Red Hat Ceph Storage 7

Administration Guide

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Abstract

This document describes how to manage processes, monitor cluster states, manage users, and add and remove daemons for Red Hat Ceph Storage. Red Hat is committed to replacing problematic language in our code, documentation, and web properties. We are beginning with these four terms: master, slave, blacklist, and whitelist. Because of the enormity of this endeavor, these changes will be implemented gradually over several upcoming releases. For more details, see our CTO Chris Wright's message.

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CHAPTER 1. CEPH ADMINISTRATION

A Red Hat Ceph Storage cluster is the foundation for all Ceph deployments. After deploying a Red Hat Ceph Storage cluster, there are administrative operations for keeping a Red Hat Ceph Storage cluster healthy and performing optimally.

The Red Hat Ceph Storage Administration Guide helps storage administrators to perform such tasks as:

- How do I check the health of my Red Hat Ceph Storage cluster?
- How do I start and stop the Red Hat Ceph Storage cluster services?
- How do I add or remove an OSD from a running Red Hat Ceph Storage cluster?
- How do I manage user authentication and access controls to the objects stored in a Red Hat Ceph Storage cluster?
- I want to understand how to use overrides with a Red Hat Ceph Storage cluster.
- I want to monitor the performance of the Red Hat Ceph Storage cluster.

A basic Ceph storage cluster consist of two types of daemons:

- A Ceph Object Storage Device (OSD) stores data as objects within placement groups assigned to the OSD
- A Ceph Monitor maintains a master copy of the cluster map

A production system will have three or more Ceph Monitors for high availability and typically a minimum of 50 OSDs for acceptable load balancing, data re-balancing and data recovery.

CHAPTER 2. UNDERSTANDING PROCESS MANAGEMENT FOR CEPH

As a storage administrator, you can manipulate the various Ceph daemons by type or instance in a Red Hat Ceph Storage cluster. Manipulating these daemons allows you to start, stop and restart all of the Ceph services as needed.

2.1. CEPH PROCESS MANAGEMENT

In Red Hat Ceph Storage, all process management is done through the Systemd service. Each time you want to **start**, **restart**, and **stop** the Ceph daemons, you must specify the daemon type or the daemon instance.

Additional Resources

- For more information on using **systemd**, see Managing system services with systemctl.

2.2. STARTING, STOPPING, AND RESTARTING ALL CEPH DAEMONS USING SYSTEMCTL COMMAND

You can start, stop, and restart all Ceph daemons as the root user from the host where you want to stop the Ceph daemons.

Prerequisites

- A running Red Hat Ceph Storage cluster.
- Having **root** access to the node.

Procedure

1. On the host where you want to start, stop, and restart the daemons, run the systemctl service to get the *SERVICE_ID* of the service.

   #### Example

   ```
   [root@host01 ~]# systemctl --type=service
   ceph-499829b4-832f-11eb-8d6d-001a4a000635@mon.host01.service
   ```

2. Starting all Ceph daemons:

   #### Syntax

   ```
   systemctl start SERVICE_ID
   ```

   #### Example

   ```
   [root@host01 ~]# systemctl start ceph-499829b4-832f-11eb-8d6d-
   001a4a000635@mon.host01.service
   ```

3. Stopping all Ceph daemons:

Syntax

```
systemctl stop SERVICE_ID
```

Example

```
[root@host01 ~]# systemctl stop ceph-499829b4-832f-11eb-8d6d-
001a4a000635@mon.host01.service
```

4. Restarting all Ceph daemons:

Syntax

```
systemctl restart SERVICE_ID
```

Example

```
[root@host01 ~]# systemctl restart ceph-499829b4-832f-11eb-8d6d-
001a4a000635@mon.host01.service
```

2.3. STARTING, STOPPING, AND RESTARTING ALL CEPH SERVICES

Ceph services are logical groups of Ceph daemons of the same type, configured to run in the same Red Hat Ceph Storage cluster. The orchestration layer in Ceph allows the user to manage these services in a centralized way, making it easy to execute operations that affect all the Ceph daemons that belong to the same logical service. The Ceph daemons running in each host are managed through the Systemd service. You can start, stop, and restart all Ceph services from the host where you want to manage the Ceph services.

IMPORTANT

If you want to start,stop, or restart a specific Ceph daemon in a specific host, you need to use the SystemD service. To obtain a list of the SystemD services running in a specific host, connect to the host, and run the following command:

Example

```
[root@host01 ~]# systemctl list-units “ceph*”
```

The output will give you a list of the service names that you can use, to manage each Ceph daemon.

Prerequisites

- A running Red Hat Ceph Storage cluster.
- Having **root** access to the node.

Procedure

1. Log into the Cephadm shell:

Example

```
[root@host01 ~]# cephadm shell
```

2. Run the **ceph orch ls** command to get a list of Ceph services configured in the Red Hat Ceph Storage cluster and to get the specific service ID.

Example

```
[ceph: root@host01 /]# ceph orch ls
NAME                       RUNNING  REFRESHED  AGE  PLACEMENT  IMAGE NAME
IMAGE ID
alertmanager                1/1  4m ago     4M   count:1    registry.redhat.io/openshift4/ose-
prometheus-alertmanager:v4.5   b7bae610cd46
crash                       3/3  4m ago     4M   *          registry.redhat.io/rhceph-alpha/rhceph-6-
rhel9:latest           c88a5d60f510
grafana                     1/1  4m ago     4M   count:1    registry.redhat.io/rhceph-alpha/rhceph-6-
dashboard-rhel9:latest  bd3d7748747b
mgr                         2/2  4m ago     4M   count:2    registry.redhat.io/rhceph-alpha/rhceph-6-
rhel9:latest           c88a5d60f510
mon                         2/2  4m ago     10w  count:2    registry.redhat.io/rhceph-alpha/rhceph-6-
rhel9:latest           c88a5d60f510
nfs.foo                     0/1  -          -    count:1    <unknown>
<unknown>
node-exporter               1/3  4m ago     4M   *          registry.redhat.io/openshift4/ose-
prometheus-node-exporter:v4.5  mix
osd.all-available-devices   5/5  4m ago     3M   *          registry.redhat.io/rhceph-
alpha/rhceph-6-rhel9:latest           c88a5d60f510
prometheus                  1/1  4m ago     4M   count:1    registry.redhat.io/openshift4/ose-
prometheus:v4.6             bebb0ddef7f0
rgw.test_realm.test_zone    2/2  4m ago     3M   count:2    registry.redhat.io/rhceph-
alpha/rhceph-6-rhel9:latest           c88a5d60f510
```

3. To start a specific service, run the following command:

Syntax

```
ceph orch start SERVICE_ID
```

Example

```
[ceph: root@host01 /]# ceph orch start node-exporter
```

4. To stop a specific service, run the following command:

IMPORTANT

The **ceph orch stop SERVICE_ID** command results in the Red Hat Ceph Storage cluster being inaccessible, only for the MON and MGR service. It is recommended to use the **systemctl stop SERVICE_ID** command to stop a specific daemon in the host.

Syntax

```
ceph orch stop SERVICE_ID
```

Example

```
[ceph: root@host01 /]# ceph orch stop node-exporter
```

In the example the **ceph orch stop node-exporter** command removes all the daemons of the **node exporter** service.

5. To restart a specific service, run the following command:

Syntax

```
ceph orch restart SERVICE_ID
```

Example

```
[ceph: root@host01 /]# ceph orch restart node-exporter
```

2.4. VIEWING LOG FILES OF CEPH DAEMONS THAT RUN IN CONTAINERS

Use the **journald** daemon from the container host to view a log file of a Ceph daemon from a container.

Prerequisites

- Installation of the Red Hat Ceph Storage software.
- Root-level access to the node.

Procedure

1. To view the entire Ceph log file, run a **journalctl** command as **root** composed in the following format:

Syntax

```
journalctl -u ceph SERVICE_ID
```

Example

```
[root@host01 ~]# journalctl -u ceph-499829b4-832f-11eb-8d6d-
001a4a000635@osd.8.service
```

In the above example, you can view the entire log for the OSD with ID **osd.8**.

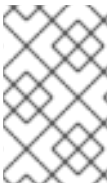
2. To show only the recent journal entries, use the **-f** option.

Syntax

```
journalctl -fu SERVICE_ID
```

Example

```
[root@host01 ~]# journalctl -fu ceph-499829b4-832f-11eb-8d6d-
001a4a000635@osd.8.service
```



NOTE

You can also use the **sosreport** utility to view the **journald** logs. For more details about SOS reports, see the What is an sosreport and how to create one in Red Hat Enterprise Linux? solution on the Red Hat Customer Portal.

Additional Resources

- The **journalctl** manual page.

2.5. POWERING DOWN AND REBOOTING RED HAT CEPH STORAGE CLUSTER

You can power down and reboot the Red Hat Ceph Storage cluster using two different approaches: **systemctl** commands and the Ceph Orchestrator. You can choose either approach to power down and reboot the cluster.

2.5.1. Powering down and rebooting the cluster using the systemctl commands

You can use the **systemctl** commands approach to power down and reboot the Red Hat Ceph Storage cluster. This approach follows the Linux way of stopping the services.

Prerequisites

- A running Red Hat Ceph Storage cluster.
- Root-level access.

Procedure

Powering down the Red Hat Ceph Storage cluster

1. Stop the clients from using the Block Device images RADOS Gateway - Ceph Object Gateway on this cluster and any other clients.
2. Log into the Cephadm shell:

   Example

   ```
   [root@host01 ~]# cephadm shell
   ```

3. The cluster must be in healthy state (**Health_OK** and all PGs **active+clean**) before proceeding. Run **ceph status** on the host with the client keyrings, for example, the Ceph Monitor or OpenStack controller nodes, to ensure the cluster is healthy.

   Example

   ```
   [ceph: root@host01 /]# ceph -s
   ```

4. If you use the Ceph File System (**CephFS**), bring down the **CephFS** cluster:

   Syntax

   ```
   ceph fs set FS_NAME max_mds 1
   ceph fs fail FS_NAME
   ceph status
   ceph fs set FS_NAME joinable false
   ```

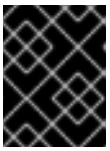
   Example

   ```
   [ceph: root@host01 /]# ceph fs set cephfs max_mds 1
   [ceph: root@host01 /]# ceph fs fail cephfs
   [ceph: root@host01 /]# ceph status
   [ceph: root@host01 /]# ceph fs set cephfs joinable false
   ```

5. Set the **noout**, **norecover**, **norebalance**, **nobackfill**, **nodown**, and **pause** flags. Run the following on a node with the client keyrings, for example, the Ceph Monitor or OpenStack controller node:

   Example

   ```
   [ceph: root@host01 /]# ceph osd set noout
   [ceph: root@host01 /]# ceph osd set norecover
   [ceph: root@host01 /]# ceph osd set norebalance
   [ceph: root@host01 /]# ceph osd set nobackfill
   [ceph: root@host01 /]# ceph osd set nodown
   [ceph: root@host01 /]# ceph osd set pause
   ```

   IMPORTANT

   The above example is only for stopping the service and each OSD in the OSD node and it needs to be repeated on each OSD node.

6. If the MDS and Ceph Object Gateway nodes are on their own dedicated nodes, power them off.

7. Shut down the OSD nodes one by one:

   Example

   ```
   [root@host01 ~]# systemctl stop ceph-499829b4-832f-11eb-8d6d-
   001a4a000635@osd.2.service
   ```

8. Shut down the monitor nodes one by one:

   Example

   ```
   [root@host01 ~]#  systemctl stop ceph-499829b4-832f-11eb-8d6d-
   001a4a000635@mon.host01.service
   ```

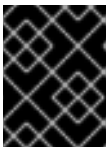
9. Shut down the admin node.

Rebooting the Red Hat Ceph Storage cluster

1. If network equipment was involved, ensure it is powered ON and stable prior to powering ON any Ceph hosts or nodes.
2. Power ON the administration node.
3. Power ON the monitor nodes:

   Example

   ```
   [root@host01 ~]# systemctl start ceph-499829b4-832f-11eb-8d6d-001a4a000635@mon.host01.service
   ```

   IMPORTANT

   The above example is only for stopping the service and each OSD in the OSD node and it needs to be repeated on each OSD node.

4. Power ON the OSD nodes:

   Example

   ```
   [root@host01 ~]# systemctl start ceph-499829b4-832f-11eb-8d6d-001a4a000635@osd.2.service
   ```

5. Wait for all the nodes to come up. Verify all the services are up and there are no connectivity issues between the nodes.
6. Unset the **noout**, **norecover**, **norebalance**, **nobackfill**, **nodown** and **pause** flags. Run the following on a node with the client keyrings, for example, the Ceph Monitor or OpenStack controller node:

   Example

   ```
   [ceph: root@host01 /]# ceph osd unset noout
   [ceph: root@host01 /]# ceph osd unset norecover
   [ceph: root@host01 /]# ceph osd unset norebalance
   [ceph: root@host01 /]# ceph osd unset nobackfill
   [ceph: root@host01 /]# ceph osd unset nodown
   [ceph: root@host01 /]# ceph osd unset pause
   ```

7. If you use the Ceph File System (**CephFS**), bring the **CephFS** cluster back up by setting the **joinable** flag to **true**:

   Syntax

   ```
   ceph fs set FS_NAME joinable true
   ```

   Example

   ```
   [ceph: root@host01 /]# ceph fs set cephfs joinable true
   ```

Verification

- Verify the cluster is in healthy state (**Health_OK** and all PGs **active+clean**). Run **ceph status** on a node with the client keyrings, for example, the Ceph Monitor or OpenStack controller nodes, to ensure the cluster is healthy.

Example

```
[ceph: root@host01 /]# ceph -s
```

Additional Resources

- For more information on installing Ceph, see the *Red Hat Ceph Storage Installation Guide*.

2.5.2. Powering down and rebooting the cluster using the Ceph Orchestrator

You can also use the capabilities of the Ceph Orchestrator to power down and reboot the Red Hat Ceph Storage cluster. In most cases, it is a single system login that can help in powering off the cluster.

The Ceph Orchestrator supports several operations, such as **start**, **stop**, and **restart**. You can use these commands with **systemctl**, for some cases, in powering down or rebooting the cluster.

Prerequisites

- A running Red Hat Ceph Storage cluster.
- Root-level access to the node.

Procedure

Powering down the Red Hat Ceph Storage cluster

1. Stop the clients from using the user Block Device Image and Ceph Object Gateway on this cluster and any other clients.
2. Log into the Cephadm shell:

   Example

   ```
   [root@host01 ~]# cephadm shell
   ```

3. The cluster must be in healthy state (**Health_OK** and all PGs **active+clean**) before proceeding. Run **ceph status** on the host with the client keyrings, for example, the Ceph Monitor or OpenStack controller nodes, to ensure the cluster is healthy.

   Example

   ```
   [ceph: root@host01 /]# ceph -s
   ```

4. If you use the Ceph File System (**CephFS**), bring down the **CephFS** cluster:

   Syntax

   ```
   ceph fs set FS_NAME max_mds 1
   ```

```
ceph fs fail FS_NAME
ceph status
ceph fs set FS_NAME joinable false
ceph mds fail FS_NAME:N
```

Example

```
[ceph: root@host01 /]# ceph fs set cephfs max_mds 1
[ceph: root@host01 /]# ceph fs fail cephfs
[ceph: root@host01 /]# ceph status
[ceph: root@host01 /]# ceph fs set cephfs joinable false
[ceph: root@host01 /]# ceph mds fail cephfs:1
```

5. Set the **noout**, **norecover**, **norebalance**, **nobackfill**, **nodown**, and **pause** flags. Run the following on a node with the client keyrings, for example, the Ceph Monitor or OpenStack controller node:

   Example

   ```
   [ceph: root@host01 /]# ceph osd set noout
   [ceph: root@host01 /]# ceph osd set norecover
   [ceph: root@host01 /]# ceph osd set norebalance
   [ceph: root@host01 /]# ceph osd set nobackfill
   [ceph: root@host01 /]# ceph osd set nodown
   [ceph: root@host01 /]# ceph osd set pause
   ```

6. Stop the MDS service.

   a. Fetch the MDS service name:

      Example

      ```
      [ceph: root@host01 /]# ceph orch ls --service-type mds
      ```

   b. Stop the MDS service using the fetched name in the previous step:

      Syntax

      ```
      ceph orch stop SERVICE-NAME
      ```

7. Stop the Ceph Object Gateway services. Repeat for each deployed service.

   a. Fetch the Ceph Object Gateway service names:

      Example

      ```
      [ceph: root@host01 /]# ceph orch ls --service-type rgw
      ```

   b. Stop the Ceph Object Gateway service using the fetched name:

      Syntax

      ```
      ceph orch stop SERVICE-NAME
      ```

8. Stop the Alertmanager service:

   Example

   ```
   [ceph: root@host01 /]# ceph orch stop alertmanager
   ```

9. Stop the node-exporter service which is a part of the monitoring stack:

   Example

   ```
   [ceph: root@host01 /]# ceph orch stop node-exporter
   ```

10. Stop the Prometheus service:

    Example

    ```
    [ceph: root@host01 /]# ceph orch stop prometheus
    ```

11. Stop the Grafana dashboard service:

    Example

    ```
    [ceph: root@host01 /]# ceph orch stop grafana
    ```

12. Stop the crash service:

    Example

    ```
    [ceph: root@host01 /]# ceph orch stop crash
    ```

13. Shut down the OSD nodes from the cephadm node, one by one. Repeat this step for all the OSDs in the cluster.

    a. Fetch the OSD ID:

       Example

       ```
       [ceph: root@host01 /]# ceph orch ps --daemon-type=osd
       ```

    b. Shut down the OSD node using the OSD ID you fetched:

       Example

       ```
       [ceph: root@host01 /]# ceph orch daemon stop osd.1
       Scheduled to stop osd.1 on host 'host02'
       ```

14. Stop the monitors one by one.

    a. Identify the hosts hosting the monitors:

       Example

```
[ceph: root@host01 /]# ceph orch ps --daemon-type mon
```

b. On each host, stop the monitor.

i. Identify the **systemctl** unit name:

Example

```
[ceph: root@host01 /]# systemctl list-units ceph-* | grep mon
```

ii. Stop the service:

Syntax

```
systemct stop SERVICE-NAME
```

15. Shut down all the hosts.

Rebooting the Red Hat Ceph Storage cluster

1. If network equipment was involved, ensure it is powered ON and stable prior to powering ON any Ceph hosts or nodes.
2. Power ON all the Ceph hosts.
3. Log into the administration node from the Cephadm shell:

Example

```
[root@host01 ~]# cephadm shell
```

4. Verify all the services are in running state:

Example

```
[ceph: root@host01 /]# ceph orch ls
```

5. Ensure the cluster health is `Health_OK`status:

Example

```
[ceph: root@host01 /]# ceph -s
```

6. Unset the **noout**, **norecover**, **norebalance**, **nobackfill**, **nodown** and **pause** flags. Run the following on a node with the client keyrings, for example, the Ceph Monitor or OpenStack controller node:

Example

```
[ceph: root@host01 /]# ceph osd unset noout
[ceph: root@host01 /]# ceph osd unset norecover
[ceph: root@host01 /]# ceph osd unset norebalance
```

```
[ceph: root@host01 /]# ceph osd unset nobackfill
[ceph: root@host01 /]# ceph osd unset nodown
[ceph: root@host01 /]# ceph osd unset pause
```

7. If you use the Ceph File System (**CephFS**), bring the **CephFS** cluster back up by setting the **joinable** flag to **true**:

   Syntax

   ```
   ceph fs set FS_NAME joinable true
   ```

   Example

   ```
   [ceph: root@host01 /]# ceph fs set cephfs joinable true
   ```

Verification

- Verify the cluster is in healthy state (**Health_OK** and all PGs **active+clean**). Run **ceph status** on a node with the client keyrings, for example, the Ceph Monitor or OpenStack controller nodes, to ensure the cluster is healthy.

Example

```
[ceph: root@host01 /]# ceph -s
```

Additional Resources

- For more information on installing Ceph see the *Red Hat Ceph Storage Installation Guide*

CHAPTER 3. MONITORING A CEPH STORAGE CLUSTER

As a storage administrator, you can monitor the overall health of the Red Hat Ceph Storage cluster, along with monitoring the health of the individual components of Ceph.

Once you have a running Red Hat Ceph Storage cluster, you might begin monitoring the storage cluster to ensure that the Ceph Monitor and Ceph OSD daemons are running, at a high-level. Ceph storage cluster clients connect to a Ceph Monitor and receive the latest version of the storage cluster map before they can read and write data to the Ceph pools within the storage cluster. So the monitor cluster must have agreement on the state of the cluster before Ceph clients can read and write data.

Ceph OSDs must peer the placement groups on the primary OSD with the copies of the placement groups on secondary OSDs. If faults arise, peering will reflect something other than the **active + clean** state.

3.1. HIGH-LEVEL MONITORING OF A CEPH STORAGE CLUSTER

As a storage administrator, you can monitor the health of the Ceph daemons to ensure that they are up and running. High level monitoring also involves checking the storage cluster capacity to ensure that the storage cluster does not exceed its **full ratio**. The Red Hat Ceph Storage Dashboard is the most common way to conduct high-level monitoring. However, you can also use the command-line interface, the Ceph admin socket or the Ceph API to monitor the storage cluster.

3.1.1. Checking the storage cluster health

After you start the Ceph storage cluster, and before you start reading or writing data, check the storage cluster's health first.

Prerequisites

- A running Red Hat Ceph Storage cluster.
- Root-level access to the node.

Procedure

1. Log into the Cephadm shell:

   Example

   ```
   root@host01 ~]# cephadm shell
   ```

2. You can check on the health of the Ceph storage cluster with the following command:

   Example

   ```
   [ceph: root@host01 /]# ceph health
   HEALTH_OK
   ```

3. You can check the status of the Ceph storage cluster by running **ceph status** command:

   Example

```
[ceph: root@host01 /]# ceph status
```

The output provides the following information:

- Cluster ID
- Cluster health status
- The monitor map epoch and the status of the monitor quorum.
- The OSD map epoch and the status of OSDs.
- The status of Ceph Managers.
- The status of Object Gateways.
- The placement group map version.
- The number of placement groups and pools.
- The notional amount of data stored and the number of objects stored.
- The total amount of data stored.
- The IO client operations.
- An update on the upgrade process if the cluster is upgrading.
  Upon starting the Ceph cluster, you will likely encounter a health warning such as **HEALTH_WARN XXX num placement groups stale**. Wait a few moments and check it again. When the storage cluster is ready, **ceph health** should return a message such as **HEALTH_OK**. At that point, it is okay to begin using the cluster.

3.1.2. Watching storage cluster events

You can watch events that are happening with the Ceph storage cluster using the command-line interface.

Prerequisites

- A running Red Hat Ceph Storage cluster.
- Root-level access to the node.

Procedure

1. Log into the Cephadm shell:

   Example

   ```
   root@host01 ~]# cephadm shell
   ```

2. To watch the cluster's ongoing events, run the following command:

   Example

```
[ceph: root@host01 /]# ceph -w
  cluster:
    id:     8c9b0072-67ca-11eb-af06-001a4a0002a0
    health: HEALTH_OK

  services:
    mon: 2 daemons, quorum Ceph5-2,Ceph5-adm (age 3d)
    mgr: Ceph5-1.nqikfh(active, since 3w), standbys: Ceph5-adm.meckej
    osd: 5 osds: 5 up (since 2d), 5 in (since 8w)
    rgw: 2 daemons active (test_realm.test_zone.Ceph5-2.bfdwcn,
test_realm.test_zone.Ceph5-adm.acndrh)

  data:
    pools:   11 pools, 273 pgs
    objects: 459 objects, 32 KiB
    usage:   2.6 GiB used, 72 GiB / 75 GiB avail
    pgs:     273 active+clean

  io:
    client:   170 B/s rd, 730 KiB/s wr, 0 op/s rd, 729 op/s wr

2021-06-02 15:45:21.655871 osd.0 [INF] 17.71 deep-scrub ok
2021-06-02 15:45:47.880608 osd.1 [INF] 1.0 scrub ok
2021-06-02 15:45:48.865375 osd.1 [INF] 1.3 scrub ok
2021-06-02 15:45:50.866479 osd.1 [INF] 1.4 scrub ok
2021-06-02 15:45:01.345821 mon.0 [INF] pgmap v41339: 952 pgs: 952 active+clean; 17130
MB data, 115 GB used, 167 GB / 297 GB avail
2021-06-02 15:45:05.718640 mon.0 [INF] pgmap v41340: 952 pgs: 1
active+clean+scrubbing+deep, 951 active+clean; 17130 MB data, 115 GB used, 167 GB /
297 GB avail
2021-06-02 15:45:53.997726 osd.1 [INF] 1.5 scrub ok
2021-06-02 15:45:06.734270 mon.0 [INF] pgmap v41341: 952 pgs: 1
active+clean+scrubbing+deep, 951 active+clean; 17130 MB data, 115 GB used, 167 GB /
297 GB avail
2021-06-02 15:45:15.722456 mon.0 [INF] pgmap v41342: 952 pgs: 952 active+clean; 17130
MB data, 115 GB used, 167 GB / 297 GB avail
2021-06-02 15:46:06.836430 osd.0 [INF] 17.75 deep-scrub ok
2021-06-02 15:45:55.720929 mon.0 [INF] pgmap v41343: 952 pgs: 1
active+clean+scrubbing+deep, 951 active+clean; 17130 MB data, 115 GB used, 167 GB /
297 GB avail
```

3.1.3. How Ceph calculates data usage

The **used** value reflects the *actual* amount of raw storage used. The **xxx GB** / **xxx GB** value means the amount available, the lesser of the two numbers, of the overall storage capacity of the cluster. The notional number reflects the size of the stored data before it is replicated, cloned or snapshotted. Therefore, the amount of data actually stored typically exceeds the notional amount stored, because Ceph creates replicas of the data and may also use storage capacity for cloning and snapshotting.

3.1.4. Understanding the storage clusters usage stats

To check a cluster's data usage and data distribution among pools, use the **df** option. It is similar to the Linux **df** command.

The **SIZE**/**AVAIL**/**RAW USED** in the **ceph df** and **ceph status** command output are different if some

OSDs are marked **OUT** of the cluster compared to when all OSDs are **IN**. The **SIZE**/**AVAIL**/**RAW USED** is calculated from sum of **SIZE** (osd disk size), **RAW USE** (total used space on disk), and **AVAIL** of all OSDs which are in **IN** state. You can see the total of **SIZE**/**AVAIL**/**RAW USED** for all OSDs in **ceph osd df tree** command output.

Example

```
[ceph: root@host01 /]#ceph df
--- RAW STORAGE ---
CLASS   SIZE    AVAIL     USED  RAW USED  %RAW USED
hdd    5 TiB  2.9 TiB  2.1 TiB   2.1 TiB      42.98
TOTAL  5 TiB  2.9 TiB  2.1 TiB   2.1 TiB      42.98

--- POOLS ---
POOL                    ID  PGS   STORED  OBJECTS     USED  %USED  MAX AVAIL
.mgr                     1    1  5.3 MiB        3   16 MiB      0    629 GiB
.rgw.root                2   32  1.3 KiB        4   48 KiB      0    629 GiB
default.rgw.log          3   32  3.6 KiB      209  408 KiB      0    629 GiB
default.rgw.control      4   32      0 B        8      0 B      0    629 GiB
default.rgw.meta         5   32  1.7 KiB       10   96 KiB      0    629 GiB
default.rgw.buckets.index    7   32  5.5 MiB       22   17 MiB      0    629 GiB
default.rgw.buckets.data     8   32  807 KiB        3  2.4 MiB      0    629 GiB
default.rgw.buckets.non-ec   9   32  1.0 MiB        1  3.1 MiB      0    629 GiB
source-ecpool-86            11   32  1.2 TiB  391.13k  2.1 TiB  53.49    1.1 TiB
```

The **ceph df detail** command gives more details about other pool statistics such as quota objects, quota bytes, used compression, and under compression.

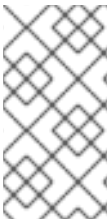
The **RAW STORAGE** section of the output provides an overview of the amount of storage the storage cluster manages for data.

- **CLASS:** The class of OSD device.
- **SIZE:** The amount of storage capacity managed by the storage cluster.
  In the above example, if the **SIZE** is 90 GiB, it is the total size without the replication factor, which is three by default. The total available capacity with the replication factor is 90 GiB/3 = 30 GiB. Based on the full ratio, which is 0.85% by default, the maximum available space is 30 GiB * 0.85 = 25.5 GiB
- **AVAIL:** The amount of free space available in the storage cluster.
  In the above example, if the **SIZE** is 90 GiB and the **USED** space is 6 GiB, then the **AVAIL** space is 84 GiB. The total available space with the replication factor, which is three by default, is 84 GiB/3 = 28 GiB
- **USED:** The amount of raw storage consumed by user data.
  In the above example, 100 MiB is the total space available after considering the replication factor. The actual available size is 33 MiB. **RAW USED:** The amount of raw storage consumed by user data, internal overhead, or reserved capacity.
- **% RAW USED:** The percentage of **RAW USED**. Use this number in conjunction with the **full ratio** and **near full ratio** to ensure that you are not reaching the storage cluster's capacity.

The **POOLS** section of the output provides a list of pools and the notional usage of each pool. The output from this section **DOES NOT** reflect replicas, clones or snapshots. For example, if you store an object with 1 MB of data, the notional usage will be 1 MB, but the actual usage may be 3 MB or more depending on the number of replicas for example, **size = 3**, clones and snapshots.

- **POOL:** The name of the pool.
- **ID:** The pool ID.
- **STORED:** The actual amount of data stored by the user in the pool. This value changes based on the raw usage data based on (k+M)/K values, number of object copies, and the number of objects degraded at the time of pool stats calculation.
- **OBJECTS:** The notional number of objects stored per pool. It is **STORED** size * replication factor.
- **USED:** The notional amount of data stored in kilobytes, unless the number appends **M** for megabytes or **G** for gigabytes.
- **%USED:** The notional percentage of storage used per pool.
- **MAX AVAIL:** An estimate of the notional amount of data that can be written to this pool. It is the amount of data that can be used before the first OSD becomes full. It considers the projected distribution of data across disks from the CRUSH map and uses the first OSD to fill up as the target.
  In the above example, **MAX AVAIL** is 153.85 MB without considering the replication factor, which is three by default.

  See the Red Hat Knowledgebase article titled *ceph df MAX AVAIL is incorrect for simple replicated pool* to calculate the value of **MAX AVAIL**.
- **QUOTA OBJECTS:** The number of quota objects.
- **QUOTA BYTES:** The number of bytes in the quota objects.
- **USED COMPR:** The amount of space allocated for compressed data including his includes compressed data, allocation, replication and erasure coding overhead.
- **UNDER COMPR:** The amount of data passed through compression and beneficial enough to be stored in a compressed form.



NOTE

The numbers in the **POOLS** section are notional. They are not inclusive of the number of replicas, snapshots or clones. As a result, the sum of the **USED** and **%USED** amounts will not add up to the **RAW USED** and **%RAW USED** amounts in the **GLOBAL** section of the output.

NOTE

The MAX AVAIL value is a complicated function of the replication or erasure code used, the CRUSH rule that maps storage to devices, the utilization of those devices, and the configured **mon_osd_full_ratio**.

Additional Resources

- See How Ceph calculates data usage for details.
- See Understanding the OSD usage stats for details.

3.1.5. Understanding the OSD usage stats

Use the **ceph osd df** command to view OSD utilization stats.

Example

```
[ceph: root@host01 /]# ceph osd df
ID CLASS WEIGHT  REWEIGHT SIZE    USE     DATA    OMAP    META    AVAIL   %USE VAR
PGS
 3   hdd 0.90959  1.00000  931GiB 70.1GiB 69.1GiB     0B    1GiB  861GiB 7.53 2.93  66
 4   hdd 0.90959  1.00000  931GiB 1.30GiB  308MiB     0B    1GiB  930GiB 0.14 0.05  59
 0   hdd 0.90959  1.00000  931GiB 18.1GiB 17.1GiB     0B    1GiB  913GiB 1.94 0.76  57
MIN/MAX VAR: 0.02/2.98  STDDEV: 2.91
```

- **ID:** The name of the OSD.
- **CLASS:** The type of devices the OSD uses.
- **WEIGHT:** The weight of the OSD in the CRUSH map.
- **REWEIGHT:** The default reweight value.
- **SIZE:** The overall storage capacity of the OSD.
- **USE:** The OSD capacity.
- **DATA:** The amount of OSD capacity that is used by user data.
- **OMAP:** An estimate value of the **bluefs** storage that is being used to store object map (**omap**) data (key value pairs stored in **rocksdb**).
- **META:** The **bluefs** space allocated, or the value set in the **bluestore_bluefs_min** parameter, whichever is larger, for internal metadata which is calculated as the total space allocated in **bluefs** minus the estimated **omap** data size.
- **AVAIL:** The amount of free space available on the OSD.
- **%USE:** The notional percentage of storage used by the OSD
- **VAR:** The variation above or below average utilization.
- **PGS:** The number of placement groups in the OSD.
- **MIN/MAX VAR:** The minimum and maximum variation across all OSDs.

Additional Resources

- See *How Ceph calculates data usage* for details.
- See *Understanding the OSD usage stats* for details.
- See *CRUSH Weights* in *Red Hat Ceph Storage Storage Strategies Guide* for details.

3.1.6. Checking the storage cluster status

You can check the status of the Red Hat Ceph Storage cluster from the command-line interface. The **status** sub command or the **-s** argument will display the current status of the storage cluster.

Prerequisites

- A running Red Hat Ceph Storage cluster.
- Root-level access to the node.

Procedure

1. Log into the Cephadm shell:

   Example

   ```
   [root@host01 ~]# cephadm shell
   ```

2. To check a storage cluster's status, execute the following:

   Example

   ```
   [ceph: root@host01 /]# ceph status
   ```

   Or

   Example

   ```
   [ceph: root@host01 /]# ceph -s
   ```

3. In interactive mode, type **ceph** and press **Enter**:

   Example

   ```
   [ceph: root@host01 /]# ceph
   ceph> status
     cluster:
       id:     499829b4-832f-11eb-8d6d-001a4a000635
       health: HEALTH_WARN
               1 stray daemon(s) not managed by cephadm
               1/3 mons down, quorum host03,host02
               too many PGs per OSD (261 > max 250)

     services:
       mon:     3 daemons, quorum host03,host02 (age 3d), out of quorum: host01
       mgr:     host01.hdhzwn(active, since 9d), standbys: host05.eobuuv, host06.wquwpj
       osd:     12 osds: 11 up (since 2w), 11 in (since 5w)
       rgw:     2 daemons active (test_realm.test_zone.host04.hgbvnq,
   test_realm.test_zone.host05.yqqilm)
       rgw-nfs: 1 daemon active (nfs.foo.host06-rgw)

     data:
       pools:   8 pools, 960 pgs
       objects: 414 objects, 1.0 MiB
       usage:   5.7 GiB used, 214 GiB / 220 GiB avail
   ```

```
    pgs:     960 active+clean

  io:
    client:   41 KiB/s rd, 0 B/s wr, 41 op/s rd, 27 op/s wr

ceph> health
HEALTH_WARN 1 stray daemon(s) not managed by cephadm; 1/3 mons down, quorum
host03,host02; too many PGs per OSD (261 > max 250)

ceph> mon stat
e3: 3 mons at {host01=[v2:10.74.255.0:3300/0,v1:10.74.255.0:6789/0],host02=
[v2:10.74.249.253:3300/0,v1:10.74.249.253:6789/0],host03=
[v2:10.74.251.164:3300/0,v1:10.74.251.164:6789/0]}, election epoch 6688, leader 1 host03,
quorum 1,2 host03,host02
```

3.1.7. Checking the Ceph Monitor status

If the storage cluster has multiple Ceph Monitors, which is a requirement for a production Red Hat Ceph Storage cluster, then you can check the Ceph Monitor quorum status after starting the storage cluster, and before doing any reading or writing of data.

A quorum must be present when multiple Ceph Monitors are running.

Check the Ceph Monitor status periodically to ensure that they are running. If there is a problem with the Ceph Monitor, that prevents an agreement on the state of the storage cluster, the fault can prevent Ceph clients from reading and writing data.

Prerequisites

- A running Red Hat Ceph Storage cluster.
- Root-level access to the node.

Procedure

1. Log into the Cephadm shell:

   Example

   ```
   [root@host01 ~]# cephadm shell
   ```

2. To display the Ceph Monitor map, execute the following:

   Example

   ```
   [ceph: root@host01 /]# ceph mon stat
   ```

   or

   Example

   ```
   [ceph: root@host01 /]# ceph mon dump
   ```

3. To check the quorum status for the storage cluster, execute the following:

```
[ceph: root@host01 /]# ceph quorum_status -f json-pretty
```

Ceph returns the quorum status.

Example


```
{
    "election_epoch": 6686,
    "quorum": [
        0,
        1,
        2
    ],
    "quorum_names": [
        "host01",
        "host03",
        "host02"
    ],
    "quorum_leader_name": "host01",
    "quorum_age": 424884,
    "features": {
        "quorum_con": "4540138297136906239",
        "quorum_mon": [
            "kraken",
            "luminous",
            "mimic",
            "osdmap-prune",
            "nautilus",
            "octopus",
            "pacific",
            "elector-pinging"
        ]
    },
    "monmap": {
        "epoch": 3,
        "fsid": "499829b4-832f-11eb-8d6d-001a4a000635",
        "modified": "2021-03-15T04:51:38.621737Z",
        "created": "2021-03-12T12:35:16.911339Z",
        "min_mon_release": 16,
        "min_mon_release_name": "pacific",
        "election_strategy": 1,
        "disallowed_leaders: ": "",
        "stretch_mode": false,
        "features": {
            "persistent": [
                "kraken",
                "luminous",
                "mimic",
                "osdmap-prune",
                "nautilus",
                "octopus",
                "pacific",
                "elector-pinging"
            ],
            "optional": []
```

```
},
"mons": [
    {
        "rank": 0,
        "name": "host01",
        "public_addrs": {
            "addrvec": [
                {
                    "type": "v2",
                    "addr": "10.74.255.0:3300",
                    "nonce": 0
                },
                {
                    "type": "v1",
                    "addr": "10.74.255.0:6789",
                    "nonce": 0
                }
            ]
        },
        "addr": "10.74.255.0:6789/0",
        "public_addr": "10.74.255.0:6789/0",
        "priority": 0,
        "weight": 0,
        "crush_location": "{}"
    },
    {
        "rank": 1,
        "name": "host03",
        "public_addrs": {
            "addrvec": [
                {
                    "type": "v2",
                    "addr": "10.74.251.164:3300",
                    "nonce": 0
                },
                {
                    "type": "v1",
                    "addr": "10.74.251.164:6789",
                    "nonce": 0
                }
            ]
        },
        "addr": "10.74.251.164:6789/0",
        "public_addr": "10.74.251.164:6789/0",
        "priority": 0,
        "weight": 0,
        "crush_location": "{}"
    },
    {
        "rank": 2,
        "name": "host02",
        "public_addrs": {
            "addrvec": [
                {
                    "type": "v2",
                    "addr": "10.74.249.253:3300",
```

```
                "nonce": 0
            },
            {
                "type": "v1",
                "addr": "10.74.249.253:6789",
                "nonce": 0
            }
        ]
    },
    "addr": "10.74.249.253:6789/0",
    "public_addr": "10.74.249.253:6789/0",
    "priority": 0,
    "weight": 0,
    "crush_location": "{}"
  }
 ]
}
}
```


3.1.8. Using the Ceph administration socket

Use the administration socket to interact with a given daemon directly by using a UNIX socket file. For example, the socket enables you to:

- List the Ceph configuration at runtime
- Set configuration values at runtime directly without relying on Monitors. This is useful when Monitors are **down**.
- Dump historic operations
- Dump the operation priority queue state
- Dump operations without rebooting
- Dump performance counters

In addition, using the socket is helpful when troubleshooting problems related to Ceph Monitors or OSDs.

Regardless, if the daemon is not running, a following error is returned when attempting to use the administration socket:

```
Error 111: Connection Refused
```

IMPORTANT

The administration socket is only available while a daemon is running. When you shut down the daemon properly, the administration socket is removed. However, if the daemon terminates unexpectedly, the administration socket might persist.

Prerequisites

- A running Red Hat Ceph Storage cluster.

- Root-level access to the node.

Procedure

1. Log into the Cephadm shell:

   Example

   ```
   [root@host01 ~]# cephadm shell
   ```

2. To use the socket:

   Syntax

   ```
   ceph daemon MONITOR_ID COMMAND
   ```

   Replace:

   - ***MONITOR_ID*** of the daemon
   - ***COMMAND*** with the command to run. Use **help** to list the available commands for a given daemon.
     To view the status of a Ceph Monitor:

     Example

     ```
     [ceph: root@host01 /]# ceph daemon mon.host01 help
     {
         "add_bootstrap_peer_hint": "add peer address as potential bootstrap peer for cluster bringup",
         "add_bootstrap_peer_hintv": "add peer address vector as potential bootstrap peer for cluster bringup",
         "compact": "cause compaction of monitor's leveldb/rocksdb storage",
         "config diff": "dump diff of current config and default config",
         "config diff get": "dump diff get <field>: dump diff of current and default config setting <field>",
         "config get": "config get <field>: get the config value",
         "config help": "get config setting schema and descriptions",
         "config set": "config set <field> <val> [<val> ...]: set a config variable",
         "config show": "dump current config settings",
         "config unset": "config unset <field>: unset a config variable",
         "connection scores dump": "show the scores used in connectivity-based elections",
         "connection scores reset": "reset the scores used in connectivity-based elections",
         "counter dump": "dump all labeled and non-labeled counters and their values",
         "counter schema": "dump all labeled and non-labeled counters schemas",
         "dump_historic_ops": "show recent ops",
         "dump_historic_slow_ops": "show recent slow ops",
         "dump_mempools": "get mempool stats",
         "get_command_descriptions": "list available commands",
         "git_version": "get git sha1",
         "heap": "show heap usage info (available only if compiled with tcmalloc)",
         "help": "list available commands",
         "injectargs": "inject configuration arguments into running daemon",
         "log dump": "dump recent log entries to log file",
         "log flush": "flush log entries to log file",
     ```

```
    "log reopen": "reopen log file",
    "mon_status": "report status of monitors",
    "ops": "show the ops currently in flight",
    "perf dump": "dump non-labeled counters and their values",
    "perf histogram dump": "dump perf histogram values",
    "perf histogram schema": "dump perf histogram schema",
    "perf reset": "perf reset <name>: perf reset all or one perfcounter name",
    "perf schema": "dump non-labeled counters schemas",
    "quorum enter": "force monitor back into quorum",
    "quorum exit": "force monitor out of the quorum",
    "sessions": "list existing sessions",
    "smart": "Query health metrics for underlying device",
    "sync_force": "force sync of and clear monitor store",
    "version": "get ceph version"
}
```

Example

```
[ceph: root@host01 /]# ceph daemon mon.host01 mon_status

{
    "name": "host01",
    "rank": 0,
    "state": "leader",
    "election_epoch": 120,
    "quorum": [
        0,
        1,
        2
    ],
    "quorum_age": 206358,
    "features": {
        "required_con": "2449958747317026820",
        "required_mon": [
            "kraken",
            "luminous",
            "mimic",
            "osdmap-prune",
            "nautilus",
            "octopus",
            "pacific",
            "elector-pinging"
        ],
        "quorum_con": "4540138297136906239",
        "quorum_mon": [
            "kraken",
            "luminous",
            "mimic",
            "osdmap-prune",
            "nautilus",
            "octopus",
            "pacific",
            "elector-pinging"
        ]
    },
    "outside_quorum": [],
```

```
"extra_probe_peers": [],
"sync_provider": [],
"monmap": {
    "epoch": 3,
    "fsid": "81a4597a-b711-11eb-8cb8-001a4a000740",
    "modified": "2021-05-18T05:50:17.782128Z",
    "created": "2021-05-17T13:13:13.383313Z",
    "min_mon_release": 16,
    "min_mon_release_name": "pacific",
    "election_strategy": 1,
    "disallowed_leaders: ": "",
    "stretch_mode": false,
    "features": {
        "persistent": [
            "kraken",
            "luminous",
            "mimic",
            "osdmap-prune",
            "nautilus",
            "octopus",
            "pacific",
            "elector-pinging"
        ],
        "optional": []
    },
    "mons": [
        {
            "rank": 0,
            "name": "host01",
            "public_addrs": {
                "addrvec": [
                    {
                        "type": "v2",
                        "addr": "10.74.249.41:3300",
                        "nonce": 0
                    },
                    {
                        "type": "v1",
                        "addr": "10.74.249.41:6789",
                        "nonce": 0
                    }
                ]
            },
            "addr": "10.74.249.41:6789/0",
            "public_addr": "10.74.249.41:6789/0",
            "priority": 0,
            "weight": 0,
            "crush_location": "{}"
        },
        {
            "rank": 1,
            "name": "host02",
            "public_addrs": {
                "addrvec": [
                    {
                        "type": "v2",
```

```
                    "addr": "10.74.249.55:3300",
                    "nonce": 0
                },
                {
                    "type": "v1",
                    "addr": "10.74.249.55:6789",
                    "nonce": 0
                }
            ]
        },
        "addr": "10.74.249.55:6789/0",
        "public_addr": "10.74.249.55:6789/0",
        "priority": 0,
        "weight": 0,
        "crush_location": "{}"
    },
    {
        "rank": 2,
        "name": "host03",
        "public_addrs": {
            "addrvec": [
                {
                    "type": "v2",
                    "addr": "10.74.249.49:3300",
                    "nonce": 0
                },
                {
                    "type": "v1",
                    "addr": "10.74.249.49:6789",
                    "nonce": 0
                }
            ]
        },
        "addr": "10.74.249.49:6789/0",
        "public_addr": "10.74.249.49:6789/0",
        "priority": 0,
        "weight": 0,
        "crush_location": "{}"
    }
  ]
},
"feature_map": {
  "mon": [
    {
        "features": "0x3f01cfb9fffdffff",
        "release": "luminous",
        "num": 1
    }
  ],
  "osd": [
    {
        "features": "0x3f01cfb9fffdffff",
        "release": "luminous",
        "num": 3
    }
  ]
```

```
    },
    "stretch_mode": false
}
```

3. Alternatively, specify the Ceph daemon by using its socket file:

   Syntax

   ```
   ceph daemon /var/run/ceph/SOCKET_FILE COMMAND
   ```

4. To view the status of a Ceph OSD named **osd.0** on the specific host:

   Example

   ```
   [ceph: root@host01 /]# ceph daemon /var/run/ceph/ceph-osd.0.asok status
   {
      "cluster_fsid": "9029b252-1668-11ee-9399-001a4a000429",
      "osd_fsid": "1de9b064-b7a5-4c54-9395-02ccda637d21",
      "whoami": 0,
      "state": "active",
      "oldest_map": 1,
      "newest_map": 58,
      "num_pgs": 33
   }
   ```

   NOTE

   You can use **help** instead of **status** for the various options that are available for the specific daemon.

5. To list all socket files for the Ceph processes:

   Example

   ```
   [ceph: root@host01 /]# ls /var/run/ceph
   ```

Additional Resources

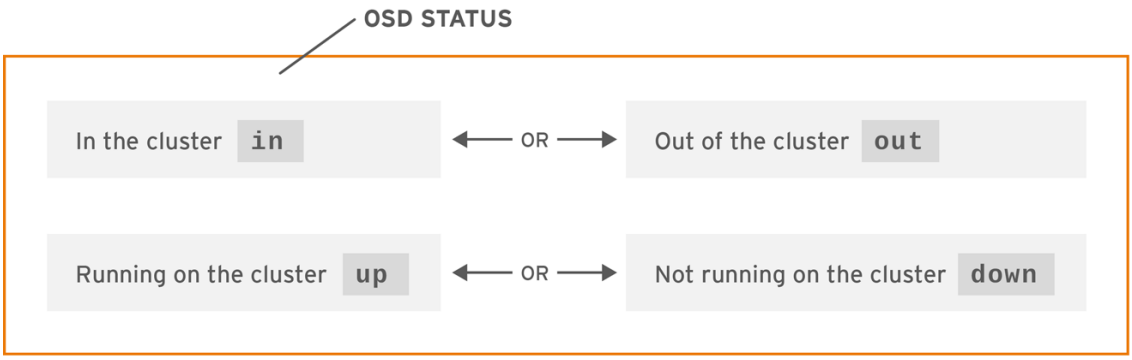
- See the *Red Hat Ceph Storage Troubleshooting Guide* for more information.

3.1.9. Understanding the Ceph OSD status

A Ceph OSD's status is either **in** the storage cluster, or **out** of the storage cluster. It is either **up** and running, or it is **down** and not running. If a Ceph OSD is **up**, it can be either **in** the storage cluster, where data can be read and written, or it is **out** of the storage cluster. If it was **in** the storage cluster and recently moved **out** of the storage cluster, Ceph starts migrating placement groups to other Ceph OSDs. If a Ceph OSD is **out** of the storage cluster, CRUSH will not assign placement groups to the Ceph OSD. If a Ceph OSD is **down**, it should also be **out**.

NOTE

If a Ceph OSD is **down** and **in**, there is a problem, and the storage cluster will not be in a healthy state.



If you execute a command such as **ceph health**, **ceph -s** or **ceph -w**, you might notice that the storage cluster does not always echo back **HEALTH OK**. Do not panic. With respect to Ceph OSDs, you can expect that the storage cluster will **NOT** echo **HEALTH OK** in a few expected circumstances:

- You have not started the storage cluster yet, and it is not responding.
- You have just started or restarted the storage cluster, and it is not ready yet, because the placement groups are getting created and the Ceph OSDs are in the process of peering.
- You just added or removed a Ceph OSD.
- You just modified the storage cluster map.

An important aspect of monitoring Ceph OSDs is to ensure that when the storage cluster is up and running that all Ceph OSDs that are **in** the storage cluster are **up** and running, too.

To see if all OSDs are running, execute:

Example

```
[ceph: root@host01 /]# ceph osd stat
```

or

Example

```
[ceph: root@host01 /]# ceph osd dump
```

The result should tell you the map epoch, **eNNNN**, the total number of OSDs, **x**, how many, **y**, are **up**, and how many, **z**, are **in**:

```
eNNNN: x osds: y up, z in
```

If the number of Ceph OSDs that are **in** the storage cluster are more than the number of Ceph OSDs that are **up**. Execute the following command to identify the **ceph-osd** daemons that are not running:

Example

-

```
[ceph: root@host01 /]# ceph osd tree

# id    weight  type name   up/down reweight
-1  3   pool default
-3  3       rack mainrack
-2  3           host osd-host
0   1               osd.0   up  1
1   1               osd.1   up  1
2   1               osd.2   up  1
```

TIP

The ability to search through a well-designed CRUSH hierarchy can help you troubleshoot the storage cluster by identifying the physical locations faster.

If a Ceph OSD is **down**, connect to the node and start it. You can use Red Hat Storage Console to restart the Ceph OSD daemon, or you can use the command line.

Syntax

```
systemctl start CEPH_OSD_SERVICE_ID
```

Example

```
[root@host01 ~]# systemctl start ceph-499829b4-832f-11eb-8d6d-001a4a000635@osd.6.service
```

Additional Resources

- See the *Red Hat Ceph Storage Dashboard Guide* for more details.

3.2. LOW-LEVEL MONITORING OF A CEPH STORAGE CLUSTER

As a storage administrator, you can monitor the health of a Red Hat Ceph Storage cluster from a low-level perspective. Low-level monitoring typically involves ensuring that Ceph OSDs are peering properly. When peering faults occur, placement groups operate in a degraded state. This degraded state can be the result of many different things, such as hardware failure, a hung or crashed Ceph daemon, network latency, or a complete site outage.

3.2.1. Monitoring Placement Group Sets

When CRUSH assigns placement groups to Ceph OSDs, it looks at the number of replicas for the pool and assigns the placement group to Ceph OSDs such that each replica of the placement group gets assigned to a different Ceph OSD. For example, if the pool requires three replicas of a placement group, CRUSH may assign them to **osd.1**, **osd.2** and **osd.3** respectively. CRUSH actually seeks a pseudo-random placement that will take into account failure domains you set in the CRUSH map, so you will rarely see placement groups assigned to nearest neighbor Ceph OSDs in a large cluster. We refer to the set of Ceph OSDs that should contain the replicas of a particular placement group as the **Acting Set**. In some cases, an OSD in the Acting Set is **down** or otherwise not able to service requests for objects in the placement group. When these situations arise, do not panic. Common examples include:

- You added or removed an OSD. Then, CRUSH reassigned the placement group to other Ceph OSDs, thereby changing the composition of the acting set and spawning the migration of data with a "backfill" process.
- A Ceph OSD was **down**, was restarted and is now **recovering**.
- A Ceph OSD in the acting set is **down** or unable to service requests, and another Ceph OSD has temporarily assumed its duties.

Ceph processes a client request using the **Up Set**, which is the set of Ceph OSDs that actually handle the requests. In most cases, the up set and the Acting Set are virtually identical. When they are not, it can indicate that Ceph is migrating data, an Ceph OSD is recovering, or that there is a problem, that is, Ceph usually echoes a **HEALTH WARN** state with a "stuck stale" message in such scenarios.

Prerequisites

- A running Red Hat Ceph Storage cluster.
- Root-level access to the node.

Procedure

1. Log into the Cephadm shell:

   Example

   ```
   [root@host01 ~]# cephadm shell
   ```

2. To retrieve a list of placement groups:

   Example

   ```
   [ceph: root@host01 /]# ceph pg dump
   ```

3. View which Ceph OSDs are in the **Acting Set** or in the **Up Set** for a given placement group:

   Syntax

   ```
   ceph pg map PG_NUM
   ```

   Example

   ```
   [ceph: root@host01 /]# ceph pg map 128
   ```

NOTE

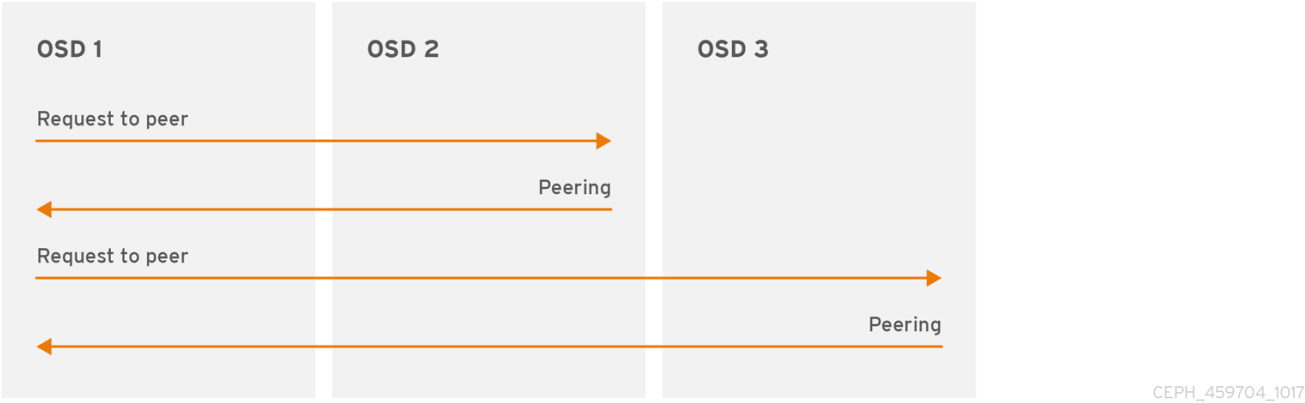
If the Up Set and Acting Set do not match, this may be an indicator that the storage cluster rebalancing itself or of a potential problem with the storage cluster.

3.2.2. Ceph OSD peering

Before you can write data to a placement group, it must be in an **active** state, and it **should** be in a **clean**

state. For Ceph to determine the current state of a placement group, the primary OSD of the placement group that is, the first OSD in the acting set, peers with the secondary and tertiary OSDs to establish agreement on the current state of the placement group. Assuming a pool with three replicas of the PG.

Figure 3.1. Peering



3.2.3. Placement Group States

If you execute a command such as **ceph health**, **ceph -s** or **ceph -w**, you may notice that the cluster does not always echo back **HEALTH OK**. After you check to see if the OSDs are running, you should also check placement group states. You should expect that the cluster will **NOT** echo **HEALTH OK** in a number of placement group peering-related circumstances:

- You have just created a pool and placement groups haven't peered yet.
- The placement groups are recovering.
- You have just added an OSD to or removed an OSD from the cluster.
- You have just modified the CRUSH map and the placement groups are migrating.
- There is inconsistent data in different replicas of a placement group.
- Ceph is scrubbing a placement group's replicas.
- Ceph doesn't have enough storage capacity to complete backfilling operations.

If one of the foregoing circumstances causes Ceph to echo **HEALTH WARN**, don't panic. In many cases, the cluster will recover on its own. In some cases, you may need to take action. An important aspect of monitoring placement groups is to ensure that when the cluster is up and running that all placement groups are **active**, and preferably in the **clean** state.

To see the status of all placement groups, execute:

Example

```
[ceph: root@host01 /]# ceph pg stat
```

The result should tell you the placement group map version, **vNNNNNN**, the total number of placement groups, **x**, and how many placement groups, **y**, are in a particular state such as **active+clean**:

```
vNNNNNN: x pgs: y active+clean; z bytes data, aa MB used, bb GB / cc GB avail
```

NOTE

It is common for Ceph to report multiple states for placement groups.

Snapshot Trimming PG States

When snapshots exist, two additional PG states will be reported.

- **snaptrim** : The PGs are currently being trimmed
- **snaptrim_wait** : The PGs are waiting to be trimmed

Example Output:

```
244 active+clean+snaptrim_wait
 32 active+clean+snaptrim
```

In addition to the placement group states, Ceph will also echo back the amount of data used, **aa**, the amount of storage capacity remaining, **bb**, and the total storage capacity for the placement group. These numbers can be important in a few cases:

- You are reaching the **near full ratio** or **full ratio**.
- Your data isn't getting distributed across the cluster due to an error in the CRUSH configuration.

Placement Group IDs

Placement group IDs consist of the pool number, and not the pool name, followed by a period (.) and the placement group ID—a hexadecimal number. You can view pool numbers and their names from the output of **ceph osd lspools**. The default pool names **data**, **metadata** and **rbd** correspond to pool numbers **0**, **1** and **2** respectively. A fully qualified placement group ID has the following form:

Syntax

```
POOL_NUM.PG_ID
```

Example output:

```
0.1f
```

- To retrieve a list of placement groups:

  #### Example

  ```
  [ceph: root@host01 /]# ceph pg dump
  ```

- To format the output in JSON format and save it to a file:

  #### Syntax

  ```
  ceph pg dump -o FILE_NAME --format=json
  ```

  #### Example

```
[ceph: root@host01 /]# ceph pg dump -o test --format=json
```

- Query a particular placement group:

  Syntax

  ```
  ceph pg POOL_NUM.PG_ID query
  ```

  Example

```
[ceph: root@host01 /]#  ceph pg 5.fe query
{
    "snap_trimq": "[]",
    "snap_trimq_len": 0,
    "state": "active+clean",
    "epoch": 2449,
    "up": [
        3,
        8,
        10
    ],
    "acting": [
        3,
        8,
        10
    ],
    "acting_recovery_backfill": [
        "3",
        "8",
        "10"
    ],
    "info": {
        "pgid": "5.ff",
        "last_update": "0'0",
        "last_complete": "0'0",
        "log_tail": "0'0",
        "last_user_version": 0,
        "last_backfill": "MAX",
        "purged_snaps": [],
        "history": {
            "epoch_created": 114,
            "epoch_pool_created": 82,
            "last_epoch_started": 2402,
            "last_interval_started": 2401,
            "last_epoch_clean": 2402,
            "last_interval_clean": 2401,
            "last_epoch_split": 114,
            "last_epoch_marked_full": 0,
            "same_up_since": 2401,
            "same_interval_since": 2401,
            "same_primary_since": 2086,
            "last_scrub": "0'0",
            "last_scrub_stamp": "2021-06-17T01:32:03.763988+0000",
            "last_deep_scrub": "0'0",
            "last_deep_scrub_stamp": "2021-06-17T01:32:03.763988+0000",
```

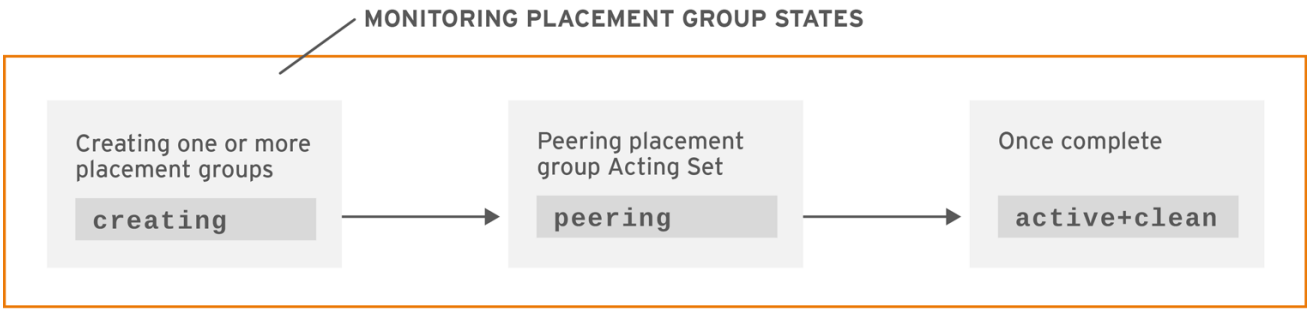
```
            "last_clean_scrub_stamp": "2021-06-17T01:32:03.763988+0000",
            "prior_readable_until_ub": 0
        },
        "stats": {
            "version": "0'0",
            "reported_seq": "2989",
            "reported_epoch": "2449",
            "state": "active+clean",
            "last_fresh": "2021-06-18T05:16:59.401080+0000",
            "last_change": "2021-06-17T01:32:03.764162+0000",
            "last_active": "2021-06-18T05:16:59.401080+0000",
....
```

Additional Resources

- See the chapter *Object Storage Daemon (OSD) configuration options* in the *OSD Object storage daemon configuratopn options* section in *Red Hat Ceph Storage Configuration Guide* for more details on the snapshot trimming settings.

3.2.4. Placement Group creating state

When you create a pool, it will create the number of placement groups you specified. Ceph will echo **creating** when it is creating one or more placement groups. Once they are created, the OSDs that are part of a placement group's Acting Set will peer. Once peering is complete, the placement group status should be **active+clean**, which means a Ceph client can begin writing to the placement group.



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3.2.5. Placement group peering state

When Ceph is Peering a placement group, Ceph is bringing the OSDs that store the replicas of the placement group into **agreement about the state** of the objects and metadata in the placement group. When Ceph completes peering, this means that the OSDs that store the placement group agree about the current state of the placement group. However, completion of the peering process does **NOT** mean that each replica has the latest contents.

Authoritative History

Ceph will **NOT** acknowledge a write operation to a client, until all OSDs of the acting set persist the write operation. This practice ensures that at least one member of the acting set will have a record of every acknowledged write operation since the last successful peering operation.

With an accurate record of each acknowledged write operation, Ceph can construct and disseminate a new authoritative history of the placement group. A complete, and fully ordered set of operations that, if performed, would bring an OSD's copy of a placement group up to date.

3.2.6. Placement group active state

Once Ceph completes the peering process, a placement group may become **active**. The **active** state means that the data in the placement group is generally available in the primary placement group and the replicas for read and write operations.

3.2.7. Placement Group clean state

When a placement group is in the **clean** state, the primary OSD and the replica OSDs have successfully peered and there are no stray replicas for the placement group. Ceph replicated all objects in the placement group the correct number of times.

3.2.8. Placement Group degraded state

When a client writes an object to the primary OSD, the primary OSD is responsible for writing the replicas to the replica OSDs. After the primary OSD writes the object to storage, the placement group will remain in a **degraded** state until the primary OSD has received an acknowledgement from the replica OSDs that Ceph created the replica objects successfully.

The reason a placement group can be **active+degraded** is that an OSD may be **active** even though it doesn't hold all of the objects yet. If an OSD goes **down**, Ceph marks each placement group assigned to the OSD as **degraded**. The Ceph OSDs must peer again when the Ceph OSD comes back online. However, a client can still write a new object to a **degraded** placement group if it is **active**.

If an OSD is **down** and the **degraded** condition persists, Ceph may mark the **down** OSD as **out** of the cluster and remap the data from the **down** OSD to another OSD. The time between being marked **down** and being marked **out** is controlled by **mon_osd_down_out_interval**, which is set to **600** seconds by default.

A placement group can also be **degraded**, because Ceph cannot find one or more objects that Ceph thinks should be in the placement group. While you cannot read or write to unfound objects, you can still access all of the other objects in the **degraded** placement group.

For example, if there are nine OSDs in a three way replica pool. If OSD number 9 goes down, the PGs assigned to OSD 9 goes into a degraded state. If OSD 9 does not recover, it goes out of the storage cluster and the storage cluster rebalances. In that scenario, the PGs are degraded and then recover to an active state.

3.2.9. Placement Group recovering state

Ceph was designed for fault-tolerance at a scale where hardware and software problems are ongoing. When an OSD goes **down**, its contents may fall behind the current state of other replicas in the placement groups. When the OSD is back **up**, the contents of the placement groups must be updated to reflect the current state. During that time period, the OSD may reflect a **recovering** state.

Recovery is not always trivial, because a hardware failure might cause a cascading failure of multiple Ceph OSDs. For example, a network switch for a rack or cabinet may fail, which can cause the OSDs of a number of host machines to fall behind the current state of the storage cluster. Each one of the OSDs must recover once the fault is resolved.

Ceph provides a number of settings to balance the resource contention between new service requests and the need to recover data objects and restore the placement groups to the current state. The **osd recovery delay start** setting allows an OSD to restart, re-peer and even process some replay requests before starting the recovery process. The **osd recovery threads** setting limits the number of threads for the recovery process, by default one thread. The **osd recovery thread timeout** sets a thread timeout, because multiple Ceph OSDs can fail, restart and re-peer at staggered rates. The **osd**

recovery max active setting limits the number of recovery requests a Ceph OSD works on simultaneously to prevent the Ceph OSD from failing to serve . The **osd recovery max chunk** setting limits the size of the recovered data chunks to prevent network congestion.

3.2.10. Back fill state

When a new Ceph OSD joins the storage cluster, CRUSH will reassign placement groups from OSDs in the cluster to the newly added Ceph OSD. Forcing the new OSD to accept the reassigned placement groups immediately can put excessive load on the new Ceph OSD. Backfilling the OSD with the placement groups allows this process to begin in the background. Once backfilling is complete, the new OSD will begin serving requests when it is ready.

During the backfill operations, you might see one of several states:

- **backfill_wait** indicates that a backfill operation is pending, but isn't underway yet
- **backfill** indicates that a backfill operation is underway
- **backfill_too_full** indicates that a backfill operation was requested, but couldn't be completed due to insufficient storage capacity.

When a placement group cannot be backfilled, it can be considered **incomplete**.

Ceph provides a number of settings to manage the load spike associated with reassigning placement groups to a Ceph OSD, especially a new Ceph OSD. By default, **osd_max_backfills** sets the maximum number of concurrent backfills to or from a Ceph OSD to 10. The **osd backfill full ratio** enables a Ceph OSD to refuse a backfill request if the OSD is approaching its full ratio, by default 85%. If an OSD refuses a backfill request, the **osd backfill retry interval** enables an OSD to retry the request, by default after 10 seconds. OSDs can also set **osd backfill scan min** and **osd backfill scan max** to manage scan intervals, by default 64 and 512.

For some workloads, it is beneficial to avoid regular recovery entirely and use backfill instead. Since backfilling occurs in the background, this allows I/O to proceed on the objects in the OSD. You can force a backfill rather than a recovery by setting the **osd_min_pg_log_entries** option to **1**, and setting the **osd_max_pg_log_entries** option to **2**. Contact your Red Hat Support account team for details on when this situation is appropriate for your workload.

3.2.11. Placement Group remapped state

When the Acting Set that services a placement group changes, the data migrates from the old acting set to the new acting set. It may take some time for a new primary OSD to service requests. So it may ask the old primary to continue to service requests until the placement group migration is complete. Once data migration completes, the mapping uses the primary OSD of the new acting set.

3.2.12. Placement Group stale state

While Ceph uses heartbeats to ensure that hosts and daemons are running, the **ceph-osd** daemons may also get into a **stuck** state where they aren't reporting statistics in a timely manner. For example, a temporary network fault. By default, OSD daemons report their placement group, up thru, boot and failure statistics every half second, that is, **0.5**, which is more frequent than the heartbeat thresholds. If the **Primary OSD** of a placement group's acting set fails to report to the monitor or if other OSDs have reported the primary OSD **down**, the monitors will mark the placement group **stale**.

When you start the storage cluster, it is common to see the **stale** state until the peering process completes. After the storage cluster has been running for awhile, seeing placement groups in the **stale** state indicates that the primary OSD for those placement groups is **down** or not reporting placement

group statistics to the monitor.

3.2.13. Placement Group misplaced state

There are some temporary backfilling scenarios where a PG gets mapped temporarily to an OSD. When that **temporary** situation should no longer be the case, the PGs might still reside in the temporary location and not in the proper location. In which case, they are said to be **misplaced**. That's because the correct number of extra copies actually exist, but one or more copies is in the wrong place.

For example, there are 3 OSDs: 0,1,2 and all PGs map to some permutation of those three. If you add another OSD (OSD 3), some PGs will now map to OSD 3 instead of one of the others. However, until OSD 3 is backfilled, the PG will have a temporary mapping allowing it to continue to serve I/O from the old mapping. During that time, the PG is **misplaced**, because it has a temporary mapping, but not **degraded**, since there are 3 copies.

Example

```
pg 1.5: up=acting: [0,1,2]
ADD_OSD_3
pg 1.5: up: [0,3,1] acting: [0,1,2]
```

[0,1,2] is a temporary mapping, so the **up** set is not equal to the **acting** set and the PG is **misplaced** but not **degraded** since [0,1,2] is still three copies.

Example

```
pg 1.5: up=acting: [0,3,1]
```

OSD 3 is now backfilled and the temporary mapping is removed, not degraded and not misplaced.

3.2.14. Placement Group incomplete state

A PG goes into a **incomplete** state when there is incomplete content and peering fails, that is, when there are no complete OSDs which are current enough to perform recovery.

Lets say OSD 1, 2, and 3 are the acting OSD set and it switches to OSD 1, 4, and 3, then **osd.1** will request a temporary acting set of OSD 1, 2, and 3 while backfilling 4. During this time, if OSD 1, 2, and 3 all go down, **osd.4** will be the only one left which might not have fully backfilled all the data. At this time, the PG will go **incomplete** indicating that there are no complete OSDs which are current enough to perform recovery.

Alternately, if **osd.4** is not involved and the acting set is simply OSD 1, 2, and 3 when OSD 1, 2, and 3 go down, the PG would likely go **stale** indicating that the mons have not heard anything on that PG since the acting set changed. The reason being there are no OSDs left to notify the new OSDs.

3.2.15. Identifying stuck Placement Groups

A placement group is not necessarily problematic just because it is not in a **active+clean** state. Generally, Ceph's ability to self repair might not be working when placement groups get stuck. The stuck states include:

- **Unclean**: Placement groups contain objects that are not replicated the desired number of times. They should be recovering.

- **Inactive**: Placement groups cannot process reads or writes because they are waiting for an OSD with the most up-to-date data to come back **up**.
- **Stale**: Placement groups are in an unknown state, because the OSDs that host them have not reported to the monitor cluster in a while, and can be configured with the **mon osd report timeout** setting.

Prerequisites

- A running Red Hat Ceph Storage cluster.
- Root-level access to the node.

Procedure

1. To identify stuck placement groups, execute the following:

   Syntax

   ```
   ceph pg dump_stuck {inactive|unclean|stale|undersized|degraded
   [inactive|unclean|stale|undersized|degraded...]} {<int>}
   ```

   Example

   ```
   [ceph: root@host01 /]# ceph pg dump_stuck stale
   OK
   ```

3.2.16. Finding an object's location

The Ceph client retrieves the latest cluster map and the CRUSH algorithm calculates how to map the object to a placement group, and then calculates how to assign the placement group to an OSD dynamically.

Prerequisites

- A running Red Hat Ceph Storage cluster.
- Root-level access to the node.

Procedure

1. To find the object location, all you need is the object name and the pool name:

   Syntax

   ```
   ceph osd map POOL_NAME OBJECT_NAME
   ```

   Example

   ```
   [ceph: root@host01 /]# ceph osd map mypool myobject
   ```

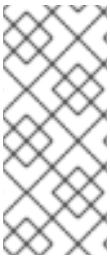
CHAPTER 4. STRETCH CLUSTERS FOR CEPH STORAGE

As a storage administrator, you can configure stretch clusters by entering stretch mode with 2-site clusters.

Red Hat Ceph Storage is capable of withstanding the loss of Ceph OSDs because of its network and cluster, which are equally reliable with failures randomly distributed across the CRUSH map. If a number of OSDs is shut down, the remaining OSDs and monitors still manage to operate.

However, this might not be the best solution for some stretched cluster configurations where a significant part of the Ceph cluster can use only a single network component. The example is a single cluster located in multiple data centers, for which the user wants to sustain a loss of a full data center.

The standard configuration is with two data centers. Other configurations are in clouds or availability zones. Each site holds two copies of the data, therefore, the replication size is four. The third site should have a tiebreaker monitor, this can be a virtual machine or high-latency compared to the main sites. This monitor chooses one of the sites to restore data if the network connection fails and both data centers remain active.



NOTE

The standard Ceph configuration survives many failures of the network or data centers and it never compromises data consistency. If you restore enough Ceph servers following a failure, it recovers. Ceph maintains availability if you lose a data center, but can still form a quorum of monitors and have all the data available with enough copies to satisfy pools' **min_size**, or CRUSH rules that replicate again to meet the size.

NOTE

There are no additional steps to power down a stretch cluster. You can see the *Powering down and rebooting Red Hat Ceph Storage cluster* for more information.

Stretch cluster failures

Red Hat Ceph Storage never compromises on data integrity and consistency. If there is a network failure or a loss of nodes and the services can still be restored, Ceph returns to normal functionality on its own.

However, there are situations where you lose data availability even if you have enough servers available to meet Ceph's consistency and sizing constraints, or where you unexpectedly do not meet the constraints.

First important type of failure is caused by inconsistent networks. If there is a network split, Ceph might be unable to mark OSD as **down** to remove it from the acting placement group (PG) sets despite the primary OSD being unable to replicate data. When this happens, the I/O is not permitted because Ceph cannot meet its durability guarantees.

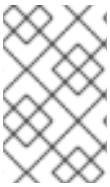
The second important category of failures is when it appears that you have data replicated across data enters, but the constraints are not sufficient to guarantee this. For example, you might have data centers A and B, and the CRUSH rule targets three copies and places a copy in each data center with a **min_size** of **2**. The PG might go active with two copies in site A and no copies in site B, which means that if you lose site A, you lose the data and Ceph cannot operate on it. This situation is difficult to avoid with standard CRUSH rules.

4.1. STRETCH MODE FOR A STORAGE CLUSTER

To configure stretch clusters, you must enter the stretch mode. When stretch mode is enabled, the Ceph OSDs only take PGs as active when they peer across data centers, or whichever other CRUSH bucket type you specified, assuming both are active. Pools increase in size from the default three to four, with two copies on each site.

In stretch mode, Ceph OSDs are only allowed to connect to monitors within the same data center. New monitors are not allowed to join the cluster without specified location.

If all the OSDs and monitors from a data center become inaccessible at once, the surviving data center will enter a **degraded** stretch mode. This issues a warning, reduces the **min_size** to **1**, and allows the cluster to reach an **active** state with the data from the remaining site.



NOTE

The **degraded** state also triggers warnings that the pools are too small, because the pool size does not get changed. However, a special stretch mode flag prevents the OSDs from creating extra copies in the remaining data center, therefore it still keeps 2 copies.

When the missing data center becomes accesible again, the cluster enters **recovery** stretch mode. This changes the warning and allows peering, but still requires only the OSDs from the data center, which was up the whole time.

When all PGs are in a known state and are not degraded or incomplete, the cluster goes back to the regular stretch mode, ends the warning, and restores **min_size** to its starting value **2**. The cluster again requires both sites to peer, not only the site that stayed up the whole time, therefore you can fail over to the other site, if necessary.

Stretch mode limitations

- It is not possible to exit from stretch mode once it is entered.
- You cannot use erasure-coded pools with clusters in stretch mode. You can neither enter the stretch mode with erasure-coded pools, nor create an erasure-coded pool when the stretch mode is active.
- Stretch mode with no more than two sites is supported.
- The weights of the two sites should be the same. If they are not, you receive the following error:

  Example

  ```
  [ceph: root@host01 /]# ceph mon enable_stretch_mode host05 stretch_rule datacenter

  Error EINVAL: the 2 datacenter instances in the cluster have differing weights 25947 and
  15728 but stretch mode currently requires they be the same!
  ```

  To achieve same weights on both sites, the Ceph OSDs deployed in the two sites should be of equal size, that is, storage capacity in the first site is equivalent to storage capacity in the second site.

- While it is not enforced, you should run two Ceph monitors on each site and a tiebreaker, for a total of five. This is because OSDs can only connect to monitors in their own site when in stretch mode.

- You have to create your own CRUSH rule, which provides two copies on each site, which totals to four on both sites.
- You cannot enable stretch mode if you have existing pools with non-default size or **min_size**.
- Because the cluster runs with **min_size 1** when degraded, you should only use stretch mode with all-flash OSDs. This minimizes the time needed to recover once connectivity is restored, and minimizes the potential for data loss.

Additional Resources

- See *Troubleshooting clusters in stretch mode* for troubleshooting steps.

4.1.1. Setting the CRUSH location for the daemons

Before you enter the stretch mode, you need to prepare the cluster by setting the CRUSH location to the daemons in the Red Hat Ceph Storage cluster. There are two ways to do this:

- Bootstrap the cluster through a service configuration file, where the locations are added to the hosts as part of deployment.
- Set the locations manually through **ceph osd crush add-bucket** and **ceph osd crush move** commands after the cluster is deployed.

Method 1: Bootstrapping the cluster

Prerequisites

- Root-level access to the nodes.

Procedure

1. If you are bootstrapping your new storage cluster, you can create the service configuration **.yaml** file that adds the nodes to the Red Hat Ceph Storage cluster and also sets specific labels for where the services should run:

   Example

```
service_type: host
addr: host01
hostname: host01
location:
  root: default
  datacenter: DC1
labels:
  - osd
  - mon
  - mgr
---
service_type: host
addr: host02
hostname: host02
location:
  datacenter: DC1
labels:
```

```
  - osd
  - mon
---
service_type: host
addr: host03
hostname: host03
location:
  datacenter: DC1
labels:
  - osd
  - mds
  - rgw
---
service_type: host
addr: host04
hostname: host04
location:
  root: default
  datacenter: DC2
labels:
  - osd
  - mon
  - mgr
---
service_type: host
addr: host05
hostname: host05
location:
  datacenter: DC2
labels:
  - osd
  - mon
---
service_type: host
addr: host06
hostname: host06
location:
  datacenter: DC2
labels:
  - osd
  - mds
  - rgw
---
service_type: host
addr: host07
hostname: host07
labels:
  - mon
---
service_type: mon
placement:
  label: "mon"
---
service_id: cephfs
placement:
  label: "mds"
```

```
---
service_type: mgr
service_name: mgr
placement:
  label: "mgr"
---
service_type: osd
service_id: all-available-devices
service_name: osd.all-available-devices
placement:
  label: "osd"
spec:
  data_devices:
    all: true
---
service_type: rgw
service_id: objectgw
service_name: rgw.objectgw
placement:
  count: 2
  label: "rgw"
spec:
  rgw_frontend_port: 8080
```

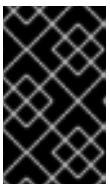
2. Bootstrap the storage cluster with the **--apply-spec** option:

   Syntax

   ```
   cephadm bootstrap --apply-spec CONFIGURATION_FILE_NAME --mon-ip
   MONITOR_IP_ADDRESS --ssh-private-key PRIVATE_KEY --ssh-public-key PUBLIC_KEY -
   -registry-url REGISTRY_URL --registry-username USER_NAME --registry-password
   PASSWORD
   ```

   Example

   ```
   [root@host01 ~]# cephadm bootstrap --apply-spec initial-config.yaml --mon-ip 10.10.128.68 -
   -ssh-private-key /home/ceph/.ssh/id_rsa --ssh-public-key /home/ceph/.ssh/id_rsa.pub --
   registry-url registry.redhat.io --registry-username myuser1 --registry-password mypassword1
   ```



IMPORTANT

You can use different command options with the **cephadm bootstrap** command. However, always include the **--apply-spec** option to use the service configuration file and configure the host locations.

Additional Resources

- See *Bootstrapping a new storage cluster* for more information about Ceph bootstrapping and different **cephadm bootstrap** command options.

Method 2: Setting the locations after the deployment

Prerequisites

- Root-level access to the nodes.

Procedure

1. Add two buckets to which you plan to set the location of your non-tiebreaker monitors to the CRUSH map, specifying the bucket type as as **datacenter**:

   Syntax

   ```
   ceph osd crush add-bucket BUCKET_NAME BUCKET_TYPE
   ```

   Example

   ```
   [ceph: root@host01 /]# ceph osd crush add-bucket DC1 datacenter
   [ceph: root@host01 /]# ceph osd crush add-bucket DC2 datacenter
   ```

2. Move the buckets under **root=default**:

   Syntax

   ```
   ceph osd crush move BUCKET_NAME root=default
   ```

   Example

   ```
   [ceph: root@host01 /]# ceph osd crush move DC1 root=default
   [ceph: root@host01 /]# ceph osd crush move DC2 root=default
   ```

3. Move the OSD hosts according to the required CRUSH placement:

   Syntax

   ```
   ceph osd crush move HOST datacenter=DATACENTER
   ```

   Example

   ```
   [ceph: root@host01 /]# ceph osd crush move host01 datacenter=DC1
   ```

4.1.2. Entering the stretch mode

The new stretch mode is designed to handle two sites. There is a lower risk of component availability outages with 2-site clusters.

Prerequisites

- Root-level access to the nodes.
- The CRUSH location is set to the hosts.

Procedure

1. Set the location of each monitor, matching your CRUSH map:

Syntax

```
ceph mon set_location HOST datacenter=DATACENTER
```

Example

```
[ceph: root@host01 /]# ceph mon set_location host01 datacenter=DC1
[ceph: root@host01 /]# ceph mon set_location host02 datacenter=DC1
[ceph: root@host01 /]# ceph mon set_location host04 datacenter=DC2
[ceph: root@host01 /]# ceph mon set_location host05 datacenter=DC2
[ceph: root@host01 /]# ceph mon set_location host07 datacenter=DC3
```

2. Generate a CRUSH rule which places two copies on each data center:

Syntax

```
ceph osd getcrushmap > COMPILED_CRUSHMAP_FILENAME
crushtool -d COMPILED_CRUSHMAP_FILENAME -o
DECOMPILED_CRUSHMAP_FILENAME
```

Example

```
[ceph: root@host01 /]# ceph osd getcrushmap > crush.map.bin
[ceph: root@host01 /]# crushtool -d crush.map.bin -o crush.map.txt
```

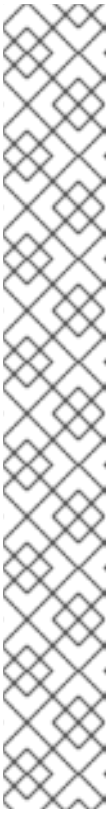
a. Edit the decompiled CRUSH map file to add a new rule:

Example

```
rule stretch_rule {
        id 1 (1)
        type replicated
        min_size 1
        max_size 10
        step take DC1 (2)
        step chooseleaf firstn 2 type host
        step emit
        step take DC2 (3)
        step chooseleaf firstn 2 type host
        step emit
}
```

(1) The rule **id** has to be unique. In this example, there is only one more rule with **id 0**, thereby the **id 1** is used, however you might need to use a different rule ID depending on the number of existing rules.

(2) (3) In this example, there are two data center buckets named **DC1** and **DC2**.



NOTE

This rule makes the cluster have read-affinity towards data center **DC1**. Therefore, all the reads or writes happen through Ceph OSDs placed in **DC1**.

If this is not desirable, and reads or writes are to be distributed evenly across the zones, the CRUSH rule is the following:

Example

```
rule stretch_rule {
id 1
type replicated
min_size 1
max_size 10
step take default
step choose firstn 0 type datacenter
step chooseleaf firstn 2 type host
step emit
}
```

In this rule, the data center is selected randomly and automatically.

See *CRUSH rules* for more information on **firstn** and **indep** options.

3. Inject the CRUSH map to make the rule available to the cluster:

   Syntax

   ```
   crushtool -c DECOMPILED_CRUSHMAP_FILENAME -o
   COMPILED_CRUSHMAP_FILENAME
   ceph osd setcrushmap -i COMPILED_CRUSHMAP_FILENAME
   ```

   Example

   ```
   [ceph: root@host01 /]# crushtool -c crush.map.txt -o crush2.map.bin
   [ceph: root@host01 /]# ceph osd setcrushmap -i crush2.map.bin
   ```

4. If you do not run the monitors in connectivity mode, set the election strategy to **connectivity**:

   Example

   ```
   [ceph: root@host01 /]# ceph mon set election_strategy connectivity
   ```

5. Enter stretch mode by setting the location of the tiebreaker monitor to split across the data centers:

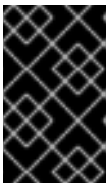
   Syntax

   ```
   ceph mon set_location HOST datacenter=DATACENTER
   ceph mon enable_stretch_mode HOST stretch_rule datacenter
   ```

   Example

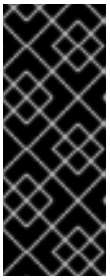
```
[ceph: root@host01 /]# ceph mon set_location host07 datacenter=DC3
[ceph: root@host01 /]# ceph mon enable_stretch_mode host07 stretch_rule datacenter
```

In this example the monitor **mon.host07** is the tiebreaker.



IMPORTANT

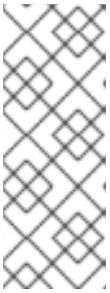
The location of the tiebreaker monitor should differ from the data centers to which you previously set the non-tiebreaker monitors. In the example above, it is data center **DC3**.



IMPORTANT

Do not add this data center to the CRUSH map as it results in the following error when you try to enter stretch mode:

```
Error EINVAL: there are 3 datacenters in the cluster but stretch mode currently only works with 2!
```



NOTE

If you are writing your own tooling for deploying Ceph, you can use a new **--set-crush-location** option when booting monitors, instead of running the **ceph mon set_location** command. This option accepts only a single **bucket=location** pair, for example **ceph-mon --set-crush-location 'datacenter=DC1'**, which must match the bucket type you specified when running the **enable_stretch_mode** command.

6. Verify that the stretch mode is enabled successfully:

Example

```
[ceph: root@host01 /]# ceph osd dump

epoch 361
fsid 1234ab78-1234-11ed-b1b1-de456ef0a89d
created 2023-01-16T05:47:28.482717+0000
modified 2023-01-17T17:36:50.066183+0000
flags sortbitwise,recovery_deletes,purged_snapdirs,pglog_hardlimit
crush_version 31
full_ratio 0.95
backfillfull_ratio 0.92
nearfull_ratio 0.85
require_min_compat_client luminous
min_compat_client luminous
require_osd_release quincy
stretch_mode_enabled true
stretch_bucket_count 2
degraded_stretch_mode 0
recovering_stretch_mode 0
stretch_mode_bucket 8
```

The **stretch_mode_enabled** should be set to **true**. You can also see the number of stretch buckets, stretch mode buckets, and if the stretch mode is degraded or recovering.

7. Verify that the monitors are in an appropriate locations:

Example

```
[ceph: root@host01 /]# ceph mon dump

epoch 19
fsid 1234ab78-1234-11ed-b1b1-de456ef0a89d
last_changed 2023-01-17T04:12:05.709475+0000
created 2023-01-16T05:47:25.631684+0000
min_mon_release 16 (pacific)
election_strategy: 3
stretch_mode_enabled 1
tiebreaker_mon host07
disallowed_leaders host07
0: [v2:132.224.169.63:3300/0,v1:132.224.169.63:6789/0] mon.host07; crush_location
{datacenter=DC3}
1: [v2:220.141.179.34:3300/0,v1:220.141.179.34:6789/0] mon.host04; crush_location
{datacenter=DC2}
2: [v2:40.90.220.224:3300/0,v1:40.90.220.224:6789/0] mon.host01; crush_location
{datacenter=DC1}
3: [v2:60.140.141.144:3300/0,v1:60.140.141.144:6789/0] mon.host02; crush_location
{datacenter=DC1}
4: [v2:186.184.61.92:3300/0,v1:186.184.61.92:6789/0] mon.host05; crush_location
{datacenter=DC2}
dumped monmap epoch 19
```

You can also see which monitor is the tiebreaker, and the monitor election strategy.

Additional Resources

- See *Configuring monitor election strategy* for more information about monitor election strategy.

4.1.3. Adding OSD hosts in stretch mode

You can add Ceph OSDs in the stretch mode. The procedure is similar to the addition of the OSD hosts on a cluster where stretch mode is not enabled.

Prerequisites

- A running Red Hat Ceph Storage cluster.
- Stretch mode in enabled on a cluster.
- Root-level access to the nodes.

Procedure

1. List the available devices to deploy OSDs:

Syntax

```
ceph orch device ls [--hostname=HOST_1 HOST_2] [--wide] [--refresh]
```

Example

```
[ceph: root@host01 /]# ceph orch device ls
```

2. Deploy the OSDs on specific hosts or on all the available devices:

   - Create an OSD from a specific device on a specific host:

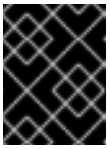
     Syntax

     ```
     ceph orch daemon add osd HOST:DEVICE_PATH
     ```

     Example

     ```
     [ceph: root@host01 /]# ceph orch daemon add osd host03:/dev/sdb
     ```

   - Deploy OSDs on any available and unused devices:

     IMPORTANT

     This command creates collocated WAL and DB devices. If you want to create non-collocated devices, do not use this command.

     Example

     ```
     [ceph: root@host01 /]# ceph orch apply osd --all-available-devices
     ```

3. Move the OSD hosts under the CRUSH bucket:

   Syntax

   ```
   ceph osd crush move HOST datacenter=DATACENTER
   ```

   Example

   ```
   [ceph: root@host01 /]# ceph osd crush move host03 datacenter=DC1
   [ceph: root@host01 /]# ceph osd crush move host06 datacenter=DC2
   ```

   NOTE

   Ensure you add the same topology nodes on both sites. Issues might arise if hosts are added only on one site.

Additional Resources

- See *Adding OSDs* for more information about the addition of Ceph OSDs.

CHAPTER 5. OVERRIDE CEPH BEHAVIOR

As a storage administrator, you need to understand how to use overrides for the Red Hat Ceph Storage cluster to change Ceph options during runtime.

5.1. SETTING AND UNSETTING CEPH OVERRIDE OPTIONS

You can set and unset Ceph options to override Ceph's default behavior.

Prerequisites

- A running Red Hat Ceph Storage cluster.
- Root-level access to the node.

Procedure

1. To override Ceph's default behavior, use the **ceph osd set** command and the behavior you wish to override:

   #### Syntax

   ```
   ceph osd set FLAG
   ```

   Once you set the behavior, **ceph health** will reflect the override(s) that you have set for the cluster.

   #### Example

   ```
   [ceph: root@host01 /]# ceph osd set noout
   ```

2. To cease overriding Ceph's default behavior, use the **ceph osd unset** command and the override you wish to cease.

   #### Syntax

   ```
   ceph osd unset FLAG
   ```

   #### Example

   ```
   [ceph: root@host01 /]# ceph osd unset noout
   ```

Flag	Description
noin	Prevents OSDs from being treated as **in** the cluster.
noout	Prevents OSDs from being treated as **out** of the cluster.
noup	Prevents OSDs from being treated as **up** and running.

Flag	Description
nodown	Prevents OSDs from being treated as **down**.
full	Makes a cluster appear to have reached its **full_ratio**, and thereby prevents write operations.
pause	Ceph will stop processing read and write operations, but will not affect OSD **in**, **out**, **up** or **down** statuses.
nobackfill	Ceph will prevent new backfill operations.
norebalance	Ceph will prevent new rebalancing operations.
norecover	Ceph will prevent new recovery operations.
noscrub	Ceph will prevent new scrubbing operations.
nodeep-scrub	Ceph will prevent new deep scrubbing operations.
notieragent	Ceph will disable the process that is looking for cold/dirty objects to flush and evict.

5.2. CEPH OVERRIDE USE CASES

- **noin**: Commonly used with **noout** to address flapping OSDs.
- **noout**: If the **mon osd report timeout** is exceeded and an OSD has not reported to the monitor, the OSD will get marked **out**. If this happens erroneously, you can set **noout** to prevent the OSD(s) from getting marked **out** while you troubleshoot the issue.
- **noup**: Commonly used with **nodown** to address flapping OSDs.
- **nodown**: Networking issues may interrupt Ceph 'heartbeat' processes, and an OSD may be **up** but still get marked down. You can set **nodown** to prevent OSDs from getting marked down while troubleshooting the issue.
- **full**: If a cluster is reaching its **full_ratio**, you can pre-emptively set the cluster to **full** and expand capacity.

NOTE

Setting the cluster to **full** will prevent write operations.

- **pause**: If you need to troubleshoot a running Ceph cluster without clients reading and writing data, you can set the cluster to **pause** to prevent client operations.
- **nobackfill**: If you need to take an OSD or node **down** temporarily, for example, upgrading daemons, you can set **nobackfill** so that Ceph will not backfill while the OSDs is **down**.

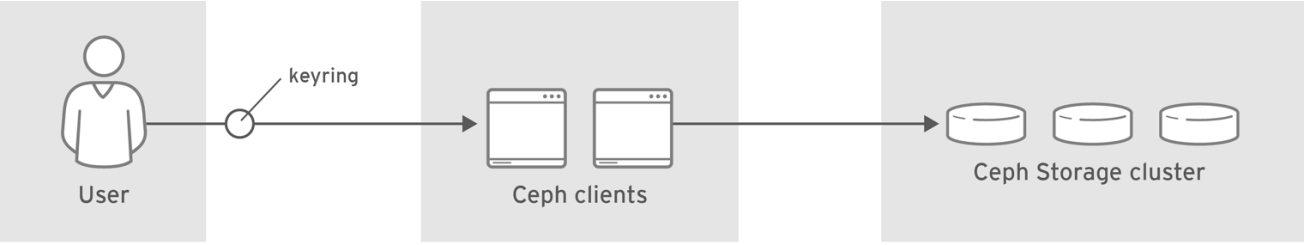
- **norecover**: If you need to replace an OSD disk and don't want the PGs to recover to another OSD while you are hotswapping disks, you can set **norecover** to prevent the other OSDs from copying a new set of PGs to other OSDs.

- **noscrub** and **nodeep-scrubb**: If you want to prevent scrubbing for example, to reduce overhead during high loads, recovery, backfilling, and rebalancing you can set **noscrub** and/or **nodeep-scrub** to prevent the cluster from scrubbing OSDs.

- **notieragent**: If you want to stop the tier agent process from finding cold objects to flush to the backing storage tier, you may set **notieragent**.

CHAPTER 6. CEPH USER MANAGEMENT

As a storage administrator, you can manage the Ceph user base by providing authentication, and access control to objects in the Red Hat Ceph Storage cluster.



IMPORTANT

Cephadm manages the client keyrings for the Red Hat Ceph Storage cluster as long as the clients are within the scope of Cephadm. Users should not modify the keyrings that are managed by Cephadm, unless there is troubleshooting.

6.1. CEPH USER MANAGEMENT BACKGROUND

When Ceph runs with authentication and authorization enabled, you must specify a user name. If you do not specify a user name, Ceph will use the **client.admin** administrative user as the default user name.

Alternatively, you may use the **CEPH_ARGS** environment variable to avoid re-entry of the user name and secret.

Irrespective of the type of Ceph client, for example, block device, object store, file system, native API, or the Ceph command line, Ceph stores all data as objects within pools. Ceph users must have access to pools in order to read and write data. Additionally, administrative Ceph users must have permissions to execute Ceph's administrative commands.

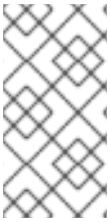
The following concepts can help you understand Ceph user management.

Storage Cluster Users

A user of the Red Hat Ceph Storage cluster is either an individual or as an application. Creating users allows you to control who can access the storage cluster, its pools, and the data within those pools.

Ceph has the notion of a **type** of user. For the purposes of user management, the type will always be **client**. Ceph identifies users in period (.) delimited form consisting of the user type and the user ID. For example, **TYPE.ID**, **client.admin**, or **client.user1**. The reason for user typing is that Ceph Monitors, and OSDs also use the Cephx protocol, but they are not clients. Distinguishing the user type helps to distinguish between client users and other users–streamlining access control, user monitoring and traceability.

Sometimes Ceph's user type may seem confusing, because the Ceph command line allows you to specify a user with or without the type, depending upon the command line usage. If you specify **--user** or **--id**, you can omit the type. So **client.user1** can be entered simply as **user1**. If you specify **--name** or **-n**, you must specify the type and name, such as **client.user1**. Red Hat recommends using the type and name as a best practice wherever possible.



NOTE

A Red Hat Ceph Storage cluster user is not the same as a Ceph Object Gateway user. The object gateway uses a Red Hat Ceph Storage cluster user to communicate between the gateway daemon and the storage cluster, but the gateway has its own user management functionality for its end users.

Authorization capabilities

Ceph uses the term "capabilities" (caps) to describe authorizing an authenticated user to exercise the functionality of the Ceph Monitors and OSDs. Capabilities can also restrict access to data within a pool or a namespace within a pool. A Ceph administrative user sets a user's capabilities when creating or updating a user. Capability syntax follows the form:

Syntax

```
DAEMON_TYPE 'allow CAPABILITY' [DAEMON_TYPE 'allow CAPABILITY']
```

- **Monitor Caps:** Monitor capabilities include **r**, **w**, **x**, **allow profile *CAP***, and **profile rbd**.

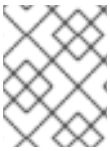
  #### Example

  ```
  mon 'allow rwx`
  mon 'allow profile osd'
  ```

- **OSD Caps:** OSD capabilities include **r**, **w**, **x**, **class-read**, **class-write**, **profile osd**, **profile rbd**, and **profile rbd-read-only**. Additionally, OSD capabilities also allow for pool and namespace settings. :

  #### Syntax

  ```
  osd 'allow CAPABILITY' [pool=POOL_NAME] [namespace=NAMESPACE_NAME]
  ```



NOTE

The Ceph Object Gateway daemon (**radosgw**) is a client of the Ceph storage cluster, so it isn't represented as a Ceph storage cluster daemon type.

The following entries describe each capability.

allow	Precedes access settings for a daemon.
r	Gives the user read access. Required with monitors to retrieve the CRUSH map.
w	Gives the user write access to objects.
x	Gives the user the capability to call class methods (that is, both read and write) and to conduct **auth** operations on monitors.
class-read	Gives the user the capability to call class read methods. Subset of **x**.

class-write	Gives the user the capability to call class write methods. Subset of **x**.
*	Gives the user read, write and execute permissions for a particular daemon or pool, and the ability to execute admin commands.
profile osd	Gives a user permissions to connect as an OSD to other OSDs or monitors. Conferred on OSDs to enable OSDs to handle replication heartbeat traffic and status reporting.
profile bootstrap-osd	Gives a user permissions to bootstrap an OSD, so that they have permissions to add keys when bootstrapping an OSD.
profile rbd	Gives a user read-write access to the Ceph Block Devices.
profile rbd-read-only	Gives a user read-only access to the Ceph Block Devices.

Pool

A pool defines a storage strategy for Ceph clients, and acts as a logical partition for that strategy.

In Ceph deployments, it is common to create a pool to support different types of use cases. For example, cloud volumes or images, object storage, hot storage, cold storage, and so on. When deploying Ceph as a back end for OpenStack, a typical deployment would have pools for volumes, images, backups and virtual machines, and users such as **client.glance**, **client.cinder**, and so on.

Namespace

Objects within a pool can be associated to a namespace—a logical group of objects within the pool. A user's access to a pool can be associated with a namespace such that reads and writes by the user take place only within the namespace. Objects written to a namespace within the pool can only be accessed by users who have access to the namespace.

NOTE

Currently, namespaces are only useful for applications written on top of **librados**. Ceph clients such as block device and object storage do not currently support this feature.

The rationale for namespaces is that pools can be a computationally expensive method of segregating data by use case, because each pool creates a set of placement groups that get mapped to OSDs. If multiple pools use the same CRUSH hierarchy and ruleset, OSD performance may degrade as load increases.

For example, a pool should have approximately 100 placement groups per OSD. So an exemplary cluster with 1000 OSDs would have 100,000 placement groups for one pool. Each pool mapped to the same CRUSH hierarchy and ruleset would create another 100,000 placement groups in the exemplary cluster. By contrast, writing an object to a namespace simply associates the namespace to the object name with out the computational overhead of a separate pool. Rather than creating a separate pool for a user or set of users, you may use a namespace.

NOTE

Only available using **librados** at this time.

Additional Resources

- See the *Red Hat Ceph Storage Configuration Guide* for details on configuring the use of authentication.

6.2. MANAGING CEPH USERS

As a storage administrator, you can manage Ceph users by creating, modifying, deleting, and importing users. A Ceph client user can be either individuals or applications, which use Ceph clients to interact with the Red Hat Ceph Storage cluster daemons.

6.2.1. Listing Ceph users

You can list the users in the storage cluster using the command-line interface.

Prerequisites

- A running Red Hat Ceph Storage cluster.
- Root-level access to the node.

Procedure

1. To list the users in the storage cluster, execute the following:

   Example

```
[ceph: root@host01 /]# ceph auth list
installed auth entries:

osd.10
 key: AQBW7U5gqOsEExAAg/CxSwZ/gSh8iOsDV3iQOA==
 caps: [mgr] allow profile osd
 caps: [mon] allow profile osd
 caps: [osd] allow *
osd.11
 key: AQBX7U5gtj/JIhAAPsLBNG+SfC2eMVEFkl3vfA==
 caps: [mgr] allow profile osd
 caps: [mon] allow profile osd
 caps: [osd] allow *
osd.9
 key: AQBV7U5g1XDULhAAKo2tw6ZhH1jki5aVui2v7g==
 caps: [mgr] allow profile osd
 caps: [mon] allow profile osd
 caps: [osd] allow *
client.admin
 key: AQADYEtgFfD3ExAAwH+C1qO7MSLE4TWRfD2g6g==
 caps: [mds] allow *
 caps: [mgr] allow *
 caps: [mon] allow *
```

```
 caps: [osd] allow *
client.bootstrap-mds
 key: AQAHYEtgpbkANBAANqoFlvzEXFwD8oB0w3TF4Q==
 caps: [mon] allow profile bootstrap-mds
client.bootstrap-mgr
 key: AQAHYEtg3dcANBAAVQf6brq3sxTSrCrPe0pKVQ==
 caps: [mon] allow profile bootstrap-mgr
client.bootstrap-osd
 key: AQAHYEtgD/QANBAATS9DuP3DbxEl86MTyKEmdw==
 caps: [mon] allow profile bootstrap-osd
client.bootstrap-rbd
 key: AQAHYEtgjxEBNBAANho25V9tWNNvIKnHknW59A==
 caps: [mon] allow profile bootstrap-rbd
client.bootstrap-rbd-mirror
 key: AQAHYEtgdE8BNBAAr6rLYxZci0b2hoIgH9GXYw==
 caps: [mon] allow profile bootstrap-rbd-mirror
client.bootstrap-rgw
 key: AQAHYEtgwGkBNBAAuRzI4WSrnowBhZxr2XtTFg==
 caps: [mon] allow profile bootstrap-rgw
client.crash.host04
 key: AQCQYEtgz8lGGhAAy5bJS8VH9fMdxuAZ3CqX5Q==
 caps: [mgr] profile crash
 caps: [mon] profile crash
client.crash.host02
 key: AQDuYUtgqgfdOhAAsyX+Mo35M+HFpURGad7nJA==
 caps: [mgr] profile crash
 caps: [mon] profile crash
client.crash.host03
 key: AQB98E5g5jHZAxAAklWSvmDsh2JaL5G7FvMrrA==
 caps: [mgr] profile crash
 caps: [mon] profile crash
client.nfs.foo.host03
 key: AQCgTk9gm+HvMxAAHbjG+XpdwL6prM/uMcdPdQ==
 caps: [mon] allow r
 caps: [osd] allow rw pool=nfs-ganesha namespace=foo
client.nfs.foo.host03-rgw
 key: AQCgTk9g8sJQNhAAPykcoYUuPc7ljubaFx09HQ==
 caps: [mon] allow r
 caps: [osd] allow rwx tag rgw *=*
client.rgw.test_realm.test_zone.host01.hgbvnq
 key: AQD5RE9gAQKdCRAAJzxDwD/dJObbInp9J95sXw==
 caps: [mgr] allow rw
 caps: [mon] allow *
 caps: [osd] allow rwx tag rgw *=*
client.rgw.test_realm.test_zone.host02.yqqilm
 key: AQD0RE9gkxA4ExAAFXp3pLJWdlhsyTe2ZR6Ilw==
 caps: [mgr] allow rw
 caps: [mon] allow *
 caps: [osd] allow rwx tag rgw *=*
mgr.host01.hdhzwn
 key: AQAEYEtg3lhIBxAAmHodoIpdvnxK0llWF80ltQ==
 caps: [mds] allow *
 caps: [mon] profile mgr
 caps: [osd] allow *
mgr.host02.eobuuv
 key: AQAn6U5gzUuiABAA2Fed+jPM1xwb4XDYtrQxaQ==
```

```
caps: [mds] allow *
caps: [mon] profile mgr
caps: [osd] allow *
mgr.host03.wquwpj
key: AQAd6U5gIzWsLBAAbOKUKZlUcAVe9kBLfajMKw==
caps: [mds] allow *
caps: [mon] profile mgr
caps: [osd] allow *
```

NOTE

The **TYPE.ID** notation for users applies such that **osd.0** is a user of type **osd** and its ID is **0**, **client.admin** is a user of type **client** and its ID is **admin**, that is, the default **client.admin** user. Note also that each entry has a **key: *VALUE*** entry, and one or more **caps:** entries.

You may use the **-o *FILE_NAME*** option with **ceph auth list** to save the output to a file.

6.2.2. Display Ceph user information

You can display a Ceph's user information using the command-line interface.

Prerequisites

- A running Red Hat Ceph Storage cluster.
- Root-level access to the node.

Procedure

1. To retrieve a specific user, key and capabilities, execute the following:

   Syntax

   ```
   ceph auth export TYPE.ID
   ```

   Example

   ```
   [ceph: root@host01 /]# ceph auth export mgr.host02.eobuuv
   ```

2. You can also use the **-o *FILE_NAME*** option.

   Syntax

   ```
   ceph auth export TYPE.ID -o FILE_NAME
   ```

   Example

   ```
   [ceph: root@host01 /]# ceph auth export osd.9 -o filename
   export auth(key=AQBV7U5g1XDULhAAKo2tw6ZhH1jki5aVui2v7g==)
   ```

The **auth export** command is identical to **auth get**, but also prints out the internal **auid**, which isn't relevant to end users.

6.2.3. Add a new Ceph user

Adding a user creates a username, that is, ***TYPE.ID***, a secret key and any capabilities included in the command you use to create the user.

A user's key enables the user to authenticate with the Ceph storage cluster. The user's capabilities authorize the user to read, write, or execute on Ceph monitors (**mon**), Ceph OSDs (**osd**) or Ceph Metadata Servers (**mds**).

There are a few ways to add a user:

- **ceph auth add**: This command is the canonical way to add a user. It will create the user, generate a key and add any specified capabilities.
- **ceph auth get-or-create**: This command is often the most convenient way to create a user, because it returns a keyfile format with the user name (in brackets) and the key. If the user already exists, this command simply returns the user name and key in the keyfile format. You may use the **-o *FILE_NAME*** option to save the output to a file.
- **ceph auth get-or-create-key**: This command is a convenient way to create a user and return the user's key only. This is useful for clients that need the key only, for example, **libvirt**. If the user already exists, this command simply returns the key. You may use the **-o *FILE_NAME*** option to save the output to a file.

When creating client users, you may create a user with no capabilities. A user with no capabilities is useless beyond mere authentication, because the client cannot retrieve the cluster map from the monitor. However, you can create a user with no capabilities if you wish to defer adding capabilities later using the **ceph auth caps** command.

A typical user has at least read capabilities on the Ceph monitor and read and write capability on Ceph OSDs. Additionally, a user's OSD permissions are often restricted to accessing a particular pool. :

```
[ceph: root@host01 /]# ceph auth add client.john mon 'allow r' osd 'allow rw pool=mypool'
[ceph: root@host01 /]# ceph auth get-or-create client.paul mon 'allow r' osd 'allow rw pool=mypool'
[ceph: root@host01 /]# ceph auth get-or-create client.george mon 'allow r' osd 'allow rw pool=mypool'
-o george.keyring
[ceph: root@host01 /]# ceph auth get-or-create-key client.ringo mon 'allow r' osd 'allow rw
pool=mypool' -o ringo.key
```

IMPORTANT

If you provide a user with capabilities to OSDs, but you DO NOT restrict access to particular pools, the user will have access to ALL pools in the cluster!

6.2.4. Modifying a Ceph User

The **ceph auth caps** command allows you to specify a user and change the user's capabilities.

Prerequisites

- A running Red Hat Ceph Storage cluster.

- Root-level access to the node.

Procedure

1. To add capabilities, use the form:

   Syntax

   ```
   ceph auth caps USERTYPE.USERID DAEMON 'allow [r|w|x|*|...] [pool=POOL_NAME] [namespace=NAMESPACE_NAME]'
   ```

   Example

   ```
   [ceph: root@host01 /]# ceph auth caps client.john mon 'allow r' osd 'allow rw pool=mypool'
   [ceph: root@host01 /]# ceph auth caps client.paul mon 'allow rw' osd 'allow rwx pool=mypool'
   [ceph: root@host01 /]# ceph auth caps client.brian-manager mon 'allow *' osd 'allow *'
   ```

2. To remove a capability, you may reset the capability. If you want the user to have no access to a particular daemon that was previously set, specify an empty string:

   Example

   ```
   [ceph: root@host01 /]# ceph auth caps client.ringo mon ' ' osd ' '
   ```

Additional Resources

- See *Authorization capabilities* for additional details on capabilities.

6.2.5. Deleting a Ceph user

You can delete a user from the Ceph storage cluster using the command-line interface.

Prerequisites

- A running Red Hat Ceph Storage cluster.
- Root-level access to the node.

Procedure

1. To delete a user, use **ceph auth del**:

   Syntax

   ```
   ceph auth del TYPE.ID
   ```

   Example

   ```
   [ceph: root@host01 /]# ceph auth del osd.6
   ```

6.2.6. Print a Ceph user key

You can display a Ceph user's key information using the command-line interface.

Prerequisites

- A running Red Hat Ceph Storage cluster.
- Root-level access to the node.

Procedure

- Print a user's authentication key to standard output:

  Syntax

  ```
  ceph auth print-key TYPE.ID
  ```

  Example

  ```
  [ceph: root@host01 /]# ceph auth print-key osd.6

  AQBQ7U5gAry3JRAA3NoPrqBBThpFMcRL6Sr+5w==[ceph: root@host01 /]#
  ```

CHAPTER 7. THE CEPH-VOLUME UTILITY

As a storage administrator, you can prepare, list, create, activate, deactivate, batch, trigger, zap, and migrate Ceph OSDs using the **ceph-volume** utility. The **ceph-volume** utility is a single-purpose command-line tool to deploy logical volumes as OSDs. It uses a plugin-type framework to deploy OSDs with different device technologies. The **ceph-volume** utility follows a similar workflow of the **ceph-disk** utility for deploying OSDs, with a predictable, and robust way of preparing, activating, and starting OSDs. Currently, the **ceph-volume** utility only supports the **lvm** plugin, with the plan to support others technologies in the future.

IMPORTANT

The **ceph-disk** command is deprecated.

7.1. CEPH VOLUME LVM PLUGIN

By making use of LVM tags, the **lvm** sub-command is able to store and re-discover by querying devices associated with OSDs so they can be activated. This includes support for lvm-based technologies like **dm-cache** as well.

When using **ceph-volume**, the use of **dm-cache** is transparent, and treats **dm-cache** like a logical volume. The performance gains and losses when using **dm-cache** will depend on the specific workload. Generally, random and sequential reads will see an increase in performance at smaller block sizes. While random and sequential writes will see a decrease in performance at larger block sizes.

To use the LVM plugin, add **lvm** as a subcommand to the **ceph-volume** command within the cephadm shell:

```
[ceph: root@host01 /]# ceph-volume lvm
```

Following are the **lvm** subcommands:

- **prepare** - Format an LVM device and associate it with an OSD.
- **activate** - Discover and mount the LVM device associated with an OSD ID and start the Ceph OSD.
- **list** - List logical volumes and devices associated with Ceph.
- **batch** - Automatically size devices for multi-OSD provisioning with minimal interaction.
- **deactivate** - Deactivate OSDs.
- **create** - Create a new OSD from an LVM device.
- **trigger** - A systemd helper to activate an OSD.
- **zap** - Removes all data and filesystems from a logical volume or partition.
- **migrate** - Migrate BlueFS data from to another LVM device.
- **new-wal** - Allocate new WAL volume for the OSD at specified logical volume.
- **new-db** - Allocate new DB volume for the OSD at specified logical volume.

NOTE

Using the **create** subcommand combines the **prepare** and **activate** subcommands into one subcommand.

Additional Resources

- See the **create** subcommand section for more details.

7.2. WHY DOES CEPH-VOLUME REPLACE CEPH-DISK?

Up to Red Hat Ceph Storage 4, **ceph-disk** utility was used to prepare, activate, and create OSDs. Starting with Red Hat Ceph Storage 4, **ceph-disk** is replaced by the **ceph-volume** utility that aims to be a single purpose command-line tool to deploy logical volumes as OSDs, while maintaining a similar API to **ceph-disk** when preparing, activating, and creating OSDs.

How does ceph-volume work?

The **ceph-volume** is a modular tool that currently supports two ways of provisioning hardware devices, legacy **ceph-disk** devices and LVM (Logical Volume Manager) devices. The **ceph-volume lvm** command uses the LVM tags to store information about devices specific to Ceph and its relationship with OSDs. It uses these tags to later re-discover and query devices associated with OSDS so that it can activate them. It supports technologies based on LVM and **dm-cache** as well.

The **ceph-volume** utility uses **dm-cache** transparently and treats it as a logical volume. You might consider the performance gains and losses when using **dm-cache**, depending on the specific workload you are handling. Generally, the performance of random and sequential read operations increases at smaller block sizes; while the performance of random and sequential write operations decreases at larger block sizes. Using **ceph-volume** does not introduce any significant performance penalties.

IMPORTANT

The **ceph-disk** utility is deprecated.

NOTE

The **ceph-volume simple** command can handle legacy **ceph-disk** devices, if these devices are still in use.

How does ceph-disk work?

The **ceph-disk** utility was required to support many different types of init systems, such as **upstart** or **sysvinit**, while being able to discover devices. For this reason, **ceph-disk** concentrates only on GUID Partition Table (GPT) partitions. Specifically on GPT GUIDs that label devices in a unique way to answer questions like:

- Is this device a **journal**?
- Is this device an encrypted data partition?
- Was the device left partially prepared?

To solve these questions, **ceph-disk** uses UDEV rules to match the GUIDs.

What are disadvantages of using ceph-disk?

Using the UDEV rules to call **ceph-disk** can lead to a back-and-forth between the **ceph-disk systemd** unit and the **ceph-disk** executable. The process is very unreliable and time consuming and can cause OSDs to not come up at all during the boot process of a node. Moreover, it is hard to debug, or even replicate these problems given the asynchronous behavior of UDEV.

Because **ceph-disk** works with GPT partitions exclusively, it cannot support other technologies, such as Logical Volume Manager (LVM) volumes, or similar device mapper devices.

To ensure the GPT partitions work correctly with the device discovery workflow, **ceph-disk** requires a large number of special flags to be used. In addition, these partitions require devices to be exclusively owned by Ceph.

7.3. PREPARING CEPH OSDS USING CEPH-VOLUME

The **prepare** subcommand prepares an OSD back-end object store and consumes logical volumes (LV) for both the OSD data and journal. It does not modify the logical volumes, except for adding some extra metadata tags using LVM. These tags make volumes easier to discover, and they also identify the volumes as part of the Ceph Storage Cluster and the roles of those volumes in the storage cluster.

The BlueStore OSD backend supports the following configurations:

- A block device, a **block.wal** device, and a **block.db** device
- A block device and a **block.wal** device
- A block device and a **block.db** device
- A single block device

The **prepare** subcommand accepts a whole device or partition, or a logical volume for **block**.

Prerequisites

- Root-level access to the OSD nodes.
- Optionally, create logical volumes. If you provide a path to a physical device, the subcommand turns the device into a logical volume. This approach is simpler, but you cannot configure or change the way the logical volume is created.

Procedure

1. Extract the Ceph keyring:

   #### Syntax

   ```
   ceph auth get client.ID -o ceph.client.ID.keyring
   ```

   #### Example

   ```
   [ceph: root@host01 /]# ceph auth get client.bootstrap-osd -o /var/lib/ceph/bootstrap-osd/ceph.keyring
   ```

2. Prepare the LVM volumes:

Syntax

```
ceph-volume lvm prepare --bluestore --data VOLUME_GROUP/LOGICAL_VOLUME
```

Example

```
[ceph: root@host01 /]# ceph-volume lvm prepare --bluestore --data example_vg/data_lv
```

a. Optionally, if you want to use a separate device for RocksDB, specify the **--block.db** and **--block.wal** options:

Syntax

```
ceph-volume lvm prepare --bluestore --block.db BLOCK_DB_DEVICE --block.wal
BLOCK_WAL_DEVICE --data DATA_DEVICE
```

Example

```
[ceph: root@host01 /]# ceph-volume lvm prepare --bluestore --block.db /dev/sda --
block.wal /dev/sdb --data /dev/sdc
```

b. Optionally, to encrypt data, use the **--dmcrypt** flag:

Syntax

```
ceph-volume lvm prepare --bluestore --dmcrypt --data
VOLUME_GROUP/LOGICAL_VOLUME
```

Example

```
[ceph: root@host01 /]# ceph-volume lvm prepare --bluestore --dmcrypt --data
example_vg/data_lv
```

Additional Resources

- See the *Activating Ceph OSDs using `ceph-volume`* section in the *Red Hat Ceph Storage Administration Guide* for more details.
- See the *Creating Ceph OSDs using `ceph-volume`* section in the *Red Hat Ceph Storage Administration Guide* for more details.

7.4. LISTING DEVICES USING CEPH-VOLUME

You can use the **ceph-volume lvm list** subcommand to list logical volumes and devices associated with a Ceph cluster, as long as they contain enough metadata to allow for that discovery. The output is grouped by the OSD ID associated with the devices. For logical volumes, the **devices key** is populated with the physical devices associated with the logical volume.

In some cases, the output of the **ceph -s** command shows the following error message:

```
1 devices have fault light turned on
```

In such cases, you can list the devices with **ceph device ls-lights** command which gives the details about the lights on the devices. Based on the information, you can turn off the lights on the devices.

Prerequisites

- A running Red Hat Ceph Storage cluster.
- Root-level access to the Ceph OSD node.

Procedure

- List the devices in the Ceph cluster:

  #### Example

```
[ceph: root@host01 /]# ceph-volume lvm list


====== osd.6 =======

  [block]       /dev/ceph-83909f70-95e9-4273-880e-5851612cbe53/osd-block-7ce687d9-07e7-4f8f-a34e-d1b0efb89920

      block device              /dev/ceph-83909f70-95e9-4273-880e-5851612cbe53/osd-block-7ce687d9-07e7-4f8f-a34e-d1b0efb89920
      block uuid                4d7gzX-Nzxp-UUG0-bNxQ-Jacr-l0mP-IPD8cX
      cephx lockbox secret
      cluster fsid              1ca9f6a8-d036-11ec-8263-fa163ee967ad
      cluster name              ceph
      crush device class        None
      encrypted                 0
      osd fsid                  7ce687d9-07e7-4f8f-a34e-d1b0efb89920
      osd id                    6
      osdspec affinity          all-available-devices
      type                      block
      vdo                       0
      devices                   /dev/vdc
```

- Optional: List the devices in the storage cluster with the lights:

  #### Example

```
[ceph: root@host01 /]# ceph device ls-lights

{
    "fault": [
        "SEAGATE_ST12000NM002G_ZL2KTGCK0000C149"
    ],
    "ident": []
}
```

  a. Optional: Turn off the lights on the device:

     #### Syntax

     -

```
ceph device light off DEVICE_NAME FAULT/INDENT --force
```

Example

```
[ceph: root@host01 /]# ceph device light off
SEAGATE_ST12000NM002G_ZL2KTGCK0000C149 fault --force
```

7.5. ACTIVATING CEPH OSDS USING CEPH-VOLUME

The activation process enables a **systemd** unit at boot time, which allows the correct OSD identifier and its UUID to be enabled and mounted.

Prerequisites

- A running Red Hat Ceph Storage cluster.
- Root-level access to the Ceph OSD node.
- Ceph OSDs prepared by the **ceph-volume** utility.

Procedure

1. Get the OSD ID and OSD FSID from an OSD node:

   ```
   [ceph: root@host01 /]# ceph-volume lvm list
   ```

2. Activate the OSD:

   Syntax

   ```
   ceph-volume lvm activate --bluestore OSD_ID OSD_FSID
   ```

   Example

   ```
   [ceph: root@host01 /]# ceph-volume lvm activate --bluestore 10 7ce687d9-07e7-4f8f-a34e-
   d1b0efb89920
   ```

   To activate all OSDs that are prepared for activation, use the **--all** option:

   Example

   ```
   [ceph: root@host01 /]# ceph-volume lvm activate --all
   ```

3. Optionally, you can use the **trigger** subcommand. This command cannot be used directly, and it is used by **systemd** so that it proxies input to **ceph-volume lvm activate**. This parses the metadata coming from systemd and startup, detecting the UUID and ID associated with an OSD.

   Syntax

   ```
   ceph-volume lvm trigger SYSTEMD_DATA
   ```

Here the *SYSTEMD_DATA* is in *OSD_ID-OSD_FSID* format.

Example

```
[ceph: root@host01 /]# ceph-volume lvm trigger 10 7ce687d9-07e7-4f8f-a34e-d1b0efb89920
```

Additional Resources

- See the *Preparing Ceph OSDs using `ceph-volume`* section in the *Red Hat Ceph Storage Administration Guide* for more details.
- See the *Creating Ceph OSDs using `ceph-volume`* section in the *Red Hat Ceph Storage Administration Guide* for more details.

7.6. DEACTIVATING CEPH OSDS USING CEPH-VOLUME

You can deactivate the Ceph OSDs using the **ceph-volume lvm** subcommand. This subcommand removes the volume groups and the logical volume.

Prerequisites

- A running Red Hat Ceph Storage cluster.
- Root-level access to the Ceph OSD node.
- The Ceph OSDs are activated using the **ceph-volume** utility.

Procedure

1. Get the OSD ID from the OSD node:

```
[ceph: root@host01 /]# ceph-volume lvm list
```

2. Deactivate the OSD:

Syntax

```
ceph-volume lvm deactivate OSD_ID
```

Example

```
[ceph: root@host01 /]# ceph-volume lvm deactivate 16
```

Additional Resources

- See the *Activating Ceph OSDs using `ceph-volume`* section in the *Red Hat Ceph Storage Administration Guide* for more details.
- See the *Preparing Ceph OSDs using `ceph-volume`* section in the *Red Hat Ceph Storage Administration Guide* for more details.
- See the *Creating Ceph OSDs using `ceph-volume`* section in the *Red Hat Ceph Storage Administration Guide* for more details.

7.7. CREATING CEPH OSDS USING CEPH-VOLUME

The **create** subcommand calls the **prepare** subcommand, and then calls the **activate** subcommand.

Prerequisites

- A running Red Hat Ceph Storage cluster.
- Root-level access to the Ceph OSD nodes.

NOTE

If you prefer to have more control over the creation process, you can use the **prepare** and **activate** subcommands separately to create the OSD, instead of using **create**. You can use the two subcommands to gradually introduce new OSDs into a storage cluster, while avoiding having to rebalance large amounts of data. Both approaches work the same way, except that using the **create** subcommand causes the OSD to become *up* and *in* immediately after completion.

Procedure

1. To create a new OSD:

Syntax

```
ceph-volume lvm create --bluestore --data VOLUME_GROUP/LOGICAL_VOLUME
```

Example

```
[root@osd ~]# ceph-volume lvm create --bluestore --data example_vg/data_lv
```

Additional Resources

- See the *Preparing Ceph OSDs using `ceph-volume`* section in the *Red Hat Ceph Storage Administration Guide* for more details.
- See the *Activating Ceph OSDs using `ceph-volume`* section in the *Red Hat Ceph Storage Administration Guide* for more details.

7.8. MIGRATING BLUEFS DATA

You can migrate the BlueStore file system (BlueFS) data, that is the RocksDB data, from the source volume to the target volume using the **migrate** LVM subcommand. The source volume, except the main one, is removed on success.

LVM volumes are primarily for the target only.

The new volumes are attached to the OSD, replacing one of the source drives.

Following are the placement rules for the LVM volumes:

- If source list has DB or WAL volume, then the target device replaces it.

- if source list has slow volume only, then explicit allocation using the **new-db** or **new-wal** command is needed.

The **new-db** and **new-wal** commands attaches the given logical volume to the given OSD as a DB or a WAL volume respectively.

Prerequisites

- A running Red Hat Ceph Storage cluster.
- Root-level access to the Ceph OSD node.
- Ceph OSDs prepared by the **ceph-volume** utility.
- Volume groups and Logical volumes are created.

Procedure

1. Log in the **cephadm** shell:

   #### Example

   ```
   [root@host01 ~]# cephadm shell
   ```

2. Stop the OSD to which you have to add the DB or the WAL device:

   #### Example

   ```
   [ceph: root@host01 /]# ceph orch daemon stop osd.1
   ```

3. Mount the new devices to the container:

   #### Example

   ```
   [root@host01 ~]# cephadm shell --mount /var/lib/ceph/72436d46-ca06-11ec-9809-ac1f6b5635ee/osd.1:/var/lib/ceph/osd/ceph-1
   ```

4. Attach the given logical volume to OSD as a DB/WAL device:

   #### NOTE

   This command fails if the OSD has an attached DB.

   #### Syntax

   ```
   ceph-volume lvm new-db --osd-id OSD_ID --osd-fsid OSD_FSID --target VOLUME_GROUP_NAME/LOGICAL_VOLUME_NAME
   ```

   #### Example

   ```
   [ceph: root@host01 /]# ceph-volume lvm new-db --osd-id 1 --osd-fsid 7ce687d9-07e7-4f8f-a34e-d1b0efb89921 --target vgname/new_db
   [ceph: root@host01 /]# ceph-volume lvm new-wal --osd-id 1 --osd-fsid 7ce687d9-07e7-4f8f-
   ```

```
a34e-d1b0efb89921 --target vgname/new_wal
```

5. You can migrate BlueFS data in the following ways:

   - Move BlueFS data from main device to LV that is already attached as DB:

     Syntax

     ```
     ceph-volume lvm migrate --osd-id OSD_ID --osd-fsid OSD_UUID --from data --target VOLUME_GROUP_NAME/LOGICAL_VOLUME_NAME
     ```

     Example

     ```
     [ceph: root@host01 /]# ceph-volume lvm migrate --osd-id 1 --osd-fsid 0263644D-0BF1-4D6D-BC34-28BD98AE3BC8 --from data --target vgname/db
     ```

   - Move BlueFS data from shared main device to LV which shall be attached as a new DB:

     Syntax

     ```
     ceph-volume lvm migrate --osd-id OSD_ID --osd-fsid OSD_UUID --from data --target VOLUME_GROUP_NAME/LOGICAL_VOLUME_NAME
     ```

     Example

     ```
     [ceph: root@host01 /]# ceph-volume lvm migrate --osd-id 1 --osd-fsid 0263644D-0BF1-4D6D-BC34-28BD98AE3BC8 --from data --target vgname/new_db
     ```

   - Move BlueFS data from DB device to new LV, and replace the DB device:

     Syntax

     ```
     ceph-volume lvm migrate --osd-id OSD_ID --osd-fsid OSD_UUID --from db --target VOLUME_GROUP_NAME/LOGICAL_VOLUME_NAME
     ```

     Example

     ```
     [ceph: root@host01 /]# ceph-volume lvm migrate --osd-id 1 --osd-fsid 0263644D-0BF1-4D6D-BC34-28BD98AE3BC8 --from db --target vgname/new_db
     ```

   - Move BlueFS data from main and DB devices to new LV, and replace the DB device:

     Syntax

     ```
     ceph-volume lvm migrate --osd-id OSD_ID --osd-fsid OSD_UUID --from data db --target VOLUME_GROUP_NAME/LOGICAL_VOLUME_NAME
     ```

     Example

     ```
     [ceph: root@host01 /]# ceph-volume lvm migrate --osd-id 1 --osd-fsid 0263644D-0BF1-4D6D-BC34-28BD98AE3BC8 --from data db --target vgname/new_db
     ```

- Move BlueFS data from main, DB, and WAL devices to new LV, remove the WAL device, and replace the the DB device:

  Syntax

  ```
  ceph-volume lvm migrate --osd-id OSD_ID --osd-fsid OSD_UUID --from data db wal --target VOLUME_GROUP_NAME/LOGICAL_VOLUME_NAME
  ```

  Example

  ```
  [ceph: root@host01 /]# ceph-volume lvm migrate --osd-id 1 --osd-fsid 0263644D-0BF1-4D6D-BC34-28BD98AE3BC8 --from data db --target vgname/new_db
  ```

- Move BlueFS data from main, DB, and WAL devices to the main device, remove the WAL and DB devices:

  Syntax

  ```
  ceph-volume lvm migrate --osd-id OSD_ID --osd-fsid OSD_UUID --from db wal --target VOLUME_GROUP_NAME/LOGICAL_VOLUME_NAME
  ```

  Example

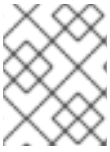
  ```
  [ceph: root@host01 /]# ceph-volume lvm migrate --osd-id 1 --osd-fsid 0263644D-0BF1-4D6D-BC34-28BD98AE3BC8 --from db wal --target vgname/data
  ```

7.9. USING BATCH MODE WITH CEPH-VOLUME

The **batch** subcommand automates the creation of multiple OSDs when single devices are provided.

The **ceph-volume** command decides the best method to use to create the OSDs, based on drive type. Ceph OSD optimization depends on the available devices:

- If all devices are traditional hard drives, **batch** creates one OSD per device.
- If all devices are solid state drives, **batch** creates two OSDs per device.
- If there is a mix of traditional hard drives and solid state drives, **batch** uses the traditional hard drives for data, and creates the largest possible journal (**block.db**) on the solid state drive.



NOTE

The **batch** subcommand does not support the creation of a separate logical volume for the write-ahead-log (**block.wal**) device.

Prerequisites

- A running Red Hat Ceph Storage cluster.
- Root-level access to the Ceph OSD nodes.

Procedure

1. To create OSDs on several drives:

   Syntax

   ```
   ceph-volume lvm batch --bluestore PATH_TO_DEVICE [PATH_TO_DEVICE]
   ```

   Example

   ```
   [ceph: root@host01 /]# ceph-volume lvm batch --bluestore /dev/sda /dev/sdb /dev/nvme0n1
   ```

Additional Resources

- See the *Creating Ceph OSDs using `ceph-volume`* section in the *Red Hat Ceph Storage Administration Guide* for more details.

7.10. ZAPPING DATA USING CEPH-VOLUME

The **zap** subcommand removes all data and filesystems from a logical volume or partition.

You can use the **zap** subcommand to zap logical volumes, partitions, or raw devices that are used by Ceph OSDs for reuse. Any filesystems present on the given logical volume or partition are removed and all data is purged.

Optionally, you can use the **--destroy** flag for complete removal of a logical volume, partition, or the physical device.

Prerequisites

- A running Red Hat Ceph Storage cluster.
- Root-level access to the Ceph OSD node.

Procedure

- Zap the logical volume:

  Syntax

  ```
  ceph-volume lvm zap VOLUME_GROUP_NAME/LOGICAL_VOLUME_NAME [--destroy]
  ```

  Example

  ```
  [ceph: root@host01 /]# ceph-volume lvm zap osd-vg/data-lv
  ```

- Zap the partition:

  Syntax

  ```
  ceph-volume lvm zap DEVICE_PATH_PARTITION [--destroy]
  ```

  Example

```
[ceph: root@host01 /]# ceph-volume lvm zap /dev/sdc1
```

- Zap the raw device:

  Syntax

  ```
  ceph-volume lvm zap DEVICE_PATH --destroy
  ```

  Example

  ```
  [ceph: root@host01 /]# ceph-volume lvm zap /dev/sdc --destroy
  ```

- Purge multiple devices with the OSD ID:

  Syntax

  ```
  ceph-volume lvm zap --destroy --osd-id OSD_ID
  ```

  Example

  ```
  [ceph: root@host01 /]# ceph-volume lvm zap --destroy --osd-id 16
  ```

  NOTE

  All the relative devices are zapped.

- Purge OSDs with the FSID:

  Syntax

  ```
  ceph-volume lvm zap --destroy --osd-fsid OSD_FSID
  ```

  Example

  ```
  [ceph: root@host01 /]# ceph-volume lvm zap --destroy --osd-fsid 65d7b6b1-e41a-4a3c-b363-
  83ade63cb32b
  ```

  NOTE

  All the relative devices are zapped.

CHAPTER 8. CEPH PERFORMANCE BENCHMARK

As a storage administrator, you can benchmark performance of the Red Hat Ceph Storage cluster. The purpose of this section is to give Ceph administrators a basic understanding of Ceph's native benchmarking tools. These tools will provide some insight into how the Ceph storage cluster is performing. This is not the definitive guide to Ceph performance benchmarking, nor is it a guide on how to tune Ceph accordingly.

8.1. PERFORMANCE BASELINE

The OSD, including the journal, disks and the network throughput should each have a performance baseline to compare against. You can identify potential tuning opportunities by comparing the baseline performance data with the data from Ceph's native tools. Red Hat Enterprise Linux has many built-in tools, along with a plethora of open source community tools, available to help accomplish these tasks.

Additional Resources

- For more details about some of the available tools, see this Knowledgebase article.

8.2. BENCHMARKING CEPH PERFORMANCE

Ceph includes the **rados bench** command to do performance benchmarking on a RADOS storage cluster. The command will execute a write test and two types of read tests. The **--no-cleanup** option is important to use when testing both read and write performance. By default the **rados bench** command will delete the objects it has written to the storage pool. Leaving behind these objects allows the two read tests to measure sequential and random read performance.

NOTE

Before running these performance tests, drop all the file system caches by running the following:

Example

```
[ceph: root@host01 /]# echo 3 | sudo tee /proc/sys/vm/drop_caches && sudo sync
```

Prerequisites

- A running Red Hat Ceph Storage cluster.
- Root-level access to the node.

Procedure

1. Create a new storage pool:

   #### Example

   ```
   [ceph: root@host01 /]# ceph osd pool create testbench 100 100
   ```

2. Execute a write test for 10 seconds to the newly created storage pool:

Example

```
[ceph: root@host01 /]# rados bench -p testbench 10 write --no-cleanup

Maintaining 16 concurrent writes of 4194304 bytes for up to 10 seconds or 0 objects
 Object prefix: benchmark_data_cephn1.home.network_10510
   sec Cur ops   started  finished  avg MB/s  cur MB/s  last lat   avg lat
     0       0         0         0         0         0         -         0
     1      16        16         0         0         0         -         0
     2      16        16         0         0         0         -         0
     3      16        16         0         0         0         -         0
     4      16        17         1  0.998879         1   3.19824   3.19824
     5      16        18         2   1.59849         4   4.56163   3.87993
     6      16        18         2   1.33222         0         -   3.87993
     7      16        19         3   1.71239         2   6.90712     4.889
     8      16        25         9   4.49551        24   7.75362   6.71216
     9      16        25         9   3.99636         0         -   6.71216
    10      16        27        11   4.39632         4   9.65085   7.18999
    11      16        27        11   3.99685         0         -   7.18999
    12      16        27        11   3.66397         0         -   7.18999
    13      16        28        12   3.68975   1.33333   12.8124   7.65853
    14      16        28        12   3.42617         0         -   7.65853
    15      16        28        12   3.19785         0         -   7.65853
    16      11        28        17   4.24726   6.66667   12.5302   9.27548
    17      11        28        17   3.99751         0         -   9.27548
    18      11        28        17   3.77546         0         -   9.27548
    19      11        28        17   3.57683         0         -   9.27548
 Total time run:         19.505620
Total writes made:      28
Write size:             4194304
Bandwidth (MB/sec):     5.742

Stddev Bandwidth:       5.4617
Max bandwidth (MB/sec): 24
Min bandwidth (MB/sec): 0
Average Latency:        10.4064
Stddev Latency:         3.80038
Max latency:            19.503
Min latency:            3.19824
```

3. Execute a sequential read test for 10 seconds to the storage pool:

Example

```
[ceph: root@host01 /]# rados bench -p testbench 10 seq

sec Cur ops   started  finished  avg MB/s  cur MB/s  last lat   avg lat
  0       0         0         0         0         0         -         0
Total time run:        0.804869
Total reads made:      28
Read size:             4194304
Bandwidth (MB/sec):    139.153
```

```
Average Latency:       0.420841
Max latency:           0.706133
Min latency:           0.0816332
```

4. Execute a random read test for 10 seconds to the storage pool:

   Example

```
[ceph: root@host01 /]# rados bench -p testbench 10 rand

sec Cur ops   started  finished  avg MB/s  cur MB/s  last lat   avg lat
  0       0         0         0         0         0         -         0
  1      16        46        30   119.801       120  0.440184  0.388125
  2      16        81        65   129.408       140  0.577359  0.417461
  3      16       120       104   138.175       156  0.597435  0.409318
  4      15       157       142   141.485       152  0.683111  0.419964
  5      16       206       190   151.553       192  0.310578  0.408343
  6      16       253       237   157.608       188 0.0745175  0.387207
  7      16       287       271   154.412       136  0.792774   0.39043
  8      16       325       309   154.044       152  0.314254   0.39876
  9      16       362       346   153.245       148  0.355576  0.406032
 10      16       405       389   155.092       172   0.64734  0.398372
Total time run:        10.302229
Total reads made:      405
Read size:             4194304
Bandwidth (MB/sec):    157.248

Average Latency:       0.405976
Max latency:           1.00869
Min latency:           0.0378431
```

5. To increase the number of concurrent reads and writes, use the **-t** option, which the default is 16 threads. Also, the **-b** parameter can adjust the size of the object being written. The default object size is 4 MB. A safe maximum object size is 16 MB. Red Hat recommends running multiple copies of these benchmark tests to different pools. Doing this shows the changes in performance from multiple clients.
   Add the **--run-name *LABEL*** option to control the names of the objects that get written during the benchmark test. Multiple **rados bench** commands might be ran simultaneously by changing the **--run-name** label for each running command instance. This prevents potential I/O errors that can occur when multiple clients are trying to access the same object and allows for different clients to access different objects. The **--run-name** option is also useful when trying to simulate a real world workload.

   Example

```
[ceph: root@host01 /]# rados bench -p testbench 10 write -t 4 --run-name client1

Maintaining 4 concurrent writes of 4194304 bytes for up to 10 seconds or 0 objects
 Object prefix: benchmark_data_node1_12631
   sec Cur ops   started  finished  avg MB/s  cur MB/s  last lat   avg lat
     0       0         0         0         0         0         -         0
     1       4         4         0         0         0         -         0
     2       4         6         2   3.99099         4   1.94755   1.93361
     3       4         8         4   5.32498         8     2.978   2.44034
     4       4         8         4   3.99504         0         -   2.44034
```

```
    5      4       10       6   4.79504       4   2.92419    2.4629
    6      3       10       7   4.64471       4   3.02498    2.5432
    7      4       12       8   4.55287       4   3.12204   2.61555
    8      4       14      10    4.9821       8   2.55901   2.68396
    9      4       16      12   5.31621       8   2.68769   2.68081
   10      4       17      13   5.18488       4   2.11937   2.63763
   11      4       17      13   4.71431       0         -   2.63763
   12      4       18      14   4.65486       2    2.4836   2.62662
   13      4       18      14   4.29757       0         -   2.62662
Total time run:         13.123548
Total writes made:      18
Write size:             4194304
Bandwidth (MB/sec):     5.486

Stddev Bandwidth:       3.0991
Max bandwidth (MB/sec): 8
Min bandwidth (MB/sec): 0
Average Latency:        2.91578
Stddev Latency:         0.956993
Max latency:            5.72685
Min latency:            1.91967
```

6. Remove the data created by the **rados bench** command:

   Example

```
[ceph: root@host01 /]# rados -p testbench cleanup
```

8.3. BENCHMARKING CEPH BLOCK PERFORMANCE

Ceph includes the **rbd bench-write** command to test sequential writes to the block device measuring throughput and latency. The default byte size is 4096, the default number of I/O threads is 16, and the default total number of bytes to write is 1 GB. These defaults can be modified by the **--io-size**, **--io-threads** and **--io-total** options respectively.

Prerequisites

- A running Red Hat Ceph Storage cluster.
- Root-level access to the node.

Procedure

- Run the write performance test against the block device

  Example

```
[root@host01 ~]# rbd bench --io-type write image01 --pool=testbench

bench-write  io_size 4096 io_threads 16 bytes 1073741824 pattern seq
  SEC       OPS   OPS/SEC   BYTES/SEC
    2     11127   5479.59  22444382.79
    3     11692   3901.91  15982220.33
    4     12372   2953.34  12096895.42
```

```
5    12580   2300.05  9421008.60
6    13141   2101.80  8608975.15
7    13195    356.07  1458459.94
8    13820    390.35  1598876.60
9    14124    325.46  1333066.62
..
```

Additional Resources

- See the *Ceph block devices* chapter in the *Red Hat Ceph Storage Block Device Guide* for more information on the **rbd** command.

CHAPTER 9. CEPH PERFORMANCE COUNTERS

As a storage administrator, you can gather performance metrics of the Red Hat Ceph Storage cluster. The Ceph performance counters are a collection of internal infrastructure metrics. The collection, aggregation, and graphing of this metric data can be done by an assortment of tools and can be useful for performance analytics.

9.1. ACCESS TO CEPH PERFORMANCE COUNTERS

The performance counters are available through a socket interface for the Ceph Monitors and the OSDs. The socket file for each respective daemon is located under **/var/run/ceph**, by default. The performance counters are grouped together into collection names. These collections names represent a subsystem or an instance of a subsystem.

Here is the full list of the Monitor and the OSD collection name categories with a brief description for each :

Monitor Collection Name Categories

- Cluster Metrics - Displays information about the storage cluster: Monitors, OSDs, Pools, and PGs
- Level Database Metrics - Displays information about the back-end **KeyValueStore** database
- Monitor Metrics - Displays general monitor information
- Paxos Metrics - Displays information on cluster quorum management
- Throttle Metrics - Displays the statistics on how the monitor is throttling

OSD Collection Name Categories

- Write Back Throttle Metrics - Displays the statistics on how the write back throttle is tracking unflushed IO
- Level Database Metrics - Displays information about the back-end **KeyValueStore** database
- Objecter Metrics - Displays information on various object-based operations
- Read and Write Operations Metrics - Displays information on various read and write operations
- Recovery State Metrics - Displays - Displays latencies on various recovery states
- OSD Throttle Metrics - Display the statistics on how the OSD is throttling

RADOS Gateway Collection Name Categories

- Object Gateway Client Metrics - Displays statistics on GET and PUT requests
- Objecter Metrics - Displays information on various object-based operations
- Object Gateway Throttle Metrics - Display the statistics on how the OSD is throttling

9.2. DISPLAY THE CEPH PERFORMANCE COUNTERS

The **ceph daemon *DAEMON_NAME* perf schema** command outputs the available metrics. Each metric has an associated bit field value type.

Prerequisites

- A running Red Hat Ceph Storage cluster.
- Root-level access to the node.

Procedure

1. To view the metric's schema:

   Synatx

   ```
   ceph daemon DAEMON_NAME perf schema
   ```

   NOTE

   You must run the **ceph daemon** command from the node running the daemon.

2. Executing **ceph daemon *DAEMON_NAME* perf schema** command from the monitor node:

   Example

   ```
   [ceph: root@host01 /]# ceph daemon mon.host01 perf schema
   ```

3. Executing the **ceph daemon *DAEMON_NAME* perf schema** command from the OSD node:

   Example

   ```
   [ceph: root@host01 /]# ceph daemon osd.11 perf schema
   ```

Table 9.1. The bit field value definitions

Bit	Meaning
1	**Floating point value**
2	**Unsigned 64-bit integer value**
4	**Average (Sum + Count)**
8	**Counter**

Each value will have bit 1 or 2 set to indicate the type, either a floating point or an integer value. When bit 4 is set, there will be two values to read, a sum and a count. When bit 8 is set, the average for the previous interval would be the sum delta, since the previous read, divided by the count delta. Alternatively, dividing the values outright would provide the lifetime average value. Typically these are used to measure latencies, the number of requests and a sum of request latencies. Some bit values are combined, for example 5, 6 and 10. A bit value of 5 is a combination of bit 1 and bit 4. This means the

average will be a floating point value. A bit value of 6 is a combination of bit 2 and bit 4. This means the average value will be an integer. A bit value of 10 is a combination of bit 2 and bit 8. This means the counter value will be an integer value.

Additional Resources

- See *Average count and sum* section in the *Red Hat Ceph Storage Administration Guide* for more details.

9.3. DUMP THE CEPH PERFORMANCE COUNTERS

The **ceph daemon .. perf dump** command outputs the current values and groups the metrics under the collection name for each subsystem.

Prerequisites

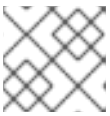
- A running Red Hat Ceph Storage cluster.
- Root-level access to the node.

Procedure

1. To view the current metric data:

   Syntax

   ```
   ceph daemon DAEMON_NAME perf dump
   ```

   NOTE

   You must run the **ceph daemon** command from the node running the daemon.

2. Executing **ceph daemon .. perf dump** command from the Monitor node:

   ```
   [ceph: root@host01 /]# ceph daemon mon.host01 perf dump
   ```

3. Executing the **ceph daemon .. perf dump** command from the OSD node:

   ```
   [ceph: root@host01 /]# ceph daemon osd.11 perf dump
   ```

Additional Resources

- To view a short description of each Monitor metric available, please see the *Ceph monitor metrics table*.

9.4. AVERAGE COUNT AND SUM

All latency numbers have a bit field value of 5. This field contains floating point values for the average count and sum. The **avgcount** is the number of operations within this range and the **sum** is the total latency in seconds. When dividing the **sum** by the **avgcount** this will provide you with an idea of the latency per operation.

Additional Resources

- To view a short description of each OSD metric available, please see the *Ceph OSD table*.

9.5. CEPH MONITOR METRICS

- *Cluster Metrics Table*
- *Level Database Metrics Table*
- *General Monitor Metrics Table*
- *Paxos Metrics Table*
- *Throttle Metrics Table*

Table 9.2. Cluster Metrics Table

Collection Name	Metric Name	Bit Field Value	Short Description
cluster	**num_mon**	2	Number of monitors
	num_mon_quorum	2	Number of monitors in quorum
	num_osd	2	Total number of OSD
	num_osd_up	2	Number of OSDs that are up
	num_osd_in	2	Number of OSDs that are in cluster
	osd_epoch	2	Current epoch of OSD map
	osd_bytes	2	Total capacity of cluster in bytes
	osd_bytes_used	2	Number of used bytes on cluster
	osd_bytes_avail	2	Number of available bytes on cluster
	num_pool	2	Number of pools
	num_pg	2	Total number of placement groups
	num_pg_active_clean	2	Number of placement groups in active+clean state

Collection Name	Metric Name	Bit Field Value	Short Description
	num_pg_active	2	Number of placement groups in active state
	num_pg_peering	2	Number of placement groups in peering state
	num_object	2	Total number of objects on cluster
	num_object_degraded	2	Number of degraded (missing replicas) objects
	num_object_misplaced	2	Number of misplaced (wrong location in the cluster) objects
	num_object_unfound	2	Number of unfound objects
	num_bytes	2	Total number of bytes of all objects
	num_mds_up	2	Number of MDSs that are up
	num_mds_in	2	Number of MDS that are in cluster
	num_mds_failed	2	Number of failed MDS
	mds_epoch	2	Current epoch of MDS map

Table 9.3. Level Database Metrics Table

Collection Name	Metric Name	Bit Field Value	Short Description
leveldb	**leveldb_get**	10	Gets
	leveldb_transaction	10	Transactions
	leveldb_compact	10	Compactions
	leveldb_compact_range	10	Compactions by range
	leveldb_compact_queue_merge	10	Mergings of ranges in compaction queue

Collection Name	Metric Name	Bit Field Value	Short Description
	leveldb_compact_queue_len	2	Length of compaction queue

Table 9.4. General Monitor Metrics Table

Collection Name	Metric Name	Bit Field Value	Short Description
mon	**num_sessions**	2	Current number of opened monitor sessions
	session_add	10	Number of created monitor sessions
	session_rm	10	Number of remove_session calls in monitor
	session_trim	10	Number of trimed monitor sessions
	num_elections	10	Number of elections monitor took part in
	election_call	10	Number of elections started by monitor
	election_win	10	Number of elections won by monitor
	election_lose	10	Number of elections lost by monitor

Table 9.5. Paxos Metrics Table

Collection Name	Metric Name	Bit Field Value	Short Description
paxos	**start_leader**	10	Starts in leader role
	start_peon	10	Starts in peon role
	restart	10	Restarts
	refresh	10	Refreshes
	refresh_latency	5	Refresh latency

Collection Name	Metric Name	Bit Field Value	Short Description
	begin	10	Started and handled begins
	begin_keys	6	Keys in transaction on begin
	begin_bytes	6	Data in transaction on begin
	begin_latency	5	Latency of begin operation
	commit	10	Commits
	commit_keys	6	Keys in transaction on commit
	commit_bytes	6	Data in transaction on commit
	commit_latency	5	Commit latency
	collect	10	Peon collects
	collect_keys	6	Keys in transaction on peon collect
	collect_bytes	6	Data in transaction on peon collect
	collect_latency	5	Peon collect latency
	collect_uncommitted	10	Uncommitted values in started and handled collects
	collect_timeout	10	Collect timeouts
	accept_timeout	10	Accept timeouts
	lease_ack_timeout	10	Lease acknowledgement timeouts
	lease_timeout	10	Lease timeouts
	store_state	10	Store a shared state on disk
	store_state_keys	6	Keys in transaction in stored state
	store_state_bytes	6	Data in transaction in stored state

Collection Name	Metric Name	Bit Field Value	Short Description
	store_state_latency	5	Storing state latency
	share_state	10	Sharings of state
	share_state_keys	6	Keys in shared state
	share_state_bytes	6	Data in shared state
	new_pn	10	New proposal number queries
	new_pn_latency	5	New proposal number getting latency

Table 9.6. Throttle Metrics Table

Collection Name	Metric Name	Bit Field Value	Short Description
throttle-*	**val**	10	Currently available throttle
	max	10	Max value for throttle
	get	10	Gets
	get_sum	10	Got data
	get_or_fail_fail	10	Get blocked during get_or_fail
	get_or_fail_success	10	Successful get during get_or_fail
	take	10	Takes
	take_sum	10	Taken data
	put	10	Puts
	put_sum	10	Put data
	wait	5	Waiting latency

9.6. CEPH OSD METRICS

- *Write Back Throttle Metrics Table*
- *Level Database Metrics Table*

- *Objecter Metrics Table*
- *Read and Write Operations Metrics Table*
- *Recovery State Metrics Table*
- *OSD Throttle Metrics Table*

Table 9.7. Write Back Throttle Metrics Table

Collection Name	Metric Name	Bit Field Value	Short Description
WBThrottle	**bytes_dirtied**	2	Dirty data
	bytes_wb	2	Written data
	ios_dirtied	2	Dirty operations
	ios_wb	2	Written operations
	inodes_dirtied	2	Entries waiting for write
	inodes_wb	2	Written entries

Table 9.8. Level Database Metrics Table

Collection Name	Metric Name	Bit Field Value	Short Description
leveldb	**leveldb_get**	10	Gets
	leveldb_transaction	10	Transactions
	leveldb_compact	10	Compactions
	leveldb_compact_range	10	Compactions by range
	leveldb_compact_queue_merge	10	Mergings of ranges in compaction queue
	leveldb_compact_queue_len	2	Length of compaction queue

Table 9.9. Objecter Metrics Table

Collection Name	Metric Name	Bit Field Value	Short Description
objecter	**op_active**	2	Active operations

Collection Name	Metric Name	Bit Field Value	Short Description
	op_laggy	2	Laggy operations
	op_send	10	Sent operations
	op_send_bytes	10	Sent data
	op_resend	10	Resent operations
	op_ack	10	Commit callbacks
	op_commit	10	Operation commits
	op	10	Operation
	op_r	10	Read operations
	op_w	10	Write operations
	op_rmw	10	Read-modify-write operations
	op_pg	10	PG operation
	osdop_stat	10	Stat operations
	osdop_create	10	Create object operations
	osdop_read	10	Read operations
	osdop_write	10	Write operations
	osdop_writefull	10	Write full object operations
	osdop_append	10	Append operation
	osdop_zero	10	Set object to zero operations
	osdop_truncate	10	Truncate object operations
	osdop_delete	10	Delete object operations
	osdop_mapext	10	Map extent operations
	osdop_sparse_read	10	Sparse read operations

Collection Name	Metric Name	Bit Field Value	Short Description
	osdop_clonerange	10	Clone range operations
	osdop_getxattr	10	Get xattr operations
	osdop_setxattr	10	Set xattr operations
	osdop_cmpxattr	10	Xattr comparison operations
	osdop_rmxattr	10	Remove xattr operations
	osdop_resetxattrs	10	Reset xattr operations
	osdop_tmap_up	10	TMAP update operations
	osdop_tmap_put	10	TMAP put operations
	osdop_tmap_get	10	TMAP get operations
	osdop_call	10	Call (execute) operations
	osdop_watch	10	Watch by object operations
	osdop_notify	10	Notify about object operations
	osdop_src_cmpxattr	10	Extended attribute comparison in multi operations
	osdop_other	10	Other operations
	linger_active	2	Active lingering operations
	linger_send	10	Sent lingering operations
	linger_resend	10	Resent lingering operations
	linger_ping	10	Sent pings to lingering operations
	poolop_active	2	Active pool operations
	poolop_send	10	Sent pool operations
	poolop_resend	10	Resent pool operations

Collection Name	Metric Name	Bit Field Value	Short Description
	poolstat_active	2	Active get pool stat operations
	poolstat_send	10	Pool stat operations sent
	poolstat_resend	10	Resent pool stats
	statfs_active	2	Statfs operations
	statfs_send	10	Sent FS stats
	statfs_resend	10	Resent FS stats
	command_active	2	Active commands
	command_send	10	Sent commands
	command_resend	10	Resent commands
	map_epoch	2	OSD map epoch
	map_full	10	Full OSD maps received
	map_inc	10	Incremental OSD maps received
	osd_sessions	2	Open sessions
	osd_session_open	10	Sessions opened
	osd_session_close	10	Sessions closed
	osd_laggy	2	Laggy OSD sessions

Table 9.10. Read and Write Operations Metrics Table

Collection Name	Metric Name	Bit Field Value	Short Description
osd	**op_wip**	2	Replication operations currently being processed (primary)
	op_in_bytes	10	Client operations total write size

Collection Name	Metric Name	Bit Field Value	Short Description
	op_out_bytes	10	Client operations total read size
	op_latency	5	Latency of client operations (including queue time)
	op_process_latency	5	Latency of client operations (excluding queue time)
	op_r	10	Client read operations
	op_r_out_bytes	10	Client data read
	op_r_latency	5	Latency of read operation (including queue time)
	op_r_process_latency	5	Latency of read operation (excluding queue time)
	op_w	10	Client write operations
	op_w_in_bytes	10	Client data written
	op_w_rlat	5	Client write operation readable/applied latency
	op_w_latency	5	Latency of write operation (including queue time)
	op_w_process_latency	5	Latency of write operation (excluding queue time)
	op_rw	10	Client read-modify-write operations
	op_rw_in_bytes	10	Client read-modify-write operations write in
	op_rw_out_bytes	10	Client read-modify-write operations read out
	op_rw_rlat	5	Client read-modify-write operation readable/applied latency

Collection Name	Metric Name	Bit Field Value	Short Description
	op_rw_latency	5	Latency of read-modify-write operation (including queue time)
	op_rw_process_latency	5	Latency of read-modify-write operation (excluding queue time)
	subop	10	Suboperations
	subop_in_bytes	10	Suboperations total size
	subop_latency	5	Suboperations latency
	subop_w	10	Replicated writes
	subop_w_in_bytes	10	Replicated written data size
	subop_w_latency	5	Replicated writes latency
	subop_pull	10	Suboperations pull requests
	subop_pull_latency	5	Suboperations pull latency
	subop_push	10	Suboperations push messages
	subop_push_in_bytes	10	Suboperations pushed size
	subop_push_latency	5	Suboperations push latency
	pull	10	Pull requests sent
	push	10	Push messages sent
	push_out_bytes	10	Pushed size
	push_in	10	Inbound push messages
	push_in_bytes	10	Inbound pushed size
	recovery_ops	10	Started recovery operations
	loadavg	2	CPU load

Collection Name	Metric Name	Bit Field Value	Short Description
	buffer_bytes	2	Total allocated buffer size
	numpg	2	Placement groups
	numpg_primary	2	Placement groups for which this osd is primary
	numpg_replica	2	Placement groups for which this osd is replica
	numpg_stray	2	Placement groups ready to be deleted from this osd
	heartbeat_to_peers	2	Heartbeat (ping) peers we send to
	heartbeat_from_peers	2	Heartbeat (ping) peers we recv from
	map_messages	10	OSD map messages
	map_message_epochs	10	OSD map epochs
	map_message_epoch_dups	10	OSD map duplicates
	stat_bytes	2	OSD size
	stat_bytes_used	2	Used space
	stat_bytes_avail	2	Available space
	copyfrom	10	Rados 'copy-from' operations
	tier_promote	10	Tier promotions
	tier_flush	10	Tier flushes
	tier_flush_fail	10	Failed tier flushes
	tier_try_flush	10	Tier flush attempts
	tier_try_flush_fail	10	Failed tier flush attempts

Collection Name	Metric Name	Bit Field Value	Short Description
	tier_evict	10	Tier evictions
	tier_whiteout	10	Tier whiteouts
	tier_dirty	10	Dirty tier flag set
	tier_clean	10	Dirty tier flag cleaned
	tier_delay	10	Tier delays (agent waiting)
	tier_proxy_read	10	Tier proxy reads
	agent_wake	10	Tiering agent wake up
	agent_skip	10	Objects skipped by agent
	agent_flush	10	Tiering agent flushes
	agent_evict	10	Tiering agent evictions
	object_ctx_cache_hit	10	Object context cache hits
	object_ctx_cache_total	10	Object context cache lookups
	ceph_cluster_osd_blocklist_count	2	Number of clients blocklisted

Table 9.11. Recovery State Metrics Table

Collection Name	Metric Name	Bit Field Value	Short Description
recoverystate_perf	**initial_latency**	5	Initial recovery state latency
	started_latency	5	Started recovery state latency
	reset_latency	5	Reset recovery state latency
	start_latency	5	Start recovery state latency
	primary_latency	5	Primary recovery state latency
	peering_latency	5	Peering recovery state latency

Collection Name	Metric Name	Bit Field Value	Short Description
	backfilling_latency	5	Backfilling recovery state latency
	waitremotebackfillreserved_latency	5	Wait remote backfill reserved recovery state latency
	waitlocalbackfillreserved_latency	5	Wait local backfill reserved recovery state latency
	notbackfilling_latency	5	Notbackfilling recovery state latency
	repnotrecovering_latency	5	Repnotrecovering recovery state latency
	repwaitrecoveryreserved_latency	5	Rep wait recovery reserved recovery state latency
	repwaitbackfillreserved_latency	5	Rep wait backfill reserved recovery state latency
	RepRecovering_latency	5	RepRecovering recovery state latency
	activating_latency	5	Activating recovery state latency
	waitlocalrecoveryreserved_latency	5	Wait local recovery reserved recovery state latency
	waitremoterecoveryreserved_latency	5	Wait remote recovery reserved recovery state latency
	recovering_latency	5	Recovering recovery state latency
	recovered_latency	5	Recovered recovery state latency
	clean_latency	5	Clean recovery state latency
	active_latency	5	Active recovery state latency
	replicaactive_latency	5	Replicaactive recovery state latency
	stray_latency	5	Stray recovery state latency

Collection Name	Metric Name	Bit Field Value	Short Description
	getinfo_latency	5	Getinfo recovery state latency
	getlog_latency	5	Getlog recovery state latency
	waitactingchange_latency	5	Waitactingchange recovery state latency
	incomplete_latency	5	Incomplete recovery state latency
	getmissing_latency	5	Getmissing recovery state latency
	waitupthru_latency	5	Waitupthru recovery state latency

Table 9.12. OSD Throttle Metrics Table

Collection Name	Metric Name	Bit Field Value	Short Description
throttle-*	**val**	10	Currently available throttle
	max	10	Max value for throttle
	get	10	Gets
	get_sum	10	Got data
	get_or_fail_fail	10	Get blocked during get_or_fail
	get_or_fail_success	10	Successful get during get_or_fail
	take	10	Takes
	take_sum	10	Taken data
	put	10	Puts
	put_sum	10	Put data
	wait	5	Waiting latency

9.7. CEPH OBJECT GATEWAY METRICS

- *Ceph Object Gateway Client Table*
- *Objecter Metrics Table*
- *Ceph Object Gateway Throttle Metrics Table*

Table 9.13. Ceph Object Gateway Client Metrics Table

Collection Name	Metric Name	Bit Field Value	Short Description
client.rgw.<rgw_node_name>	**req**	10	Requests
	failed_req	10	Aborted requests
	copy_obj_ops	10	Copy objects
	copy_obj_bytes	10	Size of copy objects
	copy_obj_lat	10	Copy object latency
	del_obj_ops	10	Delete objects
	del_obj_bytes	10	Size of delete objects
	del_obj_lat	10	Delete object latency
	del_bucket_ops	10	Delete Buckets
	del_bucket_lat	10	Delete bucket latency
	get	10	Gets
	get_b	10	Size of gets
	get_initial_lat	5	Get latency
	list_obj_ops	10	List objects
	list_obj_lat	10	List object latency
	list_buckets_ops	10	List buckets
	list_buckets_lat	10	List buckets latency
	put	10	Puts
	put_b	10	Size of puts

Collection Name	Metric Name	Bit Field Value	Short Description
	put_initial_lat	5	Put latency
	qlen	2	Queue length
	qactive	2	Active requests queue
	cache_hit	10	Cache hits
	cache_miss	10	Cache miss
	keystone_token_cache_hit	10	Keystone token cache hits
	keystone_token_cache_miss	10	Keystone token cache miss

Table 9.14. Objecter Metrics Table

Collection Name	Metric Name	Bit Field Value	Short Description
objecter	**op_active**	2	Active operations
	op_laggy	2	Laggy operations
	op_send	10	Sent operations
	op_send_bytes	10	Sent data
	op_resend	10	Resent operations
	op_ack	10	Commit callbacks
	op_commit	10	Operation commits
	op	10	Operation
	op_r	10	Read operations
	op_w	10	Write operations
	op_rmw	10	Read-modify-write operations
	op_pg	10	PG operation
	osdop_stat	10	Stat operations

Collection Name	Metric Name	Bit Field Value	Short Description
	osdop_create	10	Create object operations
	osdop_read	10	Read operations
	osdop_write	10	Write operations
	osdop_writefull	10	Write full object operations
	osdop_append	10	Append operation
	osdop_zero	10	Set object to zero operations
	osdop_truncate	10	Truncate object operations
	osdop_delete	10	Delete object operations
	osdop_mapext	10	Map extent operations
	osdop_sparse_read	10	Sparse read operations
	osdop_clonerange	10	Clone range operations
	osdop_getxattr	10	Get xattr operations
	osdop_setxattr	10	Set xattr operations
	osdop_cmpxattr	10	Xattr comparison operations
	osdop_rmxattr	10	Remove xattr operations
	osdop_resetxattrs	10	Reset xattr operations
	osdop_tmap_up	10	TMAP update operations
	osdop_tmap_put	10	TMAP put operations
	osdop_tmap_get	10	TMAP get operations
	osdop_call	10	Call (execute) operations
	osdop_watch	10	Watch by object operations
	osdop_notify	10	Notify about object operations

Collection Name	Metric Name	Bit Field Value	Short Description
	osdop_src_cmpxattr	10	Extended attribute comparison in multi operations
	osdop_other	10	Other operations
	linger_active	2	Active lingering operations
	linger_send	10	Sent lingering operations
	linger_resend	10	Resent lingering operations
	linger_ping	10	Sent pings to lingering operations
	poolop_active	2	Active pool operations
	poolop_send	10	Sent pool operations
	poolop_resend	10	Resent pool operations
	poolstat_active	2	Active get pool stat operations
	poolstat_send	10	Pool stat operations sent
	poolstat_resend	10	Resent pool stats
	statfs_active	2	Statfs operations
	statfs_send	10	Sent FS stats
	statfs_resend	10	Resent FS stats
	command_active	2	Active commands
	command_send	10	Sent commands
	command_resend	10	Resent commands
	map_epoch	2	OSD map epoch
	map_full	10	Full OSD maps received
	map_inc	10	Incremental OSD maps received

Collection Name	Metric Name	Bit Field Value	Short Description
	osd_sessions	2	Open sessions
	osd_session_open	10	Sessions opened
	osd_session_close	10	Sessions closed
	osd_laggy	2	Laggy OSD sessions

Table 9.15. Ceph Object Gateway Throttle Metrics Table

Collection Name	Metric Name	Bit Field Value	Short Description
throttle-*	**val**	10	Currently available throttle
	max	10	Max value for throttle
	get	10	Gets
	get_sum	10	Got data
	get_or_fail_fail	10	Get blocked during get_or_fail
	get_or_fail_success	10	Successful get during get_or_fail
	take	10	Takes
	take_sum	10	Taken data
	put	10	Puts
	put_sum	10	Put data
	wait	5	Waiting latency

CHAPTER 10. THE MCLOCK OSD SCHEDULER

As a storage administrator, you can implement the Red Hat Ceph Storage's quality of service (QoS) using mClock queueing scheduler. This is based on an adaptation of the mClock algorithm called dmClock.

The mClock OSD scheduler provides the desired QoS using configuration profiles to allocate proper reservation, weight, and limit tags to the service types.

The mClock OSD scheduler performs the QoS calculations for the different device types, that is SSD or HDD, by using the OSD's IOPS capability (determined automatically) and maximum sequential bandwidth capability (See **osd_mclock_max_sequential_bandwidth_hdd** and **osd_mclock_max_sequential_bandwidth_ssd** in *The mclock configuration options* section).

10.1. COMPARISON OF MCLOCK OSD SCHEDULER WITH WPQ OSD SCHEDULER

The mClock OSD scheduler replaces the Weighted Priority Queue (WPQ) OSD scheduler as a default scheduler in Red Hat Ceph Storage 6.1.

IMPORTANT

The mClock scheduler is supported for BlueStore OSDs.

The mClock OSD scheduler currently features an immediate queue, into which operations that require immediate response are queued. The immediate queue is not handled by mClock and functions as a simple first in, first out queue and is given the first priority.

Operations, such as OSD replication operations, OSD operation replies, peering, recoveries marked with the highest priority, and so forth, are queued into the immediate queue. All other operations are enqueued into the mClock queue that works according to the mClock algorithm.

The mClock queue, **mclock_scheduler**, prioritizes operations based on which bucket they belong to, that is **pg recovery**, **pg scrub**, **snap trim**, **client op**, and **pg deletion**.

With background operations in progress, the average client throughput, that is the input and output operations per second (IOPS), are significantly higher and latencies are lower with the mClock profiles when compared to the WPQ scheduler. That is because of mClock's effective allocation of the QoS parameters.

Additional Resources

- See the *mClock profiles* section for more information.

10.2. THE ALLOCATION OF INPUT AND OUTPUT RESOURCES

This section describes how the QoS controls work internally with reservation, limit, and weight allocation. The user is not expected to set these controls as the mClock profiles automatically set them. Tuning these controls can only be performed using the available mClock profiles.

The dmClock algorithm allocates the input and output (I/O) resources of the Ceph cluster in proportion to weights. It implements the constraints of minimum reservation and maximum limitation to ensure the services can compete for the resources fairly.

Currently, the **mclock_scheduler** operation queue divides Ceph services involving I/O resources into following buckets:

- **client op**: the input and output operations per second (IOPS) issued by a client.
- **pg deletion**: the IOPS issued by primary Ceph OSD.
- **snap trim**: the snapshot trimming-related requests.
- **pg recovery**: the recovery-related requests.
- **pg scrub**: the scrub-related requests.

The resources are partitioned using the following three sets of tags, meaning that the share of each type of service is controlled by these three tags:

- Reservation
- Limit
- Weight

Reservation

The minimum IOPS allocated for the service. The more reservation a service has, the more resources it is guaranteed to possess, as long as it requires so.

For example, a service with the reservation set to 0.1 (or 10%) always has 10% of the OSD's IOPS capacity allocated for itself. Therefore, even if the clients start to issue large amounts of I/O requests, they do not exhaust all the I/O resources and the service's operations are not depleted even in a cluster with high load.

Limit

The maximum IOPS allocated for the service. The service does not get more than the set number of requests per second serviced, even if it requires so and no other services are competing with it. If a service crosses the enforced limit, the operation remains in the operation queue until the limit is restored.

NOTE

If the value is set to **0** (disabled), the service is not restricted by the limit setting and it can use all the resources if there is no other competing operation. This is represented as "MAX" in the mClock profiles.

NOTE

The reservation and limit parameter allocations are per-shard, based on the type of backing device, that is HDD or SSD, under the Ceph OSD. See *OSD Object storage daemon configuration options* for more details about **osd_op_num_shards_hdd** and **osd_op_num_shards_ssd** parameters.

Weight

The proportional share of capacity if extra capacity or system is not enough. The service can use a larger portion of the I/O resource, if its weight is higher than its competitor's.

NOTE

The reservation and limit values for a service are specified in terms of a proportion of the total IOPS capacity of the OSD. The proportion is represented as a percentage in the mClock profiles. The weight does not have a unit. The weights are relative to one another, so if one class of requests has a weight of 9 and another a weight of 1, then the requests are performed at a 9 to 1 ratio. However, that only happens once the reservations are met and those values include the operations performed under the reservation phase.

IMPORTANT

If the weight is set to **W**, then for a given class of requests the next one that enters has a weight tag of **1/W** and the previous weight tag, or the current time, whichever is larger. That means, if **W** is too large and thus **1/W** is too small, the calculated tag might never be assigned as it gets a value of the current time.

Therefore, values for weight should be always under the number of requests expected to be serviced each second.

10.3. FACTORS THAT IMPACT MCLOCK OPERATION QUEUES

There are three factors that can reduce the impact of the mClock operation queues within Red Hat Ceph Storage:

- The number of shards for client operations.
- The number of operations in the operation sequencer.
- The usage of distributed system for Ceph OSDs

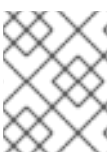
The number of shards for client operations

Requests to a Ceph OSD are sharded by their placement group identifier. Each shard has its own mClock queue and these queues neither interact, nor share information amongst them.

The number of shards can be controlled with these configuration options:

- **osd_op_num_shards**
- **osd_op_num_shards_hdd**
- **osd_op_num_shards_ssd**

A lower number of shards increase the impact of the mClock queues, but might have other damaging effects.



NOTE

Use the default number of shards as defined by the configuration options **osd_op_num_shards**, **osd_op_num_shards_hdd**, and **osd_op_num_shards_ssd**.

The number of operations in the operation sequencer

Requests are transferred from the operation queue to the operation sequencer, in which they are processed. The mClock scheduler is located in the operation queue. It determines which operation to transfer to the operation sequencer.

The number of operations allowed in the operation sequencer is a complex issue. The aim is to keep enough operations in the operation sequencer so it always works on some, while it waits for disk and network access to complete other operations.

However, mClock no longer has control over an operation that is transferred to the operation sequencer. Therefore, to maximize the impact of mClock, the goal is also to keep as few operations in the operation sequencer as possible.

The configuration options that influence the number of operations in the operation sequencer are:

- **bluestore_throttle_bytes**
- **bluestore_throttle_deferred_bytes**
- **bluestore_throttle_cost_per_io**
- **bluestore_throttle_cost_per_io_hdd**
- **bluestore_throttle_cost_per_io_ssd**

NOTE

Use the default values as defined by the **bluestore_throttle_bytes** and **bluestore_throttle_deferred_bytes** options. However, these options can be determined during the benchmarking phase.

The usage of distributed system for Ceph OSDs

The third factor that affects the impact of the mClock algorithm is the usage of a distributed system, where requests are made to multiple Ceph OSDs, and each Ceph OSD can have multiple shards. However, Red Hat Ceph Storage currently uses the mClock algorithm, which is not a distributed version of mClock.

NOTE

dmClock is the distributed version of mClock.

Additional Resources

- See *Object Storage Daemon (OSD) configuration options* for more details about **osd_op_num_shards_hdd** and **osd_op_num_shards_ssd** parameters.
- See *BlueStore configuration options* for more details about BlueStore throttle parameters.
- See *Manually benchmarking OSDs* for more information.

10.4. THE MCLOCK CONFIGURATION

To make the mClock more user-friendly and intuitive, the mClock configuration profiles are introduced in Red Hat Ceph Storage 6. The mClock profiles hide the low-level details from users, making it easier to configure and use mClock.

The following input parameters are required for an mClock profile to configure the quality of service (QoS) related parameters:

- The total capacity of input and output operations per second (IOPS) for each Ceph OSD. This is determined automatically.
- The maximum sequential bandwidth capacity (MiB/s) of each OS. See **osd_mclock_max_sequential_bandwidth_[hdd/ssd]** option
- An mClock profile type to be enabled. The default is **balanced**.

Using the settings in the specified profile, a Ceph OSD determines and applies the lower-level mClock and Ceph parameters. The parameters applied by the mClock profile make it possible to tune the QoS between the client I/O and background operations in the OSD.

Additional Resources

- See *The Ceph OSD capacity determination* for more information about the automated OSD capacity determination.

10.5. MCLOCK CLIENTS

The mClock scheduler handles requests from different types of Ceph services. Each service is considered by mClock as a type of client. Depending on the type of requests handled, mClock clients are classified into the buckets:

- Client - Handles input and output (I/O) requests issued by external clients of Ceph.
- Background recovery - Handles internal recovery requests.
- Background best-effort - Handles internal backfill, scrub, snap trim, and placement group (PG) deletion requests.

The mClock scheduler derives the cost of an operation used in the QoS calculations from *osd_mclock_max_capacity_iops_hdd* | *osd_mclock_max_capacity_iops_ssd*, *osd_mclock_max_sequential_bandwidth_hdd* | *osd_mclock_max_sequential_bandwidth_ssd* and *osd_op_num_shards_hdd* | *osd_op_num_shards_ssd* parameters.

10.6. MCLOCK PROFILES

An mClock profile is a configuration setting. When applied to a running Red Hat Ceph Storage cluster, it enables the throttling of the IOPS operations belonging to different client classes, such as background recovery, **scrub**, **snap trim**, **client op**, and **pg deletion**.

The mClock profile uses the capacity limits and the mClock profile type selected by the user to determine the low-level mClock resource control configuration parameters and applies them transparently. Other Red Hat Ceph Storage configuration parameters are also applied. The low-level mClock resource control parameters are the reservation, limit, and weight that provide control of the resource shares. The mClock profiles allocate these parameters differently for each client type.

10.6.1. mClock profile types

mClock profiles can be classified into *built-in* and *custom* profiles.

If any mClock profile is active, the following Red Hat Ceph Storage configuration sleep options get disabled, which means they are set to **0**:

- **osd_recovery_sleep**

- **osd_recovery_sleep_hdd**
- **osd_recovery_sleep_ssd**
- **osd_recovery_sleep_hybrid**
- **osd_scrub_sleep**
- **osd_delete_sleep**
- **osd_delete_sleep_hdd**
- **osd_delete_sleep_ssd**
- **osd_delete_sleep_hybrid**
- **osd_snap_trim_sleep**
- **osd_snap_trim_sleep_hdd**
- **osd_snap_trim_sleep_ssd**
- **osd_snap_trim_sleep_hybrid**

It is to ensure that mClock scheduler is able to determine when to pick the next operation from its operation queue and transfer it to the operation sequencer. This results in the desired QoS being provided across all its clients.

Custom profile

This profile gives users complete control over all the mClock configuration parameters. It should be used with caution and is meant for advanced users, who understand mClock and Red Hat Ceph Storage related configuration options.

Built-in profiles

When a *built-in* profile is enabled, the mClock scheduler calculates the low-level mClock parameters, that is, reservation, weight, and limit, based on the profile enabled for each client type.

The mClock parameters are calculated based on the maximum Ceph OSD capacity provided beforehand. Therefore, the following mClock configuration options cannot be modified when using any of the built-in profiles:

- **osd_mclock_scheduler_client_res**
- **osd_mclock_scheduler_client_wgt**
- **osd_mclock_scheduler_client_lim**
- **osd_mclock_scheduler_background_recovery_res**
- **osd_mclock_scheduler_background_recovery_wgt**
- **osd_mclock_scheduler_background_recovery_lim**
- **osd_mclock_scheduler_background_best_effort_res**
- **osd_mclock_scheduler_background_best_effort_wgt**

- **osd_mclock_scheduler_background_best_effort_lim**

NOTE

These defaults cannot be changed using any of the config subsystem commands like **config set**, **config daemon** or **config tell** commands. Although the above command(s) report success, the mclock QoS parameters are reverted to their respective built-in profile defaults.

The following recovery and backfill related Ceph options are overridden to mClock defaults:

WARNING

Do not change these options as the built-in profiles are optimized based on them. Changing these defaults can result in unexpected performance outcomes.

- **osd_max_backfills**
- **osd_recovery_max_active**
- **osd_recovery_max_active_hdd**
- **osd_recovery_max_active_ssd**

The following options show the mClock defaults which is same as the current defaults to maximize the performance of the foreground client operations:

osd_max_backfills

Original default

1

mClock default

1

osd_recovery_max_active

Original default

0

mClock default

0

osd_recovery_max_active_hdd

Original default

3

mClock default

3

osd_recovery_max_active_sdd

Original default

10

mClock default

10

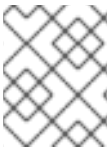
NOTE

The above mClock defaults can be modified, only if necessary, by enabling **osd_mclock_override_recovery_settings** that is by default set as **false**. See *Modifying backfill and recovery options* to modify these parameters.

Built-in profile types

Users can choose from the following *built-in* profile types:

- **balanced** (default)
- **high_client_ops**
- **high_recovery_ops**



NOTE

The values mentioned in the list below represent the proportion of the total IOPS capacity of the Ceph OSD allocated for the service type.

- **balanced**:

The default mClock profile is set to **balanced** because it represents a compromise between prioritizing client IO or recovery IO. It allocates equal reservation or priority to client operations and background recovery operations. Background best-effort operations are given lower reservation and therefore take longer to complete when there are competing operations. This profile meets the normal or steady state requirements of the cluster which is the case when external client performance requirements is not critical and there are other background operations that still need attention within the OSD.

There might be instances that necessitate giving higher priority to either client operations or recovery operations. To meet such requirements you can choose either the **high_client_ops** profile to prioritize client IO or the **high_recovery_ops** profile to prioritize recovery IO. These profiles are discussed further below.

Service type: client

Reservation

50%

Limit

MAX

Weight

1

Service type: background recovery

Reservation

50%

Limit

MAX

Weight

1

Service type: background best-effort

Reservation

MIN

Limit

90%

Weight

1

- **high_client_ops**

This profile optimizes client performance over background activities by allocating more reservation and limit to client operations as compared to background operations in the Ceph OSD. This profile, for example, can be enabled to provide the needed performance for I/O intensive applications for a sustained period of time at the cost of slower recoveries. The list below shows the resource control parameters set by the profile:

Service type: client

Reservation

60%

Limit

MAX

Weight

2

Service type: background recovery

Reservation

40%

Limit

MAX

Weight

1

Service type: background best-effort

Reservation

MIN

Limit

70%

Weight

1

- **high_recovery_ops**

This profile optimizes background recovery performance as compared to external clients and other background operations within the Ceph OSD.

For example, it could be temporarily enabled by an administrator to accelerate background recoveries during non-peak hours. The list below shows the resource control parameters set by the profile:

Service type: client

Reservation

30%

Limit

MAX

Weight

1

Service type: background recovery

Reservation

70%

Limit

MAX

Weight

2

Service type: background best-effort

Reservation

MIN

Limit

MAX

Weight

1

Additional Resources

- See the *The mClock configuration options* for more information about mClock configuration options.

10.6.2. Changing an mClock profile

The default mClock profile is set to **balanced**. The other types of the *built-in* profile are **high_client_ops** and **high_recovery_ops**.

NOTE

The *custom* profile is not recommended unless you are an advanced user.

Prerequisites

- A running Red Hat Ceph Storage cluster.
- Root-level access to the Ceph Monitor host.

Procedure

1. Log into the Cephadm shell:

   Example

   ```
   [root@host01 ~]# cephadm shell
   ```

2. Set the **osd_mclock_profile** option:

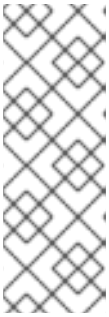
   Syntax

   ```
   ceph config set osd.OSD_ID osd_mclock_profile VALUE
   ```

   Example

   ```
   [ceph: root@host01 /]# ceph config set osd.0 osd_mclock_profile high_recovery_ops
   ```

   This example changes the profile to allow faster recoveries on **osd.0**.



NOTE

For optimal performance the profile must be set on all Ceph OSDs by using the following command:

Syntax

```
ceph config set osd osd_mclock_profile VALUE
```

10.6.3. Switching between *built-in* and *custom* profiles

The following steps describe switching from *built-in* profile to *custom* profile and vice-versa.

You might want to switch to the *custom* profile if you want complete control over all the mClock configuration options. However, it is recommended not to use the *custom* profile unless you are an advanced user.

Prerequisites

- A running Red Hat Ceph Storage cluster.
- Root-level access to the Ceph Monitor host.

Switch from *built-in* profile to *custom* profile

1. Log into the Cephadm shell:

   Example

   ```
   [root@host01 ~]# cephadm shell
   ```

2. Switch to the *custom* profile:

   Syntax

   ```
   ceph config set osd.OSD_ID osd_mclock_profile custom
   ```

   Example

   ```
   [ceph: root@host01 /]# ceph config set osd.0 osd_mclock_profile custom
   ```

   NOTE

   For optimal performance the profile must be set on all Ceph OSDs by using the following command:

   Example

   ```
   [ceph: root@host01 /]# ceph config set osd osd_mclock_profile custom
   ```

3. Optional: After switching to the *custom* profile, modify the desired mClock configuration options:

   Syntax

   ```
   ceph config set osd.OSD_ID MCLOCK_CONFIGURATION_OPTION VALUE
   ```

   Example

   ```
   [ceph: root@host01 /]# ceph config set osd.0 osd_mclock_scheduler_client_res 0.5
   ```

   This example changes the client reservation IOPS ratio for a specific OSD **osd.0** to 0.5 (50%)

   IMPORTANT

   Change the reservations of other services, such as background recovery and background best-effort accordingly to ensure that the sum of the reservations does not exceed the maximum proportion (1.0) of the IOPS capacity of the OSD.

Switch from *custom* profile to *built-in* profile

1. Log into the cephadm shell:

   Example

```
[root@host01 ~]# cephadm shell
```

2. Set the desired *built-in* profile:

   Syntax

   ```
   ceph config set osd osd_mclock_profile MCLOCK_PROFILE
   ```

   Example

   ```
   [ceph: root@host01 /]# ceph config set osd osd_mclock_profile high_client_ops
   ```

   This example sets the *built-in* profile to **high_client_ops** on all Ceph OSDs.

3. Determine the existing custom mClock configuration settings in the database:

   Example

   ```
   [ceph: root@host01 /]# ceph config dump
   ```

4. Remove the custom mClock configuration settings determined earlier:

   Syntax

   ```
   ceph config rm osd MCLOCK_CONFIGURATION_OPTION
   ```

   Example

   ```
   [ceph: root@host01 /]# ceph config rm osd osd_mclock_scheduler_client_res
   ```

   This example removes the configuration option **osd_mclock_scheduler_client_res** that was set on all Ceph OSDs.

   After all existing custom mClock configuration settings are removed from the central configuration database, the configuration settings related to **high_client_ops** are applied.

5. Verify the settings on Ceph OSDs:

   Syntax

   ```
   ceph config show osd.OSD_ID
   ```

   Example

   ```
   [ceph: root@host01 /]# ceph config show osd.0
   ```

Additional Resources

- See *mClock profile types* for the list of the mClock configuration options that cannot be modified with *built-in* profiles.

10.6.4. Switching temporarily between mClock profiles

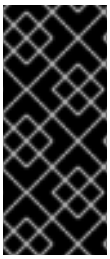
This section contains steps to temporarily switch between mClock profiles.

WARNING

This section is for advanced users or for experimental testing. Do not use the below commands on a running storage cluster as it could have unexpected outcomes.

NOTE

The configuration changes on a Ceph OSD using the below commands are temporary and are lost when the Ceph OSD is restarted.



IMPORTANT

The configuration options that are overridden using the commands described in this section cannot be modified further using the **ceph config set osd.*OSD_ID*** command. The changes do not take effect until a given Ceph OSD is restarted. This is intentional, as per the configuration subsystem design. However, any further modifications can still be made temporarily using these commands.

Prerequisites

- A running Red Hat Ceph Storage cluster.
- Root-level access to the Ceph Monitor host.

Procedure

1. Log into the Cephadm shell:

   Example

   ```
   [root@host01 ~]# cephadm shell
   ```

2. Run the following command to override the mClock settings:

   Syntax

   ```
   ceph tell osd.OSD_ID injectargs '--MCLOCK_CONFIGURATION_OPTION=VALUE'
   ```

   Example

   ```
   [ceph: root@host01 /]# ceph tell osd.0 injectargs '--osd_mclock_profile=high_recovery_ops'
   ```

   This example overrides the **osd_mclock_profile** option on **osd.0**.

3. Optional: You can use the alternative to the previous **ceph tell osd.*OSD_ID* injectargs** command:

   Syntax

   ```
   ceph daemon osd.OSD_ID config set MCLOCK_CONFIGURATION_OPTION VALUE
   ```

   Example

   ```
   [ceph: root@host01 /]# ceph daemon osd.0 config set osd_mclock_profile
   high_recovery_ops
   ```

NOTE

The individual QoS related configuration options for the *custom* profile can also be modified temporarily using the above commands.

10.6.5. Degraded and Misplaced Object Recovery Rate With mClock Profiles

Degraded object recovery is categorized into the background recovery bucket. Across all mClock profiles, degraded object recovery is given higher priority when compared to misplaced object recovery because degraded objects present a data safety issue not present with objects that are merely misplaced.

Backfill or the misplaced object recovery operation is categorized into the background best-effort bucket. According to the **balanced** and **high_client_ops** mClock profiles, background best-effort client is not constrained by reservation (set to zero) but is limited to use a fraction of the participating OSD's capacity if there are no other competing services.

Therefore, with the **balanced** or **high_client_ops** profile and with other background competing services active, backfilling rates are expected to be slower when compared to the previous *WeightedPriorityQueue* (WPQ) scheduler.

If higher backfill rates are desired, please follow the steps mentioned in the section below.

Improving backfilling rates

For faster backfilling rate when using either **balanced** or **high_client_ops** profile, follow the below steps:

- Switch to the 'high_recovery_ops' mClock profile for the duration of the backfills. See *Changing an mClock profile* to achieve this. Once the backfilling phase is complete, switch the mClock profile to the previously active profile. In case there is no significant improvement in the backfilling rate with the 'high_recovery_ops' profile, continue to the next step.
- Switch the mClock profile back to the previously active profile.
- Modify 'osd_max_backfills' to a higher value, for example, **3**. See *Modifying backfills and recovery options* to achieve this.
- Once the backfilling is complete, 'osd_max_backfills' can be reset to the default value of 1 by following the same procedure mentioned in step 3.

WARNING

Please note that modifying **osd_max_backfills** may result in other operations, for example, client operations may experience higher latency during the backfilling phase. Therefore, users are recommended to increase **osd_max_backfills** in small increments to minimize performance impact to other operations in the cluster.

10.6.6. Modifying backfills and recovery options

Modify the **backfills** and **recovery** options with the **ceph config set** command.

The backfill or recovery options that can be modified are listed in *mClock profile types*.

WARNING

This section is for advanced users or for experimental testing. Do not use the below commands on a running storage cluster as it could have unexpected outcomes.

Modify the values only for experimental testing, or if the cluster is unable to handle the values or it shows poor performance with the default settings.

IMPORTANT

The modification of the mClock default backfill or recovery options is restricted by the **osd_mclock_override_recovery_settings** option, which is set to **false** by default.

If you attempt to modify any default backfill or recovery options without setting **osd_mclock_override_recovery_settings** to **true**, it resets the options back to the mClock defaults along with a warning message logged in the cluster log.

Prerequisites

- A running Red Hat Ceph Storage cluster.
- Root-level access to the Ceph Monitor host.

Procedure

1. Log into the Cephadm shell:

   Example

   ```
   [root@host01 ~]# cephadm shell
   ```

2. Set the **osd_mclock_override_recovery_settings** configuration option to **true** on all Ceph OSDs:

   Example

   ```
   [ceph: root@host01 /]# ceph config set osd osd_mclock_override_recovery_settings true
   ```

3. Set the desired **backfills** or **recovery** option:

   Syntax

   ```
   ceph config set osd OPTION VALUE
   ```

   Example

   ```
   [ceph: root@host01 /]# ceph config set osd osd_max_backfills_ 5
   ```

4. Wait a few seconds and verify the configuration for the specific OSD:

   Syntax

   ```
   ceph config show osd.OSD_ID_ | grep OPTION
   ```

   Example

   ```
   [ceph: root@host01 /]# ceph config show osd.0 | grep osd_max_backfills
   ```

5. Reset the **osd_mclock_override_recovery_settings** configuration option to **false** on all OSDs:

   Example

   ```
   [ceph: root@host01 /]# ceph config set osd osd_mclock_override_recovery_settings false
   ```

10.7. THE CEPH OSD CAPACITY DETERMINATION

The Ceph OSD capacity in terms of total IOPS is determined automatically during the Ceph OSD initialization. This is achieved by running the Ceph OSD bench tool and overriding the default value of **osd_mclock_max_capacity_iops_[hdd, ssd]** option depending on the device type. No other action or input is expected from the user to set the Ceph OSD capacity.

Mitigation of unrealistic Ceph OSD capacity from the automated procedure

In certain conditions, the Ceph OSD bench tool might show unrealistic or inflated results depending on the drive configuration and other environment related conditions.

To mitigate the performance impact due to this unrealistic capacity, a couple of threshold configuration options depending on the OSD device type are defined and used:

- **osd_mclock_iops_capacity_threshold_hdd** = 500
- **osd_mclock_iops_capacity_threshold_ssd** = 80000

You can verify these parameters by running the following commands:

```
[ceph: root@host01 /]# ceph config show osd.0 osd_mclock_iops_capacity_threshold_hdd
500.000000
[ceph: root@host01 /]# ceph config show osd.0 osd_mclock_iops_capacity_threshold_ssd
80000.000000
```

NOTE

If you want to manually benchmark OSD(s) or manually tune the BlueStore throttle parameters, see *Manually benchmarking OSDs*.

You can verify the capacity of an OSD after the cluster is up by running the following command:

Syntax

```
ceph config show osd.N osd_mclock_max_capacity_iops_[hdd, ssd]
```

Example

```
[ceph: root@host01 /]# ceph config show osd.0 osd_mclock_max_capacity_iops_ssd
```

In the above example, you can view the maximum capacity for **osd.0** on a Red Hat Ceph Storage node whose underlying device is an SSD.

The following automated step is performed:

Fallback to using default OSD capacity

If the Ceph OSD bench tool reports a measurement that exceeds the above threshold values, the fallback mechanism reverts to the default value of **osd_mclock_max_capacity_iops_hdd** or **osd_mclock_max_capacity_iops_ssd**. The threshold configuration options can be reconfigured based on the type of drive used.

A cluster warning is logged in case the measurement exceeds the threshold:

Example

```
3403 Sep 11 11:52:50 dell-r640-039.dsal.lab.eng.rdu2.redhat.com ceph-osd[70342]:
log_channel(cluster) log [WRN] : OSD bench result of 49691.213005 IOPS exceeded the threshold
limit of 500.000000 IOPS for osd.27. IOPS capacity is unchanged at 315.000000 IOPS. The
recommendation is to establish the osd's IOPS capacity using other benchmark tools (e.g. Fio) and
then override osd_mclock_max_capacity_iops_[hdd|ssd].
```

IMPORTANT

If the default capacity does not accurately represent the Ceph OSD capacity, it is highly recommended to run a custom benchmark using the preferred tool, for example Fio, on the drive and then override the **osd_mclock_max_capacity_iops_[hdd, ssd]** option as described in *Specifying maximum OSD capacity*.

Additional Resources

- See *Manually benchmarking OSDs* to manually benchmark Ceph OSDs or manually tune the BlueStore throttle parameters.

- See *The mClock configuration options* for more information about the **osd_mclock_max_capacity_iops_[hdd, ssd]** and **osd_mclock_iops_capacity_threshold_[hdd, ssd]** options.

10.7.1. Verifying the capacity of an OSD

You can verify the capacity of a Ceph OSD after setting up the storage cluster.

Prerequisites

- A running Red Hat Ceph Storage cluster.
- Root-level access to the Ceph Monitor host.

Procedure

1. Log into the Cephadm shell:

   Example

   ```
   [root@host01 ~]# cephadm shell
   ```

2. Verify the capacity of a Ceph OSD:

   Syntax

   ```
   ceph config show osd.OSD_ID osd_mclock_max_capacity_iops_[hdd, ssd]
   ```

   Example

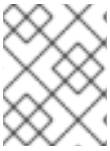
   ```
   [ceph: root@host01 /]# ceph config show osd.0 osd_mclock_max_capacity_iops_ssd

   21500.000000
   ```

10.7.2. Manually benchmarking OSDs

To manually benchmark a Ceph OSD, any existing benchmarking tool, for example Fio, can be used. Regardless of the tool or command used, the steps below remain the same.

IMPORTANT

The number of shards and BlueStore throttle parameters have an impact on the mClock operation queues. Therefore, it is critical to set these values carefully in order to maximize the impact of the mclock scheduler. See *Factors that impact mClock operation queues* for more information about these values.



NOTE

The steps in this section are only necessary if you want to override the Ceph OSD capacity determined automatically during the OSD initialization.

NOTE

If you have already determined the benchmark data and wish to manually override the maximum OSD capacity for a Ceph OSD, skip to the *Specifying maximum OSD capacity* section.

Prerequisites

- A running Red Hat Ceph Storage cluster.
- Root-level access to the Ceph Monitor host.

Procedure

1. Log into the Cephadm shell:

   Example

   ```
   [root@host01 ~]# cephadm shell
   ```

2. Benchmark a Ceph OSD:

   Syntax

   ```
   ceph tell osd.OSD_ID bench [TOTAL_BYTES] [BYTES_PER_WRITE] [OBJ_SIZE] [NUM_OBJS]
   ```

   where:

   - *TOTAL_BYTES*: Total number of bytes to write.
   - *BYTES_PER_WRITE*: Block size per write.
   - *OBJ_SIZE*: Bytes per object.
   - *NUM_OBJS*: Number of objects to write.

   Example

   ```
   [ceph: root@host01 /]# ceph tell osd.0 bench 12288000 4096 4194304 100
   {
       "bytes_written": 12288000,
       "blocksize": 4096,
       "elapsed_sec": 1.3718913019999999,
       "bytes_per_sec": 8956977.8466311768,
       "iops": 2186.7621695876896
   }
   ```

10.7.3. Determining the correct BlueStore throttle values

This optional section details the steps used to determine the correct BlueStore throttle values. The steps use the default shards.

IMPORTANT

Before running the test, clear the caches to get an accurate measurement. Clear the OSD caches between each benchmark run using the following command:

Syntax

```
ceph tell osd.OSD_ID cache drop
```

Example

```
[ceph: root@host01 /]# ceph tell osd.0 cache drop
```

Prerequisites

- A running Red Hat Ceph Storage cluster.
- Root-level access to the Ceph Monitor node hosting the OSDs that you wish to benchmark.

Procedure

1. Log into the Cephadm shell:

   Example

   ```
   [root@host01 ~]# cephadm shell
   ```

2. Run a simple 4KiB random write workload on an OSD:

   Syntax

   ```
   ceph tell osd.OSD_ID bench 12288000 4096 4194304 100
   ```

   Example

   ```
   [ceph: root@host01 /]# ceph tell osd.0 bench 12288000 4096 4194304 100
   {
       "bytes_written": 12288000,
       "blocksize": 4096,
       "elapsed_sec": 1.3718913019999999,
       "bytes_per_sec": 8956977.8466311768,
       "iops": 2186.7621695876896 (1)
   }
   ```

   (1) The overall throughput obtained from the output of the **osd bench** command. This value is the baseline throughput, when the default BlueStore throttle options are in effect.

3. Note the overall throughput, that is IOPS, obtained from the output of the previous command.

4. If the intent is to determine the BlueStore throttle values for your environment, set **bluestore_throttle_bytes** and **bluestore_throttle_deferred_bytes** options to 32 KiB, that is, 32768 Bytes:

Syntax

```
ceph config set osd.OSD_ID bluestore_throttle_bytes 32768
ceph config set osd.OSD_ID bluestore_throttle_deferred_bytes 32768
```

Example

```
[ceph: root@host01 /]# ceph config set osd.0 bluestore_throttle_bytes 32768
[ceph: root@host01 /]# ceph config set osd.0 bluestore_throttle_deferred_bytes 32768
```

Otherwise, you can skip to the next section *Specifying maximum OSD capacity*.

5. Run the 4KiB random write test as before using an OSD bench command:

Example

```
[ceph: root@host01 /]# ceph tell osd.0 bench 12288000 4096 4194304 100
```

6. Notice the overall throughput from the output and compare the value against the baseline throughput recorded earlier.
7. If the throughput does not match with the baseline, increase the BlueStore throttle options by multiplying by 2.
8. Repeat the steps by running the 4KiB random write test, comparing the value against the baseline throughput, and increasing the BlueStore throttle options by multiplying by 2, until the obtained throughput is very close to the baseline value.

NOTE

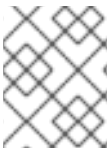
For example, during benchmarking on a machine with NVMe SSDs, a value of 256 KiB for both BlueStore throttle and deferred bytes was determined to maximize the impact of mClock. For HDDs, the corresponding value was 40 MiB, where the overall throughput was roughly equal to the baseline throughput.

In general for HDDs, the BlueStore throttle values are expected to be higher when compared to SSDs.

10.7.4. Specifying maximum OSD capacity

You can override the maximum Ceph OSD capacity automatically set during OSD initialization.

These steps are optional. Perform the following steps if the default capacity does not accurately represent the Ceph OSD capacity.



NOTE

Ensure that you determine the benchmark data first, as described in *Manually benchmarking OSDs*.

Prerequisites

- A running Red Hat Ceph Storage cluster.

- Root-level access to the Ceph Monitor host.

Procedure

1. Log into the Cephadm shell:

   Example

   ```
   [root@host01 ~]# cephadm shell
   ```

2. Set **osd_mclock_max_capacity_iops_[hdd, ssd]** option for an OSD:

   Syntax

   ```
   ceph config set osd.OSD_ID osd_mclock_max_capacity_iops_[hdd,ssd] VALUE
   ```

   Example

   ```
   [ceph: root@host01 /]# ceph config set osd.0 osd_mclock_max_capacity_iops_hdd 350
   ```

   This example sets the maximum capacity for **osd.0**, where an underlying device type is HDD, to 350 IOPS.

CHAPTER 11. BLUESTORE

BlueStore is the back-end object store for the OSD daemons and puts objects directly on the block device.

IMPORTANT

BlueStore provides a high-performance backend for OSD daemons in a production environment. By default, BlueStore is configured to be self-tuning. If you determine that your environment performs better with BlueStore tuned manually, please contact Red Hat support and share the details of your configuration to help us improve the auto-tuning capability. Red Hat looks forward to your feedback and appreciates your recommendations.

11.1. CEPH BLUESTORE

The following are some of the main features of using BlueStore:

Direct management of storage devices

BlueStore consumes raw block devices or partitions. This avoids any intervening layers of abstraction, such as local file systems like XFS, that might limit performance or add complexity.

Metadata management with RocksDB

BlueStore uses the RocksDB key-value database to manage internal metadata, such as the mapping from object names to block locations on a disk.

Full data and metadata checksumming

By default all data and metadata written to BlueStore is protected by one or more checksums. No data or metadata are read from disk or returned to the user without verification.

Inline compression

Data can be optionally compressed before being written to a disk.

Efficient copy-on-write

The Ceph Block Device and Ceph File System snapshots rely on a copy-on-write clone mechanism that is implemented efficiently in BlueStore. This results in efficient I/O both for regular snapshots and for erasure coded pools which rely on cloning to implement efficient two-phase commits.

No large double-writes

BlueStore first writes any new data to unallocated space on a block device, and then commits a RocksDB transaction that updates the object metadata to reference the new region of the disk. Only when the write operation is below a configurable size threshold, it falls back to a write-ahead journaling scheme.

Multi-device support

BlueStore can use multiple block devices for storing different data. For example: Hard Disk Drive (HDD) for the data, Solid-state Drive (SSD) for metadata, Non-volatile Memory (NVM) or Non-volatile random-access memory (NVRAM) or persistent memory for the RocksDB write-ahead log (WAL). See *Ceph BlueStore devices* for details.

Efficient block device usage

Because BlueStore does not use any file system, it minimizes the need to clear the storage device cache.

Allocation metadata

Allocation metadata is no longer using the standalone objects in RocksDB as the allocation information can be deduced from the aggregate allocation state of all onodes in the system which

are stored in the RocksDB already. BlueStore V3 code skips the RocksDB updates on allocation time and performs a full destage of the allocator object with all the OSD allocation state in a single step during **umount**. This results in a 25% increase in IOPS and reduced latency in small random-write workloads; however, it prolongs the recovery time, usually by a few extra minutes, in failure cases where an umount is not called since you need to iterate over all onodes to recreate the allocation metadata.

Cache age binning

Red Hat Ceph Storage associates items in the different caches with "age bins", which gives a view of the relative ages of all the cache items.

11.2. CEPH BLUESTORE DEVICES

BlueStore manages either one, two, or three storage devices in the backend.

- Primary
- WAL
- DB

In the simplest case, BlueStore consumes a single primary storage device. The storage device is normally used as a whole, occupying the full device that is managed by BlueStore directly. The primary device is identified by a **block** symlink in the data directory.

The data directory is a **tmpfs** mount which gets populated with all the common OSD files that hold information about the OSD, like the identifier, which cluster it belongs to, and its private keyring.

The storage device is partitioned into two parts that contain:

- **OSD metadata**: A small partition formatted with XFS that contains basic metadata for the OSD. This data directory includes information about the OSD, such as its identifier, which cluster it belongs to, and its private keyring.
- **Data**: A large partition occupying the rest of the device that is managed directly by BlueStore and that contains all of the OSD data. This primary device is identified by a block symbolic link in the data directory.

You can also use two additional devices:

- **A WAL (write-ahead-log) device**: A device that stores BlueStore internal journal or write-ahead log. It is identified by the **block.wal** symbolic link in the data directory. Consider using a WAL device only if the device is faster than the primary device. For example, when the WAL device uses an SSD disk and the primary device uses an HDD disk.
- **A DB device**: A device that stores BlueStore internal metadata. The embedded RocksDB database puts as much metadata as it can on the DB device instead of on the primary device to improve performance. If the DB device is full, it starts adding metadata to the primary device. Consider using a DB device only if the device is faster than the primary device.

WARNING

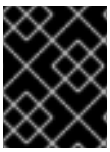
If you have only less than a gigabyte storage available on fast devices, Red Hat recommends using it as a WAL device. If you have more fast devices available, consider using it as a DB device. The BlueStore journal is always placed on the fastest device, so using a DB device provides the same benefit that the WAL device while also allows for storing additional metadata.

11.3. CEPH BLUESTORE CACHING

The BlueStore cache is a collection of buffers that, depending on configuration, can be populated with data as the OSD daemon does reading from or writing to the disk. By default in Red Hat Ceph Storage, BlueStore will cache on reads, but not writes. This is because the **bluestore_default_buffered_write** option is set to **false** to avoid potential overhead associated with cache eviction.

If the **bluestore_default_buffered_write** option is set to **true**, data is written to the buffer first, and then committed to disk. Afterwards, a write acknowledgement is sent to the client, allowing subsequent reads faster access to the data already in cache, until that data is evicted.

Read-heavy workloads will not see an immediate benefit from BlueStore caching. As more reading is done, the cache will grow over time and subsequent reads will see an improvement in performance. How fast the cache populates depends on the BlueStore block and database disk type, and the client's workload requirements.



IMPORTANT

Please contact Red Hat support before enabling the **bluestore_default_buffered_write** option.

Cache age binning

Red Hat Ceph Storage associates items in the different caches with "age bins", which gives a view of the relative ages of all the cache items. For example, when there are old onode entries sitting in the BlueStore onode cache, a hot read workload occurs against a single large object. The priority cache for that OSD sorts the older onode entries into a lower priority level than the buffer cache data for the hot object. Although Ceph might, in general, heavily favor onodes at a given priority level, in this hot workload scenario, older onodes might be assigned a lower priority level than the hot workload data, so that the buffer data memory request is fulfilled first.

11.4. SIZING CONSIDERATIONS FOR CEPH BLUESTORE

When mixing traditional and solid state drives using BlueStore OSDs, it is important to size the RocksDB logical volume (**block.db**) appropriately. Red Hat recommends that the RocksDB logical volume be no less than 4% of the block size with object, file and mixed workloads. Red Hat supports 1% of the BlueStore block size with RocksDB and OpenStack block workloads. For example, if the block size is 1 TB for an object workload, then at a minimum, create a 40 GB RocksDB logical volume.

When not mixing drive types, there is no requirement to have a separate RocksDB logical volume. BlueStore will automatically manage the sizing of RocksDB.

BlueStore's cache memory is used for the key-value pair metadata for RocksDB, BlueStore metadata, and object data.

NOTE

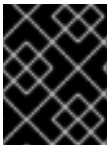
The BlueStore cache memory values are in addition to the memory footprint already being consumed by the OSD.

11.5. TUNING CEPH BLUESTORE USING BLUESTORE_MIN_ALLOC_SIZE PARAMETER

This procedure is for new or freshly deployed OSDs.

In BlueStore, the raw partition is allocated and managed in chunks of **bluestore_min_alloc_size**. By default, **bluestore_min_alloc_size** is **4096**, equivalent to 4 KiB for HDDs and SSDs. The unwritten area in each chunk is filled with zeroes when it is written to the raw partition. This can lead to wasted unused space when not properly sized for your workload, for example when writing small objects.

It is best practice to set **bluestore_min_alloc_size** to match the smallest write so this write amplification penalty can be avoided.



IMPORTANT

Changing the value of **bluestore_min_alloc_size** is not recommended. For any assistance, contact *Red Hat support*.

NOTE

The settings **bluestore_min_alloc_size_ssd** and **bluestore_min_alloc_size_hdd** are specific to SSDs and HDDs, respectively, but setting them is not necessary because setting **bluestore_min_alloc_size** overrides them.

Prerequisites

- A running Red Hat Ceph Storage cluster.
- Ceph monitors and managers are deployed in the cluster.
- Servers or nodes that can be freshly provisioned as OSD nodes
- The admin keyring for the Ceph Monitor node, if you are redeploying an existing Ceph OSD node.

Procedure

1. On the bootstrapped node, change the value of **bluestore_min_alloc_size** parameter:

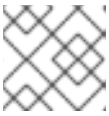
   Syntax

   ```
   ceph config set osd.OSD_ID bluestore_min_alloc_size_DEVICE_NAME_ VALUE
   ```

   Example

```
[ceph: root@host01 /]# ceph config set osd.4 bluestore_min_alloc_size_hdd 8192
```

You can see **bluestore_min_alloc_size** is set to 8192 bytes, which is equivalent to 8 KiB.



NOTE

The selected values should be power of 2 aligned.

2. Restart the OSD's service.

Syntax

```
systemctl restart SERVICE_ID
```

Example

```
[ceph: root@host01 /]# systemctl restart ceph-499829b4-832f-11eb-8d6d-
001a4a000635@osd.4.service
```

Verification

- Verify the setting using the **ceph daemon** command:

Syntax

```
ceph daemon osd.OSD_ID config get bluestore_min_alloc_size__DEVICE_
```

Example

```
[ceph: root@host01 /]# ceph daemon osd.4 config get bluestore_min_alloc_size_hdd

ceph daemon osd.4 config get bluestore_min_alloc_size
{
    "bluestore_min_alloc_size": "8192"
}
```

Additional Resources

- For OSD removal and addition, see the *Management of OSDs using the Ceph Orchestrator* chapter in the *Red Hat Ceph Storage Operations Guide* and follow the links. For already deployed OSDs, you cannot modify the **bluestore_min_alloc_size** parameter so you have to remove the OSDs and freshly deploy them again.

11.6. RESHARDING THE ROCKSDB DATABASE USING THE BLUESTORE ADMIN TOOL

You can reshard the database with the BlueStore admin tool. It transforms BlueStore's RocksDB database from one shape to another into several column families without redeploying the OSDs. Column families have the same features as the whole database, but allows users to operate on smaller data sets and apply different options. It leverages the different expected lifetime of keys stored. The keys are moved during the transformation without creating new keys or deleting existing keys.

There are two ways to reshard the OSD:

1. Use the **rocksdb-resharding.yml** playbook.
2. Manually reshard the OSDs.

Prerequisites

- A running Red Hat Ceph Storage cluster.
- The object store configured as BlueStore.
- OSD nodes deployed on the hosts.
- Root level access to the all the hosts.
- The **ceph-common** and **cephadm** packages installed on all the hosts.

11.6.1. Use the rocksdb-resharding.yml playbook

1. As a root user, on the administration node, navigate to the **cephadm** folder where the playbook is installed:

   Example

   ```
   [root@host01 ~]# cd /usr/share/cephadm-ansible
   ```

2. Run the playbook:

   Syntax

   ```
   ansible-playbook -i hosts rocksdb-resharding.yml -e osd_id=OSD_ID -e
   admin_node=HOST_NAME
   ```

   Example

   ```
   [root@host01 ~]# ansible-playbook -i hosts rocksdb-resharding.yml -e osd_id=7 -e
   admin_node=host03


   ..............
   TASK [stop the osd]
   ********************************************************************************************************************
   ***************************************************************************
   Wednesday 29 November 2023  11:25:18 +0000 (0:00:00.037)       0:00:03.864 ****
   changed: [localhost -> host03]
   TASK [set_fact ceph_cmd]
   ********************************************************************************************************************
   ***************************************************************************
   Wednesday 29 November 2023  11:25:32 +0000 (0:00:14.128)       0:00:17.992 ****
   ok: [localhost -> host03]

   TASK [check fs consistency with fsck before resharding]
   ********************************************************************************************************************
   ****************************************
   ```

```
Wednesday 29 November 2023  11:25:32 +0000 (0:00:00.041)       0:00:18.034 ****
ok: [localhost -> host03]

TASK [show current sharding]
*********************************************************************************************************************
*********************************************************************
Wednesday 29 November 2023  11:25:43 +0000 (0:00:11.053)       0:00:29.088 ****
ok: [localhost -> host03]

TASK [reshard]
*********************************************************************************************************************
*****************************************************************************
Wednesday 29 November 2023  11:25:45 +0000 (0:00:01.446)       0:00:30.534 ****
ok: [localhost -> host03]

TASK [check fs consistency with fsck after resharding]
*********************************************************************************************************************
*****************************************
Wednesday 29 November 2023  11:25:46 +0000 (0:00:01.479)       0:00:32.014 ****
ok: [localhost -> host03]

TASK [restart the osd]
*********************************************************************************************************************
***************************************************************************
Wednesday 29 November 2023  11:25:57 +0000 (0:00:10.699)       0:00:42.714 ****
changed: [localhost -> host03]
```

3. Verify that the resharding is complete.

   a. Stop the OSD that is resharded:

      Example

      ```
      [ceph: root@host01 /]# ceph orch daemon stop osd.7
      ```

   b. Enter the OSD container:

      Example

      ```
      [root@host03 ~]# cephadm shell --name osd.7
      ```

   c. Check for resharding:

      Example

      ```
      [ceph: root@host03 /]# ceph-bluestore-tool --path /var/lib/ceph/osd/ceph-7/ show-
      sharding
          m(3) p(3,0-12) O(3,0-13) L P
      ```

   d. Start the OSD:

      Example

      ```
      [ceph: root@host01 /]# ceph orch daemon start osd.7
      ```

11.6.2. Manually resharding the OSDs

1. Log into the **cephadm** shell:

   Example

   ```
   [root@host01 ~]# cephadm shell
   ```

2. Fetch the *OSD_ID* and the host details from the administration node:

   Example

   ```
   [ceph: root@host01 /]# ceph orch ps
   ```

3. Log into the respective host as a **root** user and stop the OSD:

   Syntax

   ```
   cephadm unit --name OSD_ID stop
   ```

   Example

   ```
   [root@host02 ~]# cephadm unit --name osd.0 stop
   ```

4. Enter into the stopped OSD daemon container:

   Syntax

   ```
   cephadm shell --name OSD_ID
   ```

   Example

   ```
   [root@host02 ~]# cephadm shell --name osd.0
   ```

5. Log into the **cephadm shell** and check the file system consistency:

   Syntax

   ```
   ceph-bluestore-tool --path/var/lib/ceph/osd/ceph-OSD_ID/ fsck
   ```

   Example

   ```
   [ceph: root@host02 /]# ceph-bluestore-tool --path /var/lib/ceph/osd/ceph-0/ fsck

   fsck success
   ```

6. Check the sharding status of the OSD node:

   Syntax

   ```
   ceph-bluestore-tool --path /var/lib/ceph/osd/ceph-OSD_ID/ show-sharding
   ```

Example

```
[ceph: root@host02 /]# ceph-bluestore-tool --path /var/lib/ceph/osd/ceph-6/ show-sharding

m(3) p(3,0-12) O(3,0-13) L P
```

7. Run the **ceph-bluestore-tool** command to reshard. Red Hat recommends to use the parameters as given in the command:

Syntax

```
ceph-bluestore-tool --log-level 10 -l log.txt --path /var/lib/ceph/osd/ceph-OSD_ID/ --sharding="m(3) p(3,0-12) O(3,0-13)=block_cache={type=binned_lru} L P" reshard
```

Example

```
[ceph: root@host02 /]# ceph-bluestore-tool --path /var/lib/ceph/osd/ceph-6/ --sharding="m(3) p(3,0-12) O(3,0-13)=block_cache={type=binned_lru} L P" reshard

reshard success
```

8. To check the sharding status of the OSD node, run the **show-sharding** command:

Syntax

```
ceph-bluestore-tool --path /var/lib/ceph/osd/ceph-OSD_ID/ show-sharding
```

Example

```
[ceph: root@host02 /]# ceph-bluestore-tool --path /var/lib/ceph/osd/ceph-6/ show-sharding

m(3) p(3,0-12) O(3,0-13)=block_cache={type=binned_lru} L P
```

9. Exit from the **cephadm** shell:

```
[ceph: root@host02 /]# exit
```

10. Log into the respective host as a **root** user and start the OSD:

Syntax

```
cephadm unit --name OSD_ID start
```

Example

```
[root@host02 ~]# cephadm unit --name osd.0 start
```

Additional Resources

- See the *Red Hat Ceph Storage Installation Guide* for more information.

11.7. THE BLUESTORE FRAGMENTATION TOOL

As a storage administrator, you will want to periodically check the fragmentation level of your BlueStore OSDs. You can check fragmentation levels with one simple command for offline or online OSDs.

11.7.1. What is the BlueStore fragmentation tool?

For BlueStore OSDs, the free space gets fragmented over time on the underlying storage device. Some fragmentation is normal, but when there is excessive fragmentation this causes poor performance.

The BlueStore fragmentation tool generates a score on the fragmentation level of the BlueStore OSD. This fragmentation score is given as a range, 0 through 1. A score of 0 means no fragmentation, and a score of 1 means severe fragmentation.

Table 11.1. Fragmentation scores' meaning

Score	Fragmentation Amount
0.0 - 0.4	None to tiny fragmentation.
0.4 - 0.7	Small and acceptable fragmentation.
0.7 - 0.9	Considerable, but safe fragmentation.
0.9 - 1.0	Severe fragmentation and that causes performance issues.

IMPORTANT

If you have severe fragmentation, and need some help in resolving the issue, contact Red Hat Support.

11.7.2. Checking for fragmentation

Checking the fragmentation level of BlueStore OSDs can be done either online or offline.

Prerequisites

- A running Red Hat Ceph Storage cluster.
- BlueStore OSDs.

Online BlueStore fragmentation score

1. Inspect a running BlueStore OSD process:
   a. Simple report:

      Syntax

      ```
      ceph daemon OSD_ID bluestore allocator score block
      ```

Example

```
[ceph: root@host01 /]# ceph daemon osd.123 bluestore allocator score block
```

b. A more detailed report:

Syntax

```
ceph daemon OSD_ID bluestore allocator dump block
```

Example

```
[ceph: root@host01 /]# ceph daemon osd.123 bluestore allocator dump block
```

Offline BlueStore fragmentation score

1. Follow the steps for resharding for checking the offline fragmentation score.
Example

```
[root@host01 ~]# podman exec -it 7fbd6c6293c0 /bin/bash
```

1. Inspect a non-running BlueStore OSD process:

a. Simple report:

Syntax

```
ceph-bluestore-tool --path PATH_TO_OSD_DATA_DIRECTORY --allocator block free-score
```

Example

```
[root@7fbd6c6293c0 /]# ceph-bluestore-tool --path /var/lib/ceph/osd/ceph-123 --allocator block free-score
```

b. A more detailed report:

Syntax

```
ceph-bluestore-tool --path PATH_TO_OSD_DATA_DIRECTORY --allocator block free-dump
block:
{
    "fragmentation_rating": 0.018290238194701977
}
```

Example

```
[root@7fbd6c6293c0 /]# ceph-bluestore-tool --path /var/lib/ceph/osd/ceph-123 --allocator block free-dump
block:
{
```

```
"capacity": 21470642176,
"alloc_unit": 4096,
"alloc_type": "hybrid",
"alloc_name": "block",
"extents": [
    {
        "offset": "0x370000",
        "length": "0x20000"
    },
    {
        "offset": "0x3a0000",
        "length": "0x10000"
    },
    {
        "offset": "0x3f0000",
        "length": "0x20000"
    },
    {
        "offset": "0x460000",
        "length": "0x10000"
    },
```


Additional Resources

- See the *BlueStore Fragmentation Tool* for details on the fragmentation score.
- See the *Resharding the RocskDB database using the BlueStore admin tool* for details on resharding.

11.8. CEPH BLUESTORE BLUEFS

BlueStore block database stores metadata as key-value pairs in a RocksDB database. The block database resides on a small BlueFS partition on the storage device. BlueFS is a minimal file system that is designed to hold the RocksDB files.

BlueFS files

Following are the three types of files that RocksDB produces:

- Control files, for example **CURRENT**, **IDENTITY**, and **MANIFEST-000011**.
- DB table files, for example **004112.sst**.
- Write ahead logs, for example **000038.log**.

Additionally, there is an internal, hidden file that serves as BlueFS replay log, **ino 1**, that works as directory structure, file mapping, and operations log.

Fallback hierarchy

With BlueFS it is possible to put any file on any device. Parts of file can even reside on different devices, that is WAL, DB, and SLOW. There is an order to where BlueFS puts files. File is put to secondary storage only when primary storage is exhausted, and tertiary only when secondary is exhausted.

The order for the specific files is:

- Write ahead logs: WAL, DB, SLOW
- Replay log **ino 1**: DB, SLOW
- Control and DB files: DB, SLOW
  - Control and DB file order when running out of space: SLOW

IMPORTANT

There is an exception to control and DB file order. When RocksDB detects that you are running out of space on DB file, it directly notifies you to put file to SLOW device.

11.8.1. Viewing the bluefs_buffered_io setting

As a storage administrator, you can view the current setting for the **bluefs_buffered_io** parameter.

The option **bluefs_buffered_io** is set to **True** by default for Red Hat Ceph Storage. This option enable BlueFS to perform buffered reads in some cases, and enables the kernel page cache to act as a secondary cache for reads like RocksDB block reads.

IMPORTANT

Changing the value of **bluefs_buffered_io** is not recommended. Before changing the **bluefs_buffered_io** parameter, contact your Red Hat Support account team.

Prerequisites

- A running Red Hat Ceph Storage cluster.
- Root-level access to the Ceph Monitor node.

Procedure

1. Log into the Cephadm shell:

   Example

   ```
   [root@host01 ~]# cephadm shell
   ```

2. You can view the current value of the **bluefs_buffered_io** parameter in three different ways:

Method 1

- View the value stored in the configuration database:

  Example

  ```
  [ceph: root@host01 /]# ceph config get osd bluefs_buffered_io
  ```

Method 2

- View the value stored in the configuration database for a specific OSD:

  Syntax

  ```
  ceph config get OSD_ID bluefs_buffered_io
  ```

  Example

  ```
  [ceph: root@host01 /]# ceph config get osd.2 bluefs_buffered_io
  ```

Method 3

- View the running value for an OSD where the running value is different from the value stored in the configuration database:

  Syntax

  ```
  ceph config show OSD_ID bluefs_buffered_io
  ```

  Example

  ```
  [ceph: root@host01 /]# ceph config show osd.3 bluefs_buffered_io
  ```

11.8.2. Viewing Ceph BlueFS statistics for Ceph OSDs

View the BluesFS related information about collocated and non-collocated Ceph OSDs with the **bluefs stats** command.

Prerequisites

- A running Red Hat Ceph Storage cluster.
- The object store configured as BlueStore.
- Root-level access to the OSD node.

Procedure

1. Log into the Cephadm shell:

   Example

   ```
   [root@host01 ~]# cephadm shell
   ```

2. View the BlueStore OSD statistics:

   Syntax

   ```
   ceph daemon osd.OSD_ID bluefs stats
   ```

   Example for collocated OSDs

   ```
   -
   ```

```
[ceph: root@host01 /]# ceph daemon osd.1 bluefs stats

1 : device size 0x3bfc00000 : using 0x1a428000(420 MiB)
wal_total:0, db_total:15296836403, slow_total:0
```

Example for non-collocated OSDs

```
[ceph: root@host01 /]# ceph daemon osd.1 bluefs stats

0 :
1 : device size 0x1dfbfe000 : using 0x1100000(17 MiB)
2 : device size 0x27fc00000 : using 0x248000(2.3 MiB)
RocksDBBlueFSVolumeSelector: wal_total:0, db_total:7646425907,
slow_total:10196562739, db_avail:935539507
Usage matrix:
DEV/LEV     WAL         DB          SLOW        *           *           REAL        FILES
LOG         0 B         4 MiB       0 B         0 B         0 B         756 KiB     1
WAL         0 B         4 MiB       0 B         0 B         0 B         3.3 MiB     1
DB          0 B         9 MiB       0 B         0 B         0 B         76 KiB      10
SLOW        0 B         0 B         0 B         0 B         0 B         0 B         0
TOTALS      0 B         17 MiB      0 B         0 B         0 B         0 B         12
MAXIMUMS:
LOG         0 B         4 MiB       0 B         0 B         0 B         756 KiB
WAL         0 B         4 MiB       0 B         0 B         0 B         3.3 MiB
DB          0 B         11 MiB      0 B         0 B         0 B         112 KiB
SLOW        0 B         0 B         0 B         0 B         0 B         0 B
TOTALS      0 B         17 MiB      0 B         0 B         0 B         0 B
```

where:

0: This refers to dedicated WAL device, that is **block.wal**.

1: This refers to dedicated DB device, that is **block.db**.

2: This refers to main block device, that is **block** or **slow**.

device size: It represents an actual size of the device.

using: It represents total usage. It is not restricted to BlueFS.

NOTE

DB and WAL devices are used only by BlueFS. For main device, usage from stored BlueStore data is also included. In the above example, **2.3 MiB** is the data from BlueStore.

wal_total, **db_total**, **slow_total**: These values reiterate the device values above.

db_avail: This value represents how many bytes can be taken from SLOW device if necessary.

Usage matrix

- The rows **WAL**, **DB**, **SLOW**: Describe where specific file was intended to be put.
- The row **LOG**: Describes the BlueFS replay log **ino 1**.

- The columns **WAL**, **DB**, **SLOW**: Describe where data is actually put. The values are in allocation units. WAL and DB have bigger allocation units for performance reasons.
- The columns * / *: Relate to virtual devices **new-db** and **new-wal** that are used for **ceph-bluestore-tool**. It should always show **0 B**.
- The column **REAL**: Shows actual usage in bytes.
- The column **FILES**: Shows count of files.

MAXIMUMS: this table captures the maximum value of each entry from the usage matrix.

Additional Resources

- See *Ceph BlueStore BlueFS* for more information about BlueFS files.
- See *Ceph BlueStore devices* for more information about BlueStore devices.

CHAPTER 12. CRIMSON (TECHNOLOGY PREVIEW)

As a storage administrator, the Crimson project is an effort to build a replacement of **ceph-osd** daemon that is suited to the new reality of low latency, high throughput persistent memory, and NVMe technologies.

IMPORTANT

The Crimson feature is a Technology Preview feature only. Technology Preview features are not supported with Red Hat production service level agreements (SLAs), might not be functionally complete, and Red Hat does not recommend using them for production. These features provide early access to upcoming product features, enabling customers to test functionality and provide feedback during the development process. See the support scope for Red Hat Technology Preview features for more details.

12.1. CRIMSON OVERVIEW

Crimson is the code name for **crimson-osd**, which is the next generation **ceph-osd** for multi-core scalability. It improves performance with fast network and storage devices, employing state-of-the-art technologies that includes DPDK and SPDK. BlueStore continues to support HDDs and SSDs. Crimson aims to be compatible with an earlier version of OSD daemon with the class **ceph-osd**.

Built on the SeaStar C++ framework, Crimson is a new implementation of the core Ceph object storage daemon (OSD) component and replaces **ceph-osd**. The **crimson-osd** minimizes latency and increased CPU processor usage. It uses high-performance asynchronous IO and a new threading architecture that is designed to minimize context switches and inter-thread communication for an operation for cross communication.

CAUTION

For Red Hat Ceph Storage 7, you can test RADOS Block Device (RBD) workloads on replicated pools with Crimson only. Do not use Crimson for production data.

Crimson goals

Crimson OSD is a replacement for the OSD daemon with the following goals:

Minimize CPU overload

- Minimize cycles or IOPS.
- Minimize cross-core communication.
- Minimize copies.
- Bypass kernel, avoid context switches.

Enable emerging storage technologies

- Zoned namespaces
- Persistent memory
- Fast NVMe

Seastar features

- Single reactor thread per CPU
- Asynchronous IO
- Scheduling done in user space
- Includes direct support for DPDK, a high-performance library for user space networking.

Benefits

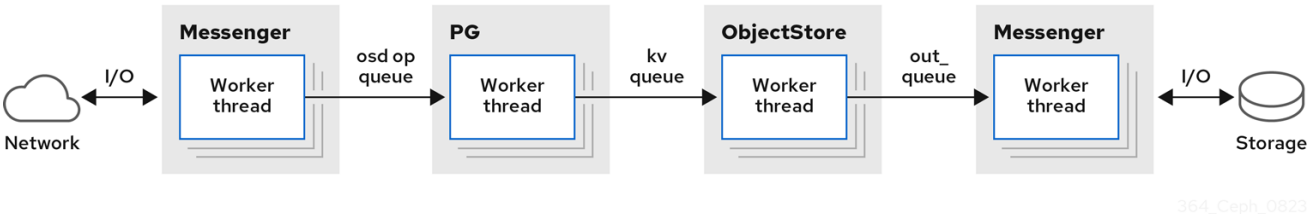
- SeaStore has an independent metadata collection.
- Transactional
- Composed of flat object namespace.
- Object Names might be Large (>1k).
- Each object contains a key>value mapping (string>bytes) and data payload.
- Supports COW object clones.
- Supports ordered listing of both OMAP and object namespaces.

12.2. DIFFERENCE BETWEEN CRIMSON AND CLASSIC CEPH OSD ARCHITECTURE

In a classic **ceph-osd** architecture, a messenger thread reads a client message from the wire, which places the message in the OP queue. The **osd-op** thread-pool then picks up the message and creates a transaction and queues it to BlueStore, the current default ObjectStore implementation. BlueStore's **kv_queue** then picks up this transaction and anything else in the queue, synchronously waits for **rocksdb** to commit the transaction, and then places the completion callback in the finisher queue. The finisher thread then picks up the completion callback and queues to replace the messenger thread to send.

Each of these actions requires inter-thread co-ordination over the contents of a queue. For **pg state**, more than one thread might need to access the internal metadata of any PG to lock contention.

This lock contention with increased processor usage scales rapidly with the number of tasks and cores, and every locking point might become the scaling bottleneck under certain scenarios. Moreover, these locks and queues incur latency costs even when uncontended. Due to this latency, the thread pools and task queues deteriorate, as the bookkeeping effort delegates tasks between the worker thread and locks can force context-switches.



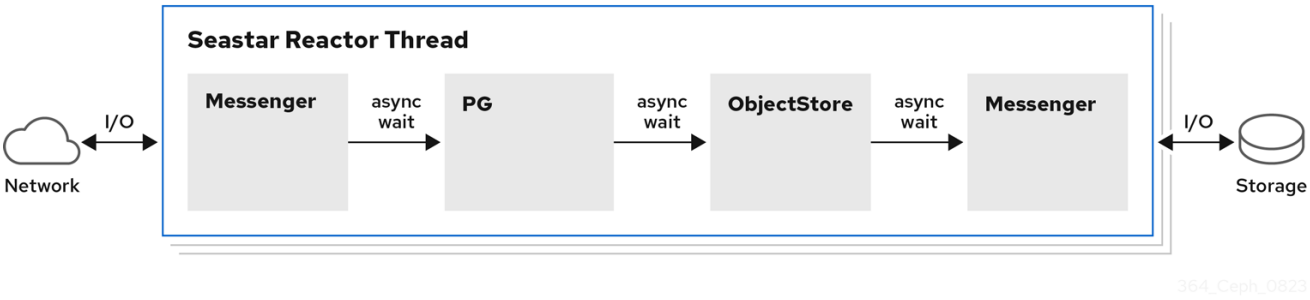
Unlike the **ceph-osd** architecture, Crimson allows a single I/O operation to complete on a single core

without context switches and without blocking if the underlying storage operations do not require it. However, some operations still need to be able to wait for asynchronous processes to complete, probably nondeterministically depending on the state of the system such as recovery or the underlying device.

Crimson uses the C++ framework that is called Seastar, a highly asynchronous engine, which generally pre-allocates one thread pinned to each core. These divide work among those cores such that the state can be partitioned between cores and locking can be avoided. With Seastar, the I/O operations are partitioned among a group of threads based on the target object. Rather than splitting the stages of running an I/O operation among different groups of threads, run all the pipeline stages within a single thread. If an operation needs to be blocked, the core's Seastar reactor switches to another concurrent operation and progresses.

Ideally, all the locks and context-switches are no longer needed as each running nonblocking task owns the CPU until it completes or cooperatively yields. No other thread can preempt the task at the same time. If the communication is not needed with other shards in the data path, the ideal performance scales linearly with the number of cores until the I/O device reaches its limit. This design fits the Ceph OSD well because, at the OSD level, the PG shard all IOs.

Unlike **ceph-osd**, **crimson-osd** does not daemonize itself even if the daemonize option is enabled. Do not daemonize **crimson-osd** since supported Linux distributions use **systemd**, which is able to daemonize the application. With **sysvinit**, use **start-stop-daemon** to daemonize **crimson-osd**.



ObjectStore backend

The **crimson-osd** offers both native and alienized object store backend. The native object store backend performs I/O with the Seastar reactor.

Following three ObjectStore backend is supported for Crimson:

- **AlienStore** - Provides compatibility with an earlier version of object store, that is, BlueStore.
- **CyanStore** - A dummy backend for tests, which are implemented by volatile memory. This object store is modeled after the **memstore** in the classic OSD.
- **SeaStore** - The new object store designed specifically for Crimson OSD. The paths toward multiple shard support are different depending on the specific goal of the backend.

Following are the other two classic OSD ObjectStore backends:

- **MemStore** - The memory as the backend object store.
- **BlueStore** - The object store used by the classic **ceph-osd**.

12.3. CRIMSON METRICS

Crimson has three ways to report statistics and metrics:

- PG stats reported to manager.
- Prometheus text protocol.
- The **asock** command.

PG stats reported to manager

Crimson collects the **per-pg**, **per-pool**, and **per-osd** stats in **MPGStats** message, which is sent to the Ceph Managers.

Prometheus text protocol

Configure the listening port and address by using the **--prometheus-port** command-line option.

The asock command

An admin socket command is offered to dump metrics.

Syntax

```
ceph tell OSD_ID dump_metrics
ceph tell OSD_ID dump_metrics reactor_utilization
```

Example

```
[ceph: root@host01 /]# ceph tell osd.0 dump_metrics
[ceph: root@host01 /]# ceph tell osd.0 dump_metrics reactor_utilization
```

Here, **reactor_utilization** is an optional string to filter the dumped metrics by prefix.

12.4. CRIMSON CONFIGURATION OPTIONS

Run the **crimson-osd --help-seastar** command for Seastar specific command-line options. Following are the options that you can use to configure Crimson:

--crimson, Description

Start **crimson-osd** instead of **ceph-osd**.

--nodaemon, Description

Do not daemonize the service.

--redirect-output, Description

Redirect the **stdout** and **stderr** to **out/$type.$num.stdout**

--osd-args, Description

Pass extra command-line options to **crimson-osd** or **ceph-osd**. This option is useful for passing Seastar options to **crimson-osd**. For example, one can supply **--osd-args "--memory 2G"** to set the amount of memory to use.

--cyanstore, Description

Use CyanStore as the object store backend.

--bluestore, Description

Use the alienized BlueStore as the object store backend. **--bluestore** is the default memory store.

--memstore, Description

Use the alienized MemStore as the object store backend.

--seastore, Description

Use SeaStore as the back end object store.

--seastore-devs, Description

Specify the block device used by SeaStore.

--seastore-secondary-devs, Description

Optional. SeaStore supports multiple devices. Enable this feature by passing the block device to this option.

--seastore-secondary-devs-type, Description

Optional. Specify the type of secondary devices. When the secondary device is slower than main device passed to **--seastore-devs**, the cold data in faster device will be evicted to the slower devices over time. Valid types include **HDD**, **SSD**, **(default)**, **ZNS**, and **RANDOM_BLOCK_SSD**. Note that secondary devices should not be faster than the main device.

12.5. CONFIGURING CRIMSON

Configure **crimson-osd** by installing a new storage cluster. Install a new cluster by using the bootstrap option. You cannot upgrade this cluster as it is in the experimental phase. WARNING: Do not use production data as it might result in data loss.

Prerequisites

- An IP address for the first Ceph Monitor container, which is also the IP address for the first node in the storage cluster.
- Login access to **registry.redhat.io**.
- A minimum of 10 GB of free space for /**var**/**lib**/**containers**/.
- Root-level access to all nodes.

Procedure

1. While bootstrapping, use the **--image** flag to use Crimson build.

   #### Example

   ```
   [root@host 01 ~]# cephadm --image quay.ceph.io/ceph-ci/ceph:b682861f8690608d831f58603303388dd7915aa7-crimson bootstrap --mon-ip 10.1.240.54 --allow-fqdn-hostname --initial-dashboard-password Ceph_Crims
   ```

2. Log in to the **cephadm** shell:

   #### Example

   ```
   [root@host 01 ~]# cephadm shell
   ```

3. Enable Crimson globally as an experimental feature.

   Example

   ```
   [ceph: root@host01 /]# ceph config set global
   'enable_experimental_unrecoverable_data_corrupting_features' crimson
   ```

   This step enables **crimson**. Crimson is highly experimental, and malfunctions including crashes and data loss are to be expected.

4. Enable the OSD Map flag.

   Example

   ```
   [ceph: root@host01 /]# ceph osd set-allow-crimson --yes-i-really-mean-it
   ```

   The monitor allows **crimson-osd** to boot only with the **--yes-i-really-mean-it** flag.

5. Enable Crimson parameter for the monitor to direct the default pools to be created as Crimson pools.

   Example

   ```
   [ceph: root@host01 /]#  ceph config set mon osd_pool_default_crimson true
   ```

   The **crimson-osd** does not initiate placement groups (PG) for non-crimson pools.

12.6. CRIMSON CONFIGURATION PARAMETERS

Following are the parameters that you can use to configure Crimson.

crimson_osd_obc_lru_size

Description

Number of obcs to cache.

Type

uint

Default

10

crimson_osd_scheduler_concurrency

Description

The maximum number concurrent IO operations, **0** for unlimited.

Type

uint

Default

0

crimson_alien_op_num_threads

Description

The number of threads for serving alienized ObjectStore.

Type

uint

Default

6

crimson_seastar_smp

Description

Number of seastar reactor threads to use for the OSD.

Type

uint

Default

1

crimson_alien_thread_cpu_cores

Description

String CPU cores on which alienstore threads run in cpuset(7) format.

Type

String

seastore_segment_size

Description

Segment size to use for Segment Manager.

Type

Size

Default

64_M

seastore_device_size

Description

Total size to use for SegmentManager block file if created.

Type

Size

Default

50_G

seastore_block_create

Description

Create SegmentManager file if it does not exist.

Type

Boolean

Default

true

seastore_journal_batch_capacity

Description

The number limit of records in a journal batch.

Type

uint

Default

16

seastore_journal_batch_flush_size

Description

The size threshold to force flush a journal batch.

Type

Size

Default

16_M

seastore_journal_iodepth_limit

Description

The IO depth limit to submit journal records.

Type

uint

Default

5

seastore_journal_batch_preferred_fullness

Description

The record fullness threshold to flush a journal batch.

Type

Float

Default

0.95

seastore_default_max_object_size

Description

The default logical address space reservation for seastore objects' data.

Type

uint

Default

16777216

seastore_default_object_metadata_reservation

Description

The default logical address space reservation for seastore objects' metadata.

Type

uint

Default

16777216

seastore_cache_lru_size

Description

Size in bytes of extents to keep in cache.

Type

Size

Default

64_M

seastore_cbjournal_size

Description

Total size to use for CircularBoundedJournal if created, it is valid only if seastore_main_device_type is RANDOM_BLOCK.

Type

Size

Default

5_G

seastore_obj_data_write_amplification

Description

Split extent if ratio of total extent size to write size exceeds this value.

Type

Float

Default

1.25

seastore_max_concurrent_transactions

Description

The maximum concurrent transactions that seastore allows.

Type

uint

Default

8

seastore_main_device_type

Description

The main device type seastore uses (SSD or RANDOM_BLOCK_SSD).

Type

String

Default

SSD

seastore_multiple_tiers_stop_evict_ratio

Description

When the used ratio of main tier is less than this value, then stop evict cold data to the cold tier.

Type

Float

Default

0.5

seastore_multiple_tiers_default_evict_ratio

Description

Begin evicting cold data to the cold tier when the used ratio of the main tier reaches this value.

Type

Float

Default

0.6

seastore_multiple_tiers_fast_evict_ratio

Description

Begin fast eviction when the used ratio of the main tier reaches this value.

Type

Float

Default

0.7

12.7. PROFILING CRIMSON

Profiling Crimson is a methodology to do performance testing with Crimson. Two types of profiling are supported:

- Flexible I/O (FIO) - The **crimson-store-nbd** shows the configurable **FuturizedStore** internals as an NBD server for use with FIO.
- Ceph benchmarking tool (CBT) - A testing harness in python to test the performance of a Ceph cluster.

Procedure

1. Install **libnbd** and compile FIO:

   Example

   ```
   [root@host01 ~]# dnf install libnbd
   [root@host01 ~]# git clone git://git.kernel.dk/fio.git
   [root@host01 ~]# cd fio
   ```

```
[root@host01 ~]# ./configure --enable-libnbd
[root@host01 ~]# make
```

2. Build **crimson-store-nbd**:

   Example

   ```
   [root@host01 ~]# cd build
   [root@host01 ~]# ninja crimson-store-nbd
   ```

3. Run the **crimson-store-nbd** server with a block device. Specify the path to the raw device, like **/dev/nvme1n1**:

   Example

   ```
   [root@host01 ~]# export disk_img=/tmp/disk.img
   [root@host01 ~]# export unix_socket=/tmp/store_nbd_socket.sock
   [root@host01 ~]# rm -f $disk_img $unix_socket
   [root@host01 ~]# truncate -s 512M $disk_img
   [root@host01 ~]# ./bin/crimson-store-nbd \
     --device-path $disk_img \
     --smp 1 \
     --mkfs true \
     --type transaction_manager \
     --uds-path ${unix_socket} &
    --smp is the CPU cores.
   --mkfs initializes the device first.
   --type is the backend.
   ```

4. Create an FIO job named nbd.fio:

   Example

   ```
   [global]
   ioengine=nbd
   uri=nbd+unix:///?socket=${unix_socket}
   rw=randrw
   time_based
   runtime=120
   group_reporting
   iodepth=1
   size=512M

   [job0]
   offset=0
   ```

5. Test the Crimson object with the FIO compiled:

   Example

   ```
   [root@host01 ~]# ./fio nbd.fio
   ```

Ceph Benchmarking Tool (CBT)

Run the same test against two branches. One is **main**(master), another is **topic** branch of your choice. Compare the test results. Along with every test case, a set of rules is defined to check whether you need to perform regressions when two sets of test results are compared. If a possible regression is found, the rule and corresponding test results are highlighted.

Procedure

1. From the main branch and the topic branch, run **make crimson osd**:

   Example

   ```
   [root@host01 ~]# git checkout master
   [root@host01 ~]# make crimson-osd
   [root@host01 ~]# ../src/script/run-cbt.sh --cbt ~/dev/cbt -a /tmp/baseline
   ../src/test/crimson/cbt/radosbench_4K_read.yaml
   [root@host01 ~]# git checkout topic
   [root@host01 ~]# make crimson-osd
   [root@host01 ~]# ../src/script/run-cbt.sh --cbt ~/dev/cbt -a /tmp/yap
   ../src/test/crimson/cbt/radosbench_4K_read.yaml
   ```

2. Compare the test results:

   Example

   ```
   [root@host01 ~]# ~/dev/cbt/compare.py -b /tmp/baseline -a /tmp/yap -v
   ```

CHAPTER 13. CEPHADM TROUBLESHOOTING

As a storage administrator, you can troubleshoot the Red Hat Ceph Storage cluster. Sometimes there is a need to investigate why a Cephadm command failed or why a specific service does not run properly.

13.1. PAUSE OR DISABLE CEPHADM

If Cephadm does not behave as expected, you can pause most of the background activity with the following command:

Example

```
[ceph: root@host01 /]# ceph orch pause
```

This stops any changes, but Cephadm periodically checks hosts to refresh it's inventory of daemons and devices.

If you want to disable Cephadm completely, run the following commands:

Example

```
[ceph: root@host01 /]# ceph orch set backend ''
[ceph: root@host01 /]# ceph mgr module disable cephadm
```

Note that previously deployed daemon containers continue to exist and start as they did before.

To re-enable Cephadm in the cluster, run the following commands:

Example

```
[ceph: root@host01 /]# ceph mgr module enable cephadm
[ceph: root@host01 /]# ceph orch set backend cephadm
```

13.2. PER SERVICE AND PER DAEMON EVENT

Cephadm stores events per service and per daemon in order to aid in debugging failed daemon deployments. These events often contain relevant information:

Per service

Syntax

```
ceph orch ls --service_name SERVICE_NAME --format yaml
```

Example

```
[ceph: root@host01 /]# ceph orch ls --service_name alertmanager --format yaml
service_type: alertmanager
service_name: alertmanager
placement:
  hosts:
  - unknown_host
```

```
status:
  ...
  running: 1
  size: 1
events:
- 2021-02-01T08:58:02.741162 service:alertmanager [INFO] "service was created"
- '2021-02-01T12:09:25.264584 service:alertmanager [ERROR] "Failed to apply: Cannot
  place <AlertManagerSpec for service_name=alertmanager> on unknown_host: Unknown hosts"'
```

Per daemon

Syntax

```
ceph orch ps --service-name SERVICE_NAME --daemon-id DAEMON_ID --format yaml
```

Example

```
[ceph: root@host01 /]# ceph orch ps --service-name mds --daemon-id cephfs.hostname.ppdhsz --
format yaml
daemon_type: mds
daemon_id: cephfs.hostname.ppdhsz
hostname: hostname
status_desc: running
...
events:
- 2021-02-01T08:59:43.845866 daemon:mds.cephfs.hostname.ppdhsz [INFO] "Reconfigured
  mds.cephfs.hostname.ppdhsz on host 'hostname'"
```

13.3. CHECK CEPHADM LOGS

You can monitor the Cephadm log in real time with the following command:

Example

```
[ceph: root@host01 /]# ceph -W cephadm
```

You can see the last few messages with the following command:

Example

```
[ceph: root@host01 /]# ceph log last cephadm
```

If you have enabled logging to files, you can see a Cephadm log file called **ceph.cephadm.log** on the monitor hosts.

13.4. GATHER LOG FILES

You can use the **journalctl** command, to gather the log files for all the daemons.

NOTE

You have to run all these commands outside the **cephadm** shell.

NOTE

By default, Cephadm stores logs in journald which means that daemon logs are no longer available in **/var/log/ceph**.

- To read the log file of a specific daemon, run the following command:

  Syntax

  ```
  cephadm logs --name DAEMON_NAME
  ```

  Example

  ```
  [root@host01 ~]# cephadm logs --name cephfs.hostname.ppdhsz
  ```

NOTE

This command works when run on the same hosts where the daemon is running.

- To read the log file of a specific daemon running on a different host, run the following command:

  Syntax

  ```
  cephadm logs --fsid FSID --name DAEMON_NAME
  ```

  Example

  ```
  [root@host01 ~]# cephadm logs --fsid 2d2fd136-6df1-11ea-ae74-002590e526e8 --name
  cephfs.hostname.ppdhsz
  ```

  where **fsid** is the cluster ID provided by the **ceph status** command.

- To fetch all log files of all the daemons on a given host, run the following command:

  Syntax

  ```
  for name in $(cephadm ls | python3 -c "import sys, json; [print(i['name']) for i in
  json.load(sys.stdin)]") ; do cephadm logs --fsid FSID_OF_CLUSTER --name "$name" >
  $name; done
  ```

  Example

  ```
  [root@host01 ~]# for name in $(cephadm ls | python3 -c "import sys, json; [print(i['name']) for
  i in json.load(sys.stdin)]") ; do cephadm logs --fsid 57bddb48-ee04-11eb-9962-
  001a4a000672 --name "$name" > $name; done
  ```

13.5. COLLECT SYSTEMD STATUS

- To print the state of a systemd unit, run the following command:

Example

```
[root@host01 ~]$ systemctl status ceph-a538d494-fb2a-48e4-82c8-
b91c37bb0684@mon.host01.service
```

13.6. LIST ALL DOWNLOADED CONTAINER IMAGES

To list all the container images that are downloaded on a host, run the following command:

Example

```
[ceph: root@host01 /]# podman ps -a --format json | jq '.[].Image'
"docker.io/library/rhel9"
"registry.redhat.io/rhceph-alpha/rhceph-6-
rhel9@sha256:9aaea414e2c263216f3cdcb7a096f57c3adf6125ec9f4b0f5f65fa8c43987155"
```

13.7. MANUALLY RUN CONTAINERS

Cephadm writes small wrappers that runs a container. Refer to **/var/lib/ceph/*CLUSTER_FSID*/*SERVICE_NAME*/unit** to run the container execution command.

Analysing SSH errors

If you get the following error:

Example

```
execnet.gateway_bootstrap.HostNotFound: -F /tmp/cephadm-conf-73z09u6g -i /tmp/cephadm-
identity-ky7ahp_5 root@10.10.1.2
...
raise OrchestratorError(msg) from e
orchestrator._interface.OrchestratorError: Failed to connect to 10.10.1.2 (10.10.1.2).
Please make sure that the host is reachable and accepts connections using the cephadm SSH key
```

Try the following options to troubleshoot the issue:

- To ensure Cephadm has a SSH identity key, run the following command:

  Example

  ```
  [ceph: root@host01 /]# ceph config-key get mgr/cephadm/ssh_identity_key >
  ~/cephadm_private_key
  INFO:cephadm:Inferring fsid f8edc08a-7f17-11ea-8707-000c2915dd98
  INFO:cephadm:Using recent ceph image docker.io/ceph/ceph:v15 obtained
  'mgr/cephadm/ssh_identity_key'
  [root@mon1 ~] # chmod 0600 ~/cephadm_private_key
  ```

  If the above command fails, Cephadm does not have a key. To generate a SSH key, run the following command:

  Example

  ```
  [ceph: root@host01 /]# chmod 0600 ~/cephadm_private_key
  ```

Or

Example

```
[ceph: root@host01 /]# cat ~/cephadm_private_key | ceph cephadm set-ssk-key -i-
```

- To ensure that the SSH configuration is correct, run the following command:

  Example

  ```
  [ceph: root@host01 /]# ceph cephadm get-ssh-config
  ```

- To verify the connection to the host, run the following command:

  Example

  ```
  [ceph: root@host01 /]# ssh -F config -i ~/cephadm_private_key root@host01
  ```

Verify public key is in authorized_keys.

To verify that the public key is in the **authorized_keys** file, run the following commands:

Example

```
[ceph: root@host01 /]# ceph cephadm get-pub-key
[ceph: root@host01 /]# grep "`cat ~/ceph.pub`" /root/.ssh/authorized_keys
```

13.8. CIDR NETWORK ERROR

Classless inter domain routing (CIDR) also known as supernetting, is a method of assigning Internet Protocol (IP) addresses,FThe Cephadm log entries shows the current state that improves the efficiency of address distribution and replaces the previous system based on Class A, Class B and Class C networks. If you see one of the following errors:

ERROR: Failed to infer CIDR network for mon ip *; pass --skip-mon-network to configure it later

Or

Must set public_network config option or specify a CIDR network, ceph addrvec, or plain IP

You need to run the following command:

Example

```
[ceph: root@host01 /]# ceph config set host public_network hostnetwork
```

13.9. ACCESS THE ADMIN SOCKET

Each Ceph daemon provides an admin socket that bypasses the MONs.

To access the admin socket, enter the daemon container on the host:

Example

```
[ceph: root@host01 /]# cephadm enter --name cephfs.hostname.ppdhsz
[ceph: root@mon1 /]# ceph --admin-daemon /var/run/ceph/ceph-cephfs.hostname.ppdhsz.asok
config show
```

13.10. MANUALLY DEPLOYING A MGR DAEMON

Cephadm requires a **mgr** daemon in order to manage the Red Hat Ceph Storage cluster. In case the last **mgr** daemon of a Red Hat Ceph Storage cluster was removed, you can manually deploy a **mgr** daemon, on a random host of the Red Hat Ceph Storage cluster.

Prerequisites

- A running Red Hat Ceph Storage cluster.
- Root-level access to all the nodes.
- Hosts are added to the cluster.

Procedure

1. Log into the Cephadm shell:

   Example

   ```
   [root@host01 ~]# cephadm shell
   ```

2. Disable the Cephadm scheduler to prevent Cephadm from removing the new MGR daemon, with the following command:

   Example

   ```
   [ceph: root@host01 /]# ceph config-key set mgr/cephadm/pause true
   ```

3. Get or create the **auth** entry for the new MGR daemon:

   Example

   ```
   [ceph: root@host01 /]# ceph auth get-or-create mgr.host01.smfvfd1 mon "profile mgr" osd
   "allow *" mds "allow *"
   [mgr.host01.smfvfd1]
   key = AQDhcORgW8toCRAAIMzIqWXnh3cGRjqYEa9ikw==
   ```

4. Open **ceph.conf** file:

   Example

   ```
   [ceph: root@host01 /]# ceph config generate-minimal-conf
   # minimal ceph.conf for 8c9b0072-67ca-11eb-af06-001a4a0002a0
   [global]
   fsid = 8c9b0072-67ca-11eb-af06-001a4a0002a0
   mon_host = [v2:10.10.200.10:3300/0,v1:10.10.200.10:6789/0]
   [v2:10.10.10.100:3300/0,v1:10.10.200.100:6789/0]
   ```

5. Get the container image:

   Example

   ```
   [ceph: root@host01 /]# ceph config get "mgr.host01.smfvfd1" container_image
   ```

6. Create a **config-json.json** file and add the following:

   NOTE

   Use the values from the output of the **ceph config generate-minimal-conf** command.

   Example

   ```
   {
     {
     "config": "# minimal ceph.conf for 8c9b0072-67ca-11eb-af06-001a4a0002a0\n[global]\n\tfsid
   = 8c9b0072-67ca-11eb-af06-001a4a0002a0\n\tmon_host =
   [v2:10.10.200.10:3300/0,v1:10.10.200.10:6789/0]
   [v2:10.10.10.100:3300/0,v1:10.10.200.100:6789/0]\n",
     "keyring": "[mgr.Ceph5-2.smfvfd1]\n\tkey =
   AQDhcORgW8toCRAAIMzlqWXnh3cGRjqYEa9ikw==\n"
   }
   }
   ```

7. Exit from the Cephadm shell:

   Example

   ```
   [ceph: root@host01 /]# exit
   ```

8. Deploy the MGR daemon:

   Example

   ```
   [root@host01 ~]# cephadm --image registry.redhat.io/rhceph-alpha/rhceph-6-rhel9:latest
   deploy --fsid  8c9b0072-67ca-11eb-af06-001a4a0002a0 --name mgr.host01.smfvfd1 --config-
   json config-json.json
   ```

Verification

In the Cephadm shell, run the following command:

Example

```
[ceph: root@host01 /]# ceph -s
```

You can see a new **mgr** daemon has been added.

CHAPTER 14. CEPHADM OPERATIONS

As a storage administrator, you can carry out Cephadm operations in the Red Hat Ceph Storage cluster.

14.1. MONITOR CEPHADM LOG MESSAGES

Cephadm logs to the cephadm cluster log channel so you can monitor progress in real time.

- To monitor progress in realtime, run the following command:

  Example

  ```
  [ceph: root@host01 /]# ceph -W cephadm
  ```

  Example

  ```
  2022-06-10T17:51:36.335728+0000 mgr.Ceph5-1.nqikfh [INF] refreshing Ceph5-adm facts
  2022-06-10T17:51:37.170982+0000 mgr.Ceph5-1.nqikfh [INF] deploying 1 monitor(s) instead
  of 2 so monitors may achieve consensus
  2022-06-10T17:51:37.173487+0000 mgr.Ceph5-1.nqikfh [ERR] It is NOT safe to stop
  ['mon.Ceph5-adm']: not enough monitors would be available (Ceph5-2) after stopping mons
  [Ceph5-adm]
  2022-06-10T17:51:37.174415+0000 mgr.Ceph5-1.nqikfh [INF] Checking pool "nfs-ganesha"
  exists for service nfs.foo
  2022-06-10T17:51:37.176389+0000 mgr.Ceph5-1.nqikfh [ERR] Failed to apply nfs.foo spec
  NFSServiceSpec({'placement': PlacementSpec(count=1), 'service_type': 'nfs', 'service_id':
  'foo', 'unmanaged': False, 'preview_only': False, 'pool': 'nfs-ganesha', 'namespace': 'nfs-ns'}):
  Cannot find pool "nfs-ganesha" for service nfs.foo
  Traceback (most recent call last):
    File "/usr/share/ceph/mgr/cephadm/serve.py", line 408, in _apply_all_services
      if self._apply_service(spec):
    File "/usr/share/ceph/mgr/cephadm/serve.py", line 509, in _apply_service
      config_func(spec)
    File "/usr/share/ceph/mgr/cephadm/services/nfs.py", line 23, in config
      self.mgr._check_pool_exists(spec.pool, spec.service_name())
    File "/usr/share/ceph/mgr/cephadm/module.py", line 1840, in _check_pool_exists
      raise OrchestratorError(f'Cannot find pool "{pool}" for '
  orchestrator._interface.OrchestratorError: Cannot find pool "nfs-ganesha" for service nfs.foo
  2022-06-10T17:51:37.179658+0000 mgr.Ceph5-1.nqikfh [INF] Found osd claims -> {}
  2022-06-10T17:51:37.180116+0000 mgr.Ceph5-1.nqikfh [INF] Found osd claims for
  drivegroup all-available-devices -> {}
  2022-06-10T17:51:37.182138+0000 mgr.Ceph5-1.nqikfh [INF] Applying all-available-devices
  on host Ceph5-adm...
  2022-06-10T17:51:37.182987+0000 mgr.Ceph5-1.nqikfh [INF] Applying all-available-devices
  on host Ceph5-1...
  2022-06-10T17:51:37.183395+0000 mgr.Ceph5-1.nqikfh [INF] Applying all-available-devices
  on host Ceph5-2...
  2022-06-10T17:51:43.373570+0000 mgr.Ceph5-1.nqikfh [INF] Reconfiguring node-
  exporter.Ceph5-1 (unknown last config time)...
  2022-06-10T17:51:43.373840+0000 mgr.Ceph5-1.nqikfh [INF] Reconfiguring daemon node-
  exporter.Ceph5-1 on Ceph5-1
  ```

- By default, the log displays info-level events and above. To see the debug-level messages, run the following commands:

Example

```
[ceph: root@host01 /]# ceph config set mgr mgr/cephadm/log_to_cluster_level debug
[ceph: root@host01 /]# ceph -W cephadm --watch-debug
[ceph: root@host01 /]# ceph -W cephadm --verbose
```

- Return debugging level to default **info**:

  Example

  ```
  [ceph: root@host01 /]# ceph config set mgr mgr/cephadm/log_to_cluster_level info
  ```

- To see the recent events, run the following command:

  Example

  ```
  [ceph: root@host01 /]# ceph log last cephadm
  ```

Theses events are also logged to **ceph.cephadm.log** file on the monitor hosts and to the monitor daemon's **stderr**

14.2. CEPH DAEMON LOGS

You can view the Ceph daemon logs through **stderr** or files.

Logging to stdout

Traditionally, Ceph daemons have logged to **/var/log/ceph**. By default, Cephadm daemons log to **stderr** and the logs are captured by the container runtime environment. For most systems, by default, these logs are sent to **journald** and accessible through the **journalctl** command.

- For example, to view the logs for the daemon on **host01** for a storage cluster with ID **5c5a50ae-272a-455d-99e9-32c6a013e694**:

  Example

  ```
  [ceph: root@host01 /]# journalctl -u ceph-5c5a50ae-272a-455d-99e9-
  32c6a013e694@host01
  ```

This works well for normal Cephadm operations when logging levels are low.

- To disable logging to **stderr**, set the following values:

  Example

  ```
  [ceph: root@host01 /]# ceph config set global log_to_stderr false
  [ceph: root@host01 /]# ceph config set global mon_cluster_log_to_stderr false
  ```

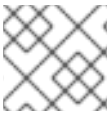
Logging to files

You can also configure Ceph daemons to log to files instead of **stderr**. When logging to files, Ceph logs are located in **/var/log/ceph/*CLUSTER_FSID***.

- To enable logging to files, set the follwing values:

Example

```
[ceph: root@host01 /]# ceph config set global log_to_file true
[ceph: root@host01 /]# ceph config set global mon_cluster_log_to_file true
```



NOTE

Red Hat recommends disabling logging to **stderr** to avoid double logs.

IMPORTANT

Currently log rotation to a non-default path is not supported.

By default, Cephadm sets up log rotation on each host to rotate these files. You can configure the logging retention schedule by modifying **/etc/logrotate.d/ceph.*CLUSTER_FSID***.

14.3. DATA LOCATION

Cephadm daemon data and logs are located in slightly different locations than the older versions of Ceph:

- **/var/log/ceph/*CLUSTER_FSID*** contains all the storage cluster logs. Note that by default Cephadm logs through **stderr** and the container runtime, so these logs are usually not present.
- **/var/lib/ceph/*CLUSTER_FSID*** contains all the cluster daemon data, besides logs.
- **var/lib/ceph/*CLUSTER_FSID*/*DAEMON_NAME*** contains all the data for an specific daemon.
- **/var/lib/ceph/*CLUSTER_FSID*/crash** contains the crash reports for the storage cluster.
- **/var/lib/ceph/*CLUSTER_FSID*/removed** contains old daemon data directories for the stateful daemons, for example monitor or Prometheus, that have been removed by Cephadm.

Disk usage

A few Ceph daemons may store a significant amount of data in **/var/lib/ceph**, notably the monitors and Prometheus daemon, hence Red Hat recommends moving this directory to its own disk, partition, or logical volume so that the root file system is not filled up.

14.4. CEPHADM CUSTOM CONFIG FILES

Cephadm supports specifying miscellaneous configuration files for daemons. You must provide both the content of the configuration file and the location within the daemon's container where it should be mounted.

A YAML spec is applied with custom config files specified. Cephadm redeploys the daemons for which the config files are specified. Then these files are mounted within the daemon's container at the specified location.

- You can apply a YAML spec with custom config files:

Example

```
service_type: grafana
```

```
service_name: grafana
custom_configs:
  - mount_path: /etc/example.conf
    content: |
      setting1 = value1
      setting2 = value2
  - mount_path: /usr/share/grafana/example.cert
    content: |
-----BEGIN PRIVATE KEY-----
V2VyIGRhcyBsaWVzdCBpc3QgZG9vZi4gTG9yZW0gaXBzdW0gZG9sb3Igc2l0IGFtZXQsIGNv
bnNldGV0dXIgc2FkaXBzY2luZyBlbGl0ciwgc2VkIGRpYW0gbm9udW15IGVpcm1vZCB0ZW1w
b3IgaW52aWR1bnQgdXQgbGFib3JlIGV0IGRvbG9yZSBtYWduYSBhbGlxdXlhbSBlcmF0LCBz
ZWQgZGlhbSB2b2x1cHR1YS4gQXQgdmVyby4gQXQgYWNjdXNhbSBldCBqdXN0byBkdW8=
-----END PRIVATE KEY-----
-----BEGIN CERTIFICATE-----
V2VyIGRhcyBsaWVzdCBpc3QgZG9vZi4gTG9yZW0gaXBzdW0gZG9sb3Igc2l0IGFtZXQsIGNv
bnNldGV0dXIgc2FkaXBzY2luZyBlbGl0ciwgc2VkIGRpYW0gbm9udW15IGVpcm1vZCB0ZW1w
b3IgaW52aWR1bnQgdXQgbGFib3JlIGV0IGRvbG9yZSBtYWduYSBhbGlxdXlhbSBlcmF0LCBz
ZWQgZGlhbSB2b2x1cHR1YS4gQXQgdmVyby4gQXQgYWNjdXNhbSBldCBqdXN0byBkdW8=
-----END CERTIFICATE-----
```

- You can mount the new config files within the containers for the daemons:

  Syntax

  ```
  ceph orch redeploy SERVICE_NAME
  ```

  Example

  ```
  [ceph: root@host01 /]# ceph orch redeploy grafana
  ```

CHAPTER 15. CEPHADM HEALTH CHECKS

As a storage administrator, you can monitor the Red Hat Ceph Storage cluster with the additional health checks provided by the Cephadm module. This is supplementary to the default healthchecks provided by the storage cluster.

15.1. CEPHADM OPERATIONS HEALTH CHECKS

Healthchecks are executed when the Cephadm module is active. You can get the following health warnings:

CEPHADM_PAUSED

Cephadm background work is paused with the **ceph orch pause** command. Cephadm continues to perform passive monitoring activities such as checking the host and daemon status, but it does not make any changes like deploying or removing daemons. You can resume Cephadm work with the **ceph orch resume** command.

CEPHADM_STRAY_HOST

One or more hosts have running Ceph daemons but are not registered as hosts managed by the Cephadm module. This means that those services are not currently managed by Cephadm, for example, a restart and upgrade that is included in the **ceph orch ps** command. You can manage the host(s) with the **ceph orch host add *HOST_NAME*** command but ensure that SSH access to the remote hosts is configured. Alternatively, you can manually connect to the host and ensure that services on that host are removed or migrated to a host that is managed by Cephadm. You can also disable this warning with the setting **ceph config set mgr mgr/cephadm/warn_on_stray_hosts false**

CEPHADM_STRAY_DAEMON

One or more Ceph daemons are running but are not managed by the Cephadm module. This might be because they were deployed using a different tool, or because they were started manually. Those services are not currently managed by Cephadm, for example, a restart and upgrade that is included in the **ceph orch ps** command.

If the daemon is a stateful one that is a monitor or OSD daemon, these daemons should be adopted by Cephadm. For stateless daemons, you can provision a new daemon with the **ceph orch apply** command and then stop the unmanaged daemon.

You can disable this health warning with the setting **ceph config set mgr mgr/cephadm/warn_on_stray_daemons false**.

CEPHADM_HOST_CHECK_FAILED

One or more hosts have failed the basic Cephadm host check, which verifies that:name: value

- The host is reachable and you can execute Cephadm.
- The host meets the basic prerequisites, like a working container runtime that is Podman , and working time synchronization. If this test fails, Cephadm wont be able to manage the services on that host.

You can manually run this check with the **ceph cephadm check-host *HOST_NAME*** command. You can remove a broken host from management with the **ceph orch host rm *HOST_NAME*** command. You can disable this health warning with the setting **ceph config set mgr mgr/cephadm/warn_on_failed_host_check false**.

15.2. CEPHADM CONFIGURATION HEALTH CHECKS

Cephadm periodically scans each of the hosts in the storage cluster, to understand the state of the OS, disks, and NICs . These facts are analyzed for consistency across the hosts in the storage cluster to identify any configuration anomalies. The configuration checks are an optional feature.

- You can enable this feature with the following command:

  Example

  ```
  [ceph: root@host01 /]# ceph config set mgr mgr/cephadm/config_checks_enabled true
  ```

The configuration checks are triggered after each host scan, which is for a duration of one minute.

- The **ceph -W cephadm** command shows log entries of the current state and outcome of the configuration checks as follows:
  Disabled state

  Example

  ```
  ALL cephadm checks are disabled, use 'ceph config set mgr
  mgr/cephadm/config_checks_enabled true' to enable
  ```

  Enabled state

  Example

  ```
  CEPHADM 8/8 checks enabled and executed (0 bypassed, 0 disabled). No issues detected
  ```

  The configuration checks themselves are managed through several **cephadm** subcommands.

- To determine whether the configuration checks are enabled, run the following command:

  Example

  ```
  [ceph: root@host01 /]# ceph cephadm config-check status
  ```

  This command returns the status of the configuration checker as either **Enabled** or **Disabled**.

- To list all the configuration checks and their current state, run the following command:

  Example

  ```
  [ceph: root@host01 /]# ceph cephadm config-check ls
  NAME             HEALTHCHECK                      STATUS   DESCRIPTION
  kernel_security  CEPHADM_CHECK_KERNEL_LSM         enabled  checks
  SELINUX/Apparmor profiles are consistent across cluster hosts
  os_subscription  CEPHADM_CHECK_SUBSCRIPTION       enabled  checks subscription
  states are consistent for all cluster hosts
  public_network   CEPHADM_CHECK_PUBLIC_MEMBERSHIP  enabled  check that all hosts
  have a NIC on the Ceph public_netork
  osd_mtu_size     CEPHADM_CHECK_MTU                enabled  check that OSD hosts share a
  common MTU setting
  osd_linkspeed    CEPHADM_CHECK_LINKSPEED          enabled  check that OSD hosts
  ```

```
share a common linkspeed
network_missing  CEPHADM_CHECK_NETWORK_MISSING    enabled  checks that the
cluster/public networks defined exist on the Ceph hosts
ceph_release     CEPHADM_CHECK_CEPH_RELEASE       enabled  check for Ceph version
consistency - ceph daemons should be on the same release (unless upgrade is active)
kernel_version   CEPHADM_CHECK_KERNEL_VERSION     enabled  checks that the
MAJ.MIN of the kernel on Ceph hosts is consistent
```

Each configuration check is described as follows:

CEPHADM_CHECK_KERNEL_LSM

Each host within the storage cluster is expected to operate within the same Linux Security Module (LSM) state. For example, if the majority of the hosts are running with SELINUX in **enforcing** mode, any host not running in this mode would be flagged as an anomaly and a healthcheck with a warning state is raised.

CEPHADM_CHECK_SUBSCRIPTION

This check relates to the status of the vendor subscription. This check is only performed for hosts using Red Hat Enterprise Linux, but helps to confirm that all the hosts are covered by an active subscription so that patches and updates are available.

CEPHADM_CHECK_PUBLIC_MEMBERSHIP

All members of the cluster should have NICs configured on at least one of the public network subnets. Hosts that are not on the public network will rely on routing which may affect performance.

CEPHADM_CHECK_MTU

The maximum transmission unit (MTU) of the NICs on OSDs can be a key factor in consistent performance. This check examines hosts that are running OSD services to ensure that the MTU is configured consistently within the cluster. This is determined by establishing the MTU setting that the majority of hosts are using, with any anomalies resulting in a Ceph healthcheck.

CEPHADM_CHECK_LINKSPEED

Similar to the MTU check, linkspeed consistency is also a factor in consistent cluster performance. This check determines the linkspeed shared by the majority of the OSD hosts, resulting in a healthcheck for any hosts that are set at a lower linkspeed rate.

CEPHADM_CHECK_NETWORK_MISSING

The **public_network** and **cluster_network** settings support subnet definitions for IPv4 and IPv6. If these settings are not found on any host in the storage cluster a healthcheck is raised.

CEPHADM_CHECK_CEPH_RELEASE

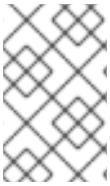
Under normal operations, the Ceph cluster should be running daemons under the same Ceph release, for example all Red Hat Ceph Storage cluster 5 releases. This check looks at the active release for each daemon, and reports any anomalies as a healthcheck. This check is bypassed if an upgrade process is active within the cluster.

CEPHADM_CHECK_KERNEL_VERSION

The OS kernel version is checked for consistency across the hosts. Once again, the majority of the hosts is used as the basis of identifying anomalies.

CHAPTER 16. MANAGING A RED HAT CEPH STORAGE CLUSTER USING CEPHADM-ANSIBLE MODULES

As a storage administrator, you can use **cephadm-ansible** modules in Ansible playbooks to administer your Red Hat Ceph Storage cluster. The **cephadm-ansible** package provides several modules that wrap **cephadm** calls to let you write your own unique Ansible playbooks to administer your cluster.



NOTE

At this time, **cephadm-ansible** modules only support the most important tasks. Any operation not covered by **cephadm-ansible** modules must be completed using either the **command** or **shell** Ansible modules in your playbooks.

16.1. THE CEPHADM-ANSIBLE MODULES

The **cephadm-ansible** modules are a collection of modules that simplify writing Ansible playbooks by providing a wrapper around **cephadm** and **ceph orch** commands. You can use the modules to write your own unique Ansible playbooks to administer your cluster using one or more of the modules.

The **cephadm-ansible** package includes the following modules:

- **cephadm_bootstrap**
- **ceph_orch_host**
- **ceph_config**
- **ceph_orch_apply**
- **ceph_orch_daemon**
- **cephadm_registry_login**

16.2. THE CEPHADM-ANSIBLE MODULES OPTIONS

The following tables list the available options for the **cephadm-ansible** modules. Options listed as required need to be set when using the modules in your Ansible playbooks. Options listed with a default value of **true** indicate that the option is automatically set when using the modules and you do not need to specify it in your playbook. For example, for the **cephadm_bootstrap** module, the Ceph Dashboard is installed unless you set **dashboard: false**.

Table 16.1. Available options for the cephadm_bootstrap module.

cephadm_bootstrap	Description	Required	Default
mon_ip	Ceph Monitor IP address.	true	
image	Ceph container image.	false	
docker	Use **docker** instead of **podman**.	false	

cephadm_bootstrap	Description	Required	Default
fsid	Define the Ceph FSID.	false	
pull	Pull the Ceph container image.	false	true
dashboard	Deploy the Ceph Dashboard.	false	true
dashboard_user	Specify a specific Ceph Dashboard user.	false	
dashboard_password	Ceph Dashboard password.	false	
monitoring	Deploy the monitoring stack.	false	true
firewalld	Manage firewall rules with firewalld.	false	true
allow_overwrite	Allow overwrite of existing --output-config, --output-keyring, or --output-pub-ssh-key files.	false	false
registry_url	URL for custom registry.	false	
registry_username	Username for custom registry.	false	
registry_password	Password for custom registry.	false	
registry_json	JSON file with custom registry login information.	false	
ssh_user	SSH user to use for **cephadm** ssh to hosts.	false	
ssh_config	SSH config file path for **cephadm** SSH client.	false	
allow_fqdn_hostname	Allow hostname that is a fully-qualified domain name (FQDN).	false	false

cephadm_bootstrap	Description	Required	Default
cluster_network	Subnet to use for cluster replication, recovery and heartbeats.	false	

Table 16.2. Available options for the **ceph_orch_host** module.

ceph_orch_host	Description	Required	Default
fsid	The FSID of the Ceph cluster to interact with.	false	
image	The Ceph container image to use.	false	
name	Name of the host to add, remove, or update.	true	
address	IP address of the host.	true when **state** is **present**.	
set_admin_label	Set the **_admin** label on the specified host.	false	false
labels	The list of labels to apply to the host.	false	[]
state	If set to **present**, it ensures the name specified in **name** is present. If set to **absent**, it removes the host specified in **name**. If set to **drain**, it schedules to remove all daemons from the host specified in **name**.	false	present

Table 16.3. Available options for the **ceph_config** module

ceph_config	Description	Required	Default
fsid	The FSID of the Ceph cluster to interact with.	false	
image	The Ceph container image to use.	false	

ceph_config	Description	Required	Default
action	Whether to **set** or **get** the parameter specified in **option**.	false	set
who	Which daemon to set the configuration to.	true	
option	Name of the parameter to **set** or **get**.	true	
value	Value of the parameter to set.	true if action is **set**	

Table 16.4. Available options for the **ceph_orch_apply** module.

ceph_orch_apply	Description	Required
fsid	The FSID of the Ceph cluster to interact with.	false
image	The Ceph container image to use.	false
spec	The service specification to apply.	true

Table 16.5. Available options for the **ceph_orch_daemon** module.

ceph_orch_daemon	Description	Required
fsid	The FSID of the Ceph cluster to interact with.	false
image	The Ceph container image to use.	false
state	The desired state of the service specified in **name**.	true If **started**, it ensures the service is started. If **stopped**, it ensures the service is stopped. If **restarted**, it will restart the service.
daemon_id	The ID of the service.	true

ceph_orch_daemon	Description	Required
daemon_type	The type of service.	true

Table 16.6. Available options for the **cephadm_registry_login** module

cephadm_registry_login	Description	Required	Default
state	Login or logout of a registry.	false	login
docker	Use **docker** instead of **podman**.	false	
registry_url	The URL for custom registry.	false	
registry_username	Username for custom registry.	**true** when **state** is **login**.	
registry_password	Password for custom registry.	**true** when **state** is **login**.	
registry_json	The path to a JSON file. This file must be present on remote hosts prior to running this task. This option is currently not supported.		

16.3. BOOTSTRAPPING A STORAGE CLUSTER USING THE CEPHADM_BOOTSTRAP AND CEPHADM_REGISTRY_LOGIN MODULES

As a storage administrator, you can bootstrap a storage cluster using Ansible by using the **cephadm_bootstrap** and **cephadm_registry_login** modules in your Ansible playbook.

Prerequisites

- An IP address for the first Ceph Monitor container, which is also the IP address for the first node in the storage cluster.
- Login access to **registry.redhat.io**.
- A minimum of 10 GB of free space for **/var/lib/containers/**.
- Red Hat Enterprise Linux 9.0 or later with **ansible-core** bundled into AppStream.
- Installation of the **cephadm-ansible** package on the Ansible administration node.

- Passwordless SSH is set up on all hosts in the storage cluster.
- Hosts are registered with CDN.

Procedure

1. Log in to the Ansible administration node.
2. Navigate to the **/usr/share/cephadm-ansible** directory on the Ansible administration node:

   Example

   ```
   [ceph-admin@admin ~]$ cd /usr/share/cephadm-ansible
   ```

3. Create the **hosts** file and add hosts, labels, and monitor IP address of the first host in the storage cluster:

   Syntax

   ```
   sudo vi INVENTORY_FILE

   HOST1 labels="['LABEL1', 'LABEL2']"
   HOST2 labels="['LABEL1', 'LABEL2']"
   HOST3 labels="['LABEL1']"

   [admin]
   ADMIN_HOST monitor_address=MONITOR_IP_ADDRESS labels="['ADMIN_LABEL',
   'LABEL1', 'LABEL2']"
   ```

   Example

   ```
   [ceph-admin@admin cephadm-ansible]$ sudo vi hosts

   host02 labels="['mon', 'mgr']"
   host03 labels="['mon', 'mgr']"
   host04 labels="['osd']"
   host05 labels="['osd']"
   host06 labels="['osd']"

   [admin]
   host01 monitor_address=10.10.128.68 labels="['_admin', 'mon', 'mgr']"
   ```

4. Run the preflight playbook:

   Syntax

   ```
   ansible-playbook -i INVENTORY_FILE cephadm-preflight.yml --extra-vars "ceph_origin=rhcs"
   ```

   Example

   ```
   [ceph-admin@admin cephadm-ansible]$ ansible-playbook -i hosts cephadm-preflight.yml --
   extra-vars "ceph_origin=rhcs"
   ```

5. Create a playbook to bootstrap your cluster:

Syntax

```
sudo vi PLAYBOOK_FILENAME.yml

---
- name: NAME_OF_PLAY
  hosts: BOOTSTRAP_HOST
  become: USE_ELEVATED_PRIVILEGES
  gather_facts: GATHER_FACTS_ABOUT_REMOTE_HOSTS
  tasks:
    -name: NAME_OF_TASK
     cephadm_registry_login:
       state: STATE
       registry_url: REGISTRY_URL
       registry_username: REGISTRY_USER_NAME
       registry_password: REGISTRY_PASSWORD

    - name: NAME_OF_TASK
      cephadm_bootstrap:
        mon_ip: "{{ monitor_address }}"
        dashboard_user: DASHBOARD_USER
        dashboard_password: DASHBOARD_PASSWORD
        allow_fqdn_hostname: ALLOW_FQDN_HOSTNAME
        cluster_network: NETWORK_CIDR
```

Example

```
[ceph-admin@admin cephadm-ansible]$ sudo vi bootstrap.yml

---
- name: bootstrap the cluster
  hosts: host01
  become: true
  gather_facts: false
  tasks:
    - name: login to registry
      cephadm_registry_login:
        state: login
        registry_url: registry.redhat.io
        registry_username: user1
        registry_password: mypassword1

    - name: bootstrap initial cluster
      cephadm_bootstrap:
        mon_ip: "{{ monitor_address }}"
        dashboard_user: mydashboarduser
        dashboard_password: mydashboardpassword
        allow_fqdn_hostname: true
        cluster_network: 10.10.128.0/28
```

6. Run the playbook:

Syntax

```
ansible-playbook -i INVENTORY_FILE PLAYBOOK_FILENAME.yml -vvv
```

Example

```
[ceph-admin@admin cephadm-ansible]$ ansible-playbook -i hosts bootstrap.yml -vvv
```

Verification

- Review the Ansible output after running the playbook.

16.4. ADDING OR REMOVING HOSTS USING THE CEPH_ORCH_HOST MODULE

As a storage administrator, you can add and remove hosts in your storage cluster by using the **ceph_orch_host** module in your Ansible playbook.

Prerequisites

- A running Red Hat Ceph Storage cluster.
- Register the nodes to the CDN and attach subscriptions.
- Ansible user with sudo and passwordless SSH access to all nodes in the storage cluster.
- Installation of the **cephadm-ansible** package on the Ansible administration node.
- New hosts have the storage cluster's public SSH key. For more information about copying the storage cluster's public SSH keys to new hosts, see *Adding hosts* in the *Red Hat Ceph Storage Installation Guide*.

Procedure

1. Use the following procedure to add new hosts to the cluster:
   a. Log in to the Ansible administration node.
   b. Navigate to the **/usr/share/cephadm-ansible** directory on the Ansible administration node:

      Example

      ```
      [ceph-admin@admin ~]$ cd /usr/share/cephadm-ansible
      ```

   c. Add the new hosts and labels to the Ansible inventory file.

      Syntax

      ```
      sudo vi INVENTORY_FILE

      NEW_HOST1 labels="['LABEL1', 'LABEL2']"
      NEW_HOST2 labels="['LABEL1', 'LABEL2']"
      NEW_HOST3 labels="['LABEL1']"
      ```

```
[admin]
ADMIN_HOST monitor_address=MONITOR_IP_ADDRESS labels="['ADMIN_LABEL',
'LABEL1', 'LABEL2']"
```

Example

```
[ceph-admin@admin cephadm-ansible]$ sudo vi hosts

host02 labels="['mon', 'mgr']"
host03 labels="['mon', 'mgr']"
host04 labels="['osd']"
host05 labels="['osd']"
host06 labels="['osd']"

[admin]
host01 monitor_address= 10.10.128.68 labels="['_admin', 'mon', 'mgr']"
```

NOTE

If you have previously added the new hosts to the Ansible inventory file and ran the preflight playbook on the hosts, skip to step 3.

d. Run the preflight playbook with the **--limit** option:

Syntax

```
ansible-playbook -i INVENTORY_FILE cephadm-preflight.yml --extra-vars
"ceph_origin=rhcs" --limit NEWHOST
```

Example

```
[ceph-admin@admin cephadm-ansible]$ ansible-playbook -i hosts cephadm-preflight.yml
--extra-vars "ceph_origin=rhcs" --limit host02
```

The preflight playbook installs **podman**, **lvm2**, **chronyd**, and **cephadm** on the new host. After installation is complete, **cephadm** resides in the **/usr/sbin/** directory.

e. Create a playbook to add the new hosts to the cluster:

Syntax

```
sudo vi PLAYBOOK_FILENAME.yml

---
- name: PLAY_NAME
  hosts: HOSTS_OR_HOST_GROUPS
  become: USE_ELEVATED_PRIVILEGES
  gather_facts: GATHER_FACTS_ABOUT_REMOTE_HOSTS
  tasks:
    - name: NAME_OF_TASK
      ceph_orch_host:
        name: "{{ ansible_facts['hostname'] }}"
        address: "{{ ansible_facts['default_ipv4']['address'] }}"
```

```
    labels: "{{ labels }}"
  delegate_to: HOST_TO_DELEGATE_TASK_TO

- name: NAME_OF_TASK
  when: inventory_hostname in groups['admin']
  ansible.builtin.shell:
    cmd: CEPH_COMMAND_TO_RUN
  register: REGISTER_NAME

- name: NAME_OF_TASK
  when: inventory_hostname in groups['admin']
  debug:
    msg: "{{ REGISTER_NAME.stdout }}"
```

NOTE

By default, Ansible executes all tasks on the host that matches the **hosts** line of your playbook. The **ceph orch** commands must run on the host that contains the admin keyring and the Ceph configuration file. Use the **delegate_to** keyword to specify the admin host in your cluster.

Example

```
[ceph-admin@admin cephadm-ansible]$ sudo vi add-hosts.yml

---
- name: add additional hosts to the cluster
  hosts: all
  become: true
  gather_facts: true
  tasks:
    - name: add hosts to the cluster
      ceph_orch_host:
        name: "{{ ansible_facts['hostname'] }}"
        address: "{{ ansible_facts['default_ipv4']['address'] }}"
        labels: "{{ labels }}"
      delegate_to: host01

    - name: list hosts in the cluster
      when: inventory_hostname in groups['admin']
      ansible.builtin.shell:
        cmd: ceph orch host ls
      register: host_list

    - name: print current list of hosts
      when: inventory_hostname in groups['admin']
      debug:
        msg: "{{ host_list.stdout }}"
```

In this example, the playbook adds the new hosts to the cluster and displays a current list of hosts.

f. Run the playbook to add additional hosts to the cluster:

Syntax

```
ansible-playbook -i INVENTORY_FILE PLAYBOOK_FILENAME.yml
```

Example

```
[ceph-admin@admin cephadm-ansible]$ ansible-playbook -i hosts add-hosts.yml
```

2. Use the following procedure to remove hosts from the cluster:

   a. Log in to the Ansible administration node.

   b. Navigate to the **/usr/share/cephadm-ansible** directory on the Ansible administration node:

   Example

   ```
   [ceph-admin@admin ~]$ cd /usr/share/cephadm-ansible
   ```

   c. Create a playbook to remove a host or hosts from the cluster:

   Syntax

   ```
   sudo vi PLAYBOOK_FILENAME.yml

   ---
   - name: NAME_OF_PLAY
     hosts: ADMIN_HOST
     become: USE_ELEVATED_PRIVILEGES
     gather_facts: GATHER_FACTS_ABOUT_REMOTE_HOSTS
     tasks:
       - name: NAME_OF_TASK
         ceph_orch_host:
           name: HOST_TO_REMOVE
           state: STATE

       - name: NAME_OF_TASK
         ceph_orch_host:
           name: HOST_TO_REMOVE
           state: STATE
         retries: NUMBER_OF_RETRIES
         delay: DELAY
         until: CONTINUE_UNTIL
         register: REGISTER_NAME

       - name: NAME_OF_TASK
         ansible.builtin.shell:
           cmd: ceph orch host ls
         register: REGISTER_NAME

       - name: NAME_OF_TASK
           debug:
             msg: "{{ REGISTER_NAME.stdout }}"
   ```

   Example

```
[ceph-admin@admin cephadm-ansible]$ sudo vi remove-hosts.yml

---
- name: remove host
  hosts: host01
  become: true
  gather_facts: true
  tasks:
    - name: drain host07
      ceph_orch_host:
        name: host07
        state: drain

    - name: remove host from the cluster
      ceph_orch_host:
        name: host07
        state: absent
      retries: 20
      delay: 1
      until: result is succeeded
      register: result

    - name: list hosts in the cluster
      ansible.builtin.shell:
        cmd: ceph orch host ls
      register: host_list

    - name: print current list of hosts
      debug:
        msg: "{{ host_list.stdout }}"
```

In this example, the playbook tasks drain all daemons on **host07**, removes the host from the cluster, and displays a current list of hosts.

d. Run the playbook to remove host from the cluster:

Syntax

```
ansible-playbook -i INVENTORY_FILE PLAYBOOK_FILENAME.yml
```

Example

```
[ceph-admin@admin cephadm-ansible]$ ansible-playbook -i hosts remove-hosts.yml
```

Verification

- Review the Ansible task output displaying the current list of hosts in the cluster:

Example

```
TASK [print current hosts]
*****************************************************************************************************
Friday 24 June 2022  14:52:40 -0400 (0:00:03.365)       0:02:31.702 ***********
ok: [host01] =>
```

```
msg: |-
  HOST    ADDR          LABELS         STATUS
  host01  10.10.128.68  _admin mon mgr
  host02  10.10.128.69  mon mgr
  host03  10.10.128.70  mon mgr
  host04  10.10.128.71  osd
  host05  10.10.128.72  osd
  host06  10.10.128.73  osd
```

16.5. SETTING CONFIGURATION OPTIONS USING THE CEPH_CONFIG MODULE

As a storage administrator, you can set or get Red Hat Ceph Storage configuration options using the **ceph_config** module.

Prerequisites

- A running Red Hat Ceph Storage cluster.
- Ansible user with sudo and passwordless SSH access to all nodes in the storage cluster.
- Installation of the **cephadm-ansible** package on the Ansible administration node.
- The Ansible inventory file contains the cluster and admin hosts.

Procedure

1. Log in to the Ansible administration node.
2. Navigate to the **/usr/share/cephadm-ansible** directory on the Ansible administration node:

   #### Example

   ```
   [ceph-admin@admin ~]$ cd /usr/share/cephadm-ansible
   ```

3. Create a playbook with configuration changes:

   #### Syntax

   ```
   sudo vi PLAYBOOK_FILENAME.yml

   ---
   - name: PLAY_NAME
     hosts: ADMIN_HOST
     become: USE_ELEVATED_PRIVILEGES
     gather_facts: GATHER_FACTS_ABOUT_REMOTE_HOSTS
     tasks:
       - name: NAME_OF_TASK
         ceph_config:
           action: GET_OR_SET
           who: DAEMON_TO_SET_CONFIGURATION_TO
           option: CEPH_CONFIGURATION_OPTION
           value: VALUE_OF_PARAMETER_TO_SET
   ```

```
- name: NAME_OF_TASK
  ceph_config:
    action: GET_OR_SET
    who: DAEMON_TO_SET_CONFIGURATION_TO
    option: CEPH_CONFIGURATION_OPTION
  register: REGISTER_NAME

- name: NAME_OF_TASK
  debug:
    msg: "MESSAGE_TO_DISPLAY {{ REGISTER_NAME.stdout }}"
```

Example

```
[ceph-admin@admin cephadm-ansible]$ sudo vi change_configuration.yml

---
- name: set pool delete
  hosts: host01
  become: true
  gather_facts: false
  tasks:
    - name: set the allow pool delete option
      ceph_config:
        action: set
        who: mon
        option: mon_allow_pool_delete
        value: true

    - name: get the allow pool delete setting
      ceph_config:
        action: get
        who: mon
        option: mon_allow_pool_delete
      register: verify_mon_allow_pool_delete

    - name: print current mon_allow_pool_delete setting
      debug:
        msg: "the value of 'mon_allow_pool_delete' is {{ verify_mon_allow_pool_delete.stdout }}"
```

In this example, the playbook first sets the **mon_allow_pool_delete** option to **false**. The playbook then gets the current **mon_allow_pool_delete** setting and displays the value in the Ansible output.

4. Run the playbook:

Syntax

```
ansible-playbook -i INVENTORY_FILE _PLAYBOOK_FILENAME.yml
```

Example

```
[ceph-admin@admin cephadm-ansible]$ ansible-playbook -i hosts change_configuration.yml
```

Verification

- Review the output from the playbook tasks.

  Example

```
TASK [print current mon_allow_pool_delete setting]
*************************************************************
Wednesday 29 June 2022  13:51:41 -0400 (0:00:05.523)       0:00:17.953 ********
ok: [host01] =>
  msg: the value of 'mon_allow_pool_delete' is true
```

Additional Resources

- See the *Red Hat Ceph Storage Configuration Guide* for more details on configuration options.

16.6. APPLYING A SERVICE SPECIFICATION USING THE CEPH_ORCH_APPLY MODULE

As a storage administrator, you can apply service specifications to your storage cluster using the **ceph_orch_apply** module in your Ansible playbooks. A service specification is a data structure to specify the service attributes and configuration settings that is used to deploy the Ceph service. You can use a service specification to deploy Ceph service types like **mon**, **crash**, **mds**, **mgr**, **osd**, **rdb**, or **rbd-mirror**.

Prerequisites

- A running Red Hat Ceph Storage cluster.
- Ansible user with sudo and passwordless SSH access to all nodes in the storage cluster.
- Installation of the **cephadm-ansible** package on the Ansible administration node.
- The Ansible inventory file contains the cluster and admin hosts.

Procedure

1. Log in to the Ansible administration node.
2. Navigate to the **/usr/share/cephadm-ansible** directory on the Ansible administration node:

   Example

```
[ceph-admin@admin ~]$ cd /usr/share/cephadm-ansible
```

3. Create a playbook with the service specifications:

   Syntax

```
sudo vi PLAYBOOK_FILENAME.yml

---
- name: PLAY_NAME
  hosts: HOSTS_OR_HOST_GROUPS
  become: USE_ELEVATED_PRIVILEGES
```

```
gather_facts: GATHER_FACTS_ABOUT_REMOTE_HOSTS
tasks:
  - name: NAME_OF_TASK
    ceph_orch_apply:
      spec: |
        service_type: SERVICE_TYPE
        service_id: UNIQUE_NAME_OF_SERVICE
        placement:
          host_pattern: 'HOST_PATTERN_TO_SELECT_HOSTS'
          label: LABEL
        spec:
          SPECIFICATION_OPTIONS:
```

Example

```
[ceph-admin@admin cephadm-ansible]$ sudo vi deploy_osd_service.yml

---
- name: deploy osd service
  hosts: host01
  become: true
  gather_facts: true
  tasks:
    - name: apply osd spec
      ceph_orch_apply:
        spec: |
          service_type: osd
          service_id: osd
          placement:
            host_pattern: '*'
            label: osd
          spec:
            data_devices:
              all: true
```

In this example, the playbook deploys the Ceph OSD service on all hosts with the label **osd**.

4. Run the playbook:

Syntax

```
ansible-playbook -i INVENTORY_FILE _PLAYBOOK_FILENAME.yml
```

Example

```
[ceph-admin@admin cephadm-ansible]$ ansible-playbook -i hosts deploy_osd_service.yml
```

Verification

- Review the output from the playbook tasks.

Additional Resources

- See the *Red Hat Ceph Storage Operations Guide* for more details on service specification options.

16.7. MANAGING CEPH DAEMON STATES USING THE CEPH_ORCH_DAEMON MODULE

As a storage administrator, you can start, stop, and restart Ceph daemons on hosts using the **ceph_orch_daemon** module in your Ansible playbooks.

Prerequisites

- A running Red Hat Ceph Storage cluster.
- Ansible user with sudo and passwordless SSH access to all nodes in the storage cluster.
- Installation of the **cephadm-ansible** package on the Ansible administration node.
- The Ansible inventory file contains the cluster and admin hosts.

Procedure

1. Log in to the Ansible administration node.
2. Navigate to the **/usr/share/cephadm-ansible** directory on the Ansible administration node:

   #### Example

   ```
   [ceph-admin@admin ~]$ cd /usr/share/cephadm-ansible
   ```

3. Create a playbook with daemon state changes:

   #### Syntax

   ```
   sudo vi PLAYBOOK_FILENAME.yml

   ---
   - name: PLAY_NAME
     hosts: ADMIN_HOST
     become: USE_ELEVATED_PRIVILEGES
     gather_facts: GATHER_FACTS_ABOUT_REMOTE_HOSTS
     tasks:
       - name: NAME_OF_TASK
         ceph_orch_daemon:
           state: STATE_OF_SERVICE
           daemon_id: DAEMON_ID
           daemon_type: TYPE_OF_SERVICE
   ```

   #### Example

   ```
   [ceph-admin@admin cephadm-ansible]$ sudo vi restart_services.yml

   ---
   - name: start and stop services
     hosts: host01
   ```

```
become: true
gather_facts: false
tasks:
  - name: start osd.0
    ceph_orch_daemon:
      state: started
      daemon_id: 0
      daemon_type: osd

  - name: stop mon.host02
    ceph_orch_daemon:
      state: stopped
      daemon_id: host02
      daemon_type: mon
```

In this example, the playbook starts the OSD with an ID of **0** and stops a Ceph Monitor with an id of **host02**.

4. Run the playbook:

Syntax

```
ansible-playbook -i INVENTORY_FILE _PLAYBOOK_FILENAME.yml
```

Example

```
[ceph-admin@admin cephadm-ansible]$ ansible-playbook -i hosts restart_services.yml
```

Verification

- Review the output from the playbook tasks.

APPENDIX A. THE MCLOCK CONFIGURATION OPTIONS

This section contains the list of mClock configuration options:

osd_mclock_profile

Description

It sets the type of mClock profile to use for providing the quality of service (QoS) based on operations belonging to different classes, such as background recovery, **backfill**, **pg scrub**, **snap trim**, **client op**, and **pg deletion**.
Once a *built-in* profile is enabled, the lower-level mClock resource control parameters, that is reservation, weight, and limit, and some Ceph configuration parameters are set transparently. This does not apply for the *custom* profile.

Type

String

Default

balanced

Valid choices

balanced, **high_recovery_ops**, **high_client_ops**, **custom**

osd_mclock_max_capacity_iops_hdd

Description

It sets a maximum random write IOPS capacity, at 4 KiB block size, to consider per OSD for rotational media. Contributes in QoS calculations when enabling a dmclock profile. It is only considered for **osd_op_queue = mclock_scheduler**

Type

Float

Default

315.0

osd_mclock_max_capacity_iops_ssd

Description

It sets a maximum random write IOPS capacity, at 4 KiB block size, to consider per OSD for solid state media.

Type

Float

Default

21500.0

osd_mclock_cost_per_byte_usec_ssd

Description

Indicates cost per byte in microseconds to consider per OSD for SDDs.Contributes in QoS calculations when enabling a dmclock profile. It is only considered for **osd_op_queue = mclock_scheduler**

Type

Float

Default

0.011

osd_mclock_max_sequential_bandwidth_hdd

Description

Indicates the maximum sequential bandwidth in bytes to consider for an OSD whose underlying device type is rotational media. This is considered by the mclock scheduler to derive the cost factor to be used in QoS calculations. Only considered for **osd_op_queue = mclock_scheduler**

Type

Size

Default

150_M

osd_mclock_max_sequential_bandwidth_ssd

Description

Indicates the maximum sequential bandwidth in bytes to consider for an OSD whose underlying device type is solid state media. This is considered by the mclock scheduler to derive the cost factor to be used in QoS calculations. Only considered for **osd_op_queue = mclock_scheduler**

Type

Size

Default

1200_M

osd_mclock_force_run_benchmark_on_init

Description

This force-runs the OSD benchmark on OSD initialization or boot-up.

Type

Boolean

Default

False

See also

osd_mclock_max_capacity_iops_hdd, **osd_mclock_max_capacity_iops_ssd**

osd_mclock_skip_benchmark

Description

Setting this option skips the OSD benchmark on OSD initialization or boot-up.

Type

Boolean

Default

False

See also

osd_mclock_max_capacity_iops_hdd, **osd_mclock_max_capacity_iops_ssd**

osd_mclock_override_recovery_settings

Description

Setting this option enables the override of the recovery or backfill limits for the mClock scheduler as defined by the **osd_recovery_max_active_hdd**, **osd_recovery_max_active_ssd**, and **osd_max_backfills** options.

Type

Boolean

Default

False

See also

osd_recovery_max_active_hdd, **osd_recovery_max_active_ssd**, **osd_max_backfills**

osd_mclock_iops_capacity_threshold_hdd

Description

It indicates the threshold IOPS capacity, at 4KiB block size, beyond which to ignore the Ceph OSD bench results for an OSD for HDDs.

Type

Float

Default

500.0

osd_mclock_iops_capacity_threshold_ssd

Description

It indicates the threshold IOPS capacity, at 4KiB block size, beyond which to ignore the Ceph OSD bench results for an OSD for SSDs.

Type

Float

Default

80000.0

osd_mclock_scheduler_client_res

Description

It is the default I/O proportion reserved for each client. The default value of **0** specifies the lowest possible reservation. Any value greater than 0 and up to 1.0 specifies the minimum IO proportion to reserve for each client in terms of a fraction of the OSD's maximum IOPS capacity.

Type

float

Default

0

min

0

max

1.0

osd_mclock_scheduler_client_wgt

Description

It is the default I/O share for each client over reservation.

Type

Unsigned integer

Default

1

osd_mclock_scheduler_client_lim

Description

It is the default I/O limit for each client over reservation. The default value of **0** specifies no limit enforcement, which means each client can use the maximum possible IOPS capacity of the OSD. Any value greater than 0 and up to 1.0 specifies the upper IO limit over reservation that each client receives in terms of a fraction of the OSD's maximum IOPS capacity.

Type

float

Default

0

min

0

max

1.0

osd_mclock_scheduler_background_recovery_res

Description

It is the default I/O proportion reserved for background recovery. The default value of 0 specifies the lowest possible reservation. Any value greater than 0 and up to 1.0 specifies the minimum IO proportion to reserve for background recovery operations in terms of a fraction of the OSD's maximum IOPS capacity.

Type

float

Default

0

min

0

max

1.0

osd_mclock_scheduler_background_recovery_wgt

Description

It indicates the I/O share for each background recovery over reservation.

Type

Unsigned integer

Default

1

osd_mclock_scheduler_background_recovery_lim

Description

It indicates the I/O limit for background recovery over reservation. The default value of 0 specifies no limit enforcement, which means background recovery operation can use the maximum possible IOPS capacity of the OSD. Any value greater than 0 and up to 1.0 specifies the upper IO limit over reservation that background recovery operation receives in terms of a fraction of the OSD's maximum IOPS capacity.

Type

float

Default

0

min

0

max

1.0

osd_mclock_scheduler_background_best_effort_res

Description

It indicates the default I/O proportion reserved for background **best_effort**. The default value of 0 specifies the lowest possible reservation. Any value greater than 0 and up to 1.0 specifies the minimum IO proportion to reserve for background best_effort operations in terms of a fraction of the OSD's maximum IOPS capacity.

Type

float

Default

0

min

0

max

1.0

osd_mclock_scheduler_background_best_effort_wgt

Description

It indicates the I/O share for each background **best_effort** over reservation.

Type

Unsigned integer

Default

1

osd_mclock_scheduler_background_best_effort_lim

Description

It indicates the I/O limit for background **best_effort** over reservation. The default value of 0 specifies no limit enforcement, which means background best_effort operation can use the maximum possible IOPS capacity of the OSD. Any value greater than 0 and up to 1.0 specifies the

upper IO limit over reservation that background best_effort operation receives in terms of a fraction of the OSD's maximum IOPS capacity.

Type

float

Default

0

min

0

max

1.0

Additional Resources

See *Object Storage Daemon (OSD) configuration options* for more details about **osd_op_queue** option.