Deploying OpenShift Data Foundation using IBM Z infrastructure

Instructions on deploying Red Hat OpenShift Data Foundation to use local storage on IBM Z infrastructure
Red Hat OpenShift Data Foundation 4.9 Deploying OpenShift Data Foundation using IBM Z infrastructure

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Abstract

Read this document for instructions on installing Red Hat OpenShift Data Foundation 4.9 to use local storage on IBM Z infrastructure. While this document refers only to IBM Z, all information in it also applies to LinuxONE.
# Table of Contents

Making Open Source More Inclusive .................................................. 3
Providing Feedback on Red Hat Documentation .................................. 4
Preface ......................................................................................... 5

## Chapter 1. Preparing to Deploy OpenShift Data Foundation .................. 6
1.1. Requirements for Installing OpenShift Data Foundation Using Local Storage Devices .......................... 6
1.2. Enabling Key Value Backend Path and Policy in Vault .................... 6

## Chapter 2. Deploy OpenShift Data Foundation Using Local Storage Devices ............ 8
2.1. Installing Red Hat OpenShift Data Foundation Operator ................. 8
2.2. Installing Local Storage Operator ............................................. 9
2.3. Finding Available Storage Devices (Optional) .............................. 10
2.4. Creating OpenShift Data Foundation Cluster on IBM Z .................. 11

## Chapter 3. Verifying OpenShift Data Foundation Deployment for Internal-Attached Devices Mode ......................... 15
3.1. Verifying the State of the Pods ................................................. 15
3.2. Verifying the OpenShift Data Foundation Cluster Is Healthy .......... 17
3.3. Verifying the Multicloud Object Gateway Is Healthy .................... 17
3.4. Verifying That the OpenShift Data Foundation Specific Storage Classes Exist .......................... 17

## Chapter 4. Uninstalling OpenShift Data Foundation .......................... 19
4.1. Uninstalling OpenShift Data Foundation in Internal-Attached Devices Mode ............................................... 19
4.1.1. Removing local storage operator configurations .................... 24
4.2. Removing Monitoring Stack From OpenShift Data Foundation ........ 28
4.3. Removing OpenShift Container Platform Registry From OpenShift Data Foundation .................. 31
4.4. Removing the Cluster Logging Operator From OpenShift Data Foundation .................................................. 32
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. As the Component, use **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**.
PREFACE

Red Hat OpenShift Data Foundation 4.9 supports deployment on existing Red Hat OpenShift Container Platform (RHOCP) IBM Z clusters in connected or disconnected environments along with out-of-the-box support for proxy environments.

NOTE

Only internal OpenShift Data Foundation clusters are supported on IBM Z. See Planning your deployment and Preparing to deploy OpenShift Data Foundation for more information about deployment requirements.

To deploy OpenShift Data Foundation, follow the appropriate deployment process for your environment:

- Internal Attached Devices mode
  - Deploy using local storage devices
CHAPTER 1. PREPARING TO DEPLOY OPENSOURCE DATA FOUNDATION

When you deploy OpenShift Data Foundation on OpenShift Container Platform using local storage devices, you can create internal cluster resources. This approach internally provisions base services. Then all applications can access additional storage classes.

Before you begin the deployment of Red Hat OpenShift Data Foundation using local storage, ensure that your resource requirements are met. See requirements for installing OpenShift Data Foundation using local storage devices.

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. See enabling key value backend path and policy in vault.
- Ensure that you are using signed certificates on your Vault servers.

After you have addressed the above, follow these steps in the order given:

1. Install the Red Hat OpenShift Data Foundation Operator.
2. Install Local Storage Operator.
3. Find the available storage devices.
4. Create the OpenShift Data Foundation cluster service on IBM Z.

1.1. REQUIREMENTS FOR INSTALLING OPENSOURCE DATA FOUNDATION USING LOCAL STORAGE DEVICES

Node requirements

The cluster must consist of at least three OpenShift Container Platform worker nodes with locally attached-storage devices on each of them.

- Each of the three selected nodes must have at least one raw block device available to be used by OpenShift Data Foundation.
- The devices you use must be empty; the disks must not include physical volumes (PVs), volume groups (VGs), or logical volumes (LVs) remaining on the disk.

For more information, see the Resource requirements section in the Planning guide.

- For storage nodes, FCP storage devices are required.

1.2. ENABLING KEY VALUE BACKEND PATH AND POLICY IN VAULT

Prerequisites

- Administrator access to Vault.
- Carefully, choose a unique path name as the backend path that follows the naming convention since it cannot be changed later.
Procedure

1. Enable the Key/Value (KV) backend path in Vault.
   For Vault KV secret engine API, version 1:
   
   ```bash
   $ vault secrets enable -path=ocs kv
   ```
   For Vault KV secret engine API, version 2:
   
   ```bash
   $ vault secrets enable -path=ocs kv-v2
   ```

2. Create a policy to restrict users to perform a write or delete operation on the secret using the following commands.

   ```bash
   echo 'path "ocs/*" {
     capabilities = ["create", "read", "update", "delete", "list"]
   }
   path "sys/mounts" {
     capabilities = ["read"]
   }' | vault policy write ocs -

3. Create a token matching the above policy.

   ```bash
   $ vault token create -policy=ocs -format json
   ```
CHAPTER 2. DEPLOY OPENSФFT DATA FOUNDATION USING LOCAL STORAGE DEVICES

Deploying OpenShift Data Foundation on OpenShift Container Platform using local storage devices provides you with the option to create internal cluster resources. Follow this deployment method to use local storage to back persistent volumes for your OpenShift Container Platform applications.

Use this section to deploy OpenShift Data Foundation on IBM Z infrastructure where OpenShift Container Platform is already installed.

2.1. INSTALLING RED HAT OPENSФFT 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.
- You must have at least three worker nodes in the Red Hat OpenShift Container Platform cluster.
- 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=  
  ```

- Taint a node as infra to ensure only Red Hat OpenShift Data Foundation resources are scheduled on that node. This helps you save on subscription costs. For more information, see How to use dedicated worker nodes for Red Hat OpenShift Data Foundation chapter in the Managing and Allocating Storage Resources guide.

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-4.9**.

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**.

![NOTE](image)

We recommend using all default settings. Changing it may result in unexpected behavior. Alter only if you are aware of its result.

**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 **Storage** and verify if **OpenShift Data Foundation** is available.

![IMPORTANT](image)

In case the console plugin option was not automatically enabled after you installed the OpenShift Data Foundation Operator, you need to enable it.

For more information on how to enable the console plugin, see **Enabling the Red Hat OpenShift Data Foundation console plugin**.

**2.2. INSTALLING LOCAL STORAGE OPERATOR**

Install the Local Storage Operator from the Operator Hub before creating Red Hat OpenShift Data Foundation clusters on local storage devices.

**Procedure**

1. Log in to the OpenShift Web Console.

2. Click **Operators → OperatorHub**.
3. Type **local storage** in the Filter by keyword box to find the Local Storage Operator from the list of operators and click on it.

4. Set the following options on the Install Operator page:
   a. Update channel as either **4.9** or **stable**.
   b. Installation mode as **A specific namespace on the cluster**
   c. Installed Namespace as **Operator recommended namespace openshift-local-storage**.
   d. Update approval as **Automatic**.

5. Click **Install**.

**Verification steps**
- Verify that the Local Storage Operator shows a green tick indicating successful installation.

### 2.3. FINDING AVAILABLE STORAGE DEVICES (OPTIONAL)

This step is additional information and can be skipped as the disks are automatically discovered during storage cluster creation. Use this procedure to identify the device names for each of the three or more worker nodes that you have labeled with the OpenShift Data Foundation label `cluster.ocs.openshift.io/openshift-storage=''` before creating Persistent Volumes (PV) for IBM Z.

**Procedure**

1. List and verify the name of the worker nodes with the OpenShift Data Foundation label.
   ```
   $ oc get nodes -l=cluster.ocs.openshift.io/openshift-storage=
   
   Example output:
   
   NAME STATUS ROLES AGE VERSION
   bmworker01 Ready worker 6h45m v1.16.2
   bmworker02 Ready worker 6h45m v1.16.2
   bmworker03 Ready worker 6h45m v1.16.2
   
   Example output:
   
   NAME STATUS ROLES AGE VERSION
   bmworker01 Ready worker 6h45m v1.16.2
   bmworker02 Ready worker 6h45m v1.16.2
   bmworker03 Ready worker 6h45m v1.16.2
   
   Example output:
   
   NAME STATUS ROLES AGE VERSION
   bmworker01 Ready worker 6h45m v1.16.2
   bmworker02 Ready worker 6h45m v1.16.2
   bmworker03 Ready worker 6h45m v1.16.2
   
   Example output:
   
   NAME STATUS ROLES AGE VERSION
   bmworker01 Ready worker 6h45m v1.16.2
   bmworker02 Ready worker 6h45m v1.16.2
   bmworker03 Ready worker 6h45m v1.16.2
   ```

2. Log in to each worker node that is used for OpenShift Data Foundation resources and find the unique **by-id** device name for each available raw block device.
   ```
   $ oc debug node/<node name>
   
   Example output:
   
   $ oc debug node/bmworker01
   Starting pod/bmworker01-debug ...
   To use host binaries, run `chroot /host`
   Pod IP: 10.0.135.71
   If you don't see a command prompt, try pressing enter.
   sh-4.2# chroot /host
   sh-4.4# lsblk
   NAME MAJ:MIN RM SIZE RO TYPE MOUNTPOINT
   ```
In this example, for **bmworker01**, the available local device is **sdb**.

3. Identify the unique ID for each of the devices selected in Step 2.

```
sh-4.4#ls -l /dev/disk/by-id/ | grep sdb
lrwxrwxrwx. 1 root root  9 Feb  3 16:49 scsi-360050763808104bc2800000000000259 ->
                    .../sdb
lrwxrwxrwx. 1 root root  9 Feb  3 16:49 scsi-SIBM_2145_00e020412f0aXX00 -> .../sdb
lrwxrwxrwx. 1 root root  9 Feb  3 16:49 scsi-0x60050763808104bc2800000000000259 ->
                    .../.../sdb
```

In the above example, the ID for the local device **sdb**

```
scsi-0x60050763808104bc2800000000000259
```

4. Repeat the above step to identify the device ID for all the other nodes that have the storage devices to be used by OpenShift Data Foundation. See this Knowledge Base article for more details.

### 2.4. CREATING OPENSOURCE DATA FOUNDATION CLUSTER ON IBM Z

Use this procedure to create an OpenShift Data Foundation cluster on IBM Z.

**Prerequisites**

- Ensure that all the requirements in the Requirements for installing OpenShift Data Foundation using local storage devices section are met.

- You must have three worker nodes with the same storage type and size attached to each node (for example, 200 GB) to use local storage devices on IBM Z or LinuxONE.

**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 on the **OpenShift Data Foundation** operator and then click **Create StorageSystem**.

3. In the Backing storage page, perform the following:
   a. Select the **Create a new StorageClass using the local storage devices** option.
   b. Expand **Advanced** and select **Full Deployment** for the **Deployment type** option.
   c. Click Next.
4. In the `Create local volume set` page, provide the following information:
   a. Enter a name for the `LocalVolumeSet` and the `StorageClass`. By default, the local volume set name appears for the storage class name. You can change the name.
   b. Choose one of the following:
      - **Disks on all nodes**
        Uses the available disks that match the selected filters on all the nodes.
      - **Disks on selected nodes**
        Uses the available disks that match the selected filters only on the selected nodes.
   c. From the available list of `Disk Type`, select `SSD/NVME`.
   d. Expand the `Advanced` section and set the following options:
      - **Volume Mode**
        Block is selected by default.
      - **Device Type**
        Select one or more device type from the dropdown list.
      - **Disk Size**
        Set a minimum size of 100GB for the device and maximum available size of the device that needs to be included.
      - **Maximum Disks Limit**
        This indicates the maximum number of PVs that can be created on a node. If this field is left empty, then PVs are created for all the available disks on the matching nodes.
   e. Click **Next**.
      A pop-up to confirm the creation of LocalVolumeSet is displayed.
f. Click Yes to continue.

5. In the **Capacity and nodes** page, configure the following:

   a. **Available raw capacity** is populated with the capacity value based on all the attached disks associated with the storage class. This takes some time to show up. The **Selected nodes** list shows the nodes based on the storage class.

   b. Click **Next**.

6. Optional: In the **Security and network** page, configure the following based on your requirement:

   a. To enable encryption, select **Enable data encryption for block and file storage**

   b. Choose one or both of the following **Encryption level**:

      - **Cluster-wide encryption**
        Encrypts the entire cluster (block and file).

      - **StorageClass encryption**
        Creates encrypted persistent volume (block only) using encryption enabled storage class.

   c. Select **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**.

      iii. Expand **Advanced Settings** to enter additional settings and certificate details based on your Vault configuration:

         A. Enter the Key Value secret path in **Backend Path** that is dedicated and unique to OpenShift Data Foundation.

         B. Optional: Enter **TLS Server Name** and **Vault Enterprise Namespace**

         C. Upload the respective PEM encoded certificate file to provide **CA Certificate**, **Client Certificate** and **Client Private Key**.

         D. Click **Save**.

   d. Select **Default (SDN)** as Multus is not yet supported on OpenShift Data Foundation on IBM Z infrastructure.

   e. Click **Next**.

7. In the Review and create page:

   a. Review the configuration details. To modify any configuration settings, click **Back** to go back to the previous configuration page.

   b. Click **Create StorageSystem**.

**Verification steps**
To verify the final Status of the installed storage cluster:

a. In the OpenShift Web Console, navigate to Installed Operators → OpenShift Data Foundation → Storage System → ocs-storagecluster-storagesystem → Resources.

b. Verify that Status of StorageCluster is Ready and has a green tick mark next to it.

To verify if flexible scaling is enabled on your storage cluster, perform the following steps:

1. In the OpenShift Web Console, navigate to Installed Operators → OpenShift Data Foundation → Storage System → ocs-storagecluster-storagesystem → Resources → ocs-storagecluster.

2. In the YAML tab, search for the keys flexibleScaling in spec section and failureDomain in status section. If flexible scaling is true and failureDomain is set to host, flexible scaling feature is enabled.

```yaml
spec:
  flexibleScaling: true

[...]
status:
  failureDomain: host
```

To verify that all components for OpenShift Data Foundation are successfully installed, see Verifying your OpenShift Data Foundation deployment.

Additional resources

- To expand the capacity of the initial cluster, see the Scaling Storage guide.
3.1. VERIFYING THE STATE OF THE PODS

Procedure

1. Click Workloads → Pods from 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 about the expected number of pods for each component and how it varies depending on the number of nodes, see Table 3.1, “Pods corresponding to OpenShift Data Foundation cluster”.

3. Click the Running and Completed tabs to verify that the following pods are in Running and Completed state:

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

<table>
<thead>
<tr>
<th>Component</th>
<th>Corresponding pods</th>
</tr>
</thead>
<tbody>
<tr>
<td>OpenShift Data Foundation Operator</td>
<td>- ocs-operator-* (1 pod on any worker node)</td>
</tr>
<tr>
<td></td>
<td>- ocs-metrics-exporter-* (1 pod on any worker node)</td>
</tr>
<tr>
<td></td>
<td>- odf-operator-controller-manager-* (1 pod on any worker node)</td>
</tr>
<tr>
<td></td>
<td>- odf-console-* (1 pod on any worker node)</td>
</tr>
<tr>
<td>Rook–ceph Operator</td>
<td>rook-ceph-operator-*</td>
</tr>
<tr>
<td></td>
<td>(1 pod on any worker node)</td>
</tr>
<tr>
<td>Component</td>
<td>Corresponding pods</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Multicloud Object Gateway</td>
<td>● noobaa-operator-* (1 pod on any worker node)</td>
</tr>
<tr>
<td></td>
<td>● noobaa-core-* (1 pod on any storage node)</td>
</tr>
<tr>
<td></td>
<td>● noobaa-db-pg-* (1 pod on any storage node)</td>
</tr>
<tr>
<td></td>
<td>● noobaa-endpoint-* (1 pod on any storage node)</td>
</tr>
<tr>
<td>MON</td>
<td>rook-ceph-mon-*</td>
</tr>
<tr>
<td></td>
<td>(3 pods distributed across storage nodes)</td>
</tr>
<tr>
<td>MGR</td>
<td>rook-ceph-mgr-*</td>
</tr>
<tr>
<td></td>
<td>(1 pod on any storage node)</td>
</tr>
<tr>
<td>MDS</td>
<td>rook-ceph-mds-ocs-storagecluster-cephfilesystem-*</td>
</tr>
<tr>
<td></td>
<td>(2 pods distributed across storage nodes)</td>
</tr>
<tr>
<td>RGW</td>
<td>rook-ceph-rgw-ocs-storagecluster-cephobjectstore-*</td>
</tr>
<tr>
<td></td>
<td>(1 pod on any storage node)</td>
</tr>
<tr>
<td>CSI</td>
<td>● cephfs</td>
</tr>
<tr>
<td></td>
<td>o csi-cephfsplugin-* (1 pod on each worker node)</td>
</tr>
<tr>
<td></td>
<td>o csi-cephfsplugin-provisioner-* (2 pods distributed across worker nodes)</td>
</tr>
<tr>
<td></td>
<td>● rbd</td>
</tr>
<tr>
<td></td>
<td>o csi-rbdplugin-* (1 pod on each worker node)</td>
</tr>
<tr>
<td></td>
<td>o csi-rbdplugin-provisioner-* (2 pods distributed across worker nodes)</td>
</tr>
<tr>
<td></td>
<td>rook-ceph-crashcollector</td>
</tr>
<tr>
<td></td>
<td>(1 pod on each storage node)</td>
</tr>
</tbody>
</table>
3.2. VERIFYING THE OPENSHIFT DATA FOUNDATION CLUSTER IS HEALTHY

Procedure

1. In the OpenShift Web Console, click Storage → OpenShift Data Foundation.
2. Click the Storage Systems tab and then click on ocs-storagecluster-storagesystem.
3. In the Status card of Block and File dashboard under Overview tab, verify that both Storage Cluster and Data Resiliency has a green tick mark.
4. In the Details card, verify that the cluster information is displayed.

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

3.3. VERIFYING THE MULTICLOUD OBJECT GATEWAY IS HEALTHY

Procedure

1. In the OpenShift Web Console, click Storage → OpenShift 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 MCG information is displayed.

For more information on the health of the OpenShift Data Foundation cluster using the object service dashboard, see Monitoring OpenShift Data Foundation.

3.4. VERIFYING THAT THE OPENSHIFT DATA FOUNDATION SPECIFIC STORAGE CLASSES EXIST

Procedure

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-storagecluster-ceph-rbd
- ocs-storagecluster-cephfs
- openshift-storage.noobaa.io
- ocs-storagecluster-ceph-rgw
CHAPTER 4. UNINSTALLING OPENSHIFT DATA FOUNDATION

4.1. UNINSTALLING OPENSHIFT DATA FOUNDATION IN INTERNAL-ATTACHED DEVICES MODE

Use the steps in this section to uninstall OpenShift Data Foundation.

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

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

<table>
<thead>
<tr>
<th>Annotation</th>
<th>Value</th>
<th>Default</th>
<th>Behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>cleanup-policy</td>
<td>delete</td>
<td>Yes</td>
<td>Rook cleans up the physical drives and the DataDirHostPath</td>
</tr>
<tr>
<td>cleanup-policy</td>
<td>retain</td>
<td>No</td>
<td>Rook does not clean up the physical drives and the DataDirHostPath</td>
</tr>
<tr>
<td>mode</td>
<td>graceful</td>
<td>Yes</td>
<td>Rook and NooBaa pauses the uninstall process until the administrator/user removes the Persistent Volume Claims (PVCs) and Object Bucket Claims (OBCs)</td>
</tr>
<tr>
<td>mode</td>
<td>forced</td>
<td>No</td>
<td>Rook and NooBaa proceeds with uninstall even if the PVCs/OBCs provisioned using Rook and NooBaa exist respectively</td>
</tr>
</tbody>
</table>

Edit the value of the annotation to change the cleanup policy or the uninstall mode.

```bash
$ oc -n openshift-storage annotate storagecluster ocs-storagecluster
uninstall.ocs.openshift.io/cleanup-policy="retain" --overwrite
```
$ oc -n openshift-storage annotate storagecluster ocs-storagecluster uninstall.ocs.openshift.io/mode="forced" --overwrite

Expected output for both commands:

storagecluster.ocs.openshift.io/ocs-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.

- If any custom resources (such as custom storage classes, cephblockpools) were created by the admin, they must be deleted by the admin after removing the resources which consumed them.

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>

   <VOLUME-SNAPSHOT-NAME>
   Is the name of the volume snapshot

   <NAMESPACE>
   Is the project 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 want to delete the Storage Cluster without deleting the PVCs, you can set the uninstall mode annotation to forced and skip this step. Doing so results 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 the 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 that are used internally by OpenShift Data Foundation.

```
#!/bin/bash

RBD_PROVISIONER="openshift-storage.rbd.csi.ceph.com"
CEPHFS_PROVISIONER="openshift-storage.cehfs.csi.ceph.com"
NOOBAAL_PROVISIONER="openshift-storage.noobaa.io/obc"
RGW_PROVISIONER="openshift-storage.ceph.rook.io/bucket"

NOOBAAL_DB_PVC="noobaa-db"
NOOBAAL_BACKINGSTORE_PVC="noobaa-default-backing-store-noobaa-pvc"

# Find all the OCS StorageClasses
OCS_STORAGECLASSES=$(oc get storageclasses | grep -e "$RBD_PROVISIONER" -e "$CEPHFS_PROVISIONER" -e "$NOOBAAL_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 $SC | grep -v -e "$NOOBAAL_DB_PVC" -e "$NOOBAAL_BACKINGSTORE_PVC"
    oc get obc  --all-namespaces --no-headers 2>/dev/null | grep $SC
    echo
done
```

**NOTE**
Omit **RGW_PROVISIONER** for cloud platforms.

- Delete the OBCs.

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

**<obc-name>**
Is the name of the OBC

**<project-name>**
Is the name of the project

- Delete the PVCs.
3. Delete the Storage System object and wait for the removal of the associated resources.

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

4. Check the cleanup pods if the `uninstall.ocs.openshift.io/cleanup-policy` was set to `delete` (default) and ensure that their status is `Completed`.

```bash
$ oc get pods -n openshift-storage | grep -i cleanup
```

Example output:

<table>
<thead>
<tr>
<th>NAME</th>
<th>READY</th>
<th>STATUS</th>
<th>RESTARTS</th>
<th>AGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>cluster-cleanup-job-&lt;xx&gt;</td>
<td>0/1</td>
<td>Completed</td>
<td>0</td>
<td>8m35s</td>
</tr>
<tr>
<td>cluster-cleanup-job-&lt;yy&gt;</td>
<td>0/1</td>
<td>Completed</td>
<td>0</td>
<td>8m35s</td>
</tr>
<tr>
<td>cluster-cleanup-job-&lt;zz&gt;</td>
<td>0/1</td>
<td>Completed</td>
<td>0</td>
<td>8m35s</td>
</tr>
</tbody>
</table>

5. Confirm that the directory `/var/lib/rook` is now empty. This directory is empty only if the `uninstall.ocs.openshift.io/cleanup-policy` annotation was set to `delete` (default).

```bash
$ for i in $(oc get node -l cluster.ocs.openshift.io/openshift-storage= -o jsonpath='{.items[*].metadata.name}'); do oc  debug node/$i -- chroot /host ls -l /var/lib/rook; done
```

6. If encryption was enabled at the time of install, remove `dm-crypt` managed device-mapper mapping from the OSD devices on all the OpenShift Data Foundation nodes.

   a. Create a `debug` pod and `chroot` to the host on the storage node.

   ```bash
   $ oc debug node/<node-name>
   $ chroot /host
   <node-name>
   Is the name of the node
   ```

   b. Get Device names and make note of the OpenShift Data Foundation devices.

   ```bash
   $ dmsetup ls
   ```
Example output:

```
ocs-deviceset-0-data-0-57snx-block-dmcrypt (253:1)
```

c. Remove the mapped device.

```
$ cryptsetup luksClose --debug --verbose ocs-deviceset-0-data-0-57snx-block-dmcrypt
```

**IMPORTANT**

If the above command gets stuck due to insufficient privileges, run the following commands:

- Press **CTRL+Z** to exit the above command.
- Find PID of the process which was stuck.
  
  ```
  $ ps -ef | grep crypt
  ```
- Terminate the process using **kill** command.
  
  ```
  $ kill -9 <PID>
  ```
  
  Where `<PID>` is the process ID
- Verify that the device name is removed.
  
  ```
  $ dmsetup ls
  ```

7. Delete the namespace and wait till the deletion is complete. You 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 **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.
8. Delete local storage operator configurations if you have deployed OpenShift Data Foundation using local storage devices. See Removing local storage operator configurations.

9. Unlabel the storage nodes.

   ```
   $ oc label nodes --all cluster.ocs.openshift.io/openshift-storage-
   $ oc label nodes --all topology.rook.io/rack-
   ```

10. Remove the OpenShift Data Foundation taint if the nodes were tainted.

    ```
    $ oc adm taint nodes --all node.ocs.openshift.io/storage-
    ```

11. Confirm all the Persistent volumes (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>
    
    <pv-name>
    Is the name of the PV
    ```

12. Remove the 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
    ```

13. To ensure that OpenShift Data Foundation is uninstalled completely, on the OpenShift Container Platform Web Console,

    a. Click Storage.

    b. Verify that OpenShift Data Foundation no longer appears under Storage.

4.1.1. Removing local storage operator configurations

Use the instructions in this section only if you have deployed OpenShift Data Foundation using local storage devices.

**NOTE**

For OpenShift Data Foundation deployments only using localvolume resources, go directly to step 8.

**Procedure**
1. Identify the **LocalVolumeSet** and the corresponding **StorageClassName** being used by OpenShift Data Foundation.

```bash
$ oc get localvolumesets.local.storage.openshift.io -n openshift-local-storage
```

2. Set the variable SC to the **StorageClass** providing the **LocalVolumeSet**.

```bash
$ export SC="<StorageClassName>"
```

3. List and note the devices to be cleaned up later. In order to list the device ids of the disks, please follow the procedure mentioned here, See Find the available storage devices.

Example output:

- /dev/disk/by-id/scsi-360050763808104bc28000000000000eb
- /dev/disk/by-id/scsi-360050763808104bc28000000000000ef
- /dev/disk/by-id/scsi-360050763808104bc28000000000000f3

4. Delete the **LocalVolumeSet**.

```bash
$ oc delete localvolumesets.local.storage.openshift.io <name-of-volumeset> -n openshift-local-storage
```

5. Delete the local storage PVs for the given **StorageClassName**.

```bash
$ oc get pv | grep $SC | awk '{print $1}' | xargs oc delete pv
```

6. Delete the **StorageClassName**.

```bash
$ oc delete sc $SC
```

7. Delete the symlinks created by the **LocalVolumeSet**.

```bash
[[ ! -z $SC ]] && for i in $(oc get node -l cluster.ocs.openshift.io/openshift-storage= -o jsonpath='{ .items[*].metadata.name }'); do oc debug node/${i} -- chroot /host rm -rfv /mnt/local-storage/${SC}/; done
```

8. Delete **LocalVolumeDiscovery**.

```bash
$ oc delete localvolumediscovery.local.storage.openshift.io/auto-discover-devices -n openshift-local-storage
```

9. Remove the **LocalVolume** resources (if any).

   Use the following steps to remove the **LocalVolume** resources that were used to provision PVs in the current or previous OpenShift Data Foundation version. Also, ensure that these resources are not being used by other tenants on the cluster.

   For each of the local volumes, do the following:

   a. Identify the **LocalVolume** and the corresponding **StorageClassName** being used by OpenShift Data Foundation.

```bash
$ oc get localvolume.local.storage.openshift.io -n openshift-local-storage
```
b. Set the variable LV to the name of the LocalVolume and variable SC to the name of the StorageClass
   For example:

   ```
   $ LV=local-block
   $ SC=localblock
   ```

c. List and note the devices to be cleaned up later.

   ```
   $ oc get localvolume -n openshift-local-storage $LV -o jsonpath='{.spec.storageClassDevices[0].devicePaths }["n"]'
   ```

   Example output:

   ```
   /dev/sdb
   /dev/sdc
   /dev/sdd
   /dev/sde
   ```

d. Delete the local volume resource.

   ```
   $ oc delete localvolume -n openshift-local-storage --wait=true $LV
   ```

e. Delete the remaining PVs and StorageClasses if they exist.

   ```
   $ oc delete pv -l storage.openshift.com/local-volume-oiderator-name=${LV} --wait --timeout=5m
   $ oc delete storageclass $SC --wait --timeout=5m
   ```

f. Clean up the artifacts from the storage nodes for that resource.

   ```
   $ [[ ! -z $SC ]] && for i in $(oc get node -l cluster.ocs.openshift.io/openshift-storage= -o jsonpath='{ .items[*].metadata.name }'); do oc debug node/${i} -- chroot /host rm -rfv /mnt/local-storage/${SC}/; done
   ```

   Example output:

   ```
   Starting pod/node-xxx-debug ...
   To use host binaries, run `chroot /host`
   removed `/mnt/local-storage/localblock/nvme2n1`
   removed directory `/mnt/local-storage/localblock`

   Removing debug pod ...
   Starting pod/node-yyy-debug ...
   To use host binaries, run `chroot /host`
   removed `/mnt/local-storage/localblock/nvme2n1`
   removed directory `/mnt/local-storage/localblock`

   Removing debug pod ...
   Starting pod/node-zzz-debug ...
   To use host binaries, run `chroot /host`
   removed `/mnt/local-storage/localblock/nvme2n1`
   ```
removed directory '/mnt/local-storage/localblock'

Removing debug pod ...

10. Wipe the disks for each of the local volumesets or local volumes listed in step 1 and 8 respectively so that they can be reused.

   a. List the storage nodes.

      oc get nodes -l cluster.ocs.openshift.io/openshift-storage=

      Example output:

      | NAME     | STATUS | ROLES    | AGE      | VERSION |
      |----------|--------|----------|----------|---------|
      | node-xxx | Ready  | worker   | 4h45m    | v1.18.3+6c42de8 |
      | node-yxx | Ready  | worker   | 4h46m    | v1.18.3+6c42de8 |
      | node-zz  | Ready  | worker   | 4h45m    | v1.18.3+6c42de8 |

   b. Obtain the node console and execute `chroot /host` command when the prompt appears.

      $ oc debug node/node-xxx
      Starting pod/node-xxx-debug ...
      To use host binaries, run `chroot /host`
      Pod IP: w.x.y.z
      If you don’t see a command prompt, try pressing enter.
      sh-4.2# chroot /host

   c. Store the disk paths in the `DISKS` variable within quotes. For the list of disk paths, see step 3 and step 8.c for local volumeset and local volume respectively.

      Example output:

      sh-4.4# DISKS="/dev/disk/by-id/scsi-360050763808104bc28000000000000eb /dev/disk/by-id/scsi-360050763808104bc28000000000000ef /dev/disk/by-id/scsi-360050763808104bc2800000000000f3" 
      or
      sh-4.2# DISKS="/dev/sdb /dev/sdc /dev/sdd /dev/sde".

   d. Run `sgdisk --zap-all` on all the disks.

      sh-4.4# for disk in $DISKS; do sgdisk --zap-all $disk;done

      Example output:

      Creating new GPT entries.
      GPT data structures destroyed! You may now partition the disk using fdisk or other utilities.
      Creating new GPT entries.
      GPT data structures destroyed! You may now partition the disk using fdisk or other utilities.
      Creating new GPT entries.
      GPT data structures destroyed! You may now partition the disk using fdisk or other utilities.
Creating new GPT entries.
GPT data structures destroyed! You may now partition the disk using fdisk or other utilities.

e. Exit the shell and repeat for the other nodes.

```
sh-4.4# exit
exit
sh-4.2# exit
exit
```

Removing debug pod ...

11. Delete the `openshift-local-storage` namespace and wait till the deletion is complete. You will need to switch to another project if the `openshift-local-storage` namespace is the active project.

For example:

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

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

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

## 4.2. REMOVING MONITORING STACK FROM OPENSHIFT DATA FOUNDATION

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

The Persistent Volume Claims (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 more information, see [configuring monitoring stack](#).

**Procedure**

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

```
$ oc get pod,pvc -n openshift-monitoring
```

Example output:

```
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-pkxmr  1/1   Running   0          8d
pod/grafana-79ccf6689f-2li28       2/2   Running   0          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-storagecluster-ceph-rbd
  prometheusK8s:
    volumeClaimTemplate:
      metadata:
        name: my-prometheus-claim
      spec:
        resources:
          requests:
            storage: 40Gi
        storageClassName: ocs-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
In this example, `alertmanagerMain` and `prometheusK8s` monitoring components are using the OpenShift Data Foundation PVCs.

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

   ```bash
   $ oc delete -n openshift-monitoring pvc <pvc-name> --wait=true --timeout=5m
   
   <pvc-name>
   Is the name of the PVC
   ```

### 4.3. REMOVING OPENSHIFT CONTAINER PLATFORM REGISTRY
### FROM OPENSHIFT DATA FOUNDATION

Use this section to clean up the OpenShift Container Platform registry from OpenShift Data Foundation. If you want to configure an alternative storage, see Image registry.

The Persistent Volume Claims (PVCs) that are created as a part of configuring the OpenShift Container Platform registry are in the `openshift-image-registry` namespace.

**Prerequisites**

- The image registry must 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.

   ```bash
   $ oc edit configs.imageregistry.operator.openshift.io
   ```
In this example, the PVC is called `registry-cephfs-rwx-pvc`, which is now safe to delete.

2. Delete the PVC.

   ```bash
   $ oc delete pvc <pvc-name> -n openshift-image-registry --wait=true --timeout=5m
   
   <pvc-name>
   Is the name of the PVC
   ```

### 4.4. Removing the Cluster Logging Operator from OpenShift 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