Red Hat OpenStack Platform 16.1

Deploying an overcloud with containerized Red Hat Ceph

Configuring the director to deploy and use a containerized Red Hat Ceph cluster

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Abstract

This guide provides information about using the Red Hat OpenStack Platform director to create an overcloud with a containerized Red Hat Ceph Storage cluster. This includes instructions for customizing your Ceph cluster through the director.

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CHAPTER 1. INTRODUCTION

Red Hat OpenStack Platform director creates a cloud environment called the overcloud. You can use director to configure extra features for an overcloud, including integration with Red Hat Ceph Storage (both Ceph Storage clusters created with the director or existing Ceph Storage clusters).

This guide includes instructions about how to integrate an existing Ceph Storage cluster with an overcloud. This means that director configures the overcloud to use the Ceph Storage cluster for storage needs. You manage and scale the cluster itself outside of the overcloud configuration.

This guide contains instructions for deploying a containerized Red Hat Ceph Storage cluster with your overcloud. Director uses Ansible playbooks provided through the **ceph-ansible** package to deploy a containerized Ceph cluster. The director also manages the configuration and scaling operations of the cluster.

For more information about containerized services in Red Hat OpenStack Platform (RHOSP), see Configuring a basic overcloud with the CLI tools in the *Director Installation and Usage* guide.

1.1. INTRODUCTION TO CEPH STORAGE

Red Hat Ceph Storage is a distributed data object store designed to provide excellent performance, reliability, and scalability. Distributed object stores are the future of storage, because they accommodate unstructured data, and because clients can use modern object interfaces and legacy interfaces simultaneously. At the core of every Ceph deployment is the Ceph Storage cluster, which consists of several types of daemons, but primarily, these two:

Ceph OSD (Object Storage Daemon)

Ceph OSDs store data on behalf of Ceph clients. Additionally, Ceph OSDs utilize the CPU and memory of Ceph nodes to perform data replication, rebalancing, recovery, monitoring and reporting functions.

Ceph Monitor

A Ceph monitor maintains a master copy of the Ceph storage cluster map with the current state of the storage cluster.

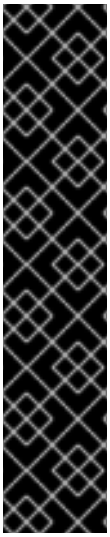
For more information about Red Hat Ceph Storage, see the Red Hat Ceph Storage Architecture Guide .

1.2. REQUIREMENTS

This guide contains information supplementary to the Director Installation and Usage guide.

Before you deploy a containerized Ceph Storage cluster with your overcloud, your environment must contain the following configuration:

- An undercloud host with the Red Hat OpenStack Platform director installed. See Installing director.
- Any additional hardware recommended for Red Hat Ceph Storage. For more information about recommended hardware, see the Red Hat Ceph Storage Hardware Guide .



IMPORTANT

The Ceph Monitor service installs on the overcloud Controller nodes, so you must provide adequate resources to avoid performance issues. Ensure that the Controller nodes in your environment use at least 16 GB of RAM for memory and solid-state drive (SSD) storage for the Ceph monitor data. For a medium to large Ceph installation, provide at least 500 GB of Ceph monitor data. This space is necessary to avoid levelDB growth if the cluster becomes unstable. The following examples are common sizes for Ceph storage clusters:

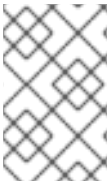
- Small: 250 terabytes
- Medium: 1 petabyte
- Large: 2 petabytes or more.

If you use the Red Hat OpenStack Platform director to create Ceph Storage nodes, note the following requirements.

1.2.1. Ceph Storage node requirements

Ceph Storage nodes are responsible for providing object storage in a Red Hat OpenStack Platform environment.

For information about how to select a processor, memory, network interface cards (NICs), and disk layout for Ceph Storage nodes, see Hardware selection recommendations for Red Hat Ceph Storage in the *Red Hat Ceph Storage Hardware Guide* . Each Ceph Storage node also requires a supported power management interface, such as Intelligent Platform Management Interface (IPMI) functionality on the motherboard of the server.



NOTE

Red Hat OpenStack Platform (RHOSP) director uses **ceph-ansible**, which does not support installing the OSD on the root disk of Ceph Storage nodes. This means that you need at least two disks for a supported Ceph Storage node.

Placement Groups (PGs)

- Ceph Storage uses placement groups (PGs) to facilitate dynamic and efficient object tracking at scale. In the case of OSD failure or cluster rebalancing, Ceph can move or replicate a placement group and its contents, which means a Ceph Storage cluster can rebalance and recover efficiently.
- The default placement group count that director creates is not always optimal, so it is important to calculate the correct placement group count according to your requirements. You can use the placement group calculator to calculate the correct count. To use the PG calculator, enter the predicted storage usage per service as a percentage, as well as other properties about your Ceph cluster, such as the number OSDs. The calculator returns the optimal number of PGs per pool. For more information, see Placement Groups (PGs) per Pool Calculator.
- Auto-scaling is an alternative way to manage placement groups. With the auto-scale feature, you set the expected Ceph Storage requirements per service as a percentage instead of a specific number of placement groups. Ceph automatically scales placement groups based on how the cluster is used. For more information, see Auto-scaling placement groups in the *Red Hat Ceph Storage Strategies Guide*.

Processor

- 64-bit x86 processor with support for the Intel 64 or AMD64 CPU extensions.

Network Interface Cards

- A minimum of one 1 Gbps Network Interface Cards (NICs), although Red Hat recommends that you use at least two NICs in a production environment. Use additional NICs for bonded interfaces or to delegate tagged VLAN traffic. Use a 10 Gbps interface for storage nodes, especially if you want to create a Red Hat OpenStack Platform (RHOSP) environment that serves a high volume of traffic.

Power management

- Each Controller node requires a supported power management interface, such as Intelligent Platform Management Interface (IPMI) functionality on the motherboard of the server.

1.3. ADDITIONAL RESOURCES

The **/usr/share/openstack-tripleo-heat-templates/environments/ceph-ansible/ceph-ansible.yaml** environment file instructs the director to use playbooks derived from the ceph-ansible project. These playbooks are installed in **/usr/share/ceph-ansible/** of the undercloud. In particular, the following file contains all the default settings that the playbooks apply:

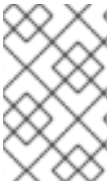
- **/usr/share/ceph-ansible/group_vars/all.yml.sample**

WARNING

While **ceph-ansible** uses playbooks to deploy containerized Ceph Storage, do not edit these files to customize your deployment. Instead, use heat environment files to override the defaults set by these playbooks. If you edit the **ceph-ansible** playbooks directly, your deployment will fail.

For more information about the playbook collection, see the documentation for this project (http://docs.ceph.com/ceph-ansible/master/) to learn more about the playbook collection.

Alternatively, for information about the default settings applied by director for containerized Ceph Storage, see the heat templates in **/usr/share/openstack-tripleo-heat-templates/deployment/ceph-ansible**.



NOTE

Reading these templates requires a deeper understanding of how environment files and heat templates work in director. See Understanding Heat Templates and Environment Files for reference.

Lastly, for more information about containerized services in OpenStack, see Configuring a basic overcloud with the CLI tools in the *Director Installation and Usage* guide.

CHAPTER 2. PREPARING CEPH STORAGE NODES FOR OVERCLOUD DEPLOYMENT

All nodes in this scenario are bare metal systems using IPMI for power management. These nodes do not require an operating system because the director copies a Red Hat Enterprise Linux 8 image to each node. Additionally, the Ceph Storage services on these nodes are containerized. The director communicates to each node through the Provisioning network during the introspection and provisioning processes. All nodes connect to this network through the native VLAN.

2.1. CLEANING CEPH STORAGE NODE DISKS

The Ceph Storage OSDs and journal partitions require GPT disk labels. This means the additional disks on Ceph Storage require conversion to GPT before installing the Ceph OSD services. You must delete all metadata from the disks to allow the director to set GPT labels on them.

You can configure the director to delete all disk metadata by default by adding the following setting to your **/home/stack/undercloud.conf** file:

```
clean_nodes=true
```

With this option, the Bare Metal Provisioning service runs an additional step to boot the nodes and clean the disks each time the node is set to **available**. This process adds an additional power cycle after the first introspection and before each deployment. The Bare Metal Provisioning service uses the **wipefs --force --all** command to perform the clean.

After setting this option, run the **openstack undercloud install** command to execute this configuration change.

WARNING

The **wipefs --force --all** command deletes all data and metadata on the disk, but does not perform a secure erase. A secure erase takes much longer.

2.2. REGISTERING NODES

Import a node inventory file (**instackenv.json**) in JSON format to the director so that the director can communicate with the nodes. This inventory file contains hardware and power management details that the director can use to register nodes:

```
{
    "nodes":[
        {
            "mac":[
                "b1:b1:b1:b1:b1:b1"
            ],
            "cpu":"4",
            "memory":"6144",
            "disk":"40",
            "arch":"x86_64",
```

```
    "pm_type":"ipmi",
    "pm_user":"admin",
    "pm_password":"p@55w0rd!",
    "pm_addr":"192.0.2.205"
  },
  {
    "mac":[
      "b2:b2:b2:b2:b2:b2"
    ],
    "cpu":"4",
    "memory":"6144",
    "disk":"40",
    "arch":"x86_64",
    "pm_type":"ipmi",
    "pm_user":"admin",
    "pm_password":"p@55w0rd!",
    "pm_addr":"192.0.2.206"
  },
  {
    "mac":[
      "b3:b3:b3:b3:b3:b3"
    ],
    "cpu":"4",
    "memory":"6144",
    "disk":"40",
    "arch":"x86_64",
    "pm_type":"ipmi",
    "pm_user":"admin",
    "pm_password":"p@55w0rd!",
    "pm_addr":"192.0.2.207"
  },
  {
    "mac":[
      "c1:c1:c1:c1:c1:c1"
    ],
    "cpu":"4",
    "memory":"6144",
    "disk":"40",
    "arch":"x86_64",
    "pm_type":"ipmi",
    "pm_user":"admin",
    "pm_password":"p@55w0rd!",
    "pm_addr":"192.0.2.208"
  },
  {
    "mac":[
      "c2:c2:c2:c2:c2:c2"
    ],
    "cpu":"4",
    "memory":"6144",
    "disk":"40",
    "arch":"x86_64",
    "pm_type":"ipmi",
    "pm_user":"admin",
    "pm_password":"p@55w0rd!",
    "pm_addr":"192.0.2.209"
```

```
        },
        {
            "mac":[
                "c3:c3:c3:c3:c3:c3"
            ],
            "cpu":"4",
            "memory":"6144",
            "disk":"40",
            "arch":"x86_64",
            "pm_type":"ipmi",
            "pm_user":"admin",
            "pm_password":"p@55w0rd!",
            "pm_addr":"192.0.2.210"
        },
        {
            "mac":[
                "d1:d1:d1:d1:d1:d1"
            ],
            "cpu":"4",
            "memory":"6144",
            "disk":"40",
            "arch":"x86_64",
            "pm_type":"ipmi",
            "pm_user":"admin",
            "pm_password":"p@55w0rd!",
            "pm_addr":"192.0.2.211"
        },
        {
            "mac":[
                "d2:d2:d2:d2:d2:d2"
            ],
            "cpu":"4",
            "memory":"6144",
            "disk":"40",
            "arch":"x86_64",
            "pm_type":"ipmi",
            "pm_user":"admin",
            "pm_password":"p@55w0rd!",
            "pm_addr":"192.0.2.212"
        },
        {
            "mac":[
                "d3:d3:d3:d3:d3:d3"
            ],
            "cpu":"4",
            "memory":"6144",
            "disk":"40",
            "arch":"x86_64",
            "pm_type":"ipmi",
            "pm_user":"admin",
            "pm_password":"p@55w0rd!",
            "pm_addr":"192.0.2.213"
        }
    ]
}
```

Procedure

1. After you create the inventory file, save the file to the home directory of the stack user (**/home/stack/instackenv.json**).
2. Initialize the stack user, then import the **instackenv.json** inventory file into director:

```
$ source ~/stackrc
$ openstack overcloud node import ~/instackenv.json
```

The **openstack overcloud node import** command imports the inventory file and registers each node with the director.

3. Assign the kernel and ramdisk images to each node:

```
$ openstack overcloud node configure <node>
```

Result

The nodes are registered and configured in director.

2.3. PRE-DEPLOYMENT VALIDATIONS FOR CEPH STORAGE

To help avoid overcloud deployment failures, verify that the required packages exist on your servers.

2.3.1. Verifying the ceph-ansible package version

The undercloud contains Ansible-based validations that you can run to identify potential problems before you deploy the overcloud. These validations can help you avoid overcloud deployment failures by identifying common problems before they happen.

Procedure

Verify that the correction version of the **ceph-ansible** package is installed:

```
$ ansible-playbook -i /usr/bin/tripleo-ansible-inventory /usr/share/openstack-tripleo-validations/validations/ceph-ansible-installed.yaml
```

2.3.2. Verifying packages for pre-provisioned nodes

Ceph can only service overcloud nodes that have a certain set of packages. When you use pre-provisioned nodes, you can verify the presence of these packages.

For more information about pre-provisioned nodes, see Configuring a Basic Overcloud using Pre-Provisioned Nodes.

Procedure

Verify that the servers contained the required packages:

```
ansible-playbook -i /usr/bin/tripleo-ansible-inventory /usr/share/openstack-tripleo-validations/validations/ceph-dependencies-installed.yaml
```

2.4. MANUALLY TAGGING NODES INTO PROFILES

After you register each node, you must inspect the hardware and tag the node into a specific profile. Use profile tags to match your nodes to flavors, and then assign flavors to deployment roles.

Procedure

1. Trigger hardware introspection to retrieve the hardware attributes of each node:

```
$ openstack overcloud node introspect --all-manageable --provide
```

   - The **--all-manageable** option introspects only the nodes that are in a managed state. In this example, all nodes are in a managed state.
   - The **--provide** option resets all nodes to an **active** state after introspection.

IMPORTANT

Ensure that this process completes successfully. This process usually takes 15 minutes for bare metal nodes.

2. Retrieve a list of your nodes to identify their UUIDs:

```
$ openstack baremetal node list
```

3. Add a profile option to the **properties**/**capabilities** parameter for each node to manually tag a node to a specific profile. The addition of the **profile** option tags the nodes into each respective profile.

NOTE

As an alternative to manual tagging, use the Automated Health Check (AHC) Tools to automatically tag larger numbers of nodes based on benchmarking data.

For example, a typical deployment contains three profiles: **control**, **compute**, and **ceph-storage**. Run the following commands to tag three nodes for each profile:

```
$ openstack baremetal node set --property capabilities='profile:control,boot_option:local'
1a4e30da-b6dc-499d-ba87-0bd8a3819bc0
$ openstack baremetal node set --property capabilities='profile:control,boot_option:local'
6faba1a9-e2d8-4b7c-95a2-c7fbdc12129a
$ openstack baremetal node set --property capabilities='profile:control,boot_option:local'
6faba1a9-e2d8-4b7c-95a2-c7fbdc12129a
$ openstack baremetal node set --property capabilities='profile:compute,boot_option:local'
484587b2-b3b3-40d5-925b-a26a2fa3036f
$ openstack baremetal node set --property capabilities='profile:compute,boot_option:local'
d010460b-38f2-4800-9cc4-d69f0d067efe
$ openstack baremetal node set --property capabilities='profile:compute,boot_option:local'
d930e613-3e14-44b9-8240-4f3559801ea6
$ openstack baremetal node set --property capabilities='profile:ceph-
storage,boot_option:local' 484587b2-b3b3-40d5-925b-a26a2fa3036f
$ openstack baremetal node set --property capabilities='profile:ceph-
storage,boot_option:local' d010460b-38f2-4800-9cc4-d69f0d067efe
$ openstack baremetal node set --property capabilities='profile:ceph-
storage,boot_option:local' d930e613-3e14-44b9-8240-4f3559801ea6
```

TIP

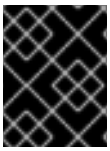
You can also configure a new custom profile that you can use to tag a node for the Ceph MON and Ceph MDS services. See Chapter 3, *Deploying Ceph services on dedicated nodes* for details.

2.5. DEFINING THE ROOT DISK FOR MULTI-DISK CLUSTERS

Director must identify the root disk during provisioning in the case of nodes with multiple disks. For example, most Ceph Storage nodes use multiple disks. By default, director writes the overcloud image to the root disk during the provisioning process

There are several properties that you can define to help director identify the root disk:

- **model** (String): Device identifier.
- **vendor** (String): Device vendor.
- **serial** (String): Disk serial number.
- **hctl** (String): Host:Channel:Target:Lun for SCSI.
- **size** (Integer): Size of the device in GB.
- **wwn** (String): Unique storage identifier.
- **wwn_with_extension** (String): Unique storage identifier with the vendor extension appended.
- **wwn_vendor_extension** (String): Unique vendor storage identifier.
- **rotational** (Boolean): True for a rotational device (HDD), otherwise false (SSD).
- **name** (String): The name of the device, for example: /dev/sdb1.



IMPORTANT

Use the **name** property only for devices with persistent names. Do not use **name** to set the root disk for any other devices because this value can change when the node boots.

Complete the following steps to specify the root device using its serial number.

Procedure

1. Check the disk information from the hardware introspection of each node. Run the following command to display the disk information of a node:

```
(undercloud) $ openstack baremetal introspection data save 1a4e30da-b6dc-499d-ba87-0bd8a3819bc0 | jq ".inventory.disks"
```

For example, the data for one node might show three disks:

```
[
  {
    "size": 299439751168,
    "rotational": true,
    "vendor": "DELL",
```

```
  "name": "/dev/sda",
  "wwn_vendor_extension": "0x1ea4dcc412a9632b",
  "wwn_with_extension": "0x61866da04f3807001ea4dcc412a9632b",
  "model": "PERC H330 Mini",
  "wwn": "0x61866da04f380700",
  "serial": "61866da04f3807001ea4dcc412a9632b"
 }
 {
  "size": 299439751168,
  "rotational": true,
  "vendor": "DELL",
  "name": "/dev/sdb",
  "wwn_vendor_extension": "0x1ea4e13c12e36ad6",
  "wwn_with_extension": "0x61866da04f380d001ea4e13c12e36ad6",
  "model": "PERC H330 Mini",
  "wwn": "0x61866da04f380d00",
  "serial": "61866da04f380d001ea4e13c12e36ad6"
 }
 {
  "size": 299439751168,
  "rotational": true,
  "vendor": "DELL",
  "name": "/dev/sdc",
  "wwn_vendor_extension": "0x1ea4e31e121cfb45",
  "wwn_with_extension": "0x61866da04f37fc001ea4e31e121cfb45",
  "model": "PERC H330 Mini",
  "wwn": "0x61866da04f37fc00",
  "serial": "61866da04f37fc001ea4e31e121cfb45"
 }
]
```

2. Enter **openstack baremetal node set --property root_device=** to set the root disk for a node. Include the most appropriate hardware attribute value to define the root disk.

```
(undercloud) $ openstack baremetal node set --property
root_device='{"serial":"<serial_number>"}' <node-uuid>
```

For example, to set the root device to disk 2, which has the serial number **61866da04f380d001ea4e13c12e36ad6**, enter the following command:

```
(undercloud) $ openstack baremetal node set --property root_device='{"serial":
"61866da04f380d001ea4e13c12e36ad6"}' 1a4e30da-b6dc-499d-ba87-0bd8a3819bc0
```

NOTE

Ensure that you configure the BIOS of each node to include booting from the root disk that you choose. Configure the boot order to boot from the network first, then to boot from the root disk.

Director identifies the specific disk to use as the root disk. When you run the **openstack overcloud deploy** command, director provisions and writes the overcloud image to the root disk.

2.6. USING THE OVERCLOUD-MINIMAL IMAGE TO AVOID USING A RED HAT SUBSCRIPTION ENTITLEMENT

By default, director writes the QCOW2 **overcloud-full** image to the root disk during the provisioning process. The **overcloud-full** image uses a valid Red Hat subscription. However, you can also use the **overcloud-minimal** image, for example, to provision a bare OS where you do not want to run any other OpenStack services and consume your subscription entitlements.

A common use case for this occurs when you want to provision nodes with only Ceph daemons. For this and similar use cases, you can use the **overcloud-minimal** image option to avoid reaching the limit of your paid Red Hat subscriptions. For information about how to obtain the **overcloud-minimal** image, see Obtaining images for overcloud nodes .

NOTE

A Red Hat OpenStack Platform subscription contains Open vSwitch (OVS), but core services, such as OVS, are not available when you use the **overcloud-minimal** image. OVS is not required to deploy Ceph Storage nodes. Instead of using 'ovs_bond' to define bonds, use 'linux_bond'. For more information about **linux_bond**, see Linux bonding options.

Procedure

1. To configure director to use the **overcloud-minimal** image, create an environment file that contains the following image definition:

```
parameter_defaults:
  <roleName>Image: overcloud-minimal
```

2. Replace **<roleName>** with the name of the role and append **Image** to the name of the role. The following example shows an **overcloud-minimal** image for Ceph storage nodes:

```
parameter_defaults:
  CephStorageImage: overcloud-minimal
```

3. Pass the environment file to the **openstack overcloud deploy** command.

NOTE

The **overcloud-minimal** image supports only standard Linux bridges and not OVS because OVS is an OpenStack service that requires a Red Hat OpenStack Platform subscription entitlement.

CHAPTER 3. DEPLOYING CEPH SERVICES ON DEDICATED NODES

By default, the director deploys the Ceph MON and Ceph MDS services on the Controller nodes. This is suitable for small deployments. However, with larger deployments Red Hat recommends that you deploy the Ceph MON and Ceph MDS services on dedicated nodes to improve the performance of your Ceph cluster. Create a custom role for services that you want to isolate on dedicated nodes.

NOTE

For more information about custom roles, see Creating a New Role in the Advanced Overcloud Customization guide.

The director uses the following file as a default reference for all overcloud roles:

- **/usr/share/openstack-tripleo-heat-templates/roles_data.yaml**

3.1. CREATING A CUSTOM ROLES FILE

To create a custom role file, complete the following steps:

Procedure

1. Make a copy of the **roles_data.yaml** file in **/home/stack/templates/** so that you can add custom roles:

```
$ cp /usr/share/openstack-tripleo-heat-templates/roles_data.yaml
/home/stack/templates/roles_data_custom.yaml
```

2. Include the new custom role file in the **openstack overcloud deploy** command.

3.2. CREATING A CUSTOM ROLE AND FLAVOR FOR THE CEPH MON SERVICE

Complete the following steps to create a custom role **CephMon** and flavor **ceph-mon** for the Ceph MON role. You must already have a copy of the default roles data file as described in Chapter 3, *Deploying Ceph services on dedicated nodes*.

Procedure

1. Open the **/home/stack/templates/roles_data_custom.yaml** file.
2. Remove the service entry for the Ceph MON service, **OS::TripleO::Services::CephMon**, from the Controller role.
3. Add the **OS::TripleO::Services::CephClient** service to the Controller role:

```
[...]
- name: Controller # the 'primary' role goes first
  CountDefault: 1
  ServicesDefault:
    - OS::TripleO::Services::CACerts
```

```
    - OS::TripleO::Services::CephMds
    - OS::TripleO::Services::CephClient
    - OS::TripleO::Services::CephExternal
    - OS::TripleO::Services::CephRbdMirror
    - OS::TripleO::Services::CephRgw
    - OS::TripleO::Services::CinderApi
[...]
```

4. At the end of the **roles_data_custom.yaml** file, add a custom **CephMon** role that contains the Ceph MON service and all the other required node services:

```
- name: CephMon
  ServicesDefault:
    # Common Services
    - OS::TripleO::Services::AuditD
    - OS::TripleO::Services::CACerts
    - OS::TripleO::Services::CertmongerUser
    - OS::TripleO::Services::Collectd
    - OS::TripleO::Services::Docker
    - OS::TripleO::Services::FluentdClient
    - OS::TripleO::Services::Kernel
    - OS::TripleO::Services::Ntp
    - OS::TripleO::Services::ContainersLogrotateCrond
    - OS::TripleO::Services::SensuClient
    - OS::TripleO::Services::Snmp
    - OS::TripleO::Services::Timezone
    - OS::TripleO::Services::TripleoFirewall
    - OS::TripleO::Services::TripleoPackages
    - OS::TripleO::Services::Tuned
    # Role-Specific Services
    - OS::TripleO::Services::CephMon
```

5. Enter the **openstack flavor create** command to define a new flavor named **ceph-mon** for the **CephMon** role:

```
$ openstack flavor create --id auto --ram 6144 --disk 40 --vcpus 4 ceph-mon
```

NOTE

For more information about this command, enter: **openstack flavor create --help**.

6. Map this flavor to a new profile, also named **ceph-mon**:

```
$ openstack flavor set --property "cpu_arch"="x86_64" --property
"capabilities:boot_option"="local" --property "capabilities:profile"="ceph-mon" ceph-mon
```

NOTE

For more information about this command, enter **openstack flavor set --help**.

7. Tag nodes into the new **ceph-mon** profile:

```
$ openstack baremetal node set --property capabilities='profile:ceph-mon,boot_option:local'
UUID
```

8. Add the following configuration to the **node-info.yaml** file to associate the **ceph-mon** flavor with the CephMon role:

```
parameter_defaults:
  OvercloudCephMonFlavor: CephMon
  CephMonCount: 3
```

For more information about tagging nodes, see Section 2.4, “Manually tagging nodes into profiles” . For more information about custom role profiles, see Tagging Nodes Into Profiles.

3.3. CREATING A CUSTOM ROLE AND FLAVOR FOR THE CEPH MDS SERVICE

Complete the following steps to create a custom role **CephMDS** and flavor **ceph-mds** for the Ceph MDS role. You must already have a copy of the default roles data file as described in Chapter 3, *Deploying Ceph services on dedicated nodes* .

Procedure

1. Open the **/home/stack/templates/roles_data_custom.yaml** file.

2. Remove the service entry for the Ceph MDS service, **OS::TripleO::Services::CephMds**, from the Controller role:

```
[...]
- name: Controller # the 'primary' role goes first
  CountDefault: 1
  ServicesDefault:
    - OS::TripleO::Services::CACerts
    # - OS::TripleO::Services::CephMds (1)
    - OS::TripleO::Services::CephMon
    - OS::TripleO::Services::CephExternal
    - OS::TripleO::Services::CephRbdMirror
    - OS::TripleO::Services::CephRgw
    - OS::TripleO::Services::CinderApi
[...]
```

(1) Comment out this line. In the next step, you add this service to the new custom role.

3. At the end of the **roles_data_custom.yaml** file, add a custom **CephMDS** role that contains the Ceph MDS service and all the other required node services:

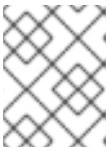
```
- name: CephMDS
  ServicesDefault:
    # Common Services
    - OS::TripleO::Services::AuditD
    - OS::TripleO::Services::CACerts
    - OS::TripleO::Services::CertmongerUser
    - OS::TripleO::Services::Collectd
    - OS::TripleO::Services::Docker
```

```
    - OS::TripleO::Services::FluentdClient
    - OS::TripleO::Services::Kernel
    - OS::TripleO::Services::Ntp
    - OS::TripleO::Services::ContainersLogrotateCrond
    - OS::TripleO::Services::SensuClient
    - OS::TripleO::Services::Snmp
    - OS::TripleO::Services::Timezone
    - OS::TripleO::Services::TripleoFirewall
    - OS::TripleO::Services::TripleoPackages
    - OS::TripleO::Services::Tuned
    # Role-Specific Services
    - OS::TripleO::Services::CephMds
    - OS::TripleO::Services::CephClient 1
```

1 The Ceph MDS service requires the admin keyring, which you can set with either the Ceph MON or Ceph Client service. If you deploy Ceph MDS on a dedicated node without the Ceph MON service, you must also include the Ceph Client service in the new **CephMDS** role.

4. Enter the **openstack flavor create** command to define a new flavor named **ceph-mds** for this role:

```
$ openstack flavor create --id auto --ram 6144 --disk 40 --vcpus 4 ceph-mds
```



NOTE

For more information about this command, enter **openstack flavor create --help**.

5. Map the new **ceph-mds** flavor to a new profile, also named **ceph-mds**:

```
$ openstack flavor set --property "cpu_arch"="x86_64" --property
"capabilities:boot_option"="local" --property "capabilities:profile"="ceph-mds" ceph-mds
```

NOTE

For more information about this command, enter **openstack flavor set --help**.

6. Tag nodes into the new **ceph-mds** profile:

```
$ openstack baremetal node set --property capabilities='profile:ceph-mds,boot_option:local'
UUID
```

For more information about tagging nodes, see Section 2.4, “Manually tagging nodes into profiles” . For more information about custom role profiles, see Tagging Nodes Into Profiles.

CHAPTER 4. CUSTOMIZING THE STORAGE SERVICE

The heat template collection provided by the director already contains the necessary templates and environment files to enable a basic Ceph Storage configuration.

The director uses the **/usr/share/openstack-tripleo-heat-templates/environments/ceph-ansible/ceph-ansible.yaml** environment file to create a Ceph cluster and integrate it with your overcloud during deployment. This cluster features containerized Ceph Storage nodes. For more information about containerized services in OpenStack, see Configuring a basic overcloud with the CLI tools in the *Director Installation and Usage* guide.

The Red Hat OpenStack director also applies basic, default settings to the deployed Ceph cluster. You must also define any additional configuration in a custom environment file:

Procedure

1. Create the file **storage-config.yaml** in **/home/stack/templates/**. In this example, the **~/templates/storage-config.yaml** file contains most of the overcloud-related custom settings for your environment. Parameters that you include in the custom environment file override the corresponding default settings from the **/usr/share/openstack-tripleo-heat-templates/environments/ceph-ansible/ceph-ansible.yaml** file.

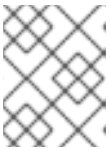
2. Add a **parameter_defaults** section to **~/templates/storage-config.yaml**. This section contains custom settings for your overcloud. For example, to set **vxlan** as the network type of the networking service (**neutron**), add the following snippet to your custom environment file:

```
parameter_defaults:
  NeutronNetworkType: vxlan
```

3. If necessary, set the following options under **parameter_defaults** according to your requirements:

Option	Description	Default value
CinderEnableIscsiBackend	Enables the iSCSI backend	false
CinderEnableRbdBackend	Enables the Ceph Storage back end	true
CinderBackupBackend	Sets ceph or swift as the back end for volume backups. For more information, see Section 4.4, “Configuring the Backup Service to use Ceph”.	ceph
NovaEnableRbdBackend	Enables Ceph Storage for Nova ephemeral storage	true
GlanceBackend	Defines which back end the Image service should use: **rbd** (Ceph), **swift**, or **file**	rbd

Option	Description	Default value
GnocchiBackend	Defines which back end the Telemetry service should use: **rbd** (Ceph), **swift**, or **file**	rbd



NOTE

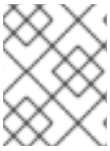
You can omit an option from **~/templates/storage-config.yaml** if you intend to use the default setting.

The contents of your custom environment file change depending on the settings that you apply in the following sections. See Appendix A, *Sample environment file: creating a Ceph Storage cluster* for a completed example.

The following subsections contain information about overriding the common default storage service settings that the director applies.

4.1. ENABLING THE CEPH METADATA SERVER

The Ceph Metadata Server (MDS) runs the **ceph-mds** daemon, which manages metadata related to files stored on CephFS. CephFS can be consumed through NFS. For more information about using CephFS through NFS, see File System Guide and CephFS via NFS Back End Guide for the Shared File Systems service.



NOTE

Red Hat supports deploying Ceph MDS only with the CephFS through NFS back end for the Shared File Systems service.

Procedure

To enable the Ceph Metadata Server, invoke the following environment file when you create your overcloud:

- **/usr/share/openstack-tripleo-heat-templates/environments/ceph-ansible/ceph-mds.yaml**

For more information, see Section 7.2, "Initiating overcloud deployment". For more information about the Ceph Metadata Server, see Configuring Metadata Server Daemons.

NOTE

By default, the Ceph Metadata Server will be deployed on the Controller node. You can deploy the Ceph Metadata Server on its own dedicated node. For more information, see Section 3.3, "Creating a custom role and flavor for the Ceph MDS service".

4.2. ENABLING THE CEPH OBJECT GATEWAY

The Ceph Object Gateway (RGW) provides applications with an interface to object storage capabilities

within a Ceph Storage cluster. When you deploy RGW, you can replace the default Object Storage service (**swift**) with Ceph. For more information, see Object Gateway Configuration and Administration Guide.

Procedure

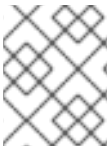
To enable RGW in your deployment, invoke the following environment file when you create the overcloud:

- **/usr/share/openstack-tripleo-heat-templates/environments/ceph-ansible/ceph-rgw.yaml**

For more information, see Section 7.2, "Initiating overcloud deployment" .

By default, Ceph Storage allows 250 placement groups per OSD. When you enable RGW, Ceph Storage creates six additional pools that are required by RGW. The new pools are:

- .rgw.root
- default.rgw.control
- default.rgw.meta
- default.rgw.log
- default.rgw.buckets.index
- default.rgw.buckets.data



NOTE

In your deployment, **default** is replaced with the name of the zone to which the pools belongs.

Therefore, when you enable RGW, be sure to set the default **pg_num** using the **CephPoolDefaultPgNum** parameter to account for the new pools. For more information about how to calculate the number of placement groups for Ceph pools, see Section 5.4, "Assigning custom attributes to different Ceph pools".

The Ceph Object Gateway is a direct replacement for the default Object Storage service. As such, all other services that normally use **swift** can seamlessly start using the Ceph Object Gateway instead without further configuration. For more information, see the Block Storage Backup Guide .

4.3. CONFIGURING CEPH OBJECT STORE TO USE EXTERNAL CEPH OBJECT GATEWAY

Red Hat OpenStack Platform (RHOSP) director supports configuring an external Ceph Object Gateway (RGW) as an Object Store service. To authenticate with the external RGW service, you must configure RGW to verify users and their roles in the Identity service (keystone).

For more information about how to configure an external Ceph Object Gateway, see Configuring the Ceph Object Gateway to use Keystone authentication in the *Using Keystone with the Ceph Object Gateway Guide*.

Procedure

1. Add the following **parameter_defaults** to a custom environment file, for example, **swift-external-params.yaml**, and adjust the values to suit your deployment:

```
parameter_defaults:
  ExternalSwiftPublicUrl: 'http://<Public RGW endpoint or
loadbalancer>:8080/swift/v1/AUTH_%(project_id)s'
  ExternalSwiftInternalUrl: 'http://<Internal RGW endpoint>:8080/swift/v1/AUTH_%
(project_id)s'
  ExternalSwiftAdminUrl: 'http://<Admin RGW endpoint>:8080/swift/v1/AUTH_%(project_id)s'
  ExternalSwiftUserTenant: 'service'
  SwiftPassword: 'choose_a_random_password'
```

NOTE

The example code snippet contains parameter values that might differ from values that you use in your environment:

- The default port where the remote RGW instance listens is **8080**. The port might be different depending on how the external RGW is configured.
- The **swift** user created in the overcloud uses the password defined by the **SwiftPassword** parameter. You must configure the external RGW instance to use the same password to authenticate with the Identity service by using the **rgw_keystone_admin_password**.

2. Add the following code to the Ceph config file to configure RGW to use the Identity service. Adjust the variable values to suit your environment.

```
rgw_keystone_api_version: 3
rgw_keystone_url: http://<public Keystone endpoint>:5000/
rgw_keystone_accepted_roles: 'member, Member, admin'
rgw_keystone_accepted_admin_roles: ResellerAdmin, swiftoperator
rgw_keystone_admin_domain: default
rgw_keystone_admin_project: service
rgw_keystone_admin_user: swift
rgw_keystone_admin_password: <Password as defined in the environment parameters>
rgw_keystone_implicit_tenants: 'true'
rgw_keystone_revocation_interval: '0'
rgw_s3_auth_use_keystone: 'true'
rgw_swift_versioning_enabled: 'true'
rgw_swift_account_in_url: 'true'
```

NOTE

Director creates the following roles and users in the Identity service by default:

- rgw_keystone_accepted_admin_roles: ResellerAdmin, swiftoperator
- rgw_keystone_admin_domain: default
- rgw_keystone_admin_project: service
- rgw_keystone_admin_user: swift

3. Deploy the overcloud with the additional environment files:

```
openstack overcloud deploy --templates \
-e <your environment files>
-e /usr/share/openstack-tripleo-heat-templates/environments/swift-external.yaml
-e swift-external-params.yaml
```

4.4. CONFIGURING THE BACKUP SERVICE TO USE CEPH

The Block Storage Backup service (**cinder-backup**) is disabled by default. To enable the Block Storage Backup service, complete the following steps:

Procedure

Invoke the following environment file when you create your overcloud:

- **/usr/share/openstack-tripleo-heat-templates/environments/cinder-backup.yaml**

4.5. CONFIGURING MULTIPLE BONDED INTERFACES FOR CEPH NODES

Use a bonded interface to combine multiple NICs and add redundancy to a network connection. If you have enough NICs on your Ceph nodes, you can create multiple bonded interfaces on each node to expand redundancy capability.

You can then use a bonded interface for each network connection that the node requires. This provides both redundancy and a dedicated connection for each network.

The simplest implementation of bonded interfaces involves the use of two bonds, one for each storage network used by the Ceph nodes. These networks are the following:

Front-end storage network (StorageNet)

The Ceph client uses this network to interact with the corresponding Ceph cluster.

Back-end storage network (StorageMgmtNet)

The Ceph cluster uses this network to balance data in accordance with the placement group policy of the cluster. For more information, see Placement Groups (PG) in the in the *Red Hat Ceph Architecture Guide*.

To configure multiple bonded interfaces, you must create a new network interface template, as the director does not provide any sample templates that you can use to deploy multiple bonded NICs. However, the director does provide a template that deploys a single bonded interface. This template is **/usr/share/openstack-tripleo-heat-templates/network/config/bond-with-vlans/ceph-storage.yaml**. You can define an additional bonded interface for your additional NICs in this template.

NOTE

For more information about creating custom interface templates, Creating Custom Interface Templates in the *Advanced Overcloud Customization* guide.

The following snippet contains the default definition for the single bonded interface defined in the **/usr/share/openstack-tripleo-heat-templates/network/config/bond-with-vlans/ceph-storage.yaml** file:

```
type: ovs_bridge // 1
name: br-bond
members:
 -
   type: ovs_bond // 2
   name: bond1 // 3
   ovs_options: {get_param: BondInterfaceOvsOptions} 4
   members: // 5
     -
       type: interface
       name: nic2
       primary: true
     -
       type: interface
       name: nic3
 -
   type: vlan // 6
   device: bond1 // 7
   vlan_id: {get_param: StorageNetworkVlanID}
   addresses:
     -
       ip_netmask: {get_param: StorageIpSubnet}
 -
   type: vlan
   device: bond1
   vlan_id: {get_param: StorageMgmtNetworkVlanID}
   addresses:
     -
       ip_netmask: {get_param: StorageMgmtIpSubnet}
```

1. A single bridge named **br-bond** holds the bond defined in this template. This line defines the bridge type, namely OVS.

2. The first member of the **br-bond** bridge is the bonded interface itself, named **bond1**. This line defines the bond type of **bond1**, which is also OVS.

3. The default bond is named **bond1**.

4. The **ovs_options** entry instructs director to use a specific set of bonding module directives. Those directives are passed through the **BondInterfaceOvsOptions**, which you can also configure in this file. For more information about configuring bonding module directives, see Section 4.5.1, "Configuring bonding module directives".

5. The **members** section of the bond defines which network interfaces are bonded by **bond1**. In this example, the bonded interface uses **nic2** (set as the primary interface) and **nic3**.

6. The **br-bond** bridge has two other members: a VLAN for both front-end (**StorageNetwork**) and back-end (**StorageMgmtNetwork**) storage networks.

7. The **device** parameter defines which device a VLAN should use. In this example, both VLANs use the bonded interface, **bond1**.

With at least two more NICs, you can define an additional bridge and bonded interface. Then, you can move one of the VLANs to the new bonded interface, which increases throughput and reliability for both storage network connections.

When you customize the **/usr/share/openstack-tripleo-heat-templates/network/config/bond-with-vlans/ceph-storage.yaml** file for this purpose, Red Hat recommends that you use Linux bonds (**type: linux_bond**) instead of the default OVS (**type: ovs_bond**). This bond type is more suitable for enterprise production deployments.

The following edited snippet defines an additional OVS bridge (**br-bond2**) which houses a new Linux bond named **bond2**. The **bond2** interface uses two additional NICs, **nic4** and **nic5**, and is used solely for back-end storage network traffic:

```
  type: ovs_bridge
  name: br-bond
  members:
    -
      type: linux_bond
      name: bond1
      bonding_options: {get_param: BondInterfaceOvsOptions} // 1
      members:
        -
          type: interface
          name: nic2
          primary: true
        -
          type: interface
          name: nic3
    -
      type: vlan
      device: bond1
      vlan_id: {get_param: StorageNetworkVlanID}
      addresses:
        -
          ip_netmask: {get_param: StorageIpSubnet}
-
  type: ovs_bridge
  name: br-bond2
  members:
    -
      type: linux_bond
      name: bond2
      bonding_options: {get_param: BondInterfaceOvsOptions}
      members:
        -
          type: interface
          name: nic4
          primary: true
        -
          type: interface
          name: nic5
    -
      type: vlan
      device: bond1
      vlan_id: {get_param: StorageMgmtNetworkVlanID}
```

```
    addresses:
      -
        ip_netmask: {get_param: StorageMgmtIpSubnet}
```

1 As **bond1** and **bond2** are both Linux bonds (instead of OVS), they use **bonding_options** instead of **ovs_options** to set bonding directives. For more information, see Section 4.5.1, "Configuring bonding module directives".

For the full contents of this customized template, see Appendix B, *Sample custom interface template: multiple bonded interfaces*.

4.5.1. Configuring bonding module directives

After you add and configure the bonded interfaces, use the **BondInterfaceOvsOptions** parameter to set the directives that you want each bonded interface to use. You can find this information in the **parameters:** section of the **/usr/share/openstack-tripleo-heat-templates/network/config/bond-with-vlans/ceph-storage.yaml** file. The following snippet shows the default definition of this parameter (namely, empty):

```
BondInterfaceOvsOptions:
  default: ''
  description: The ovs_options string for the bond interface. Set
               things like lacp=active and/or bond_mode=balance-slb
               using this option.
  type: string
```

Define the options you need in the **default:** line. For example, to use 802.3ad (mode 4) and a LACP rate of 1 (fast), use **'mode=4 lacp_rate=1'**:

```
BondInterfaceOvsOptions:
  default: 'mode=4 lacp_rate=1'
  description: The bonding_options string for the bond interface. Set
               things like lacp=active and/or bond_mode=balance-slb
               using this option.
  type: string
```

For more information about other supported bonding options, see Open vSwitch Bonding Options in the *Advanced Overcloud Optimization* guide. For the full contents of the customized **/usr/share/openstack-tripleo-heat-templates/network/config/bond-with-vlans/ceph-storage.yaml** template, see Appendix B, *Sample custom interface template: multiple bonded interfaces* .

CHAPTER 5. CUSTOMIZING THE CEPH STORAGE CLUSTER

Director deploys containerized Red Hat Ceph Storage using a default configuration. You can customize Ceph Storage by overriding the default settings.

Prerequistes

To deploy containerized Ceph Storage you must include the **/usr/share/openstack-tripleo-heat-templates/environments/ceph-ansible/ceph-ansible.yaml** file during overcloud deployment. This environment file defines the following resources:

- **CephAnsibleDisksConfig** - This resource maps the Ceph Storage node disk layout. For more information, see Section 5.3, “Mapping the Ceph Storage node disk layout” .
- **CephConfigOverrides** - This resource applies all other custom settings to your Ceph Storage cluster.

Use these resources to override any defaults that the director sets for containerized Ceph Storage.

Procedure

1. Enable the Red Hat Ceph Storage 4 Tools repository:

```
$ sudo subscription-manager repos --enable=rhceph-4-tools-for-rhel-8-x86_64-rpms
```

2. Install the **ceph-ansible** package on the undercloud:

```
$ sudo dnf install ceph-ansible
```

3. To customize your Ceph Storage cluster, define custom parameters in a new environment file, for example, **/home/stack/templates/ceph-config.yaml**. You can apply Ceph Storage cluster settings with the following syntax in the **parameter_defaults** section of your environment file:

```
parameter_defaults:
  CephConfigOverrides:
    section:
      KEY:VALUE
```

NOTE

You can apply the **CephConfigOverrides** parameter to the **[global]** section of the **ceph.conf** file, as well as any other section, such as **[osd]**, **[mon]**, and **[client]**. If you specify a section, the **key:value** data goes into the specified section. If you do not specify a section, the data goes into the **[global]** section by default. For information about Ceph Storage configuration, customization, and supported parameters, see Red Hat Ceph Storage Configuration Guide .

4. Replace **KEY** and **VALUE** with the Ceph cluster settings that you want to apply. For example, in the **global** section, **max_open_files** is the **KEY** and **131072** is the corresponding **VALUE**:

```
parameter_defaults:
  CephConfigOverrides:
    global:
```

```
    max_open_files: 131072
  osd:
    osd_scrub_during_recovery: false
```

This configuration results in the following settings defined in the configuration file of your Ceph cluster:

```
[global]
max_open_files = 131072
[osd]
osd_scrub_during_recovery = false
```

5.1. SETTING CEPH-ANSIBLE GROUP VARIABLES

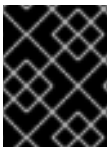
The **ceph-ansible** tool is a playbook used to install and manage Ceph Storage clusters.

The **ceph-ansible** tool has a **group_vars** directory that defines configuration options and the default settings for those options. Use the **group_vars** directory to set Ceph Storage parameters.

For information about the **group_vars** directory, see Installing a Red Hat Ceph Storage cluster in the *Installation Guide*.

To change the variable defaults in director, use the **CephAnsibleExtraConfig** parameter to pass the new values in heat environment files. For example, to set the **ceph-ansible** group variable **journal_size** to 40960, create an environment file with the following **journal_size** definition:

```
parameter_defaults:
  CephAnsibleExtraConfig:
    journal_size: 40960
```



IMPORTANT

Change **ceph-ansible** group variables with the override parameters; do not edit group variables directly in the **/usr/share/ceph-ansible** directory on the undercloud.

5.2. CEPH CONTAINERS FOR RED HAT OPENSTACK PLATFORM WITH CEPH STORAGE

A Ceph container is required to configure OpenStack Platform to use Ceph, even with an external Ceph cluster. To be compatible with Red Hat Enterprise Linux 8, Red Hat OpenStack Platform (RHOSP) 15 requires Red Hat Ceph Storage 4. The Ceph Storage 4 container is hosted at registry.redhat.io, a registry that requires authentication.

You can use the heat environment parameter **ContainerImageRegistryCredentials** to authenticate at **registry.redhat.io**. For more information, see Container image preparation parameters.

5.3. MAPPING THE CEPH STORAGE NODE DISK LAYOUT

When you deploy containerized Ceph Storage, you must map the disk layout and specify dedicated block devices for the Ceph OSD service. You can perform this mapping in the environment file that you created earlier to define your custom Ceph parameters: **/home/stack/templates/ceph-config.yaml**.

Use the **CephAnsibleDisksConfig** resource in **parameter_defaults** to map your disk layout. This resource uses the following variables:

Variable	Required?	Default value (if unset)	Description
osd_scenario	Yes	lvm NOTE: The default value is **lvm**.	The **lvm** value allows ceph-ansible to use **ceph-volume** to configure OSDs and BlueStore WAL devices.
devices	Yes	NONE. Variable must be set.	A list of block devices that you want to use for OSDs on the node.
dedicated_devices	Yes (only if **osd_scenario** is **non-collocated**)	devices	A list of block devices that maps each entry in the **devices** parameter to a dedicated journaling block device. You can use this variable only when **osd_scenario=non-collocated**.
dmcrypt	No	false	Sets whether data stored on OSDs is encrypted (**true**) or unencrypted (**false**).
osd_objectstore	No	bluestore NOTE: The default value is **bluestore**.	Sets the storage back end used by Ceph.

5.3.1. Using BlueStore

Procedure

1. To specify the block devices that you want to use as Ceph OSDs, use a variation of the following snippet:

```
parameter_defaults:
  CephAnsibleDisksConfig:
    devices:
      - /dev/sdb
      - /dev/sdc
      - /dev/sdd
      - /dev/nvme0n1
    osd_scenario: lvm
    osd_objectstore: bluestore
```

2. Because **/dev/nvme0n1** is in a higher performing device class, the example parameter defaults produce three OSDs that run on **/dev/sdb**, **/dev/sdc**, and **/dev/sdd**. The three OSDs use **/dev/nvme0n1** as a BlueStore WAL device. The ceph-volume tool does this by using the **batch** subcommand. The same configuration is duplicated for each Ceph storage node and assumes uniform hardware. If the BlueStore WAL data resides on the same disks as the OSDs, then change the parameter defaults in the following way:

```
parameter_defaults:
  CephAnsibleDisksConfig:
    devices:
      - /dev/sdb
      - /dev/sdc
      - /dev/sdd
    osd_scenario: lvm
    osd_objectstore: bluestore
```

5.3.2. Referring to devices with persistent names

Procedure

1. In some nodes, disk paths, such as **/dev/sdb** and **/dev/sdc**, might not point to the same block device during reboots. If this is the case with your **CephStorage** nodes, specify each disk with the **/dev/disk/by-path/** symlink to ensure that the block device mapping is consistent throughout deployments:

```
parameter_defaults:
  CephAnsibleDisksConfig:
    devices:

      - /dev/disk/by-path/pci-0000:03:00.0-scsi-0:0:10:0
      - /dev/disk/by-path/pci-0000:03:00.0-scsi-0:0:11:0


    dedicated_devices:
      - /dev/nvme0n1
      - /dev/nvme0n1
```

2. Optional: Because you must set the list of OSD devices before overcloud deployment, it might not be possible to identify and set the PCI path of disk devices. In this case, gather the **/dev/disk/by-path/symlink** data for block devices during introspection.
In the following example, run the first command to download the introspection data from the undercloud Object Storage service (swift) for the server **b08-h03-r620-hci** and save the data in a file called **b08-h03-r620-hci.json**. Run the second command to grep for "by-path". The output of this command contains the unique **/dev/disk/by-path** values that you can use to identify disks.

```
(undercloud) [stack@b08-h02-r620 ironic]$ openstack baremetal introspection data save
b08-h03-r620-hci | jq . > b08-h03-r620-hci.json
(undercloud) [stack@b08-h02-r620 ironic]$ grep by-path b08-h03-r620-hci.json
        "by_path": "/dev/disk/by-path/pci-0000:02:00.0-scsi-0:2:0:0",
        "by_path": "/dev/disk/by-path/pci-0000:02:00.0-scsi-0:2:1:0",
        "by_path": "/dev/disk/by-path/pci-0000:02:00.0-scsi-0:2:3:0",
        "by_path": "/dev/disk/by-path/pci-0000:02:00.0-scsi-0:2:4:0",
        "by_path": "/dev/disk/by-path/pci-0000:02:00.0-scsi-0:2:5:0",
```

```
"by_path": "/dev/disk/by-path/pci-0000:02:00.0-scsi-0:2:6:0",
"by_path": "/dev/disk/by-path/pci-0000:02:00.0-scsi-0:2:7:0",
"by_path": "/dev/disk/by-path/pci-0000:02:00.0-scsi-0:2:0:0",
```

For more information about naming conventions for storage devices, see Overview of persistent naming attributes in the *Managing storage devices* guide.

For more information about each journaling scenario and disk mapping for containerized Ceph Storage, see OSD Scenarios in the project documentation for ceph-ansible.

5.4. ASSIGNING CUSTOM ATTRIBUTES TO DIFFERENT CEPH POOLS

By default, Ceph Storage pools created with director have the same number of placement groups (**pg_num** and **pgp_num**) and sizes. You can use either method in Chapter 5, *Customizing the Ceph Storage cluster* to override these settings globally. Doing so applies the same values to all pools.

Use the **CephPools** parameter to apply different attributes to each Ceph Storage pool or create a new custom pool.

Procedure

1. Replace **POOL** with the name of the pool that you want to configure:

```
parameter_defaults:
  CephPools:
    - name: POOL
```

2. Configure placement groups by doing one of the following:

   - To manually override the default settings, set **pg_num** to the number of placement groups:

```
parameter_defaults:
  CephPools:
    - name: POOL
      pg_num: 128
      application: rbd
```

   - Alternatively, to automatically scale placement groups, set **pg_autoscale_mode** to **True** and set **target_size_ratio** to a percentage relative to your expected Ceph Storage requirements:

```
parameter_defaults:
  CephPools:
    - name: POOL
      pg_autoscale_mode: True
      target_size_ratio: PERCENTAGE
      application: rbd
```

     Replace **PERCENTAGE** with a decimal. For example, 0.5 equals 50 percent. The total percentage must equal 1.0 or 100 percent.

     The following values are for example only:

```
paramter_defaults:
```

```
  CephPools:
    - {"name": backups, "target_size_ratio": 0.1, "pg_autoscale_mode": True, "application":
rbd}
    - {"name": volumes, "target_size_ratio": 0.5, "pg_autoscale_mode": True, "application":
rbd}
    - {"name": vms,     "target_size_ratio": 0.2, "pg_autoscale_mode": True, "application":
rbd}
    - {"name": images,  "target_size_ratio": 0.2, "pg_autoscale_mode": True, "application":
rbd}
```

3. Specify the application type.
   The application type for Compute, Block Storage, and Image Storage is`rbd`. However, depending on what you use the pool for, you can specify a different application type.

   For example, the application type for the gnocchi metrics pool is **openstack_gnocchi**. For more information, see Enable Application in the *Storage Strategies Guide* .

NOTE

If you do not use the **CephPools** parameter, director sets the appropriate application type automatically, but only for the default pool list.

4. Optional: Add a pool called **custompool** to create a custom pool, and set the parameters specific to the needs of your environment:

```
parameter_defaults:
  CephPools:
    - name: custompool
      pg_num: 128
      application: rbd
```

TIP

For typical pool configurations of common Ceph use cases, see the Ceph Placement Groups (PGs) per Pool Calculator. This calculator is normally used to generate the commands for manually configuring your Ceph pools. In this deployment, the director configures the pools based on your specifications.

WARNING

Red Hat Ceph Storage 3 (Luminous) introduced a hard limit on the maximum number of PGs an OSD can have, which is 200 by default. Do not override this parameter beyond 200. If there is a problem because the Ceph PG number exceeds the maximum, adjust the **pg_num** per pool to address the problem, not the **mon_max_pg_per_osd**.

5.5. MAPPING THE DISK LAYOUT TO NON-HOMOGENEOUS CEPH STORAGE NODES

By default, all nodes of a role that host Ceph OSDs (indicated by the **OS::TripleO::Services::CephOSD** service in **roles_data.yaml**), for example **CephStorage** or **ComputeHCI** nodes, use the global **devices** and **dedicated_devices** lists set in Section 5.3, "Mapping the Ceph Storage node disk layout" . This assumes that all of these servers have homogeneous hardware. If a subset of these servers do not have homogeneous hardware, then director needs to be aware that each of these servers has different **devices** and **dedicated_devices** lists. This is known as a *node-specific disk configuration*.

To pass a node-specific disk configuration to director, you must pass a heat environment file, such as **node-spec-overrides.yaml**, to the **openstack overcloud deploy** command and the file content must identify each server by a machine unique UUID and a list of local variables to override the global variables.

You can extract the machine unique UUID for each individual server or from the Ironic database.

Procedure

1. To locate the UUID for an individual server, log in to the server and enter the following command:

```
dmidecode -s system-uuid
```

2. To extract the UUID from the Ironic database, enter the following command on the undercloud.

```
openstack baremetal introspection data save NODE-ID | jq .extra.system.product.uuid
```

WARNING

If the **undercloud.conf** does not have **inspection_extras = true** before undercloud installation or upgrade and introspection, then the machine unique UUID is not in the Ironic database.

IMPORTANT

The machine unique UUID is not the Ironic UUID.

A valid **node-spec-overrides.yaml** file might look like the following:

```
parameter_defaults:
  NodeDataLookup: {"32E87B4C-C4A7-418E-865B-191684A6883B": {"devices":
["/dev/sdc"]}}
```

3. All lines after the first two lines must be valid JSON. You can verify that the JSON is valid by using the **jq** command:

   a. Remove the first two lines (**parameter_defaults:** and **NodeDataLookup:**) from the file temporarily.

   b. Run **cat node-spec-overrides.yaml | jq .**

4. As the **node-spec-overrides.yaml** file grows, you can also use **jq** to ensure that the embedded JSON is valid. For example, because the **devices** and **dedicated_devices** list must be the same length, use the following to verify that they are the same length before you start the deployment.

```
(undercloud) [stack@b08-h02-r620 tht]$ cat node-spec-c05-h17-h21-h25-6048r.yaml | jq '.[] |
.devices | length'
33
30
33
(undercloud) [stack@b08-h02-r620 tht]$ cat node-spec-c05-h17-h21-h25-6048r.yaml | jq '.[] |
.dedicated_devices | length'
33
30
33
(undercloud) [stack@b08-h02-r620 tht]$
```

   In the above example, the **node-spec-c05-h17-h21-h25-6048r.yaml** has three servers in rack c05 in which slots h17, h21, and h25 are missing disks. A more complicated example is included at the end of this section.

5. After the JSON has been validated add back the two lines which makes it a valid environment YAML file (**parameter_defaults:** and **NodeDataLookup:**) and include it with **-e** in the deployment. In the example below, the updated heat environment file uses **NodeDataLookup** for Ceph deployment. All of the servers had a devices list with 35 disks except one of them had a disk missing. This environment file overrides the default devices list for only that single node and gives it the list of 34 disks it must use instead of the global list.

```
parameter_defaults:
  # c05-h01-6048r is missing scsi-0:2:35:0 (00000000-0000-0000-0000-0CC47A6EFD0C)
  NodeDataLookup: {
    "00000000-0000-0000-0000-0CC47A6EFD0C": {
      "devices": [
    "/dev/disk/by-path/pci-0000:03:00.0-scsi-0:2:1:0",
    "/dev/disk/by-path/pci-0000:03:00.0-scsi-0:2:32:0",
    "/dev/disk/by-path/pci-0000:03:00.0-scsi-0:2:2:0",
    "/dev/disk/by-path/pci-0000:03:00.0-scsi-0:2:3:0",
    "/dev/disk/by-path/pci-0000:03:00.0-scsi-0:2:4:0",
    "/dev/disk/by-path/pci-0000:03:00.0-scsi-0:2:5:0",
    "/dev/disk/by-path/pci-0000:03:00.0-scsi-0:2:6:0",
    "/dev/disk/by-path/pci-0000:03:00.0-scsi-0:2:33:0",
    "/dev/disk/by-path/pci-0000:03:00.0-scsi-0:2:7:0",
    "/dev/disk/by-path/pci-0000:03:00.0-scsi-0:2:8:0",
    "/dev/disk/by-path/pci-0000:03:00.0-scsi-0:2:34:0",
    "/dev/disk/by-path/pci-0000:03:00.0-scsi-0:2:9:0",
    "/dev/disk/by-path/pci-0000:03:00.0-scsi-0:2:10:0",
    "/dev/disk/by-path/pci-0000:03:00.0-scsi-0:2:11:0",
    "/dev/disk/by-path/pci-0000:03:00.0-scsi-0:2:12:0",
    "/dev/disk/by-path/pci-0000:03:00.0-scsi-0:2:13:0",
    "/dev/disk/by-path/pci-0000:03:00.0-scsi-0:2:14:0",
    "/dev/disk/by-path/pci-0000:03:00.0-scsi-0:2:15:0",
    "/dev/disk/by-path/pci-0000:03:00.0-scsi-0:2:16:0",
    "/dev/disk/by-path/pci-0000:03:00.0-scsi-0:2:17:0",
    "/dev/disk/by-path/pci-0000:03:00.0-scsi-0:2:18:0",
    "/dev/disk/by-path/pci-0000:03:00.0-scsi-0:2:19:0",
    "/dev/disk/by-path/pci-0000:03:00.0-scsi-0:2:20:0",
```

```
"/dev/disk/by-path/pci-0000:03:00.0-scsi-0:2:21:0",
"/dev/disk/by-path/pci-0000:03:00.0-scsi-0:2:22:0",
"/dev/disk/by-path/pci-0000:03:00.0-scsi-0:2:23:0",
"/dev/disk/by-path/pci-0000:03:00.0-scsi-0:2:24:0",
"/dev/disk/by-path/pci-0000:03:00.0-scsi-0:2:25:0",
"/dev/disk/by-path/pci-0000:03:00.0-scsi-0:2:26:0",
"/dev/disk/by-path/pci-0000:03:00.0-scsi-0:2:27:0",
"/dev/disk/by-path/pci-0000:03:00.0-scsi-0:2:28:0",
"/dev/disk/by-path/pci-0000:03:00.0-scsi-0:2:29:0",
"/dev/disk/by-path/pci-0000:03:00.0-scsi-0:2:30:0",
"/dev/disk/by-path/pci-0000:03:00.0-scsi-0:2:31:0"
    ],
  "dedicated_devices": [
"/dev/disk/by-path/pci-0000:81:00.0-nvme-1",
"/dev/disk/by-path/pci-0000:81:00.0-nvme-1",
"/dev/disk/by-path/pci-0000:81:00.0-nvme-1",
"/dev/disk/by-path/pci-0000:81:00.0-nvme-1",
"/dev/disk/by-path/pci-0000:81:00.0-nvme-1",
"/dev/disk/by-path/pci-0000:81:00.0-nvme-1",
"/dev/disk/by-path/pci-0000:81:00.0-nvme-1",
"/dev/disk/by-path/pci-0000:81:00.0-nvme-1",
"/dev/disk/by-path/pci-0000:81:00.0-nvme-1",
"/dev/disk/by-path/pci-0000:81:00.0-nvme-1",
"/dev/disk/by-path/pci-0000:81:00.0-nvme-1",
"/dev/disk/by-path/pci-0000:81:00.0-nvme-1",
"/dev/disk/by-path/pci-0000:81:00.0-nvme-1",
"/dev/disk/by-path/pci-0000:81:00.0-nvme-1",
"/dev/disk/by-path/pci-0000:81:00.0-nvme-1",
"/dev/disk/by-path/pci-0000:81:00.0-nvme-1",
"/dev/disk/by-path/pci-0000:81:00.0-nvme-1",
"/dev/disk/by-path/pci-0000:81:00.0-nvme-1",
"/dev/disk/by-path/pci-0000:84:00.0-nvme-1",
"/dev/disk/by-path/pci-0000:84:00.0-nvme-1",
"/dev/disk/by-path/pci-0000:84:00.0-nvme-1",
"/dev/disk/by-path/pci-0000:84:00.0-nvme-1",
"/dev/disk/by-path/pci-0000:84:00.0-nvme-1",
"/dev/disk/by-path/pci-0000:84:00.0-nvme-1",
"/dev/disk/by-path/pci-0000:84:00.0-nvme-1",
"/dev/disk/by-path/pci-0000:84:00.0-nvme-1",
"/dev/disk/by-path/pci-0000:84:00.0-nvme-1",
"/dev/disk/by-path/pci-0000:84:00.0-nvme-1",
"/dev/disk/by-path/pci-0000:84:00.0-nvme-1",
"/dev/disk/by-path/pci-0000:84:00.0-nvme-1",
"/dev/disk/by-path/pci-0000:84:00.0-nvme-1",
"/dev/disk/by-path/pci-0000:84:00.0-nvme-1",
"/dev/disk/by-path/pci-0000:84:00.0-nvme-1",
"/dev/disk/by-path/pci-0000:84:00.0-nvme-1"
    ]
  }
}
```

5.6. INCREASING THE RESTART DELAY FOR LARGE CEPH CLUSTERS

During deployment, Ceph services such as OSDs and Monitors, are restarted and the deployment does not continue until the service is running again. Ansible waits 15 seconds (the delay) and checks 5 times

for the service to start (the retries). If the service does not restart, the deployment stops so the operator can intervene.

Depending on the size of the Ceph cluster, you may need to increase the retry or delay values. The exact names of these parameters and their defaults are as follows:

```
health_mon_check_retries: 5
health_mon_check_delay: 15
health_osd_check_retries: 5
health_osd_check_delay: 15
```

Procedure

1. Update the **CephAnsibleExtraConfig** parameter to change the default delay and retry values:

```
parameter_defaults:
  CephAnsibleExtraConfig:
    health_osd_check_delay: 40
    health_osd_check_retries: 30
    health_mon_check_delay: 20
    health_mon_check_retries: 10
```

   This example makes the cluster check 30 times and wait 40 seconds between each check for the Ceph OSDs, and check 20 times and wait 10 seconds between each check for the Ceph MONs.

2. To incorporate the changes, pass the updated **yaml** file with **-e** using **openstack overcloud deploy**.

5.7. OVERRIDING ANSIBLE ENVIRONMENT VARIABLES

The Red Hat OpenStack Platform Workflow service (mistral) uses Ansible to configure Ceph Storage, but you can customize the Ansible environment by using Ansible environment variables.

Procedure

To override an **ANSIBLE_*** environment variable, use the **CephAnsibleEnvironmentVariables** heat template parameter.

This example configuration increases the number of forks and SSH retries:

```
parameter_defaults:
  CephAnsibleEnvironmentVariables:
    ANSIBLE_SSH_RETRIES: '6'
    DEFAULT_FORKS: '35'
```

For more information about Ansible environment variables, see Ansible Configuration Settings.

For more information about how to customize your Ceph Storage cluster, see Customizing the Ceph Storage cluster.

5.8. ENABLING CEPH ON-WIRE ENCRYPTION

Starting with Red Hat Ceph Storage 4 and later, you can enable encryption for all Ceph traffic over the

network with the introduction of the messenger version 2 protocol. The **secure mode** setting for messenger v2 encrypts communication between Ceph daemons and Ceph clients, giving you end-to-end encryption.

This feature is available in this release as a *Technology Preview*, and therefore is not fully supported by Red Hat. It should only be used for testing, and should not be deployed in a production environment. For more information about Technology Preview features, see Scope of Coverage Details.

NOTE

This feature, although it is currently a Technology Preview, is intended for use with Red Hat OpenStack Platform (RHOSP) versions 16.1 and later. It is not supported on RHOSP version 13 deployments that use external Red Hat Ceph Storage version 4. For more information, see Ceph on-wire encryption in the *Red Hat Ceph Storage Architecture Guide*.

To enable Ceph on-wire encryption on RHOSP, set the following parameters in your environment override file:

```
parameter_defaults:
  CephConfigOverrides:
    global:
      ms_cluster_mode: secure
      ms_service_mode: secure
      ms_client_mode: secure
```

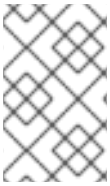
For more information about Ceph on-wire encryption, see Ceph on-wire encryption in the *Architecture Guide*.

CHAPTER 6. DEFINING PERFORMANCE TIERS FOR VARYING WORKLOADS IN A CEPH STORAGE CLUSTER WITH DIRECTOR

Important

This procedure is currently for new director deployments only.

You can use Red Hat OpenStack Platform (RHOSP) director to deploy different Red Hat Ceph Storage performance tiers. You can combine Ceph CRUSH rules and the **CephPools** director parameter to use the device classes feature and build different tiers to accommodate workloads that have different performance requirements. For example, you can define a HDD class for normal workloads and an SSD class that distributes data only over SSDs for high performance loads. In this scenario, when you create a new Block Storage volume, you can choose the performance tier, either HDDs or SSDs.



NOTE

Ceph autodetects the disk type and assigns it to the corresponding device class, either HDD, SSD, or NVMe based on the hardware properties exposed by the Linux kernel. However, you can also customize the category according to your needs.

Prerequisites

- Red Hat Ceph Storage (RHCS) version 4.1 or later.

To deploy different Red Hat Ceph Storage performance tiers, create a new environment file that contains the CRUSH map details and then include it in the deployment command.

In the following procedures, each Ceph Storage node contains three OSDs, **sdb** and **sdc** are spinning disks and **sdc** is a SSD. Ceph automatically detects the correct disk type. You then configure two CRUSH rules, HDD and SSD, to map to the two respective device classes. The HDD rule is the default and applies to all pools unless you configure pools with a different rule.

Finally, you create an extra pool called **fastpool** and map it to the SSD rule. This pool is ultimately exposed through a Block Storage (cinder) back end. Any workload that consumes this Block Storage back end is backed by SSD only for fast performances. You can leverage this for either data or boot from volume.

6.1. CONFIGURING THE PERFORMANCE TIERS

Director does not expose specific parameters to cover this feature, however, you can generate the **ceph-ansible** expected variables by completing the following steps.

Procedure

1. Log in to the undercloud node as the **stack** user.
2. Create an environment file, such as **/home/stack/templates/ceph-config.yaml**, to contain the Ceph config parameters and the device classes variables. Alternatively, you can add the following configurations to an existing environment file.
3. In the environment file, use the **CephAnsibleDisksConfig** parameter to list the block devices that you want to use as Ceph OSDs:

```
CephAnsibleDisksConfig:
  devices:
    - /dev/sdb
    - /dev/sdc
    - /dev/sdd
  osd_scenario: lvm
  osd_objectstore: bluestore
```

4. Optional: Ceph automatically detects the type of disk and assigns it to the corresponding device class. However, you can also use the **crush_device_class** property to force a specific device to belong to a specific class or create your own custom classes. The following example contains the same list of OSDs with specified classes:

```
CephAnsibleDisksConfig:
  lvm_volumes:
    - data: '/dev/sdb'
      crush_device_class: 'hdd'
    - data: '/dev/sdc'
      crush_device_class: 'hdd'
    - data: '/dev/sdd'
      crush_device_class: 'ssd'
  osd_scenario: lvm
  osd_objectstore: bluestore
```

5. Add the **CephAnsibleExtraVars** parameters. The **crush_rules** parameter must contain a rule for each class that you define or that Ceph detects automatically. When you create a new pool, if no rule is specified, the rule that you want Ceph to use as the default is selected.

```
CephAnsibleExtraConfig:
  crush_rule_config: true
  create_crush_tree: true
  crush_rules:
    - name: HDD
      root: default
      type: host
      class: hdd
      default: true
    - name: SSD
      root: default
      type: host
      class: ssd
      default: false
```

6. Add the **CephPools** parameter:

   - Use the **rule_name** parameter to specify the tier for each pool that does not use the default rule. In the following example, the **fastpool** pool uses the SSD device class that is configured as a fast tier, to manage Block Storage volumes.

   - Replace **<appropriate_PG_num>** with the appropriate number of placement groups (PGs). Alternatively, use the placement group auto-scaler to calculate the number of PGs for the Ceph pools.
     For more information, see Assigning custom attributes to different Ceph pools .

- Use the **CinderRbdExtraPools** parameter to configure **fastpool** as a Block Storage back end.

```
CephPools:
  - name: fastpool
    pg_num: <appropraiate_PG_num>
    rule_name: SSD
    application: rbd
CinderRbdExtraPools: fastpool
```

7. Use the following example to ensure that your environment file contains the correct values:

```
parameter_defaults:
    CephAnsibleDisksConfig:
        devices:
            - '/dev/sdb'
            - '/dev/sdc'
            - '/dev/sdd'
        osd_scenario: lvm
        osd_objectstore: bluestore
    CephAnsibleExtraConfig:
        crush_rule_config: true
        create_crush_tree: true
        crush_rules:
            - name: HDD
              root: default
              type: host
              class: hdd
              default: true
            - name: SSD
              root: default
              type: host
              class: ssd
              default: false
    CinderRbdExtraPools: fastpool
    CephPools:
        - name: fastpool
          pg_num: <appropriate_PG_num>
          rule_name: SSD
          application: rbd
```

8. Include the new environment file in the **openstack overcloud deploy** command. Replace **<existing_overcloud_environment_files>** with the list of environment files that are part of your existing deployment.

```
$ openstack overcloud deploy \
--templates \
…
-e <existing_overcloud_environment_files> \
-e /home/stack/templates/ceph-config.yaml  \
…
```

6.2. MAPPING A BLOCK STORAGE (CINDER) TYPE TO YOUR NEW CEPH POOL

After you complete the configuration steps, make the performance tiers feature available to RHOSP tenants by using Block Storage (cinder) to create a type that is mapped to the **fastpool** tier that you created.

Procedure

1. Log in to the undercloud node as the **stack** user.
2. Source the **overcloudrc** file:

```
$ source overcloudrc
```

3. Check the Block Storage volume existing types:

```
$ cinder type-list
```

4. Create the new Block Storage volume fast_tier:

```
$ cinder type-create fast_tier
```

5. Check that the Block Storage type is created:

```
$ cinder type-list
```

6. When the **fast_tier** Block Storage type is available, set the **fastpool** as the Block Storage volume back end for the new tier that you created:

```
$ cinder type-key fast_tier set volume_backend_name=tripleo_ceph_fastpool
```

7. Use the new tier to create new volumes:

```
$ cinder create 1 --volume-type fast_tier --name fastdisk
```

IMPORTANT

If you apply the environment file to an existing Ceph cluster, the pre-existing Ceph pools are not updated with the new rules. For this reason, you must enter the following command after the deployment completes to set the rules to the specified pools.

```
$ ceph osd pool set <pool> crush_rule <rule>
```

- Replace <pool> with the name of the pool that you want to apply the new rule to.
- Replace <rule> with one of the rule names that you specified with the **crush_rules** parameter.
- Replace <appropriate_PG_num> with the appropriate number of placement groups or a **target_size_ratio** and set **pg_autoscale_mode** to **true**.

For every rule that you change with this command, update the existing entry or add a new entry in the **CephPools** parameter in your existing templates:

```
CephPools:
  - name: <pool>
    pg_num: <appropriate_PG_num>
    rule_name: <rule>
    application: rbd
```

6.3. VERIFYING THAT THE CRUSH RULES ARE CREATED AND THAT YOUR POOLS ARE SET TO THE CORRECT CRUSH RULE

Procedure

1. Log in to the overcloud Controller node as the **heat-admin** user.
2. To verify that your OSD tiers are successfully set, enter the following command. Replace <controller_hostname> with the name of your host Controller node.

```
$ sudo podman exec -it ceph-mon-<controller_hostname> ceph osd tree
```

3. In the resulting tree view, verify that the **CLASS** column displays the correct device class for each OSD that you set.
4. Also verify that the OSDs are properly assigned to the device classes with following command. Replace <controller_hostname> with the name of your host Controller node.

```
$ sudo podman exec -it ceph-mon-<controller hostname> ceph osd crush tree --show-shadow
```

5. Compare the resulting hierarchy with the results of the following command to ensure that the same values apply for each rule.
   - Replace <controller_hostname> with the name of your host Controller node.
   - Replace <rule_name> with the name of the rule you want to check.

```
$ sudo podman exec <controller hostname> ceph osd crush rule dump <rule_name>
```

6. Verify that the rules name and ID that you created are correct according to the **crush_rules** parameter that you used during deployment. Replace <controller_hostname> with the name of your host Controller node.

```
$ sudo podman exec -it ceph-mon-<controller_hostname>  ceph osd crush rule dump | grep -
E "rule_(id|name)"
```

7. Verify that the Ceph pools are tied to the correct CRUSH rule ID that you retrieved in Step 3. Replace <controller_hostname> with the name of your host Controller node.

```
$ sudo podman exec -it ceph-mon-<controller_hostname> ceph osd dump | grep pool
```

8. For each pool, ensure that the rule ID matches the rule name that you expect.

CHAPTER 7. CREATING THE OVERCLOUD

When your custom environment files are ready, you can specify the flavors and nodes that each role uses and then execute the deployment. The following subsections explain both steps in greater detail.

7.1. ASSIGNING NODES AND FLAVORS TO ROLES

Planning an overcloud deployment involves specifying how many nodes and which flavors to assign to each role. Like all Heat template parameters, these role specifications are declared in the **parameter_defaults** section of your environment file (in this case, **~/templates/storage-config.yaml**).

For this purpose, use the following parameters:

Table 7.1. Roles and Flavors for Overcloud Nodes

Heat Template Parameter	Description
ControllerCount	The number of Controller nodes to scale out
OvercloudControlFlavor	The flavor to use for Controller nodes (**control**)
ComputeCount	The number of Compute nodes to scale out
OvercloudComputeFlavor	The flavor to use for Compute nodes (**compute**)
CephStorageCount	The number of Ceph storage (OSD) nodes to scale out
OvercloudCephStorageFlavor	The flavor to use for Ceph Storage (OSD) nodes (**ceph-storage**)
CephMonCount	The number of dedicated Ceph MON nodes to scale out
OvercloudCephMonFlavor	The flavor to use for dedicated Ceph MON nodes (**ceph-mon**)
CephMdsCount	The number of dedicated Ceph MDS nodes to scale out
OvercloudCephMdsFlavor	The flavor to use for dedicated Ceph MDS nodes (**ceph-mds**)

IMPORTANT

The **CephMonCount**, **CephMdsCount**, **OvercloudCephMonFlavor**, and **OvercloudCephMdsFlavor** parameters (along with the **ceph-mon** and **ceph-mds** flavors) will only be valid if you created a custom **CephMON** and **CephMds** role, as described in Chapter 3, *Deploying Ceph services on dedicated nodes*.

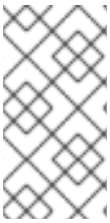
For example, to configure the overcloud to deploy three nodes for each role (Controller, Compute, Ceph-Storage, and CephMon), add the following to your **parameter_defaults**:

```
parameter_defaults:
  ControllerCount: 3
  OvercloudControlFlavor: control
  ComputeCount: 3
  OvercloudComputeFlavor: compute
  CephStorageCount: 3
  OvercloudCephStorageFlavor: ceph-storage
  CephMonCount: 3
  OvercloudCephMonFlavor: ceph-mon
  CephMdsCount: 3
  OvercloudCephMdsFlavor: ceph-mds
```

NOTE

See Creating the Overcloud with the CLI Tools from the Director Installation and Usage guide for a more complete list of Heat template parameters.

7.2. INITIATING OVERCLOUD DEPLOYMENT



NOTE

During undercloud installation, set **generate_service_certificate=false** in the **undercloud.conf** file. Otherwise, you must inject a trust anchor when you deploy the overcloud, as described in Enabling SSL/TLS on Overcloud Public Endpoints in the *Advanced Overcloud Customization* guide.

Note

If you want to add Ceph Dashboard during your overcloud deployment, see Chapter 8, *Adding the Red Hat Ceph Storage Dashboard to an overcloud deployment*.

The creation of the overcloud requires additional arguments for the **openstack overcloud deploy** command. For example:

```
$ openstack overcloud deploy --templates -r /home/stack/templates/roles_data_custom.yaml \
  -e /usr/share/openstack-tripleo-heat-templates/environments/ceph-ansible/ceph-ansible.yaml \
  -e /usr/share/openstack-tripleo-heat-templates/environments/ceph-ansible/ceph-rgw.yaml \
  -e /usr/share/openstack-tripleo-heat-templates/environments/ceph-ansible/ceph-mds.yaml
  -e /usr/share/openstack-tripleo-heat-templates/environments/cinder-backup.yaml \
  -e /home/stack/templates/storage-config.yaml \
  -e /home/stack/templates/ceph-config.yaml \
  --ntp-server pool.ntp.org
```

The above command uses the following options:

- **--templates** - Creates the Overcloud from the default Heat template collection (namely, **/usr/share/openstack-tripleo-heat-templates/**).
- **-r /home/stack/templates/roles_data_custom.yaml** - Specifies the customized roles definition file from Chapter 3, *Deploying Ceph services on dedicated nodes*, which adds custom roles for either Ceph MON or Ceph MDS services. These roles allow either service to be installed on

dedicated nodes.

- **-e /usr/share/openstack-tripleo-heat-templates/environments/ceph-ansible/ceph-ansible.yaml** - Sets the director to create a Ceph cluster. In particular, this environment file will deploy a Ceph cluster with *containerized* Ceph Storage nodes.
- **-e /usr/share/openstack-tripleo-heat-templates/environments/ceph-ansible/ceph-rgw.yaml** - Enables the Ceph Object Gateway, as described in Section 4.2, "Enabling the Ceph Object Gateway".
- **-e /usr/share/openstack-tripleo-heat-templates/environments/ceph-ansible/ceph-mds.yaml** - Enables the Ceph Metadata Server, as described in Section 4.1, "Enabling the Ceph Metadata Server".
- **-e /usr/share/openstack-tripleo-heat-templates/environments/cinder-backup.yaml** - Enables the Block Storage Backup service (**cinder-backup**), as described in Section 4.4, "Configuring the Backup Service to use Ceph".
- **-e /home/stack/templates/storage-config.yaml** - Adds the environment file containing your custom Ceph Storage configuration.
- **-e /home/stack/templates/ceph-config.yaml** - Adds the environment file containing your custom Ceph cluster settings, as described in Chapter 5, *Customizing the Ceph Storage cluster* .
- **--ntp-server pool.ntp.org** - Sets our NTP server.

TIP

You can also use an *answers file* to invoke all your templates and environment files. For example, you can use the following command to deploy an identical overcloud:

```
$ openstack overcloud deploy -r /home/stack/templates/roles_data_custom.yaml \
  --answers-file /home/stack/templates/answers.yaml --ntp-server pool.ntp.org
```

In this case, the answers file **/home/stack/templates/answers.yaml** contains:

```
templates: /usr/share/openstack-tripleo-heat-templates/
environments:
  - /usr/share/openstack-tripleo-heat-templates/environments/ceph-ansible/ceph-ansible.yaml
  - /usr/share/openstack-tripleo-heat-templates/environments/ceph-rgw.yaml
  - /usr/share/openstack-tripleo-heat-templates/environments/ceph-mds.yaml
  - /usr/share/openstack-tripleo-heat-templates/environments/cinder-backup.yaml
  - /home/stack/templates/storage-config.yaml
  - /home/stack/templates/ceph-config.yaml
```

See Including environment files in an overcloud deployment for more details.

For a full list of options, enter:

```
$ openstack help overcloud deploy
```

For more information, see Configuring a basic overcloud with the CLI tools in the *Director Installation and Usage* guide.

The overcloud creation process begins and the director provisions your nodes. This process takes some time to complete. To view the status of the overcloud creation, open a separate terminal as the **stack** user and enter the following commands:

```
$ source ~/stackrc
$ openstack stack list --nested
```

7.2.1. Limiting the nodes on which ceph-ansible runs

You can reduce deployment update time by limiting the nodes where **ceph-ansible** runs. When Red Hat OpenStack Platform (RHOSP) uses **config-download** to configure Ceph, you can use the **--limit** option to specify a list of nodes, instead of running **config-download** and **ceph-ansible** across your entire deployment. This feature is useful, for example, as part of scaling up your overcloud, or replacing a failed disk. In these scenarios, the deployment can run only on the new nodes that you add to the environment.

Example scenario that uses --limit in a failed disk replacement

In the following example procedure, the Ceph storage node **oc0-cephstorage-0** has a disk failure so it receives a new factory clean disk. Ansible needs to run on the **oc0-cephstorage-0** node so that the new disk can be used as an OSD but it does not need to run on all of the other Ceph storage nodes. Replace the example environment files and node names with those appropriate to your environment.

Procedure

1. Log in to the undercloud node as the **stack** user and source the **stackrc** credentials file:

```
# source stackrc
```

2. Complete one of the following steps so that the new disk is used to start the missing OSD.

- Run a stack update and include the **--limit** option to specify the nodes where you want **ceph-ansible** to run:

```
$ openstack overcloud deploy --templates \
  -r /home/stack/roles_data.yaml \
  -n /usr/share/openstack-tripleo-heat-templates/network_data_dashboard.yaml \
  -e /usr/share/openstack-tripleo-heat-templates/environments/ceph-ansible/ceph-
ansible.yaml \
  -e ~/my-ceph-settings.yaml \
  -e <other-environment_files> \
  --limit oc0-controller-0:oc0-controller-2:oc0-controller-1:oc0-cephstorage-0:undercloud
```

  In this example, the Controllers are included because the Ceph mons need Ansible to change their OSD definitions.

- If **config-download** has generated an **ansible-playbook-command.sh** script, you can also run the script with the **--limit** option to pass the specified nodes to **ceph-ansible**:

```
./ansible-playbook-command.sh --limit oc0-controller-0:oc0-controller-2:oc0-controller-
1:oc0-cephstorage-0:undercloud
```

  Warning

  You must always include the undercloud in the limit list otherwise **ceph-ansible** cannot be executed when you use **--limit**. This is necessary because the **ceph-ansible**

execution occurs through the **external_deploy_steps_tasks** playbook, which runs only on the undercloud.

CHAPTER 8. ADDING THE RED HAT CEPH STORAGE DASHBOARD TO AN OVERCLOUD DEPLOYMENT

Red Hat Ceph Storage Dashboard is disabled by default but you can enable it in your overcloud with the Red Hat OpenStack Platform director. The Ceph Dashboard is a built-in, web-based Ceph management and monitoring application that administers various aspects and objects in your cluster. Red Hat Ceph Storage Dashboard comprises the following components:

- The Ceph Dashboard manager module provides the user interface and embeds the platform front end, Grafana.
- Prometheus, the monitoring plugin.
- Alertmanager sends alerts to the Dashboard.
- Node Exporters export cluster data to the Dashboard.

Note

This feature is supported with Ceph Storage 4.1 or later. For more information about how to determine the version of Ceph Storage installed on your system, see Red Hat Ceph Storage releases and corresponding Ceph package versions.

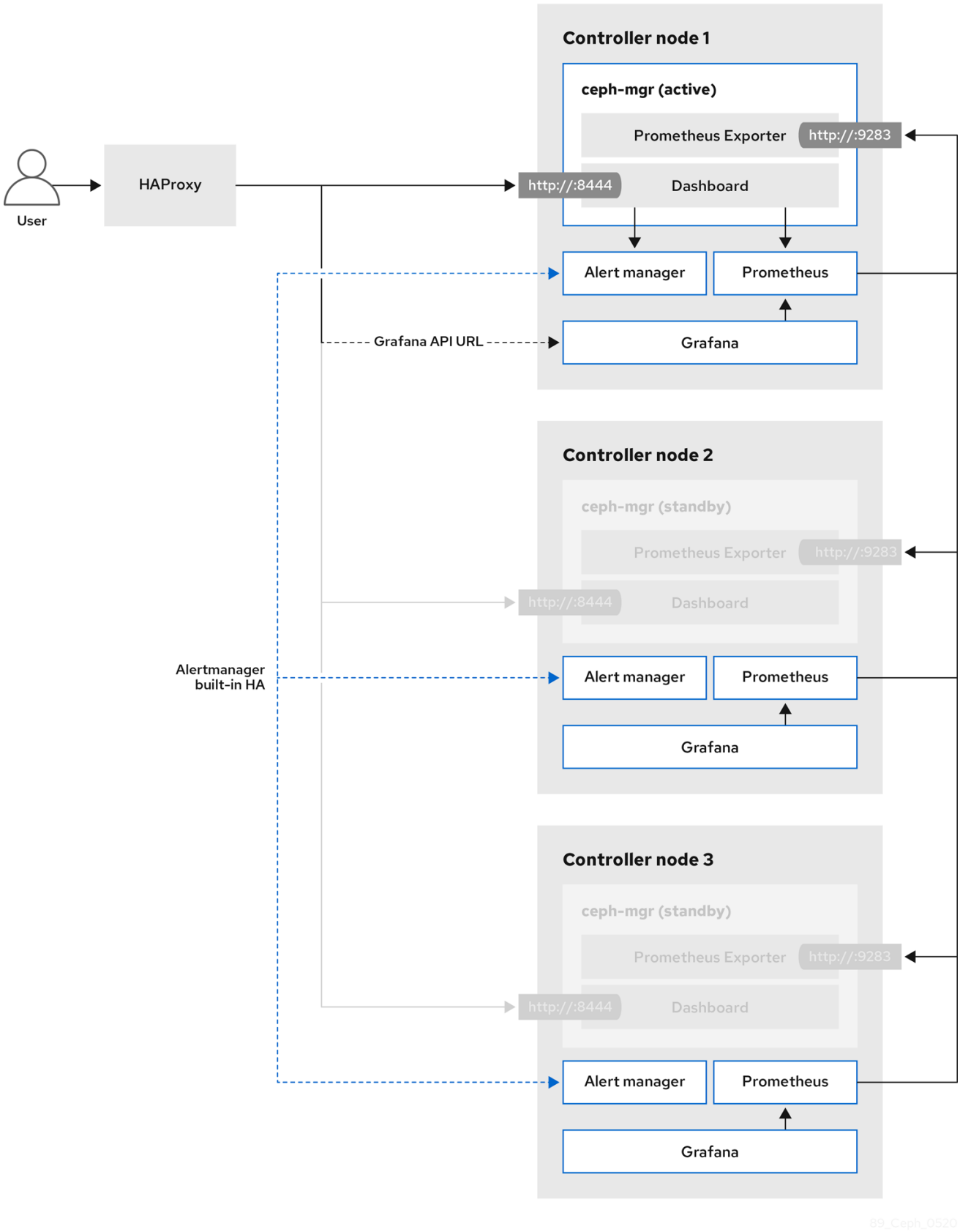
Note

The Red Hat Ceph Storage Dashboard is always colocated on the same nodes as the other Ceph manager components.

Note

If you want to add Ceph Dashboard during your initial overcloud deployment, complete the procedures in this chapter before you deploy your initial overcloud in Section 7.2, “Initiating overcloud deployment”.

The following diagram shows the architecture of Ceph Dashboard on Red Hat OpenStack Platform:



For more information about the Dashboard and its features and limitations, see Dashboard features in the *Red Hat Ceph Storage Dashboard Guide* .

TLS everywhere with Ceph Dashboard

The Dashboard front end is fully integrated with the TLS everywhere framework. You can enable TLS everywhere provided that you have the required environment files and they are included in the

overcloud deploy command. This triggers the certificate request for both Grafana and the Ceph Dashboard and the generated certificate and key files are passed to **ceph-ansible** during the overcloud deployment. For instructions and more information about how to enable TLS for the Dashboard as well as for other openstack services, see the following locations in the *Advanced Overcloud Customization* guide:

- Enabling SSL/TLS on Overcloud Public Endpoints.
- Enabling SSL/TLS on Internal and Public Endpoints with Identity Management .

Note

The port to reach the Ceph Dashboard remains the same even in the TLS-everywhere context.

8.1. INCLUDING THE NECESSARY CONTAINERS FOR THE CEPH DASHBOARD

Before you can add the Ceph Dashboard templates to your overcloud, you must include the necessary containers by using the **containers-prepare-parameter.yaml** file. To generate the **containers-prepare-parameter.yaml** file to prepare your container images, complete the following steps:

Procedure

1. Log in to your undercloud host as the **stack** user.
2. Generate the default container image preparation file:

```
$ openstack tripleo container image prepare default \
  --local-push-destination \
  --output-env-file containers-prepare-parameter.yaml
```

3. Edit the **containers-prepare-parameter.yaml** file and make the modifications to suit your requirements. The following example **containers-prepare-parameter.yaml** file contains the image locations and tags related to the Dashboard services including Grafana, Prometheus, Alertmanager, and Node Exporter. Edit the values depending on your specific scenario:

```
parameter_defaults:
    ContainerImagePrepare:
    - push_destination: true
        set:
            ceph_alertmanager_image: ose-prometheus-alertmanager
            ceph_alertmanager_namespace: registry.redhat.io/openshift4
            ceph_alertmanager_tag: v4.1
            ceph_grafana_image: rhceph-4-dashboard-rhel8
            ceph_grafana_namespace: registry.redhat.io/rhceph
            ceph_grafana_tag: 4
            ceph_image: rhceph-4-rhel8
            ceph_namespace: registry.redhat.io/rhceph
            ceph_node_exporter_image: ose-prometheus-node-exporter
            ceph_node_exporter_namespace: registry.redhat.io/openshift4
            ceph_node_exporter_tag: v4.1
            ceph_prometheus_image: ose-prometheus
```

```
    ceph_prometheus_namespace: registry.redhat.io/openshift4
    ceph_prometheus_tag: v4.1
    ceph_tag: latest
```

For more information about registry and image configuration with the **containers-prepare-parameter.yaml** file, see Container image preparation parameters in the *Transitioning to Containerized Services* guide.

8.2. DEPLOYING CEPH DASHBOARD

Note

If you want to deploy Ceph Dashboard with a composable network, see Section 8.3, "Deploying Ceph Dashboard with a composable network"

Note

The Ceph Dashboard admin user role is set to read-only mode by default. To change the Ceph Dashboard admin default mode, see Section 8.4, "Changing the default permissions" .

Procedure

1. Log in to the undercloud node as the **stack** user.
2. Include the following environment files, with all environment files that are part of your deployment, in the **openstack overcloud deploy** command:

```
$ openstack overcloud deploy \
 --templates \
 -e <overcloud_environment_files> \
 -e /usr/share/openstack-tripleo-heat-templates/environments/ceph-ansible/ceph-ansible.yaml \
 -e /usr/share/openstack-tripleo-heat-templates/environments/ceph-ansible/ceph-dashboard.yaml
```

Replace **<overcloud_environment_files>** with the list of environment files that are part of your deployment.

Result

The resulting deployment comprises an external stack with the grafana, prometheus, alertmanager, and node-exporter containers. The Ceph Dashboard manager module is the back end for this stack, and it embeds the grafana layouts to provide ceph cluster specific metrics to the end users.

8.3. DEPLOYING CEPH DASHBOARD WITH A COMPOSABLE NETWORK

You can deploy the Ceph Dashboard on a composable network instead of on the default Provisioning network. This eliminates the need to expose the Ceph Dashboard service on the Provisioning network. When you deploy the Dashboard on a composable network, you can also implement separate authorization profiles.

You must choose which network to use before you deploy because you can apply the Dashboard to a new network only when you first deploy the overcloud. You cannot apply the Dashboard to the existing external network or reuse one of the existing networks other than the Provisioning network. Use the following procedure to choose a composable network before you deploy.

Procedure

1. Log in to the undercloud as the stack user.
2. Generate the Controller specific role to include the Dashboard composable network:

```
$ openstack overcloud roles generate -o /home/stack/roles_data_dashboard.yaml
ControllerStorageDashboard Compute BlockStorage ObjectStorage CephStorage
```

Result

- A new **ControllerStorageDashboard** role is generated inside the **roles_data.yaml** defined as the output of the command. You must include this file in the template list when you use the overcloud deploy command.
  NOTE: The **ControllerStorageDashboard** role does not contain **CephNFS** nor **network_date_dashboard.yaml**.
- Director provides a network environment file where the composable network is defined. The default location of this file is **/usr/share/openstack-tripleo-heat-templates/network_data_dashboard.yaml**. You must include this file in the overcloud template list when you use the overcloud deploy command.

3. Include the following environment files, with all environment files that are part of your deployment, in the **openstack overcloud deploy** command:

```
$ openstack overcloud deploy \
  --templates \
  -r /home/stack/roles_data.yaml \
  -n /usr/share/openstack-tripleo-heat-templates/network_data_dashboard.yaml \
  -e /usr/share/openstack-tripleo-heat-templates/environments/network-isolation.yaml \
  -e /usr/share/openstack-tripleo-heat-templates/environments/network-environment.yaml \
  -e <overcloud_environment_files> \
  -e /usr/share/openstack-tripleo-heat-templates/environments/ceph-ansible/ceph-
ansible.yaml \
  -e /usr/share/openstack-tripleo-heat-templates/environments/ceph-ansible/ceph-
dashboard.yaml
```

Replace **<overcloud_environment_files>** with the list of environment files that are part of your deployment.

Result

The resulting deployment comprises an external stack with the grafana, prometheus, alertmanager, and node-exporter containers. The Ceph Dashboard manager module is the back end for this stack, and it embeds the grafana layouts to provide Ceph cluster-specific metrics to the end users.

8.4. CHANGING THE DEFAULT PERMISSIONS

The Ceph Dashboard admin user role is set to read-only mode by default for safe monitoring of the Ceph cluster. To permit an admin user to have elevated privileges so that they can alter elements of the Ceph cluster with the Dashboard, you can use the **CephDashboardAdminRO** parameter to change the default admin permissions.

Warning

A user with full permissions might alter elements of your cluster that director configures. This can cause a conflict with director-configured options when you run a stack update. To avoid this problem, do not alter director-configured options with Ceph Dashboard, for example, Ceph OSP pools attributes.

Procedure

1. Log in to the undercloud as the **stack** user.
2. Create the following **ceph_dashboard_admin.yaml** environment file:

```
parameter_defaults:
  CephDashboardAdminRO: false
```

3. Run the overcloud deploy command to update the existing stack and include the environment file you created with all other environment files that are part of your existing deployment:

```
$ openstack overcloud deploy \
--templates \
-e <existing_overcloud_environment_files> \
-e ceph_dashboard_admin.yml
```

Replace **<existing_overcloud_environment_files>** with the list of environment files that are part of your existing deployment.

8.5. ACCESSING CEPH DASHBOARD

To test that Ceph Dashboard is running correctly, complete the following verification steps to access it and check that the data it displays from the Ceph cluster is correct.

Procedure

1. Log in to the undercloud node as the **stack** user.
2. Retrieve the dashboard admin login credentials:

```
[stack@undercloud ~]$ grep dashboard_admin_password /var/lib/mistral/overcloud/ceph-ansible/group_vars/all.yml
```

3. Retrieve the VIP address to access the Ceph Dashboard:

```
[stack@undercloud-0 ~]$ grep dashboard_frontend_vip /var/lib/mistral/overcloud/ceph-ansible/group_vars/all.yml
```

4. Use a web browser to point to the front end VIP and access the Dashboard. Director configures and exposes the Dashboard on the provisioning network, so you can use the VIP that you retrieved in step 2 to access the dashboard directly on TCP port 8444. Ensure that the following conditions are met:
   - The Web client host is layer 2 connected to the provisioning network.
   - The provisioning network is properly routed or proxied, and it can be reached from the web client host. If these conditions are not met, you can still open a SSH tunnel to reach the Dashboard VIP on the overcloud:

```
client_host$ ssh -L 8444:<dashboard vip>:8444 stack@<your undercloud>
```

Replace <dashboard vip> with the IP address of the control plane VIP that you retrieved in step 3.

5. Access the Dashboard by pointing your web browser to http://localhost:8444. The default user that **ceph-ansible** creates is admin. You can retrieve the password in **/var/lib/mistral/overcloud/ceph-ansible/group_vars/all.yml**.

   Results

   - You can access the Ceph Dashboard.
   - The numbers and graphs that the Dashboard displays reflect the same cluster status that the CLI command, **ceph -s**, returns.

For more information about the Red Hat Ceph Storage Dashboard, see the *Red Hat Ceph Storage Administration Guide*

CHAPTER 9. POST-DEPLOYMENT

The following subsections describe several post-deployment operations for managing the Ceph cluster.

9.1. ACCESSING THE OVERCLOUD

The director generates a script to configure and help authenticate interactions with your overcloud from the undercloud. The director saves this file (**overcloudrc**) in your **stack** user's home directory. Run the following command to use this file:

```
$ source ~/overcloudrc
```

This loads the necessary environment variables to interact with your overcloud from the undercloud CLI. To return to interacting with the undercloud, run the following command:

```
$ source ~/stackrc
```

9.2. MONITORING CEPH STORAGE NODES

After you create the overcloud, check the status of the Ceph Storage Cluster to ensure that it works correctly.

Procedure

1. Log in to a Controller node as the **heat-admin** user:

```
$ nova list
$ ssh heat-admin@192.168.0.25
```

2. Check the health of the cluster:

```
$ sudo podman exec ceph-mon-<HOSTNAME> ceph health
```

If the cluster has no issues, the command reports back **HEALTH_OK**. This means the cluster is safe to use.

3. Log in to an overcloud node that runs the Ceph monitor service and check the status of all OSDs in the cluster:

```
$ sudo podman exec ceph-mon-<HOSTNAME> ceph osd tree
```

4. Check the status of the Ceph Monitor quorum:

```
$ sudo podman exec ceph-mon-<HOSTNAME> ceph quorum_status
```

This shows the monitors participating in the quorum and which one is the leader.

5. Verify that all Ceph OSDs are running:

```
$ sudo podman exec ceph-mon-<HOSTNAME> ceph osd stat
```

For more information on monitoring Ceph Storage clusters, see Monitoring in the *Red Hat Ceph Storage Administration Guide*.

CHAPTER 10. REBOOTING THE ENVIRONMENT

A situation might occur where you need to reboot the environment. For example, when you might need to modify the physical servers, or you might need to recover from a power outage. In this situation, it is important to make sure your Ceph Storage nodes boot correctly.

Make sure to boot the nodes in the following order:

- **Boot all Ceph Monitor nodes first**- This ensures the Ceph Monitor service is active in your high availability cluster. By default, the Ceph Monitor service is installed on the Controller node. If the Ceph Monitor is separate from the Controller in a custom role, make sure this custom Ceph Monitor role is active.
- **Boot all Ceph Storage nodes**- This ensures the Ceph OSD cluster can connect to the active Ceph Monitor cluster on the Controller nodes.

10.1. REBOOTING A CEPH STORAGE (OSD) CLUSTER

Complete the following steps to reboot a cluster of Ceph Storage (OSD) nodes.

Procedure

1. Log into a Ceph MON or Controller node and disable Ceph Storage cluster rebalancing temporarily:

```
$ sudo podman exec -it ceph-mon-controller-0 ceph osd set noout
$ sudo podman exec -it ceph-mon-controller-0 ceph osd set norebalance
```

2. Select the first Ceph Storage node that you want to reboot and log in to the node.
3. Reboot the node:

```
$ sudo reboot
```

4. Wait until the node boots.
5. Log into the node and check the cluster status:

```
$ sudo podman exec -it ceph-mon-controller-0 ceph status
```

   Check that the **pgmap** reports all **pgs** as normal (**active+clean**).

6. Log out of the node, reboot the next node, and check its status. Repeat this process until you have rebooted all Ceph storage nodes.
7. When complete, log into a Ceph MON or Controller node and re-enable cluster rebalancing:

```
$ sudo podman exec -it ceph-mon-controller-0 ceph osd unset noout
$ sudo podman exec -it ceph-mon-controller-0 ceph osd unset norebalance
```

8. Perform a final status check to verify that the cluster reports **HEALTH_OK**:

```
$ sudo podman exec -it ceph-mon-controller-0 ceph status
```

If a situation occurs where all overcloud nodes boot at the same time, the Ceph OSD services might not start correctly on the Ceph Storage nodes. In this situation, reboot the Ceph Storage OSDs so they can connect to the Ceph Monitor service.

Verify a **HEALTH_OK** status of the Ceph Storage node cluster with the following command:

```
$ sudo ceph status
```

CHAPTER 11. SCALING THE CEPH STORAGE CLUSTER

11.1. SCALING UP THE CEPH STORAGE CLUSTER

You can scale up the number of Ceph Storage nodes in your overcloud by re-running the deployment with the number of Ceph Storage nodes you need.

Before doing so, ensure that you have enough nodes for the updated deployment. These nodes must be registered with the director and tagged accordingly.

Registering new Ceph Storage nodes

To register new Ceph storage nodes with director, complete the following steps.

Procedure

1. Log in to the undercloud as the **stack** user and initialize your director configuration:

```
$ source ~/stackrc
```

2. Define the hardware and power management details for the new nodes in a new node definition template; for example, **instackenv-scale.json**.

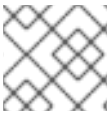
3. Import this file in to director:

```
$ openstack overcloud node import ~/instackenv-scale.json
```

   Importing the node definition template registers each node that is defined there to director.

4. Assign the kernel and ramdisk images to all nodes:

```
$ openstack overcloud node configure
```



NOTE

For more information about registering new nodes, see Section 2.2, “Registering nodes”.

Manually tagging new nodes

After you register each node, you must inspect the hardware and tag the node into a specific profile. Use profile tags to match your nodes to flavors, and then assign flavors to deployment roles.

Procedure

1. Trigger hardware introspection to retrieve the hardware attributes of each node:

```
$ openstack overcloud node introspect --all-manageable --provide
```

   - The **--all-manageable** option introspects only the nodes that are in a managed state. In this example, all nodes are in a managed state.
   - The **--provide** option resets all nodes to an **active** state after introspection.

IMPORTANT

Ensure that this process completes successfully. This process usually takes 15 minutes for bare metal nodes.

2. Retrieve a list of your nodes to identify their UUIDs:

```
$ openstack baremetal node list
```

3. Add a profile option to the **properties/capabilities** parameter for each node to manually tag a node to a specific profile. The addition of the **profile** option tags the nodes into each respective profile.

NOTE

As an alternative to manual tagging, use the Automated Health Check (AHC) Tools to automatically tag larger numbers of nodes based on benchmarking data. For example, the following commands tag three additional nodes with the **ceph-storage** profile:

```
$ openstack baremetal node set --property capabilities='profile:baremetal,boot_option:local'
551d81f5-4df2-4e0f-93da-6c5de0b868f7
$ openstack baremetal node set --property capabilities='profile:baremetal,boot_option:local'
5e735154-bd6b-42dd-9cc2-b6195c4196d7
$ openstack baremetal node set --property capabilities='profile:baremetal,boot_option:local'
1a2b090c-299d-4c20-a25d-57dd21a7085b
```

TIP

If the nodes you tagged and registered use multiple disks, you can set director to use a specific root disk on each node. For more information, see Section 2.5, “Defining the root disk for multi-disk clusters”.

Redeploying the overcloud with additional Ceph Storage nodes

After you register and tag the new nodes, you can scale up the number of Ceph Storage nodes by redeploying the overcloud.

Procedure

1. Before you redeploy the overcloud, set the **CephStorageCount** parameter in the **parameter_defaults** of your environment file, in this case, **~/templates/storage-config.yaml**. In Section 7.1, “Assigning nodes and flavors to roles”, the overcloud is configured to deploy with three Ceph Storage nodes. The following example scales the overcloud to 6 nodes:

```
parameter_defaults:
  ControllerCount: 3
  OvercloudControlFlavor: control
  ComputeCount: 3
  OvercloudComputeFlavor: compute
  CephStorageCount: 6
  OvercloudCephStorageFlavor: ceph-storage
  CephMonCount: 3
  OvercloudCephMonFlavor: ceph-mon
```

2. Redeploy the overcloud. The overcloud now has six Ceph Storage nodes instead of three.

11.2. SCALING DOWN AND REPLACING CEPH STORAGE NODES

In some cases, you might need to scale down your Ceph cluster, or even replace a Ceph Storage node, for example, if a Ceph Storage node is faulty. In either situation, you must disable and rebalance any Ceph Storage node that you want to remove from the overcloud to avoid data loss.

NOTE

This procedure uses steps from the *Red Hat Ceph Storage Administration Guide* to manually remove Ceph Storage nodes. For more in-depth information about manual removal of Ceph Storage nodes, see Starting, stopping, and restarting Ceph daemons that run in containers and Removing a Ceph OSD using the command-line interface .

Procedure

1. Log in to a Controller node as the **heat-admin** user. The director **stack** user has an SSH key to access the **heat-admin** user.

2. List the OSD tree and find the OSDs for your node. For example, the node you want to remove might contain the following OSDs:

```
-2 0.09998     host overcloud-cephstorage-0
0 0.04999        osd.0                 up  1.00000        1.00000
1 0.04999        osd.1                 up  1.00000        1.00000
```

3. Disable the OSDs on the Ceph Storage node. In this case, the OSD IDs are 0 and 1.

```
[heat-admin@overcloud-controller-0 ~]$ sudo podman exec ceph-mon-<HOSTNAME> ceph osd out 0
[heat-admin@overcloud-controller-0 ~]$ sudo podman exec ceph-mon-<HOSTNAME> ceph osd out 1
```

4. The Ceph Storage cluster begins rebalancing. Wait for this process to complete. Follow the status by using the following command:

```
[heat-admin@overcloud-controller-0 ~]$ sudo podman exec ceph-mon-<HOSTNAME> ceph -w
```

5. After the Ceph cluster completes rebalancing, log in to the Ceph Storage node you are removing, in this case, **overcloud-cephstorage-0**, as the **heat-admin** user, and stop and disable the node.

```
[heat-admin@overcloud-cephstorage-0 ~]$ sudo systemctl stop ceph-osd@0
[heat-admin@overcloud-cephstorage-0 ~]$ sudo systemctl stop ceph-osd@1
[heat-admin@overcloud-cephstorage-0 ~]$ sudo systemctl disable ceph-osd@0
[heat-admin@overcloud-cephstorage-0 ~]$ sudo systemctl disable ceph-osd@1
```

6. Stop the OSDs.

```
[heat-admin@overcloud-cephstorage-0 ~]$ sudo systemctl stop ceph-osd@0
[heat-admin@overcloud-cephstorage-0 ~]$ sudo systemctl stop ceph-osd@1
```

7. While logged in to the Controller node, remove the OSDs from the CRUSH map so that they no longer receive data.

```
[heat-admin@overcloud-controller-0 ~]$ sudo podman exec ceph-mon-<HOSTNAME> ceph osd crush remove osd.0
[heat-admin@overcloud-controller-0 ~]$ sudo podman exec ceph-mon-<HOSTNAME> ceph osd crush remove osd.1
```

8. Remove the OSD authentication key.

```
[heat-admin@overcloud-controller-0 ~]$ sudo podman exec ceph-mon-<HOSTNAME> ceph auth del osd.0
[heat-admin@overcloud-controller-0 ~]$ sudo podman exec ceph-mon-<HOSTNAME> ceph auth del osd.1
```

9. Remove the OSD from the cluster.

```
[heat-admin@overcloud-controller-0 ~]$ sudo podman exec ceph-mon-<HOSTNAME> ceph osd rm 0
[heat-admin@overcloud-controller-0 ~]$ sudo podman exec ceph-mon-<HOSTNAME> ceph osd rm 1
```

10. Remove the Storage node from the CRUSH map:

```
[heat-admin@overcloud-controller-0 ~]$ sudo docker exec ceph-mon-<HOSTNAME> ceph osd crush rm <NODE>
[heat-admin@overcloud-controller-0 ~]$ sudo ceph osd crush remove <NODE>
```

You can confirm the <NODE> name as defined in the CRUSH map by searching the CRUSH tree:

```
[heat-admin@overcloud-controller-0 ~]$ sudo podman exec ceph-mon-<HOSTNAME> ceph osd crush tree | grep overcloud-osd-compute-3 -A 4
            "name": "overcloud-osd-compute-3",
            "type": "host",
            "type_id": 1,
            "items": []
        },
[heat-admin@overcloud-controller-0 ~]$
```

In the CRUSH tree, ensure that the items list is empty. If the list is not empty, revisit step 7.

11. Leave the node and return to the undercloud as the **stack** user.

```
[heat-admin@overcloud-controller-0 ~]$ exit
[stack@director ~]$
```

12. Disable the Ceph Storage node so that director does not reprovision it.

```
[stack@director ~]$ openstack baremetal node list
[stack@director ~]$ openstack baremetal node maintenance set UUID
```

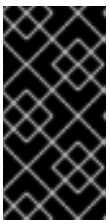
13. Removing a Ceph Storage node requires an update to the **overcloud** stack in director with the local template files. First identify the UUID of the overcloud stack:

```
$ openstack stack list
```

14. Identify the UUIDs of the Ceph Storage node you want to delete:

```
$ openstack server list
```

15. Delete the node from the stack and update the plan accordingly:



IMPORTANT

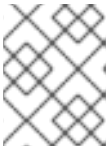
If you passed any extra environment files when you created the overcloud, pass them again here using the **-e** option to avoid making undesired changes to the overcloud. For more information, see Modifying the overcloud environment in the *Director Installation and Usage* guide.

```
$ openstack overcloud node delete /
--stack <stack-name> /
--templates /
-e <other-environment-files> /
<node_UUID>
```

16. Wait until the stack completes its update. Use the **heat stack-list --show-nested** command to monitor the stack update.

17. Add new nodes to the director node pool and deploy them as Ceph Storage nodes. Use the **CephStorageCount** parameter in **parameter_defaults** of your environment file, in this case, **~/templates/storage-config.yaml**, to define the total number of Ceph Storage nodes in the overcloud.

```
parameter_defaults:
  ControllerCount: 3
  OvercloudControlFlavor: control
  ComputeCount: 3
  OvercloudComputeFlavor: compute
  CephStorageCount: 3
  OvercloudCephStorageFlavor: ceph-storage
  CephMonCount: 3
  OvercloudCephMonFlavor: ceph-mon
```



NOTE

For more information about how to define the number of nodes per role, see Section 7.1, “Assigning nodes and flavors to roles” .

18. After you update your environment file, redeploy the overcloud:

```
$ openstack overcloud deploy --templates -e <ENVIRONMENT_FILE>
```

Director provisions the new node and updates the entire stack with the details of the new node.

19. Log in to a Controller node as the **heat-admin** user and check the status of the Ceph Storage node:

```
-
```

```
[heat-admin@overcloud-controller-0 ~]$ sudo ceph status
```

20. Confirm that the value in the **osdmap** section matches the number of nodes in your cluster that you want. The Ceph Storage node that you removed is replaced with a new node.

11.3. ADDING AN OSD TO A CEPH STORAGE NODE

This procedure demonstrates how to add an OSD to a node. For more information about Ceph OSDs, see Ceph OSDs in the *Red Hat Ceph Storage Operations Guide* .

Procedure

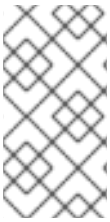
1. Notice the following heat template deploys Ceph Storage with three OSD devices:

```
parameter_defaults:
  CephAnsibleDisksConfig:
    devices:
      - /dev/sdb
      - /dev/sdc
      - /dev/sdd
    osd_scenario: lvm
    osd_objectstore: bluestore
```

2. To add an OSD, update the node disk layout as described in Section 5.3, "Mapping the Ceph Storage node disk layout". In this example, add **/dev/sde** to the template:

```
parameter_defaults:
  CephAnsibleDisksConfig:
    devices:
      - /dev/sdb
      - /dev/sdc
      - /dev/sdd
      - /dev/sde
    osd_scenario: lvm
    osd_objectstore: bluestore
```

3. Run **openstack overcloud deploy** to update the overcloud.



NOTE

This example assumes that all hosts with OSDs have a new device called **/dev/sde**. If you do not want all nodes to have the new device, update the heat template as shown and see Section 5.5, "Mapping the disk layout to non-homogeneous Ceph Storage nodes" for information about how to define hosts with a differing **devices** list.

11.4. REMOVING AN OSD FROM A CEPH STORAGE NODE

This procedure demonstrates how to remove an OSD from a node. It assumes the following about the environment:

- A server (**ceph-storage0**) has an OSD (**ceph-osd@4**) running on **/dev/sde**.
- The Ceph monitor service (**ceph-mon**) is running on **controller0**.

- There are enough available OSDs to ensure the storage cluster is not at its near-full ratio.

For more information about Ceph OSDs, see Ceph OSDs in the *Red Hat Ceph Storage Operations Guide*.

Procedure

1. SSH into **ceph-storage0** and log in as **root**.
2. Disable and stop the OSD service:

```
[root@ceph-storage0 ~]# systemctl disable ceph-osd@4
[root@ceph-stoarge0 ~]# systemctl stop ceph-osd@4
```

3. Disconnect from **ceph-storage0**.
4. SSH into **controller0** and log in as **root**.
5. Identify the name of the Ceph monitor container:

```
[root@controller0 ~]# podman ps | grep ceph-mon
ceph-mon-controller0
[root@controller0 ~]#
```

6. Enable the Ceph monitor container to mark the undesired OSD as **out**:

```
[root@controller0 ~]# podman exec ceph-mon-controller0 ceph osd out 4
```

NOTE

This command causes Ceph to rebalance the storage cluster and copy data to other OSDs in the cluster. The cluster temporarily leaves the **active+clean** state until rebalancing is complete.

7. Run the following command and wait for the storage cluster state to become **active+clean**:

```
[root@controller0 ~]# podman exec ceph-mon-controller0 ceph -w
```

8. Remove the OSD from the CRUSH map so that it no longer receives data:

```
[root@controller0 ~]# podman exec ceph-mon-controller0 ceph osd crush remove osd.4
```

9. Remove the OSD authentication key:

```
[root@controller0 ~]# podman exec ceph-mon-controller0 ceph auth del osd.4
```

10. Remove the OSD:

```
[root@controller0 ~]# podman exec ceph-mon-controller0 ceph osd rm 4
```

11. Disconnect from **controller0**.

12. SSH into the undercloud as the **stack** user and locate the heat environment file in which you defined the **CephAnsibleDisksConfig** parameter.

13. Notice the heat template contains four OSDs:

```
parameter_defaults:
  CephAnsibleDisksConfig:
    devices:
      - /dev/sdb
      - /dev/sdc
      - /dev/sdd
      - /dev/sde
    osd_scenario: lvm
    osd_objectstore: bluestore
```

14. Modify the template to remove /**dev**/**sde**.

```
parameter_defaults:
  CephAnsibleDisksConfig:
    devices:
      - /dev/sdb
      - /dev/sdc
      - /dev/sdd
    osd_scenario: lvm
    osd_objectstore: bluestore
```

15. Run **openstack overcloud deploy** to update the overcloud.

NOTE

This example assumes that you removed the /**dev**/**sde** device from all hosts with OSDs. If you do not remove the same device from all nodes, update the heat template as shown and see Section 5.5, “Mapping the disk layout to non-homogeneous Ceph Storage nodes” for information about how to define hosts with a differing **devices** list.

CHAPTER 12. REPLACING A FAILED DISK

If one of the disks fails in your Ceph cluster, complete the following procedures to replace it:

1. Determining if there is a device name change, see Section 12.1, "Determining if there is a device name change".
2. Ensuring that the OSD is down and destroyed, see Section 12.2, "Ensuring that the OSD is down and destroyed".
3. Removing the old disk from the system and installing the replacement disk, see Section 12.3, "Removing the old disk from the system and installing the replacement disk".
4. Verifying that the disk replacement is successful, see Section 12.4, "Verifying that the disk replacement is successful".

12.1. DETERMINING IF THERE IS A DEVICE NAME CHANGE

Before you replace the disk, determine if the replacement disk for the replacement OSD has a different name in the operating system than the device that you want to replace. If the replacement disk has a different name, you must update Ansible parameters for the devices list so that subsequent runs of **ceph-ansible**, including when director runs **ceph-ansible**, do not fail as a result of the change. For an example of the devices list that you must change when you use director, see Section 5.3, "Mapping the Ceph Storage node disk layout".

WARNING

If the device name changes and you use the following procedures to update your system outside of **ceph-ansible** or director, there is a risk that the configuration management tools are out of sync with the system that they manage until you update the system definition files and the configuration is reasserted without error.

Persistent naming of storage devices

Storage devices that the **sd** driver manages might not always have the same name across reboots. For example, a disk that is normally identified by **/dev/sdc** might be named **/dev/sdb**. It is also possible for the replacement disk, **/dev/sdc**, to appear in the operating system as **/dev/sdd** even if you want to use it as a replacement for **/dev/sdc**. To address this issue, use names that are persistent and match the following pattern: **/dev/disk/by-***. For more information, see Persistent Naming in the Red Hat Enterprise Linux (RHEL) 7 *Storage Administration Guide*.

Depending on the naming method that you use to deploy Ceph, you might need to update the **devices** list after you replace the OSD. Use the following list of naming methods to determine if you must change the devices list:

The major and minor number range method

If you used **sd** and want to continue to use it, after you install the new disk, check if the name has changed. If the name did not change, for example, if the same name appears correctly as **/dev/sdd**, it is not necessary to change the name after you complete the disk replacement procedures.

IMPORTANT

This naming method is not recommended because there is still a risk that the name becomes inconsistent over time. For more information, see Persistent Naming in the RHEL 7 *Storage Administration Guide*.

The by-path method

If you use this method, and you add a replacement disk in the same slot, then the path is consistent and no change is necessary.

IMPORTANT

Although this naming method is preferable to the major and minor number range method, use caution to ensure that the target numbers do not change. For example, use persistent binding and update the names if a host adapter is moved to a different PCI slot. In addition, there is the possibility that the SCSI host numbers can change if a HBA fails to probe, if drivers are loaded in a different order, or if a new HBA is installed on the system. The **by-path** naming method also differs between RHEL7 and RHEL8. For more information, see:

- Article [What is the difference between "by-path" links created in RHEL8 and RHEL7?] https://access.redhat.com/solutions/5171991
- Overview of persistent naming attributes in the RHEL 8 *Managing file systems* guide.

The by-uuid method

If you use this method, you can use the **blkid** utility to set the new disk to have the same UUID as the old disk. For more information, see Persistent Naming in the RHEL 7 *Storage Administration Guide*.

The by-id method

If you use this method, you must change the devices list because this identifier is a property of the device and the device has been replaced.

When you add the new disk to the system, if it is possible to modify the persistent naming attributes according to the *RHEL7 Storage Administrator Guide* , see Persistent Naming, so that the device name is unchanged, then it is not necessary to update the devices list and re-run **ceph-ansible**, or trigger director to re-run **ceph-ansible** and you can proceed with the disk replacement procedures. However, you can re-run **ceph-ansible** to ensure that the change did not result in any inconsistencies.

12.2. ENSURING THAT THE OSD IS DOWN AND DESTROYED

On the server that hosts the Ceph Monitor, use the **ceph** command in the running monitor container to ensure that the OSD that you want to replace is down, and then destroy it.

Procedure

1. Identify the name of the running Ceph monitor container and store it in an environment variable called **MON**:

```
MON=$(podman ps | grep ceph-mon | awk {'print $1'})
```

2. Alias the **ceph** command so that it executes within the running Ceph monitor container:

```
alias ceph="podman exec $MON ceph"
```

3. Use the new alias to verify that the OSD that you want to replace is down:

```
[root@overcloud-controller-0 ~]# ceph osd tree | grep 27
27   hdd 0.04790         osd.27                 down  1.00000 1.00000
```

4. Destroy the OSD. The following example command destroys **OSD 27**:

```
[root@overcloud-controller-0 ~]# ceph osd destroy 27 --yes-i-really-mean-it
destroyed osd.27
```

12.3. REMOVING THE OLD DISK FROM THE SYSTEM AND INSTALLING THE REPLACEMENT DISK

On the container host with the OSD that you want to replace, remove the old disk from the system and install the replacement disk.

Prerequisites:

- Verify that the device ID has changed. For more information, see Section 12.1, "Determining if there is a device name change".

The **ceph-volume** command is present in the Ceph container but is not installed on the overcloud node. Create an alias so that the **ceph-volume** command runs the **ceph-volume** binary inside the Ceph container. Then use the **ceph-volume** command to clean the new disk and add it as an OSD.

Procedure

1. Ensure that the failed OSD is not running:

```
systemctl stop ceph-osd@27
```

2. Identify the image ID of the ceph container image and store it in an environment variable called **IMG**:

```
IMG=$(podman images | grep ceph | awk {'print $3'})
```

3. Alias the **ceph-volume** command so that it runs inside the **$IMG** Ceph container, with the **ceph-volume** entry point and relevant directories:

```
alias ceph-volume="podman run --rm --privileged --net=host --ipc=host -v
/run/lock/lvm:/run/lock/lvm:z -v /var/run/udev/:/var/run/udev/:z -v /dev:/dev -v
/etc/ceph:/etc/ceph:z -v /var/lib/ceph/:/var/lib/ceph/:z -v /var/log/ceph/:/var/log/ceph/:z --
entrypoint=ceph-volume $IMG --cluster ceph"
```

4. Verify that the aliased command runs successfully:

```
ceph-volume lvm list
```

5. Check that your new OSD device is not already part of LVM. Use the **pvdisplay** command to inspect the device, and ensure that the **VG Name** field is empty. Replace **<NEW_DEVICE>** with the /**dev**/* path of your new OSD device:

```
[root@overcloud-computehci-2 ~]# pvdisplay <NEW_DEVICE>
  --- Physical volume ---
  PV Name               /dev/sdj
  VG Name               ceph-0fb0de13-fc8e-44c8-99ea-911e343191d2
  PV Size               50.00 GiB / not usable 1.00 GiB
  Allocatable           yes (but full)
  PE Size               1.00 GiB
  Total PE              49
  Free PE               0
  Allocated PE          49
  PV UUID               kOO0If-ge2F-UH44-6S1z-9tAv-7ypT-7by4cp
[root@overcloud-computehci-2 ~]#
```

If the **VG Name** field is not empty, then the device belongs to a volume group that you must remove.

6. If the device belongs to a volume group, use the **lvdisplay** command to check if there is a logical volume in the volume group. Replace **<VOLUME_GROUP>** with the value of the **VG Name** field that you retrieved from the **pvdisplay** command:

```
[root@overcloud-computehci-2 ~]# lvdisplay | grep <VOLUME_GROUP>
  LV Path                /dev/ceph-0fb0de13-fc8e-44c8-99ea-911e343191d2/osd-data-a0810722-
7673-43c7-8511-2fd9db1dbbc6
  VG Name                ceph-0fb0de13-fc8e-44c8-99ea-911e343191d2
[root@overcloud-computehci-2 ~]#
```

If the **LV Path** field is not empty, then the device contains a logical volume that you must remove.

7. If the new device is part of a logical volume or volume group, remove the logical volume, volume group, and the device association as a physical volume within the LVM system.

   - Replace **<LV_PATH>** with the value of the **LV Path** field.
   - Replace **<VOLUME_GROUP>** with the value of the **VG Name** field.
   - Replace **<NEW_DEVICE>** with the /**dev**/* path of your new OSD device.

```
[root@overcloud-computehci-2 ~]# lvremove --force <LV_PATH>
  Logical volume "osd-data-a0810722-7673-43c7-8511-2fd9db1dbbc6" successfully
removed
```

```
[root@overcloud-computehci-2 ~]# vgremove --force <VOLUME_GROUP>
  Volume group "ceph-0fb0de13-fc8e-44c8-99ea-911e343191d2" successfully removed
```

```
[root@overcloud-computehci-2 ~]# pvremove <NEW_DEVICE>
  Labels on physical volume "/dev/sdj" successfully wiped.
```

8. Ensure that the new OSD device is clean. In the following example, the device is /**dev**/**sdj**:

```
[root@overcloud-computehci-2 ~]# ceph-volume lvm zap /dev/sdj
```

```
--> Zapping: /dev/sdj
--> --destroy was not specified, but zapping a whole device will remove the partition table
Running command: /usr/sbin/wipefs --all /dev/sdj
Running command: /bin/dd if=/dev/zero of=/dev/sdj bs=1M count=10
 stderr: 10+0 records in
10+0 records out
10485760 bytes (10 MB, 10 MiB) copied, 0.010618 s, 988 MB/s
--> Zapping successful for: <Raw Device: /dev/sdj>
[root@overcloud-computehci-2 ~]#
```

9. Create the new OSD with the existing OSD ID by using the new device but pass **--no-systemd** so that **ceph-volume** does not attempt to start the OSD. This is not possible from within the container:

```
ceph-volume lvm create --osd-id 27 --data /dev/sdj --no-systemd
```

10. Start the OSD outside of the container:

```
systemctl start ceph-osd@27
```

12.4. VERIFYING THAT THE DISK REPLACEMENT IS SUCCESSFUL

To check that your disk replacement is successful, on the undercloud, complete the following steps.

Procedure

1. Check if the device name changed, update the devices list according to the naming method you used to deploy Ceph. For more information, see Section 12.1, “Determining if there is a device name change”.

2. To ensure that the change did not introduce any inconsistencies, re-run the overcloud deploy command to perform a stack update.

3. In cases where you have hosts that have different device lists, you might have to define an exception. For example, you might use the following example heat environment file to deploy a node with three OSD devices.

```
parameter_defaults:
  CephAnsibleDisksConfig:
    devices:
      - /dev/sdb
      - /dev/sdc
      - /dev/sdd
    osd_scenario: lvm
    osd_objectstore: bluestore
```

The **CephAnsibleDisksConfig** parameter applies to all nodes that host OSDs, so you cannot update the **devices** parameter with the new device list. Instead, you must define an exception for the new host that has a different device list. For more information about defining an exception, see Section 5.5, “Mapping the disk layout to non-homogeneous Ceph Storage nodes”.

APPENDIX A. SAMPLE ENVIRONMENT FILE: CREATING A CEPH STORAGE CLUSTER

The following custom environment file uses many of the options described throughout Chapter 2, *Preparing Ceph Storage nodes for overcloud deployment* . This sample does not include any commented-out options. For an overview on environment files, see Environment Files (from the Advanced Overcloud Customization guide).

/home/stack/templates/storage-config.yaml

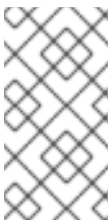
```
parameter_defaults: 1
  CinderBackupBackend: ceph 2
  CephAnsibleDisksConfig: 3
    osd_scenario: lvm
    osd_objectstore: bluestore
    dmcrypt: true
    devices:
      - /dev/disk/by-path/pci-0000:03:00.0-scsi-0:0:10:0
      - /dev/disk/by-path/pci-0000:03:00.0-scsi-0:0:11:0
      - /dev/nvme0n1
  ControllerCount: 3 4
  OvercloudControlFlavor: control
  ComputeCount: 3
  OvercloudComputeFlavor: compute
  CephStorageCount: 3
  OvercloudCephStorageFlavor: ceph-storage
  CephMonCount: 3
  OvercloudCephMonFlavor: ceph-mon
  CephMdsCount: 3
  OvercloudCephMdsFlavor: ceph-mds
  NeutronNetworkType: vxlan 5
```

1. The **parameter_defaults** section modifies the default values for parameters in all templates. Most of the entries listed here are described in Chapter 4, *Customizing the Storage service* .

2. If you are deploying the Ceph Object Gateway, you can use Ceph Object Storage (**ceph-rgw**) as a backup target. To configure this, set **CinderBackupBackend** to **swift**. See Section 4.2, "Enabling the Ceph Object Gateway" for details.

3. The **CephAnsibleDisksConfig** section defines a custom disk layout for deployments using BlueStore.

4. For each role, the ***Count** parameters assign a number of nodes while the **Overcloud*Flavor** parameters assign a flavor. For example, **ControllerCount: 3** assigns 3 nodes to the Controller role, and **OvercloudControlFlavor: control** sets each of those roles to use the **control** flavor. See Section 7.1, "Assigning nodes and flavors to roles" for details.



NOTE

The **CephMonCount**, **CephMdsCount**, **OvercloudCephMonFlavor**, and **OvercloudCephMdsFlavor** parameters (along with the **ceph-mon** and **ceph-mds** flavors) will only be valid if you created a custom **CephMON** and **CephMds** role, as described in Chapter 3, *Deploying Ceph services on dedicated nodes* .

5 **NeutronNetworkType:** sets the network type that the **neutron** service should use (in this case, **vxlan**).

APPENDIX B. SAMPLE CUSTOM INTERFACE TEMPLATE: MULTIPLE BONDED INTERFACES

The following template is a customized version of **/usr/share/openstack-tripleo-heat-templates/network/config/bond-with-vlans/ceph-storage.yaml**. It features multiple bonded interfaces to isolate back-end and front-end storage network traffic, along with redundancy for both connections, as described in Section 4.5, "Configuring multiple bonded interfaces for Ceph nodes" .

It also uses custom bonding options, **'mode=4 lacp_rate=1'**, as described in Section 4.5.1, "Configuring bonding module directives".

/usr/share/openstack-tripleo-heat-templates/network/config/bond-with-vlans/ceph-storage.yaml (custom)

```
heat_template_version: 2015-04-30

description: >
  Software Config to drive os-net-config with 2 bonded nics on a bridge
  with VLANs attached for the ceph storage role.

parameters:
  ControlPlaneIp:
    default: ''
    description: IP address/subnet on the ctlplane network
    type: string
  ExternalIpSubnet:
    default: ''
    description: IP address/subnet on the external network
    type: string
  InternalApiIpSubnet:
    default: ''
    description: IP address/subnet on the internal API network
    type: string
  StorageIpSubnet:
    default: ''
    description: IP address/subnet on the storage network
    type: string
  StorageMgmtIpSubnet:
    default: ''
    description: IP address/subnet on the storage mgmt network
    type: string
  TenantIpSubnet:
    default: ''
    description: IP address/subnet on the tenant network
    type: string
  ManagementIpSubnet: # Only populated when including environments/network-management.yaml
    default: ''
    description: IP address/subnet on the management network
    type: string
  BondInterfaceOvsOptions:
    default: 'mode=4 lacp_rate=1'
    description: The bonding_options string for the bond interface. Set
                 things like lacp=active and/or bond_mode=balance-slb
                 using this option.
    type: string
```

```
    constraints:
      - allowed_pattern: "^((?!balance.tcp).)*$"
        description: |
          The balance-tcp bond mode is known to cause packet loss and
          should not be used in BondInterfaceOvsOptions.
  ExternalNetworkVlanID:
    default: 10
    description: Vlan ID for the external network traffic.
    type: number
  InternalApiNetworkVlanID:
    default: 20
    description: Vlan ID for the internal_api network traffic.
    type: number
  StorageNetworkVlanID:
    default: 30
    description: Vlan ID for the storage network traffic.
    type: number
  StorageMgmtNetworkVlanID:
    default: 40
    description: Vlan ID for the storage mgmt network traffic.
    type: number
  TenantNetworkVlanID:
    default: 50
    description: Vlan ID for the tenant network traffic.
    type: number
  ManagementNetworkVlanID:
    default: 60
    description: Vlan ID for the management network traffic.
    type: number
  ControlPlaneSubnetCidr: # Override this via parameter_defaults
    default: '24'
    description: The subnet CIDR of the control plane network.
    type: string
  ControlPlaneDefaultRoute: # Override this via parameter_defaults
    description: The default route of the control plane network.
    type: string
  ExternalInterfaceDefaultRoute: # Not used by default in this template
    default: '10.0.0.1'
    description: The default route of the external network.
    type: string
  ManagementInterfaceDefaultRoute: # Commented out by default in this template
    default: unset
    description: The default route of the management network.
    type: string
  DnsServers: # Override this via parameter_defaults
    default: []
    description: A list of DNS servers (2 max for some implementations) that will be added to
resolv.conf.
    type: comma_delimited_list
  EC2MetadataIp: # Override this via parameter_defaults
    description: The IP address of the EC2 metadata server.
    type: string

resources:
  OsNetConfigImpl:
    type: OS::Heat::StructuredConfig
```

```
properties:
  group: os-apply-config
  config:
    os_net_config:
      network_config:
        -
          type: interface
          name: nic1
          use_dhcp: false
          dns_servers: {get_param: DnsServers}
          addresses:
            -
              ip_netmask:
                list_join:
                  - '/'
                  - - {get_param: ControlPlaneIp}
                    - {get_param: ControlPlaneSubnetCidr}
          routes:
            -
              ip_netmask: 169.254.169.254/32
              next_hop: {get_param: EC2MetadataIp}
            -
              default: true
              next_hop: {get_param: ControlPlaneDefaultRoute}
        -
          type: ovs_bridge
          name: br-bond
          members:
            -
              type: linux_bond
              name: bond1
              bonding_options: {get_param: BondInterfaceOvsOptions}
              members:
                -
                  type: interface
                  name: nic2
                  primary: true
                -
                  type: interface
                  name: nic3
            -
              type: vlan
              device: bond1
              vlan_id: {get_param: StorageNetworkVlanID}
              addresses:
                -
                  ip_netmask: {get_param: StorageIpSubnet}
        -
          type: ovs_bridge
          name: br-bond2
          members:
            -
              type: linux_bond
              name: bond2
              bonding_options: {get_param: BondInterfaceOvsOptions}
              members:
```

```
                -
                  type: interface
                  name: nic4
                  primary: true
                -
                  type: interface
                  name: nic5
              -
                type: vlan
                device: bond1
                vlan_id: {get_param: StorageMgmtNetworkVlanID}
                addresses:
                  -
                    ip_netmask: {get_param: StorageMgmtIpSubnet}
outputs:
  OS::stack_id:
    description: The OsNetConfigImpl resource.
    value: {get_resource: OsNetConfigImpl}
```