR OPENSIFT DATA FOUNDATION INSTALLATION FOR EXTERNAL CEPH STORAGE SYSTEM

Use this section to verify that OpenShift Data Foundation is deployed correctly.

### 2.3.1. Verifying the state of the pods

1. Click **Workloads** → **Pods** from the left pane of the OpenShift Web Console.
2. Select **openshift-storage** from the **Project** drop-down list.

**NOTE**


If the **Show default projects** option is disabled, use the toggle button to list all the default projects.

For more information on the expected number of pods for each component and how it varies depending on the number of nodes, see [Table 2.1, “Pods corresponding to OpenShift Data Foundation components”](#)

3. Verify that the following pods are in running state:

**Table 2.1. Pods corresponding to OpenShift Data Foundation components**

Component	Corresponding pods
OpenShift Data Foundation Operator	<ul style="list-style-type: none"> <li>● <b>ocs-operator-*</b> (1 pod on any worker node)</li> <li>● <b>ocs-metrics-exporter-*</b> (1 pod on any worker node)</li> <li>● <b>odf-operator-controller-manager-*</b> (1 pod on any worker node)</li> <li>● <b>odf-console-*</b> (1 pod on any worker node)</li> <li>● <b>csi-addons-controller-manager-*</b> (1 pod on any worker node)</li> </ul>
Rook-ceph Operator	<p><b>rook-ceph-operator-*</b></p> <p>(1 pod on any worker node)</p>
Multicloud Object Gateway	<ul style="list-style-type: none"> <li>● <b>noobaa-operator-*</b> (1 pod on any worker node)</li> <li>● <b>noobaa-core-*</b> (1 pod on any worker node)</li> <li>● <b>noobaa-db-pg-*</b> (1 pod on any worker node)</li> <li>● <b>noobaa-endpoint-*</b> (1 pod on any worker node)</li> </ul>

Component	Corresponding pods
CSI	<ul style="list-style-type: none"> <li>● <b>cephfs</b> <ul style="list-style-type: none"> <li>○ <b>csi-cephfsplugin-*</b> (1 pod on each worker node)</li> <li>○ <b>csi-cephfsplugin-provisioner-*</b> (2 pods distributed across worker nodes)</li> </ul> </li> </ul> <div style="display: flex; align-items: center; margin: 10px 0;">  <div> <p><b>NOTE</b></p> <p>If an MDS is not deployed in the external cluster, the csi-cephfsplugin pods will not be created.</p> </div> </div> <ul style="list-style-type: none"> <li>● <b>rbd</b> <ul style="list-style-type: none"> <li>○ <b>csi-rbdplugin-*</b> (1 pod on each worker node)</li> <li>○ <b>csi-rbdplugin-provisioner-*</b> (2 pods distributed across worker nodes)</li> </ul> </li> </ul>

### 2.3.2. Verifying that the OpenShift Data Foundation cluster is healthy

1. In the OpenShift Web Console, click **Storage → Data Foundation**.
2. In the **Status** card of the **Overview** tab, click **Storage System** and then click the storage system link from the pop up that appears.
3. In the **Status** card of the **Block and File** tab, verify that *Storage Cluster* has a green tick.
4. In the **Details** card, verify that the cluster information is displayed.

For more information on the health of OpenShift Data Foundation cluster using the Block and File dashboard, see [Monitoring OpenShift Data Foundation](#).

### 2.3.3. Verifying that the Multicloud Object Gateway is healthy

1. In the OpenShift Web Console, click **Storage → Data Foundation**.
2. In the **Status** card of the **Overview** tab, click **Storage System** and then click the storage system link from the pop up that appears.
  - a. In the **Status** card of the **Object** tab, verify that both *Object Service* and *Data Resiliency* have a green tick.
  - b. In the **Details** card, verify that the Multicloud Object Gateway (MCG) information is displayed.



#### NOTE

The RADOS Object Gateway is only listed in case RADOS Object Gateway endpoint details are included while deploying OpenShift Data Foundation in external mode.



For more information on the health of OpenShift Data Foundation cluster using the object dashboard, see [Monitoring OpenShift Data Foundation](#).

### 2.3.4. Verifying that the storage classes are created and listed

1. Click **Storage** → **Storage Classes** from the left pane of the OpenShift Web Console.
2. Verify that the following storage classes are created with the OpenShift Data Foundation cluster creation:

- **ocs-external-storagecluster-ceph-rbd**
- **ocs-external-storagecluster-ceph-rgw**
- **ocs-external-storagecluster-cephfs**
- **openshift-storage.noobaa.io**



#### NOTE

- If an MDS is not deployed in the external cluster, **ocs-external-storagecluster-cephfs** storage class will not be created.
- If RGW is not deployed in the external cluster, the **ocs-external-storagecluster-ceph-rgw** storage class will not be created.

For more information regarding MDS and RGW, see [Red Hat Ceph Storage documentation](#)

### 2.3.5. Verifying that Ceph cluster is connected

Run the following command to verify if the OpenShift Data Foundation cluster is connected to the external Red Hat Ceph Storage cluster.

```
$ oc get cephcluster -n openshift-storage
NAME DATADIRHOSTPATH MONCOUNT AGE PHASE MESSAGE
HEALTH EXTERNAL
ocs-external-storagecluster-cephcluster 30m Connected Cluster connected
successfully HEALTH_OK true
```

### 2.3.6. Verifying that storage cluster is ready

Run the following command to verify if the storage cluster is ready and the **External** option is set to **true**.

```
$ oc get storagecluster -n openshift-storage
NAME AGE PHASE EXTERNAL CREATED AT VERSION
ocs-external-storagecluster 30m Ready true 2021-11-17T09:09:52Z 4.10.0
```

## CHAPTER 3. DEPLOY OPENSHIFT DATA FOUNDATION USING IBM FLASHSYSTEM

OpenShift Data Foundation can use IBM FlashSystem storage available for consumption through OpenShift Container Platform clusters. You need to install the OpenShift Data Foundation operator and then create an OpenShift Data Foundation cluster for IBM FlashSystem storage.

### 3.1. INSTALLING RED HAT OPENSHIFT DATA FOUNDATION OPERATOR

You can install Red Hat OpenShift Data Foundation Operator using the Red Hat OpenShift Container Platform Operator Hub.

#### Prerequisites

- Access to an OpenShift Container Platform cluster using an account with **cluster-admin** and Operator installation permissions.
- For additional resource requirements, see the [Planning your deployment](#) guide.



#### IMPORTANT

- When you need to override the cluster-wide default node selector for OpenShift Data Foundation, you can use the following command in the command line interface to specify a blank node selector for the **openshift-storage** namespace (create openshift-storage namespace in this case):

```
$ oc annotate namespace openshift-storage openshift.io/node-selector=
```

#### Procedure

1. Log in to the OpenShift Web Console.
2. Click **Operators** → **OperatorHub**.
3. Scroll or type **OpenShift Data Foundation** into the **Filter by keyword** box to find the **OpenShift Data Foundation** Operator.
4. Click **Install**.
5. Set the following options on the **Install Operator** page:
  - a. Update Channel as **stable-4.10**.
  - b. Installation Mode as **A specific namespace on the cluster**
  - c. Installed Namespace as **Operator recommended namespace openshift-storage**. If Namespace **openshift-storage** does not exist, it is created during the operator installation.
  - d. Select Approval Strategy as **Automatic** or **Manual**.  
If you select **Automatic** updates, then the Operator Lifecycle Manager (OLM) automatically upgrades the running instance of your Operator without any intervention.

If you select **Manual** updates, then the OLM creates an update request. As a cluster administrator, you must then manually approve that update request to update the Operator to a newer version.

- e. Ensure that the **Enable** option is selected for the **Console plugin**.
- f. Click **Install**.

### Verification steps

- Verify that the **OpenShift Data Foundation** Operator shows a green tick indicating successful installation.
- After the operator is successfully installed, a pop-up with a message, **Web console update is available** appears on the user interface. Click **Refresh web console** from this pop-up for the console changes to reflect.
  - In the Web Console, navigate to **Operators** and verify if **OpenShift Data Foundation** is available.

## 3.2. CREATING AN OPENSIFT DATA FOUNDATION CLUSTER FOR EXTERNAL IBM FLASHSYSTEM STORAGE

You need to create a new OpenShift Data Foundation cluster after you install the OpenShift Data Foundation operator on the OpenShift Container Platform.

### Prerequisites

- For Red Hat Enterprise Linux® operating system, ensure that there is iSCSI connectivity and then configure Linux multipath devices on the host.
- For Red Hat Enterprise Linux CoreOS or when the packages are already installed, configure Linux multipath devices on the host.
- Ensure to configure each worker with storage connectivity according to your storage system instructions. For the latest supported FlashSystem products and versions, see the Installing section within your Spectrum Virtualize family product documentation in [IBM Documentation](#).

### Procedure

1. In the OpenShift Web Console, click **Operators** → **Installed Operators** to view all the installed operators.  
Ensure that the **Project** selected is **openshift-storage**.
2. Click OpenShift Data Foundation and then click **Create StorageSystem**.
3. In the Backing storage page, select the following options:
  - a. Select **Full deployment** for the **Deployment type** option.
  - b. Select **Connect an external storage platform** from the available options.
  - c. Select **IBM FlashSystem Storage** from the **Storage platform** list.
  - d. Click **Next**.

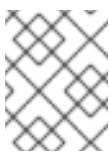
4. In the Create storage class page, provide the following information:
  - a. Enter a name for the storage class.  
When creating block storage persistent volumes, select the storage class `<storage_class_name>` for best performance. The storage class allows direct I/O path to the FlashSystem.
  - b. Enter the following details of IBM FlashSystem connection:
    - IP address
    - User name
    - Password
    - Pool name
  - c. Select **thick** or **thin** for the **Volume mode**.
  - d. Click **Next**.
5. In the Capacity and nodes page, provide the necessary details:
  - a. Select a value for Requested capacity.  
The available options are **0.5 TiB**, **2 TiB**, and **4 TiB**. The requested capacity is dynamically allocated on the infrastructure storage class.
  - b. Select at least three nodes in three different zones.  
It is recommended to start with at least 14 CPUs and 34 GiB of RAM per node. If the nodes selected do not match the OpenShift Data Foundation cluster requirement of an aggregated 30 CPUs and 72 GiB of RAM, a minimal cluster will be deployed. For minimum starting node requirements, see the [Resource requirements](#) section in the Planning guide.
  - c. Click **Next**.
6. Optional: In the Security and network page, provide the necessary details:
  - a. To enable encryption, select **Enable data encryption for block and file storage**
  - b. Choose any one or both Encryption level:
    - **Cluster-wide encryption** to encrypt the entire cluster (block and file).
    - **StorageClass encryption** to create encrypted persistent volume (block only) using encryption enabled storage class.
  - c. Select the **Connect to an external key management service** checkbox. This is optional for cluster-wide encryption.
    - i. Key Management Service Provider is set to Vault by default.
    - ii. Enter Vault Service Name, host Address of Vault server ('https://<hostname or ip>'), Port number, and Token.
  - d. Expand Advanced Settings to enter additional settings and certificate details based on your Vault configuration:

- i. Enter the Key Value secret path in the 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.
- e. Click **Save**.
- f. Select **Default (SDN)** if you are using a single network or **Custom (Multus)** if you are using multiple network interfaces.
- i. Select a Public Network Interface from the dropdown.
  - ii. Select a Cluster Network Interface from the dropdown. NOTE: If you are using only one additional network interface, select the single **NetworkAttachmentDefinition**, that is, **ocs-public-cluster** for the Public Network Interface, and leave the Cluster Network Interface blank.
- g. Click Next.
7. In the Review and create page, review if all the details are correct:
- To modify any configuration settings, click **Back** to go back to the previous configuration page.
8. Click **Create StorageSystem**.

## Verification Steps

### Verifying the state of the pods

1. Click **Workloads** → **Pods** from the left pane of the OpenShift Web Console.
2. Select **openshift-storage** from the **Project** drop-down list.



#### NOTE

If the **Show default projects** option is disabled, use the toggle button to list all the default projects.

**Table 3.1. Pods corresponding to OpenShift Data Foundation components**

Component	Corresponding pods
-----------	--------------------

Component	Corresponding pods
OpenShift Data Foundation Operator	<ul style="list-style-type: none"> <li>● <b>ocs-operator-*</b> (1 pod on any worker node)</li> <li>● <b>ocs-metrics-exporter-*</b> (1 pod on any worker node)</li> <li>● <b>odf-operator-controller-manager-*</b> (1 pod on any worker node)</li> <li>● <b>odf-console-*</b> (1 pod on any worker node)</li> <li>● <b>csi-addons-controller-manager-*</b> (1 pod on any worker node)</li> </ul>
<b>ibm-storage-odf-operator</b>	<ul style="list-style-type: none"> <li>● <b>ibm-storage-odf-operator-*</b> (2 pods on any worker nodes)</li> <li>● <b>ibm-odf-console-*</b></li> </ul>
<b>ibm-flashsystem-storage</b>	<b>ibm-flashsystem-storage-*</b> (1 pod on any worker node)
<b>rook-ceph Operator</b>	<b>rook-ceph-operator-*</b> (1 pod on any worker node)
Multicloud Object Gateway	<ul style="list-style-type: none"> <li>● <b>noobaa-operator-*</b> (1 pod on any worker node)</li> <li>● <b>noobaa-core-*</b> (1 pod on any worker node)</li> <li>● <b>noobaa-db-pg-*</b> (1 pod on any worker node)</li> <li>● <b>noobaa-endpoint-*</b> (1 pod on any worker node)</li> </ul>
CSI	<ul style="list-style-type: none"> <li>● <b>ibm-block-csi-*</b> (1 pod on any worker node)</li> </ul>

### Verifying that the OpenShift Data Foundation cluster is healthy

1. In the Web Console, click **Storage → Data Foundation**.
2. In the Status card of the **Overview** tab, verify that *Storage System* has a green tick mark.
3. In the **Details** card, verify that the cluster information is displayed.

For more information on the health of OpenShift Data Foundation cluster using the Block and File dashboard, see [Monitoring OpenShift Data Foundation](#).

### Verifying that the Multicloud Object Gateway is healthy

1. In the Web Console, click **Storage → Data Foundation**.

2. In the Status card of the **Overview** tab, click **Storage System** and then click the storage system link from the pop up.
3. In the Status card of the **Object** tab, verify that both *Object Service* and *Data Resiliency* have a green tick.
4. In the **Details** card, verify that the MCG information is displayed.

For more information on the health of OpenShift Data Foundation cluster using the object dashboard, see [Monitoring OpenShift Data Foundation](#).

### Verifying that IBM FlashSystem is connected and the storage cluster is ready

- Run the following command to verify if the OpenShift Data Foundation cluster is connected to the external IBM FlashSystem.

```
$ oc get flashsystemclusters.odf.ibm.com
NAME AGE PHASE CREATED AT
ibm-flashsystemcluster 35s 2021-09-23T07:44:52Z
```

### Verifying the StorageSystem of the storage

- Run the following command to verify the storageSystem of IBM FlashSystem storage cluster.

```
$ oc get storagesystems.odf.openshift.io
NAME STORAGE-SYSTEM-KIND STORAGE-SYSTEM-NAME
ibm-flashsystemcluster-storagesystem flashsystemcluster.odf.ibm.com/v1alpha1 ibm-
flashsystemcluster
ocs-storagecluster-storagesystem storagecluster.ocs.openshift.io/v1 ocs-storagecluster
```

### Verifying the subscription of the IBM operator

- Run the following command to verify the subscription:

```
$ oc get subscriptions.operators.coreos.com
NAME PACKAGE SOURCE
CHANNEL
ibm-block-csi-operator-stable-certified-operators-openshift-marketplace ibm-block-csi-operator
certified-operators stable
ibm-storage-odf-operator ibm-storage-odf-operator odf-
catalogsource stable-v1
noobaa-operator-alpha-odf-catalogsource-openshift-storage noobaa-operator
odf-catalogsource alpha
ocs-operator-alpha-odf-catalogsource-openshift-storage ocs-operator odf-
catalogsource alpha
odf-operator odf-operator odf-catalogsource
alpha
```

### Verifying the CSVs

- Run the following command to verify that the CSVs are in the succeeded state.

```
$ oc get csv
NAME DISPLAY VERSION REPLACES
```

## PHASE

```

ibm-block-csi-operator.v1.6.0 Operator for IBM block storage CSI driver 1.6.0 ibm-block-csi-
operator.v1.5.0 Succeeded
ibm-storage-odf-operator.v0.2.1 IBM Storage ODF operator 0.2.1
Installing
noobaa-operator.v5.9.0 NooBaa Operator 5.9.0
Succeeded
ocs-operator.v4.10.0 OpenShift Container Storage 4.10.0
Succeeded
odf-operator.v4.10.0 OpenShift Data Foundation 4.10.0
Succeeded

```

## Verifying the IBM operator and CSI pods

- Run the following command to verify the IBM operator and CSI pods:

```

$ oc get pods
NAME READY STATUS RESTARTS AGE
5cb2b16ec2b11bf63dbe691d44a63535dc026bb5315d5075dc6c398b3c58l94 0/1 Completed
0 10m
7c806f6568f85cf10d72508261a2535c220429b54dbcf87349b9b4b9838fctg 0/1 Completed
0 8m47s
c4b05566c04876677a22d39fc9c02512401d0962109610e85c8fb900d3jd7k2 0/1 Completed
0 10m
c5d1376974666727b02bf25b3a4828241612186744ef417a668b4bc1759rzts 0/1 Completed
0 10m
ibm-block-csi-operator-7b656d6cc8-bqnwp 1/1 Running 0 8m3s
ibm-odf-console-97cb7c84c-r52dq 0/1 ContainerCreating 0 8m4s
ibm-storage-odf-operator-57b8bc47df-mgkc7 1/2 ImagePullBackOff 0 94s
noobaa-operator-7698579d56-x2zqs 1/1 Running 0 9m37s
ocs-metrics-exporter-94b57d764-zq2g2 1/1 Running 0 9m32s
ocs-operator-5d96d778f6-vxlq5 1/1 Running 0 9m33s
odf-catalogsource-j7q72 1/1 Running 0 10m
odf-console-8987868cd-m7v29 1/1 Running 0 9m35s
odf-operator-controller-manager-5dbf785564-rwsgq 2/2 Running 0
9m35s
rook-ceph-operator-68b4b976d8-dlc6w 1/1 Running 0 9m32s

```



## CHAPTER 4. UNINSTALLING OPENSIFT DATA FOUNDATION FROM EXTERNAL STORAGE SYSTEM

Use the steps in this section to uninstall OpenShift Data Foundation. Uninstalling OpenShift Data Foundation does not remove the RBD pool from the external cluster, or uninstall the external Red Hat Ceph Storage cluster.

### Uninstall Annotations

Annotations on the Storage Cluster are used to change the behavior of the uninstall process. To define the uninstall behavior, the following two annotations have been introduced in the storage cluster:

- **uninstall.ocs.openshift.io/cleanup-policy: delete**
- **uninstall.ocs.openshift.io/mode: graceful**



#### NOTE

The **uninstall.ocs.openshift.io/cleanup-policy** is not applicable for external mode.

The below table provides information on the different values that can be used with these annotations:

**Table 4.1. uninstall.ocs.openshift.io uninstall annotations descriptions**

Annotation	Value	Default	Behavior
cleanup-policy	delete	Yes	Rook cleans up the physical drives and the <b>DataDirHostPath</b>
cleanup-policy	retain	No	Rook does <b>not</b> clean up the physical drives and the <b>DataDirHostPath</b>
mode	graceful	Yes	Rook and NooBaa <b>pauses</b> the uninstall process until the PVCs and the OBCs are removed by the administrator/user
mode	forced	No	Rook and NooBaa proceeds with uninstall even if PVCs/OBCs provisioned using Rook and NooBaa exist respectively

You can change the uninstall mode by editing the value of the annotation by using the following commands:

```
$ oc annotate storagecluster ocs-external-storagecluster -n openshift-storage
uninstall.ocs.openshift.io/mode="forced" --overwrite
storagecluster.ocs.openshift.io/ocs-external-storagecluster annotated
```

## Prerequisites

- Ensure that the OpenShift Data Foundation cluster is in a healthy state. The uninstall process can fail when some of the pods are not terminated successfully due to insufficient resources or nodes. In case the cluster is in an unhealthy state, contact Red Hat Customer Support before uninstalling OpenShift Data Foundation.
- Ensure that applications are not consuming persistent volume claims (PVCs) or object bucket claims (OBCs) using the storage classes provided by OpenShift Data Foundation.

## Procedure

1. Delete the volume snapshots that are using OpenShift Data Foundation.

- a. List the volume snapshots from all the namespaces

```
$ oc get volumesnapshot --all-namespaces
```

- b. From the output of the previous command, identify and delete the volume snapshots that are using OpenShift Data Foundation.

```
$ oc delete volumesnapshot <VOLUME-SNAPSHOT-NAME> -n <NAMESPACE>
```

2. Delete PVCs and OBCs that are using OpenShift Data Foundation.

In the default uninstall mode (graceful), the uninstaller waits till all the PVCs and OBCs that use OpenShift Data Foundation are deleted.

If you wish to delete the Storage Cluster without deleting the PVCs beforehand, you may set the uninstall mode annotation to "forced" and skip this step. Doing so will result in orphan PVCs and OBCs in the system.

- a. Delete OpenShift Container Platform monitoring stack PVCs using OpenShift Data Foundation.

See [Removing monitoring stack from OpenShift Data Foundation](#)

- b. Delete OpenShift Container Platform Registry PVCs using OpenShift Data Foundation. [Removing OpenShift Container Platform registry from OpenShift Data Foundation](#)

- c. Delete OpenShift Container Platform logging PVCs using OpenShift Data Foundation. [Removing the cluster logging operator from OpenShift Data Foundation](#)

- d. Delete other PVCs and OBCs provisioned using OpenShift Data Foundation.

- Given below is a sample script to identify the PVCs and OBCs provisioned using OpenShift Data Foundation. The script ignores the PVCs and OBCs that are used internally by OpenShift Data Foundation.

```
#!/bin/bash

RBD_PROVISIONER="openshift-storage.rbd.csi.ceph.com"
CEPHFS_PROVISIONER="openshift-storage.cephfs.csi.ceph.com"
```

```

NOOBAA_PROVISIONER="openshift-storage.noobaa.io/obc"
RGW_PROVISIONER="openshift-storage.ceph.rook.io/bucket"

NOOBAA_DB_PVC="noobaa-db"
NOOBAA_BACKINGSTORE_PVC="noobaa-default-backing-store-noobaa-pvc"

Find all the OCS StorageClasses
OCS_STORAGECLASSES=$(oc get storageclasses | grep -e
"$RBD_PROVISIONER" -e "$CEPHFS_PROVISIONER" -e
"$NOOBAA_PROVISIONER" -e "$RGW_PROVISIONER" | awk '{print $1}')

List PVCs in each of the StorageClasses
for SC in $OCS_STORAGECLASSES
do
 echo
 "=====
=="
 echo "$SC StorageClass PVCs and OBCs"
 echo
 "=====
=="
 oc get pvc --all-namespaces --no-headers 2>/dev/null | grep $SC | grep -v -e
"$NOOBAA_DB_PVC" -e "$NOOBAA_BACKINGSTORE_PVC"
 oc get obc --all-namespaces --no-headers 2>/dev/null | grep $SC
 echo
done

```

- Delete the OBCs.

```
$ oc delete obc <obc name> -n <project name>
```

- Delete the PVCs.

```
$ oc delete pvc <pvc name> -n <project-name>
```

Ensure that you have removed any custom backing stores, bucket classes, and so on that are created in the cluster.

3. Delete the Storage Cluster object and wait for the removal of the associated resources.

```
$ oc delete -n openshift-storage storagesystem --all --wait=true
```

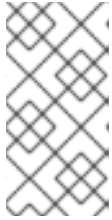
4. Delete the namespace and wait until the deletion is complete. You will need to switch to another project if **openshift-storage** is the active project.

For example:

```
$ oc project default
$ oc delete project openshift-storage --wait=true --timeout=5m
```

The project is deleted if the following command returns a **NotFound** error.

```
$ oc get project openshift-storage
```

**NOTE**

While uninstalling OpenShift Data Foundation, if the namespace is not deleted completely and remains in **Terminating** state, perform the steps in [Troubleshooting and deleting remaining resources during Uninstall](#) to identify objects that are blocking the namespace from being terminated.

- Confirm all PVs provisioned using OpenShift Data Foundation are deleted. If there is any PV left in the **Released** state, delete it.

```
$ oc get pv
$ oc delete pv <pv name>
```

- Remove **CustomResourceDefinitions**.

```
$ oc delete crd backingstores.noobaa.io bucketclasses.noobaa.io
cephblockpools.ceph.rook.io cephclusters.ceph.rook.io cephfilesystems.ceph.rook.io
cephnfses.ceph.rook.io cephobjectstores.ceph.rook.io cephobjectstoreusers.ceph.rook.io
noobaas.noobaa.io ocsinitializations.ocs.openshift.io storageclusters.ocs.openshift.io
cephclients.ceph.rook.io cephobjectrealms.ceph.rook.io cephobjectzonegroups.ceph.rook.io
cephobjectzones.ceph.rook.io cephrbdmirrors.ceph.rook.io storagesystems.odf.openshift.io --
wait=true --timeout=5m
```

- To ensure that OpenShift Data Foundation is uninstalled completely:
  - In the OpenShift Container Platform Web Console, click **Storage**.
  - Verify that **OpenShift Data Foundation** no longer appears under Storage.

## 4.1. REMOVING MONITORING STACK FROM OPENSIFT DATA FOUNDATION

Use this section to clean up the monitoring stack from OpenShift Data Foundation.

The PVCs that are created as a part of configuring the monitoring stack are in the **openshift-monitoring** namespace.

### Prerequisites

- PVCs are configured to use OpenShift Container Platform monitoring stack. For information, see [configuring monitoring stack](#).

### Procedure

- List the pods and PVCs that are currently running in the **openshift-monitoring** namespace.

```
$ oc get pod,pvc -n openshift-monitoring
NAME READY STATUS RESTARTS AGE
pod/alertmanager-main-0 3/3 Running 0 8d
pod/alertmanager-main-1 3/3 Running 0 8d
pod/alertmanager-main-2 3/3 Running 0 8d
pod/cluster-monitoring-
operator-84457656d-pkrxm 1/1 Running 0 8d
pod/grafana-79ccf6689f-2ll28 2/2 Running 0 8d
```

```

pod/kube-state-metrics-
7d86fb966-rvd9w 3/3 Running 0 8d
pod/node-exporter-25894 2/2 Running 0 8d
pod/node-exporter-4dsd7 2/2 Running 0 8d
pod/node-exporter-6p4zc 2/2 Running 0 8d
pod/node-exporter-jbjvg 2/2 Running 0 8d
pod/node-exporter-jj4t5 2/2 Running 0 6d18h
pod/node-exporter-k856s 2/2 Running 0 6d18h
pod/node-exporter-rf8gn 2/2 Running 0 8d
pod/node-exporter-rmb5m 2/2 Running 0 6d18h
pod/node-exporter-zj7kx 2/2 Running 0 8d
pod/openshift-state-metrics-
59dbd4f654-4clng 3/3 Running 0 8d
pod/prometheus-adapter-
5df5865596-k8dzn 1/1 Running 0 7d23h
pod/prometheus-adapter-
5df5865596-n2gj9 1/1 Running 0 7d23h
pod/prometheus-k8s-0 6/6 Running 1 8d
pod/prometheus-k8s-1 6/6 Running 1 8d
pod/prometheus-operator-
55cfb858c9-c4zd9 1/1 Running 0 6d21h
pod/telemeter-client-
78fc8fc97d-2rgfp 3/3 Running 0 8d

```

NAME	CAPACITY	ACCESS MODES	STATUS	VOLUME	STORAGECLASS	AGE
persistentvolumeclaim/my-alertmanager-claim-alertmanager-main-0	40Gi	RWO	Running	pvc-0d519c4f-15a5-11ea-baa0-026d231574aa	ocs-external-storagecluster-ceph-rbd	8d
persistentvolumeclaim/my-alertmanager-claim-alertmanager-main-1	40Gi	RWO	Running	pvc-0d5a9825-15a5-11ea-baa0-026d231574aa	ocs-external-storagecluster-ceph-rbd	8d
persistentvolumeclaim/my-alertmanager-claim-alertmanager-main-2	40Gi	RWO	Running	pvc-0d6413dc-15a5-11ea-baa0-026d231574aa	ocs-external-storagecluster-ceph-rbd	8d
persistentvolumeclaim/my-prometheus-claim-prometheus-k8s-0	40Gi	RWO	Running	pvc-0b7c19b0-15a5-11ea-baa0-026d231574aa	ocs-external-storagecluster-ceph-rbd	8d
persistentvolumeclaim/my-prometheus-claim-prometheus-k8s-1	40Gi	RWO	Running	pvc-0b8aed3f-15a5-11ea-baa0-026d231574aa	ocs-external-storagecluster-ceph-rbd	8d

2. Edit the monitoring **configmap**.

```
$ oc -n openshift-monitoring edit configmap cluster-monitoring-config
```

Remove any **config** sections that reference the OpenShift Data Foundation storage classes as shown in the following example and save it.

Before editing

```
.
. .
apiVersion: v1
data:
 config.yaml: |
 alertmanagerMain:
 volumeClaimTemplate:
 metadata:
 name: my-alertmanager-claim
 spec:
 resources:
 requests:
 storage: 40Gi
 storageClassName: ocs-external-storagecluster-ceph-rbd
 prometheusK8s:
 volumeClaimTemplate:
 metadata:
 name: my-prometheus-claim
 spec:
 resources:
 requests:
 storage: 40Gi
 storageClassName: ocs-external-storagecluster-ceph-rbd
kind: ConfigMap
metadata:
 creationTimestamp: "2019-12-02T07:47:29Z"
 name: cluster-monitoring-config
 namespace: openshift-monitoring
 resourceVersion: "22110"
 selfLink: /api/v1/namespaces/openshift-monitoring/configmaps/cluster-monitoring-config
 uid: fd6d988b-14d7-11ea-84ff-066035b9efa8
.
.
.
```

**After editing**

```

.
.
.
apiVersion: v1
data:
 config.yaml: |
kind: ConfigMap
metadata:
 creationTimestamp: "2019-11-21T13:07:05Z"
 name: cluster-monitoring-config
 namespace: openshift-monitoring
 resourceVersion: "404352"
 selfLink: /api/v1/namespaces/openshift-monitoring/configmaps/cluster-monitoring-config
 uid: d12c796a-0c5f-11ea-9832-063cd735b81c
.
.
.

```

In this example, **alertmanagerMain** and **prometheusK8s** monitoring components are using the OpenShift Data Foundation PVCs.

### 3. List the pods consuming the PVC.

In this example, the **alertmanagerMain** and **prometheusK8s** pods that were consuming the PVCs are in the **Terminating** state. You can delete the PVCs once these pods are no longer using OpenShift Data Foundation PVC.

```

$ oc get pod,pvc -n openshift-monitoring
NAME READY STATUS RESTARTS AGE
pod/alertmanager-main-0 3/3 Terminating 0 10h
pod/alertmanager-main-1 3/3 Terminating 0 10h
pod/alertmanager-main-2 3/3 Terminating 0 10h
pod/cluster-monitoring-operator-84cd9df668-zhjfn 1/1 Running 0 18h
pod/grafana-5db6fd97f8-pmtbf 2/2 Running 0 10h
pod/kube-state-metrics-895899678-z2r9q 3/3 Running 0 10h
pod/node-exporter-4njxv 2/2 Running 0 18h
pod/node-exporter-b8ckz 2/2 Running 0 11h
pod/node-exporter-c2vp5 2/2 Running 0 18h
pod/node-exporter-cq65n 2/2 Running 0 18h
pod/node-exporter-f5sm7 2/2 Running 0 11h
pod/node-exporter-f852c 2/2 Running 0 18h
pod/node-exporter-l9zn7 2/2 Running 0 11h
pod/node-exporter-ngbs8 2/2 Running 0 18h
pod/node-exporter-rv4v9 2/2 Running 0 18h
pod/openshift-state-metrics-77d5f699d8-69q5x 3/3 Running 0 10h
pod/prometheus-adapter-765465b56-4tbxx 1/1 Running 0 10h
pod/prometheus-adapter-765465b56-s2qg2 1/1 Running 0 10h
pod/prometheus-k8s-0 6/6 Terminating 1 9m47s
pod/prometheus-k8s-1 6/6 Terminating 1 9m47s
pod/prometheus-operator-cbfd89f9-ldnwc 1/1 Running 0 43m
pod/telemeter-client-7b5ddb4489-2xfpz 3/3 Running 0 10h

```

```

NAME STATUS VOLUME
CAPACITY ACCESS MODES STORAGECLASS AGE

```

```

persistentvolumeclaim/ocs-alertmanager-claim-alertmanager-main-0 Bound pvc-
2eb79797-1fed-11ea-93e1-0a88476a6a64 40Gi RWO ocs-external-
storagecluster-ceph-rbd 19h
persistentvolumeclaim/ocs-alertmanager-claim-alertmanager-main-1 Bound pvc-
2eb79797-1fed-11ea-93e1-0a88476a6a64 40Gi RWO ocs-external-
storagecluster-ceph-rbd 19h
persistentvolumeclaim/ocs-alertmanager-claim-alertmanager-main-2 Bound pvc-2ec6a9cf-
1fed-11ea-93e1-0a88476a6a64 40Gi RWO ocs-external-storagecluster-ceph-rbd
19h
persistentvolumeclaim/ocs-prometheus-claim-prometheus-k8s-0 Bound pvc-3162a80c-
1fed-11ea-93e1-0a88476a6a64 40Gi RWO ocs-external-storagecluster-ceph-rbd
19h
persistentvolumeclaim/ocs-prometheus-claim-prometheus-k8s-1 Bound pvc-
316e99e2-1fed-11ea-93e1-0a88476a6a64 40Gi RWO ocs-external-
storagecluster-ceph-rbd 19h

```

4. Delete relevant PVCs. Make sure you delete all the PVCs that are consuming the storage classes.

```
$ oc delete -n openshift-monitoring pvc <pvc-name> --wait=true --timeout=5m
```

## 4.2. REMOVING OPENSIFT CONTAINER PLATFORM REGISTRY FROM OPENSIFT DATA FOUNDATION

Use this section to clean up OpenShift Container Platform registry from OpenShift Data Foundation. If you want to configure an alternative storage, see [image registry](#)

The PVCs that are created as a part of configuring OpenShift Container Platform registry are in the **openshift-image-registry** namespace.

### Prerequisites

- The image registry should have been configured to use an OpenShift Data Foundation PVC.

### Procedure

1. Edit the **configs.imageregistry.operator.openshift.io** object and remove the content in the **storage** section.

```
$ oc edit configs.imageregistry.operator.openshift.io
```

Before editing



```

.
.
.
storage:
 pvc:
 claim: registry-cephfs-rwx-pvc
.
.
.

```

**After editing**

```

.
.
.
storage:
 emptyDir: {}
.
.
.

```

In this example, the PVC is called **registry-cephfs-rwx-pvc**, which is now safe to delete.

2. Delete the PVC.

```
$ oc delete pvc <pvc-name> -n openshift-image-registry --wait=true --timeout=5m
```

### 4.3. REMOVING THE CLUSTER LOGGING OPERATOR FROM OPENSIFT DATA FOUNDATION

Use this section to clean up the cluster logging operator from OpenShift Data Foundation.

The Persistent Volume Claims (PVCs) that are created as a part of configuring the cluster logging operator are in the **openshift-logging** namespace.

#### Prerequisites

- The cluster logging instance should have been configured to use the OpenShift Data Foundation PVCs.

#### Procedure

1. Remove the **ClusterLogging** instance in the namespace.

```
$ oc delete clusterlogging instance -n openshift-logging --wait=true --timeout=5m
```

The PVCs in the **openshift-logging** namespace are now safe to delete.

2. Delete the PVCs.

```
$ oc delete pvc <pvc-name> -n openshift-logging --wait=true --timeout=5m
```

**<pvc-name>**

Is the name of the PVC

## 4.4. REMOVING EXTERNAL IBM FLASHSYSTEM SECRET

You need to clean up the FlashSystem secret from OpenShift Data Foundation while uninstalling. This secret is created when you configure the external IBM FlashSystem Storage. See [Creating an OpenShift Data Foundation Cluster for external IBM FlashSystem storage](#).

### Procedure

- Remove the IBM FlashSystem secret by using the following command:

```
$ oc delete secret -n openshift-storage ibm-flashsystem-storage
```