Red Hat Ceph Storage 3

Ceph Object Gateway for Production

Planning, designing and deploying Ceph Storage clusters and Ceph Object Gateway clusters for production.

Last Updated: 2021-05-05

Red Hat Ceph Storage 3 Ceph Object Gateway for Production

Planning, designing and deploying Ceph Storage clusters and Ceph Object Gateway clusters for production.

Legal Notice

Abstract

This guide covers planning a cluster, considering hardware, developing storage strategies, configuring gateways and load balancers and using the Ceph Object Gateway.

Table of Contents

CHAPTER 1. INTRODUCTION

Welcome to the **Ceph Object Gateway for Production**guide. This guide covers topics for building Ceph Storage clusters and Ceph Object Gateway clusters for production use.

1.1. AUDIENCE

This guide is for those who intend to deploy a Ceph Object Gateway environment for production. It provides a sequential series of topics for planning, designing and deploying a production Ceph Storage cluster and Ceph Object Gateway cluster with links to general Ceph documentation where appropriate.

1.2. ASSUMPTIONS

This guide assumes the reader has a basic understanding of the Ceph Storage Cluster and the Ceph Object Gateway. Readers with no Ceph experience should consider setting up a small Ceph test environment or using the Ceph Sandbox Environment to get familiar with Ceph concepts before proceeding with this guide.

This guide assumes a single-site cluster consisting of a single Ceph Storage cluster and multiple Ceph Object Gateway instances in the same zone. This guide assumes the single-site cluster will expand to a multi-zone and multi-site cluster by repeating the procedures in this guide for each zone group and zone with the naming modifications required for secondary zone groups and zones.

1.3. SCOPE

This guide covers the following topics when setting up a Ceph Storage Cluster and a Ceph Object Gateway for production:

- Planning a Cluster
- Considering Hardware
- Configuring a Cluster
- Deploying Ceph
- Developing Storage Strategies
- Configuring Gateways
- Additional Use Cases

NOTE

This document is intended to complement the hardware, installation, administration and Ceph Object Gateway guides. This guide does not replace the other guides.

CHAPTER 2. PLANNING A CLUSTER

Planning a cluster for use with the Ceph Object Gateway involves several important considerations:

- Identifying use cases
- Selecting data durability methods
- Considering multi-site deployment

These factors will have a significant influence when considering hardware. Consider these factors carefully before selecting hardware.

2.1. IDENTIFYING USE CASES

Ceph Storage is capable of serving many different types of storage use cases. For Ceph Object Storage, the typical use cases are:

- **Throughput-optimized:** A throughput-optimized cluster seeks to ensure fast data access. Host bus adapters (HBAs), storage media with fast sequential read/write characteristics and high network bandwidth provide capability for applications such as graphics, streaming audio and streaming video. Throughput-optimized optimized clusters also consider whether write performance is a consideration. Throughput-optimized clusters that use SSDs for journaling realize substantially better write performance, which can be important for applications like storing CCTV streams. Throughput-optimized clusters should consider the throughput characteristics of a Host Bus Adapter (HBA) controller and network throughput for intensive applications such as streaming 4K video. HBA-based hardware controllers offer significant performance improvements over on-board controllers.

- **Capacity-optimized:** A capacity-optimized cluster seeks to ensure the lowest cost per terabyte of storage. Capacity-optimized clusters often use the least expensive storage media and often avoid the added expense of separate SSD journals for applications such as archiving infrequently accessed legacy financial records, old emails, etc.

- **IOPS-optimized:** An IOPS-optimized cluster seeks to provide high performance for read- and write-intensive workloads. While IOPS-optimized workloads are not as common for Ceph Object Gateways, they can be supported with SSD, Flash memory or NVMe CRUSH hierarchies.

Carefully consider the storage use case(s) **BEFORE** considering hardware, because it can significantly impact the price and performance of the cluster. For example, if the use case is capacity-optimized and the hardware is better suited to a throughput-optimized use case, the hardware will be more expensive than necessary. Conversely, if the use case is throughput-optimized and the hardware is better suited to a capacity-optimized use case, the cluster may suffer from poor performance.

Also, note that since Ceph Object Gateway supports storage policies, it is possible to create CRUSH hierarchies for **ALL** of the foregoing scenarios and invoke them with storage policies supported in the APIs. See Creating Data Placement Strategies for details.

2.2. SELECTING DATA DURABILITY METHODS

Cluster design should also consider the data durability strategy. Ceph Storage uses either replication or erasure coding to ensure data durability.

Replication stores one or more redundant copies of the data across failure domains in case of a hardware failure. However, redundant copies of data can become expensive at scale. For example, to store 1 petabyte of data with triple replication would require a cluster with at least 3 petabytes of storage capacity.

The Erasure coding section of the Storage Strategies Guide for Red Hat Ceph Storage 3 describes how erasure coding stores data as data chunks and coding chunks. In the event of a lost data chunk, erasure coding can recover the lost data chunk with the remaining data chunks and coding chunks. Erasure coding is substantially more economical than replication. For example, using erasure coding with 8 data chunks and 3 coding chunks provides the same redundancy as 3 copies of the data. However, such an encoding scheme uses approximately 1.5x of the initial data stored compared to 3x with replication.

NOTE

ONLY the data storage pool can use erasure coding. Pools storing service data and bucket indexes use replication.

2.3. CONSIDERING MULTI-SITE DEPLOYMENT

Another important aspect of designing a cluster is to determine if the cluster will be in one data center site or span multiple data center sites. Multi-site clusters benefit from geographically distributed failover and disaster recovery, such as long-term power outages, earthquakes, hurricanes, floods or other disasters. Additionally, multi-site clusters in an active-active configuration can direct client applications to the closest available cluster in the manner of content delivery networks. Placing data as close to the client as possible is increasingly important for throughput intensive workloads such as streaming 4k video.

For details of multi-site clusters, see the Multi-site chapter in the Object Gateway for Red Hat Enterprise Linux guide for Red Hat Ceph Storage 3.

NOTE

Red Hat recommends identifying realm, zone group and zone names BEFORE creating Ceph Storage pools. Some pool names should be pre-pended with the zone name by convention.

CHAPTER 3. CONSIDERING HARDWARE

Considering hardware is an important part of building Ceph Storage clusters and Ceph Object Gateway clusters for production environments. High-level considerations include:

- Considering Storage Sizing
- Considering Storage Density
- Considering Uninterrupted Power Supplies
- Considering Network Hardware
- Selecting Hardware for Use Cases
- Selecting Media for Indexes
- Selecting Media for Monitor Nodes

IMPORTANT

Consider these factors **BEFORE** identifying and purchasing computing and networking hardware for the cluster.

3.1. CONSIDERING STORAGE SIZING

One of the most important factors in designing a cluster is to determine the storage requirements (sizing). Ceph Storage is designed to scale into petabytes and beyond. The following examples are common sizes for Ceph storage clusters.

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

Sizing should include current needs and the needs of the near future. Consider the rate at which the gateway client will add new data to the cluster. That may differ from use-case to use-case. For example, recording CCTV video, 4k video or medical imaging may add significant amounts of data far more quickly then less storage intensive information such as financial market data. Additionally, consider that data durability methods such as replication versus erasure coding will have a significant impact on the storage media required.

For additional information on sizing, see the Red Hat Ceph Storage Hardware Selection Guide and its associated links for selecting OSD hardware.

3.2. CONSIDERING STORAGE DENSITY

Another important aspect of cluster design includes storage density. Generally, a cluster should store data across at least 10 nodes to ensure reasonable performance when replicating, backfilling and recovery. If a node fails, with at least 10 nodes in the cluster, only 10% of the data has to move to the surviving nodes. If the number of nodes is substantially less, a higher percentage of the data must move to the surviving nodes. Additionally, the **full_ratio** and **near_full_ratio** need to be set to accommodate a node failure to ensure that the cluster can write data. For this reason, it is is important to consider storage density. Higher storage density isn’t necessarily a good idea.

Another factor that favors more nodes over higher storage density is erasure coding. When writing an object using erasure coding and using **node** as the minimum CRUSH failure domain, the cluster will need as many nodes as data and coding chunks. For example, a cluster using **k=8, m=3** should have at least 11 nodes so that each data or coding chunk is stored on a separate node.

Hot-swapping is also an important consideration. Most modern servers support drive hot-swapping. However, some hardware configurations require removing more than one drive to replace a drive. Red Hat recommends avoiding such configurations, because they can bring down more OSDs than required when swapping out failed disks.

3.3. CONSIDERING NETWORK HARDWARE

A major advantage of Ceph Storage is that it allows scaling capacity, IOPS and throughput independently. An important aspect of a cloud storage solution is that clusters can run out of IOPS due to network latency and other factors or run out of throughput due to bandwidth constraints long before the clusters run out of storage capacity. This means that the network hardware configuration must support the use case(s) in order to meet price/performance targets. Network performance is increasingly important when considering the use of SSDs, flash, NVMe, and other high performance storage methods.

Another important consideration of Ceph Storage is that it supports a front side or public network for client and monitor data, and a back side or cluster network for heart beating, data replication and recovery. This means that the back side or cluster network will **always** require more network resources than the front side or public network. Depending upon whether the data pool uses replication or erasure coding for data durability, the network requirements for the back side or cluster network should be quantified appropriately.

Finally, verify network throughput before installing and testing Ceph. Most performance-related problems in Ceph usually begin with a networking issue. Simple network issues like a kinked or bent Cat-6 cable could result in degraded bandwidth. Use a minimum of 10 GB ethernet for the front side network. For large clusters, consider using 40 GB ethernet for the backend or cluster network. Alternatively, use LACP mode 4 to bond networks. Additionally, use jumbo frames, maximum transmission unit (MTU) of 9000, especially on the backend or cluster network. If using jumbo frames, then validate all interconnecting network equipment and nodes are using jumbo frames. If jumbo frames are not configured throughout the full network path, then a mismatch in MTU size will result in packet loss and the possibility of Ceph OSD issues.

Additional Resources

- See the *Verifying and configuring the MTU value* in the *{storage-product} Configuration Guide* for more details.

3.4. CONSIDERING UNINTERRUPTED POWER SUPPLIES

Since Ceph writes are atomic—all or nothing—it isn't a requirement to invest in uninterruptable power supplies (UPS) for Ceph OSD nodes. However, Red Hat recommends investing in UPSs for Ceph Monitor nodes. Monitors use **leveldb**, which is sensitive to synchronous write latency. A power outage could cause corruption, requiring technical support to restore the state of the cluster.

Ceph OSDs may benefit from the use of a UPS if a storage controller uses a writeback cache. In this scenario, a UPS may help prevent filesystem corruption during a power outage if the controller doesn't flush the writeback cache in time.

3.5. SELECTING HARDWARE FOR USE CASES

A major advantage of Ceph Storage is that it can be configured to support many use cases. Generally, Red Hat recommends configuring OSD hosts identically for a particular use case. The three primary use cases for a Ceph Storage cluster are:

- IOPS optimized
- Throughput optimized
- Capacity optimized

Since these use cases typically have different drive, HBA controller and networking requirements among other factors, configuring a series of identical hosts to facilitate all of these use cases with a single node configuration is possible, but is not necessarily recommended.

Using the same hosts to facilitate multiple CRUSH hierarchies will involve the use of logical, rather than actual host names in the CRUSH map. Additionally, deployment tools such as Ansible would need to consider a group for each use case, rather than deploying all OSDs in the default **[osds]** group.

NOTE

Generally, it is easier to configure and manage hosts that serve a single use case, such as high IOPS, high throughput, or high capacity.

3.6. SELECTING MEDIA FOR INDEXES

When selecting OSD hardware for use with a Ceph Object Gateway—irrespective of the use case—Red Hat recommends considering an OSD node that has at least one high performance drive for storing the index pool. This is particularly important when buckets will contain a large number of objects.

The host should have at least one SSD or NVMe drive. In Red Hat lab testing, NVMe drives have shown enough performance to support both OSD journals and index pools on the same drive, but in different partitions of the NVMe drive.

An index entry is approximately 200 bytes of data, stored as an object map (omap) in **leveldb**. While this is a trivial amount of data, some uses of Ceph Object Gateway can result in tens or hundreds of millions of objects in a single bucket. By mapping the index pool to a CRUSH hierarchy of high performance storage media, the reduced latency provides a dramatic performance improvement when buckets contain very large numbers of objects.

IMPORTANT

In a production cluster, a typical OSD node will have at least one SSD or NVMe drive for storing the OSD journal and the index pool, which will use separate partitions or logical volumes when using the same physical drive.

3.7. SELECTING MEDIA FOR MONITOR NODES

Ceph monitors use **leveldb**, which is sensitive to synchronous write latency. Red Hat strongly recommends using SSDs to store monitor data. Ensure that the selected SSDs have sufficient sequential write and throughput characteristics.

CHAPTER 4. CONFIGURING A CLUSTER

The initial configuring of a production cluster is identical to configuring a proof-of-concept system. The only material difference is that the initial deployment will use production-grade hardware. First, follow the Requirements for Installing Red Hat Ceph Storage chapter of the Red Hat Ceph Storage 3 Installation Guide for Red Hat Enterprise Linux and execute the appropriate steps for each node. The following sections provide additional guidance relevant to production clusters.

4.1. NAMING HOSTS

When naming hosts, consider their use case and performance profile. For example, if the hosts will store client data, consider naming them according to their hardware configuration and performance profile. For example:

- **data-ssd-1**, **data-ssd-2**
- **hot-storage-1**, **hot-storage-2**
- **sata-1**, **sata-2**
- **sas-ssd-1**, **sas-ssd-2**

The naming convention may make it easier to manage the cluster and troubleshoot hardware issues as they arise.

If the host contains hardware for multiple use cases—for example, the host contains SSDs for data, SAS drives with SSDs for journals, and SATA drives with co-located journals for cold storage—choose a generic name for the host. For example:

- **osd-node-1 osd-node-2**

Generic host names can be extended when using logical host names in the CRUSH hierarchy as needed. For example:

- **osd-node-1-ssd osd-node-1-sata osd-node-1-sas-ssd osd-node-1-bucket-index**
- **osd-node-2-ssd osd-node-2-sata osd-node-2-sas-ssd osd-node-2-bucket-index**

See Using Logical Host Names in a CRUSH Map for additional details.

4.2. TUNING THE KERNEL

Production clusters benefit from tuning the operating system, specifically limits and memory allocation. Ensure that adjustments are set for all nodes within the cluster. Consult Red Hat support for additional guidance.

4.2.1. Reserving Free Memory for OSDs

To help prevent insufficient memory-related errors during OSD memory allocation requests, set the **vm.min_free_kbytes** option in the **sysctl.conf** file on OSD nodes. This option specifies the amount of physical memory to keep in reserve. The recommended settings are based on the amount of system RAM. For example:

- For 64GB RAM, reserve 1GB.

```
vm.min_free_kbytes = 1048576
```

- For 128GB RAM, reserve 2GB.

```
vm.min_free_kbytes = 2097152
```

- For 256GB RAM, reserve 3GB.

```
vm.min_free_kbytes = 3145728
```

4.2.2. Increasing File Descriptors

The Ceph Object Gateway may hang if it runs out of file descriptors. Modify **/etc/security/limits.conf** on Ceph Object Gateway nodes to increase the file descriptors for the Ceph Object Gateway. For example:

```
ceph       soft    nproc     unlimited
```

4.2.3. Adjusting **ulimit** on Large Clusters

For system administrators that will run Ceph administrator commands on large clusters—for example, 1024 OSDs or more—create an **/etc/security/limits.d/50-ceph.conf** file on each node that will run administrator commands with the following contents:

```
<username>       soft    nproc     unlimited
```

Replace **<username>** with the name of the non-root account that will run Ceph administrator commands.

NOTE

The root user's ulimit is already set to "unlimited" by default on RHEL.

4.3. CONFIGURING ANSIBLE GROUPS

This procedure is only pertinent for deploying Ceph using Ansible. The **ceph-ansible** package is already configured with a default **osds** group. If the cluster will only have one use case and storage policy, proceed with the procedure documented in the Installing a Red Hat Ceph Storage Cluster section of the Red Hat Ceph Storage 3 Installation Guide for Red Hat Enterprise Linux. If the cluster will support multiple use cases and storage policies, create a group for each one. Each use case should copy **/usr/share/ceph-ansible/group_vars/osd.sample** to a file named for the group name. For example, if the cluster has IOPS-optimized, throughput-optimized and capacity-optimized use cases, create separate files representing the groups for each use case. For example:

```
cd /usr/share/ceph-ansible/group_vars/
cp osds.sample osds-iops
cp osds.sample osds-throughput
cp osds.sample osds-capacity
```

Then, configure each file according to the use case.

Once the group variable files are configured, edit the **site.yml** file to ensure that it includes each new group. For example:

```
- hosts: osds-iops
  gather_facts: false
  become: True
  roles:
  - ceph-osd

- hosts: osds-throughput
  gather_facts: false
  become: True
  roles:
  - ceph-osd

- hosts: osds-capacity
  gather_facts: false
  become: True
  roles:
  - ceph-osd
```

Finally, in the **/etc/ansible/hosts** file, place the OSD nodes associated to a group under the corresponding group name. For example:

```
[osds-iops]
<ceph-host-name> devices="[ '<device_1>', '<device_2>' ]"

[osds-throughput]
<ceph-host-name> devices="[ '<device_1>', '<device_2>' ]"

[osds-capacity]
<ceph-host-name> devices="[ '<device_1>', '<device_2>' ]"
```

4.4. CONFIGURING CEPH

Generally, administrators should configure the Red Hat Ceph Storage cluster before the initial deployment using the Ceph Ansible configuration files found in the **/usr/share/ceph-ansible/group_vars** directory.

As indicated in the Installing a Red Hat Ceph Storage Cluster section of the Red Hat Ceph Storage installation guide:

- For Monitors, create a **mons.yml** file from the **sample.mons.yml** file.
- For OSDs, create an **osds.yml** file from the **sample.osds.yml** file.
- For the cluster, create an **all.yml** file from the **sample.all.yml** file.

Modify the settings as directed in the Installation Guide.

Also refer to Installing the Ceph Object Gateway , and create an **rgws.yml** file from **sample.rgws.yml**.

NOTE

The settings in the foregoing files may take precedence over settings in **ceph_conf_overrides**.

To configure settings with no corresponding values in the **mons.yml**, **osds.yml**, or **rgws.yml** file, add configuration settings to the **ceph_conf_overrides** section of the **all.yml** file. For example:

```
ceph_conf_overrides:
  global:
    osd_pool_default_pg_num: <number>
```

See the Configuration File Structure for details on configuration file sections.

IMPORTANT

There are syntactic differences between specifying a Ceph configuration setting in an Ansible configuration file and how it renders in the Ceph configuration file.

In RHCS version 3.1 and earlier, the Ceph configuration file uses **ini** style notion. Sections like **[global]** in the Ceph configuration file should be specified as **global:**, indented on their own lines. It is also possible to specify configuration sections for specific daemon instances. For example, placing **osd.1:** in the **ceph_conf_overrides** section of the **all.yml** file will render as **[osd.1]** in the Ceph configuration file and the settings under that section will apply to **osd.1** only.

Ceph configuration settings SHOULD contain dashes (**-**) or underscores (_) rather than spaces, and should terminate with a colon (**:**), not an equal sign (**=**).

Before deploying the Ceph cluster, consider the following configuration settings. When setting Ceph configuration settings, Red Hat recommends setting the values in the **ceph-ansible** configuration files, which will generate a Ceph configuration file automatically.

4.4.1. Setting the Journal Size

Set the journal size for the Ceph cluster. Configuration tools such as Ansible may have a default value. Generally, the journal size should find the product of the synchronization interval and the slower of the disk and network throughput, and multiply the product by two (2).

For details, see the Journal Settings section in the Configuration Guide for Red Hat Ceph Storage 3.

4.4.2. Adjusting Backfill & Recovery Settings

I/O is negatively impacted by both backfilling and recovery operations, leading to poor performance and unhappy end users. To help accommodate I/O demand during a cluster expansion or recovery, set the following options and values in the Ceph Configuration file:

```
[osd]
osd_max_backfills = 1
osd_recovery_max_active = 1
osd_recovery_op_priority = 1
```

4.4.3. Adjusting the Cluster Map Size

For Red Hat Ceph Storage version 2 and earlier, when the cluster has thousands of OSDs, download the cluster map and check its file size. By default, the **ceph-osd** daemon caches 500 previous osdmaps. Even with deduplication, the map may consume a lot of memory per daemon. Tuning the cache size in the Ceph configuration file may help reduce memory consumption significantly. For example:

```
[global]
osd_map_message_max=10

[osd]
osd_map_cache_size=20
osd_map_max_advance=10
osd_map_share_max_epochs=10
osd_pg_epoch_persisted_max_stale=10
```

For Red Hat Ceph Storage version 3 and later, the **ceph-manager** daemon handles PG queries, so the cluster map should not impact performance.

4.4.4. Adjusting Scrubbing

By default, Ceph performs light scrubbing daily and deep scrubbing weekly. Light scrubbing checks object sizes and checksums to ensure that PGs are storing the same object data. Over time, disk sectors can go bad irrespective of object sizes and checksums. Deep scrubbing checks an object's content with that of its replicas to ensure that the actual contents are the same. In this respect, deep scrubbing ensures data integrity in the manner of **fsck**, but the procedure imposes an I/O penalty on the cluster. Even light scrubbing can impact I/O.

The default settings may allow Ceph OSDs to initiate scrubbing at inopportune times such as peak operating times or periods with heavy loads. End users may experience latency and poor performance when scrubbing operations conflict with end user operations.

To prevent end users from experiencing poor performance, Ceph provides a number of scrubbing settings that can limit scrubbing to periods with lower loads or during off-peak hours. For details, see the Scrubbing section in the Configuration Guide for Red Hat Ceph Storage 3.

If the cluster experiences high loads during the day and low loads late at night, consider restricting scrubbing to night time hours. For example:

```
[osd]
osd_scrub_begin_hour = 23   #23:01H, or 10:01PM.
osd_scrub_end_hour = 6      #06:01H or 6:01AM.
```

If time constraints aren't an effective method of determining a scrubbing schedule, consider using the **osd_scrub_load_threshold**. The default value is **0.5**, but it could be modified for low load conditions. For example:

```
[osd]
osd_scrub_load_threshold = 0.25
```

4.4.5. Increase objecter_inflight_ops

In RHCS 3.0 and earlier releases, consider increasing **objecter_inflight_ops** to the default size for version 3.1 and later releases to improve scalability.

```
objecter_inflight_ops = 24576
```

4.4.6. Increase rgw_thread_pool_size

In RHCS 3.0 and earlier releases, consider increasing **rgw_thread_pool_size** to the default size for version 3.1 and later releases to improve scalability. For example:

```
rgw_thread_pool_size = 512
```

4.4.7. Set the filestore_merge_threshold

In RHCS 3.0 and earlier releases, consider increasing **filestore_merge_threshold** to the default size for version 3.1 and later releases to improve scalability. For example:

```
filestore_merge_threshold = -10
```

4.4.8. Adjusting Garbage Collection Settings

The Ceph Object Gateway allocates storage for new and overwritten objects immediately. Additionally, the parts of a multi-part upload also consume storage.

The Ceph Object Gateway purges the storage space used for deleted objects in the Ceph Storage cluster some time after the gateway deletes the objects from the bucket index. Similarly, the gateway will delete data associated with a multi-part upload after the multi-part upload completes or when the upload has gone inactive or failed to complete for a configurable time frame. The process of purging the deleted object data from the Ceph Storage cluster is known as Garbage Collection or GC.

To view the queue of objects awaiting garbage collection, execute the following:

```
# radosgw-admin gc list
```

Garbage collection is a background activity that may execute continuously or during times of low loads, depending upon how the administrator configures the Ceph Object Gateway. By default, the Ceph Object Gateway conducts GC operations continuously. Since GC operations are a normal part of Ceph Object Gateway operations, especially with object delete operations, objects eligible for garbage collection exist most of the time.

Some workloads may temporarily or permanently outpace the rate of garbage collection activity. This is especially true of delete-heavy workloads, where many objects get stored for a short period of time and then deleted. For these types of workloads, administrators can increase the priority of garbage collection operations relative to other operations with the following configuration parameters.

The **rgw_gc_obj_min_wait** configuration setting waits a minimum length of time (in seconds) before purging a deleted object's data. By default, it is set to two hours. Under delete heavy workloads, this setting may consume too much storage or leave a large number of deleted objects to purge. To address such a situation, consider decreasing this setting to a shorter time interval.

The **rgw_gc_processor_period** configuration setting is the GC cycle run time. That is, the amount of time between the start of consecutive runs of GC threads. If GC runs takes more than this period, the Ceph Object Gateway will not wait before running a GC cycle again.

The **rgw_gc_max_concurrent_io** configuration setting specifies the maximum number of concurrent IO operations that the gateway garbage collection thread will use when purging deleted data. Under delete heavy workloads, consider increasing this setting to a larger number of concurrent IO operations.

The **rgw_gc_max_trim_chunk** configuration setting specifies the maximum number of keys to remove from the garbage collector log in a single operation. Under delete heavy operations, consider increasing the maximum number of keys so that more objects are purged during each GC operation.

NOTE

These garbage collection configuration parameters are for Red Hat Ceph Storage 3.3 and higher.

NOTE

In testing, during an evenly balanced delete-write workload, such as 50% delete and 50% write operations, the cluster fills completely in eleven hours. This is because Ceph Object Gateway garbage collection fails to keep pace with the delete operations. The cluster status switches to the **HEALTH_ERR** state if this happens. Aggressive settings for parallel garbage collection tunables significantly delayed the onset of cluster fill in testing and can be helpful for many workloads. Typical real-world cluster workloads are not likely to cause a cluster fill primarily due to garbage collection.

Administrators may also modify Ceph configuration settings at runtime after deployment. See Setting a Specific Configuration Setting at Runtime for details.

CHAPTER 5. DEPLOYING CEPH

Once the pre-requisites and initial tuning are complete, consider deploying a Ceph cluster. When deploying a production cluster, Red Hat recommends setting up the initial monitor cluster and enough OSD nodes to reach an **active + clean** state. For details, see the Installing a Red Hat Ceph Storage Cluster section in the Red Hat Ceph Storage 3 Installation Guide for Red Hat Enterprise Linux.

Then, install the Ceph CLI client on an administration node. For details, see the Installing the Ceph Command Line Interface section in the Red Hat Ceph Storage 3 Installation Guide for Red Hat Enterprise Linux.

Once the initial cluster is running, consider adding the settings in the following sections to the Ceph configuration file.

CHAPTER 6. EXPANDING THE CLUSTER

Once the initial cluster is running and in an **active+clean** state, add additional OSD nodes and Ceph Object Gateway nodes to the cluster. Apply the steps detailed in Tuning the Kernel to each node. See the Adding and Removing OSD Nodes section in the Red Hat Ceph Storage 3 Administration Guide for details on adding nodes.

For each OSD node added to the cluster, add OSDs to the cluster for each drive in the node that will store client data. See the Adding an OSD section in the Red Hat Ceph Storage 3 Administration Guide for additional details. When using Ansible to add OSD nodes, see Configuring Ansible Groups, and add the OSD nodes to the appropriate group if the cluster will support multiple use cases.

For each Ceph Object Gateway node, install a gateway instance. For details, see the Installing the Ceph Object Gateway section in the Red Hat Ceph Storage 3 Installation Guide for Red Hat Enterprise Linux.

Once the cluster returns to an **active+clean** state, remove any overrides and proceed with Developing Storage Strategies.

NOTE

Step 3 of **Adding a Node** and Step 10 of **Adding an OSD With the Command Line Interface** will be revisited in topics beginning with Developing CRUSH Hierarchies.

CHAPTER 7. DEVELOPING STORAGE STRATEGIES

One of the more challenging aspects of setting up Ceph Storage clusters and Ceph Object Gateways for production use is defining effective storage strategies. Storage strategies involve the following factors:

- Considering Object Count
- Developing CRUSH Hierarchies
- Creating CRUSH Roots
- Using Logical Host Names in a CRUSH Map
- Creating CRUSH Rules
- Creating the Root Pool
- Creating a Realm
- Creating Service Pools
- Creating Data Placement Strategies

See the Red Hat Ceph Storage 3 Storage Strategies guide for general guidance on storage strategies and command-line usage.

7.1. CONSIDERING EXPECTED OBJECT COUNT

Starting with Red Hat Ceph Storage 3.1 and later, an additional argument was added to the **ceph osd pool create** command. The new argument sets the expected number of objects for the storage pool, and this argument only works when creating a storage pool using **FileStore**. Setting the expected number of objects applies only to storage pools where you anticipate large object counts. By setting the expected number of objects during pool creation, the placement group folder splitting happens immediately and not at runtime.

NOTE

While this behavior can affect all Ceph use cases, the impact to the Object Gateway use case will be more significant, because Object Gateway is likely going to have storage pools containing many objects, that is the **default.rgw.buckets.data** storage pool.

Setting the **[expected-num-objects]** value will improve runtime performance. Here's why:

- The **FileStore** stores objects as files in an **xfs** filesystem. **FileStore** stores these object files in directories. As object counts increase or decrease, **FileStore** may split or merge directories to keep object count in a directory within a reasonable range. The advanced **filestore_merge_threshold**, **filestore_split_multiple** and **filestore_split_rand_factor** configuration settings govern this behavior.

- The splitting and merging behavior in **FileStore** has performance implications, because **FileStore** has to move objects from one directory to another during splitting or merging operations. To avoid this performance penalty in Red Hat Ceph Storage 3.1 and later releases when using **FileStore**, it is important for storage administrators to estimate the expected object count for a pool BEFORE creating the pool.

- Gateway clients store and retrieve gateway objects, which will be stored as one or more Ceph storage cluster objects. That is, a client object may invoke the storage of one or more Ceph storage cluster objects due to object striping. For example, if a client stores a 40 MB video object, the Ceph Object Gateway will stripe the video object into a series of 10 4 MB objects and store them on different OSDs across the cluster. Striping provides some performance improvement via parallelism. The advanced **rgw_obj_stripe_size** configuration setting governs the stripe size, and CANNOT be changed after creating the pool.

To estimate what the expected object count might be, you will base it on the storage capacity of the Red Hat Ceph Storage cluster. There are three approximate sizes based on storage capacity:

- Small = 250 TB
- Medium = 1 PB
- Large = 2 PB+

See the Red Hat Ceph Storage Hardware Selection Guide for more information.

Assuming an OSD disk size of 4 TB, these sizes provide the number of OSDs, as follows:

- Small = 250 TB = 63 OSDs
- Medium = 1 PB = 256 OSDs
- Large = 2 PB+ = 512 OSDs

Red Hat recommends using the following formula to determine the expected number of objects per storage pool:

1 M x *Number of OSDs*

For the three approximate sizes, the expected object count must be set to **63M**, **256M**, and **512M** respectively.

Another consideration, is that a bucket index entry is approximately 200 bytes of data, stored as an object map (omap) in leveldb. Since this is smaller than **rgw_obj_stripe_size**, the expected object count for the bucket index should be the same as the number of gateway objects the client stores and retrieves.

When creating pools, specify the expected number of objects and ensure **filestore_merge_threshold** is set to a negative number to ensure that placement group folder splitting occurs at pool creation time rather than at runtime.

IMPORTANT

While the storage pools are being created, the directory structures are being put into place. This will take some time and will consume the storage cluster's resources. If the expected object count is set too high, for example, 1 trillion, then OSD sucidie timeouts can occur.

7.2. DEVELOPING CRUSH HIERARCHIES

When deploying a Ceph cluster and an Object Gateway, typically the object gateway will have a default zone group and zone. The Ceph storage cluster will have default pools, which in turn will use a CRUSH map with a default CRUSH hierarchy and a default CRUSH rule.

IMPORTANT

The default **rbd** pool may use the default CRUSH rule. **DO NOT** delete the default rule or hierarchy if Ceph clients have used them to store client data.

For general details on CRUSH hierarchies, see the CRUSH Administration section of the Storage Strategies guide.

Production gateways typically use a custom realm, zone group and zone named according to the use and geographic location of the gateways. Additionally, the Ceph cluster will have a CRUSH map that has multiple CRUSH hierarchies.

- **Service Pools:** At least one CRUSH hierarchy will be for service pools and potentially for data. The service pools include **.rgw.root** and the service pools associated with the zone. Service pools typically fall under a single CRUSH hierarchy, and use replication for data durability. A data pool may also use the CRUSH hierarchy, but the pool will usually be configured with erasure coding for data durability.

- **Index:** At least one CRUSH hierarchy **SHOULD** be for the index pool, where the CRUSH hierarchy maps to high performance media such as SSD or NVMe drives. Bucket indices can be a performance bottleneck. It is strongly recommended to use SSD or NVMe drives in this CRUSH hierarchy. To economize, create partitions for indices on SSDs or NVMe drives used for OSD journals. Additionally, an index should be configured with bucket sharding. See Creating an Index Pool and supporting links for details.

- **Placement Pools:** The placement pools for each placement target include the bucket index, the data bucket and the bucket extras. These pools may fall under separate CRUSH hierarchies. Since Ceph Object Gateway can support multiple storage policies, the bucket pools of the storage policies may be associated with different CRUSH hierarchies, reflecting different use cases such as IOPS-optimized, throughput-optimized, and capacity-optimized respectively. The bucket index pool **SHOULD** use its own CRUSH hierarchy to map the bucket index pool to higher performance storage media such as SSD or NVMe drives.

7.2.1. Creating CRUSH Roots

From the command line on the administration node, create CRUSH roots in the CRUSH map for each CRUSH hierarchy. There **MUST** be at least one CRUSH hierarchy for service pools that may also potentially serve data storage pools. There **SHOULD** be at least one CRUSH hierarchy for the bucket index pool, mapped to high performance storage media such as SSDs or NVMe drives.

For details on CRUSH hierarchies, see {storage-strategies-guid}#crush_hierarchies[CRUSH Hierarchies] section in the Storage Strategies Guide for Red Hat Ceph Storage 3.

To manually edit a CRUSH map, see Editing a CRUSH Map section in the Storage Strategies Guide for Red Hat Ceph Storage 3.

In the following examples, the hosts named **data0**, **data1** and **data2** use extended logical names such as **data0-sas-ssd**, **data0-index** and so forth in the CRUSH map, because there are multiple CRUSH hierarchies pointing to the same physical hosts.

A typical CRUSH root might represent nodes with SAS drives and SSDs for journals. For example:

```
##
# SAS-SSD ROOT DECLARATION
##
```

```
root sas-ssd {
  id -1   # do not change unnecessarily
  # weight 0.000
  alg straw
  hash 0  # rjenkins1
  item data2-sas-ssd weight 4.000
  item data1-sas-ssd weight 4.000
  item data0-sas-ssd weight 4.000
}
```

A CRUSH root for bucket indexes **SHOULD** represent high performance media such as SSD or NVMe drives. Consider creating partitions on SSD or NVMe media that store OSD journals. For example:

```
##
# INDEX ROOT DECLARATION
##

root index {
  id -2    # do not change unnecessarily
  # weight 0.000
  alg straw
  hash 0  # rjenkins1
  item data2-index weight 1.000
  item data1-index weight 1.000
  item data0-index weight 1.000
}
```

7.2.2. Using Logical Host Names in a CRUSH Map

In RHCS 3 and later releases, CRUSH supports the notion of a storage device "class," which is not supported in RHCS 2 and earlier releases. In RHCS 3 clusters with hosts or nodes that contain multiple classes of storage device, such as NVMe, SSD or HDD, use a single CRUSH hierarchy with device classes to distinguish different classes of storage device. This eliminates the need to use logical host names. In RHCS 2 and earlier releases, use multiple CRUSH hierarchies, one for each class of device, and logical host names to distinguish the hosts or nodes in the CRUSH hierarchy.

In the CRUSH map, host names must be unique and used only once. When the host serves multiple CRUSH hierarchies and use cases, a CRUSH map may use logical host names instead of the actual host name in order to ensure the host name is only used once. For example, a node may have multiple classes of drives such as SSDs, SAS drives with SSD journals, and SATA drives with co-located journals. To create multiple CRUSH hierarchies for the same host in RHCS 2 and earlier releases, the hierarchies will need to use logical host names in lieu of the actual host names so the bucket names are unique within the CRUSH hierarchy. For example, if the host name is **data2**, the CRUSH hierarchy might use logical names such as **data2-sas-ssd** and **data2-index**. For example:

```
host data2-sas-ssd {
  id -11   # do not change unnecessarily
  # weight 0.000
  alg straw
  hash 0  # rjenkins1
  item osd.0 weight 1.000
  item osd.1 weight 1.000
  item osd.2 weight 1.000
  item osd.3 weight 1.000
}
```

In the foregoing example, the host **data2** uses the logical name **data2-sas-ssd** to map the SAS drives with journals on SSDs into one hierarchy. The OSD IDs **osd.0** through **osd.3** in the forgoing example represent SAS drives using SSD journals in a high throughput hardware configuration. These OSD IDs differ from the OSD ID in the following example.

In the following example, the host **data2** uses the logical name **data2-index** to map the SSD drive for a bucket index into a second hierarchy. The OSD ID **osd.4** in the following example represents an SSD drive or other high speed storage media used exclusively for a bucket index pool.

```
host data2-index {
  id -21   # do not change unnecessarily
  # weight 0.000
  alg straw
  hash 0  # rjenkins1
  item osd.4 weight 1.000
}
```

IMPORTANT

When using logical host names, ensure that one of the following settings is present in the Ceph configuration file to prevent the OSD startup scripts from using the actual host names upon startup and thereby failing to locate data in CRUSH map.

When the CRUSH map uses logical host names, as in the foregoing examples, prevent the OSD startup scripts from identifying the hosts according to their actual host names at initialization. In the **[global]** section of the Ceph configuration file, add the following setting:

```
osd_crush_update_on_start = false
```

An alternative method of defining a logical host name is to define the location of the CRUSH map for each OSD in the **[osd.<ID>]** sections of the Ceph configuration file. This will override any locations the OSD startup script defines. From the foregoing examples, the entries might look like the following:

```
[osd.0]
osd crush location = "host=data2-sas-ssd"

[osd.1]
osd crush location = "host=data2-sas-ssd"

[osd.2]
osd crush location = "host=data2-sas-ssd"

[osd.3]
osd crush location = "host=data2-sas-ssd"

[osd.4]
osd crush location = "host=data2-index"
```

IMPORTANT

If one of the foregoing approaches isn't used when a CRUSH map uses logical host names rather than actual host names, on restart, the Ceph Storage Cluster will assume that the OSDs map to the actual host names, and the actual host names will not be found in the CRUSH map, and Ceph Storage Cluster clients will not find the OSDs and their data.

7.2.3. Creating CRUSH Rules

Like the default CRUSH hierarchy, the CRUSH map also contains a default CRUSH rule.

NOTE

The default **rbd** pool may use this rule. DO NOT delete the default rule if other pools have used it to store customer data.

For general details on CRUSH rules, see the CRUSH Rules section in the Storage Strategies guide for Red Hat Ceph Storage 3. To manually edit a CRUSH map, see the Editing a CRUSH Map section in the Storage Strategies guide for Red Hat Ceph Storage 3.

For each CRUSH hierarchy, create a CRUSH rule. The following example illustrates a rule for the CRUSH hierarchy that will store the service pools, including **.rgw.root**. In this example, the root **sas-ssd** serves as the main CRUSH hierarchy. It uses the name **rgw-service** to distinguish itself from the default rule. The **step take sas-ssd** line tells the pool to use the **sas-ssd** root created in Creating CRUSH Roots, whose child buckets contain OSDs with SAS drives and high performance storage media such as SSD or NVMe drives for journals in a high throughput hardware configuration. The **type rack** portion of **step chooseleaf** is the failure domain. In the following example, it is a rack.

```
##
# SERVICE RULE DECLARATION
##

rule rgw-service {
 type replicated
 min_size 1
 max_size 10
 step take sas-ssd
 step chooseleaf firstn 0 type rack
 step emit
}
```

NOTE

In the foregoing example, if data gets replicated three times, there should be at least three racks in the cluster containing a similar number of OSD nodes.

TIP

The **type replicated** setting has NOTHING to do with data durability, the number of replicas or the erasure coding. Only **replicated** is supported.

The following example illustrates a rule for the CRUSH hierarchy that will store the data pool. In this example, the root **sas-ssd** serves as the main CRUSH hierarchy—the same CRUSH hierarchy as the service rule. It uses **rgw-throughput** to distinguish itself from the default rule and **rgw-service**. The **step take sas-ssd** line tells the pool to use the **sas-ssd** root created in Creating CRUSH Roots, whose child buckets contain OSDs with SAS drives and high performance storage media such as SSD or NVMe drives in a high throughput hardware configuration. The **type host** portion of **step chooseleaf** is the failure domain. In the following example, it is a host. Notice that the rule uses the same CRUSH hierarchy, but a different failure domain.

```
##
# THROUGHPUT RULE DECLARATION
##

rule rgw-throughput {
 type replicated
 min_size 1
 max_size 10
 step take sas-ssd
 step chooseleaf firstn 0 type host
 step emit
}
```

NOTE

In the foregoing example, if the pool uses erasure coding with a larger number of data and encoding chunks than the default, there should be at least as many racks in the cluster containing a similar number of OSD nodes to facilitate the erasure coding chunks. For smaller clusters, this may not be practical, so the foregoing example uses **host** as the CRUSH failure domain.

The following example illustrates a rule for the CRUSH hierarchy that will store the index pool. In this example, the root **index** serves as the main CRUSH hierarchy. It uses **rgw-index** to distinguish itself from **rgw-service** and **rgw-throughput**. The **step take index** line tells the pool to use the **index** root created in Creating CRUSH Roots, whose child buckets contain high performance storage media such as SSD or NVMe drives or partitions on SSD or NVMe drives that also store OSD journals. The **type rack** portion of **step chooseleaf** is the failure domain. In the following example, it is a rack.

```
##
# INDEX RULE DECLARATION
##

rule rgw-index {
 type replicated
 min_size 1
 max_size 10
 step take index
 step chooseleaf firstn 0 type rack
 step emit
}
```

7.3. CREATING THE ROOT POOL

The Ceph Object Gateway configuration gets stored in a pool named **.rgw.root**, including realms, zone groups and zones. By convention, its name is not prepended with the zone name.

.rgw.root

If the Ceph Storage Cluster is running, create an **.rgw.root** pool using the new rule. See the Ceph Placement Groups (PGs) per Pool Calculator and the Placement Groups chapter in the Storage Strategies Guide for details on the number of PGs. See the Create a Pool section in the Storage Strategies Guide for details on creating a pool.

In this instance, the pool will use **replicated** and **NOT erasure** for data durability. For example:

```
# ceph osd pool create .rgw.root 32 32 replicated sas-ssd
```

NOTE

For service pools, including **.rgw.root**, the suggested PG count from the Ceph Placement Groups (PGs) per Pool Calculator is substantially less than the target PGs per OSD. Also, ensure the number of OSDs is set in step 3 of the calculator.

Once this pool gets created, the Ceph Object Gateway can store its configuration data in the pool.

7.4. CREATING A REALM

The Ceph Storage pools supporting the Ceph Object Gateway apply to a zone within a zone group. By default, Ceph Object Gateway will define a default zone group and zone.

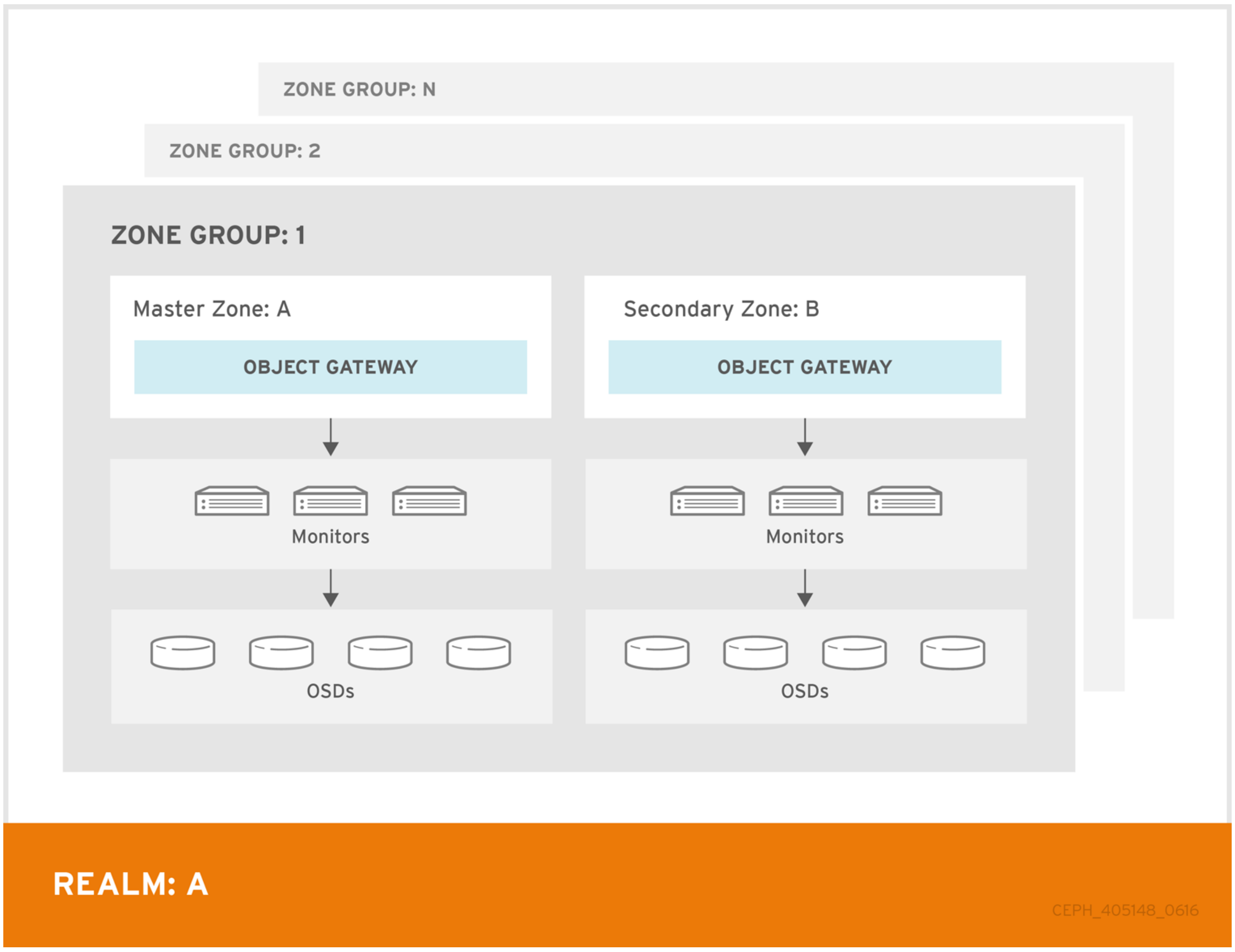
For the master zone group and zone, Red Hat recommends creating a new realm, zone group and zone. Then, delete the default zone and its pools if they were already generated. Use Configuring a Master Zone as a best practice, because this configures the cluster for Multi Site operation.

1. Create a realm. See Realms for additional details.
2. Create a master zone group. See Zone Groups for additional details on zone groups.
3. Create a master zone. See Zones for additional details on zones.
4. Delete the default zone group and zone. You **MAY** delete default pools if they were created, and are not storing client data. **DO NOT** delete the **.rgw.root** pool.
5. Create a System User.
6. Update the period.
7. Update the Ceph Configuration file.

NOTE

This procedure omits the step of starting the gateway, since the gateway may create the pools manually. To specify specific CRUSH rules and data durability methods, create the pools manually.

By setting up a new realm, zone group and zone, the cluster is now prepared for expansion to a multi site cluster where there are multiple zones within the zone group. This means that the cluster can be expanded and configured for failover, and disaster recovery. See Expanding the Cluster with Multi Site for additional details.



In Red Hat Ceph Storage 2, multi site configurations are active-active by default. When deploying a multi site cluster, the zones and their underlying Ceph storage clusters may be in different geographic regions. Since each zone has a deep copy of each object in the same namespace, users can access the copy from the zone that is physically the closest to them, reducing latency. However, the cluster may be configured in active-passive mode if the secondary zones are intended only for failover and disaster recovery.

NOTE

Using a zone group with multiple zones is supported. Using multiple zone groups is a technology preview only, and is not supported in production.

7.5. CREATING SERVICE POOLS

The Ceph Object Gateway uses many pools for various service functions, and a separate set of placement pools for storing bucket indexes, data and other information.

Since it is computationally expensive to peer a pool’s placement groups, Red Hat generally recommends that the Ceph Object Gateway’s service pools use substantially fewer placement groups than data storage pools.

The service pools store objects related to service control, garbage collection, logging, user information, usage, etc. By convention, these pool names have the zone name prepended to the pool name.

- **.<zone-name>.rgw.control**: The control pool.

- **.<zone-name>.rgw.gc**: The garbage collection pool, which contains hash buckets of objects to be deleted.
- **.<zone-name>.log**: The log pool contains logs of all bucket/container and object actions such as create, read, update and delete.
- **.<zone-name>.intent-log**: The intent log pool contains a copy of an object update request to facilitate undo/redo if a request fails.
- **.<zone-name>.users.uid**: The user ID pool contains a map of unique user IDs.
- **.<zone-name>.users.keys**: The keys pool contains access keys and secret keys for each user ID.
- **.<zone-name>.users.email**: The email pool contains email addresses associated to a user ID.
- **.<zone-name>.users.swift**: The Swift pool contains the Swift subuser information for a user ID.
- **.<zone-name>.usage**: The usage pool contains a usage log on a per user basis.

Execute the Get a Zone procedure to see the pool names.

```
# radosgw-admin zone get [--rgw-zone=<zone>]
```

When **radosgw-admin** creates a zone, the pool names **SHOULD** be prepended with the zone name. For example, a zone named **us-west SHOULD** have pool names that look something like this:

```
{ "domain_root": ".rgw.root",
  "control_pool": ".us-west.rgw.control",
  "gc_pool": ".us-west.rgw.gc",
  "log_pool": ".us-west.log",
  "intent_log_pool": ".us-west.intent-log",
  "usage_log_pool": ".us-west.usage",
  "user_keys_pool": ".us-west.users.keys",
  "user_email_pool": ".us-west.users.email",
  "user_swift_pool": ".us-west.users.swift",
  "user_uid_pool": ".us-west.users.uid",
  "system_key": { "access_key": "", "secret_key": ""},
  "placement_pools": [
    {  "key": "default-placement",
       "val": { "index_pool": ".us-west.rgw.buckets.index",
                "data_pool": ".us-west.rgw.buckets",
                "data_extra_pool": ".us-west.rgw.buckets.non-ec"
                "index_type": 0
              }
    }
  ]
}
```

Beginning with **control_pool** and ending with **user_uid_pool**, create the pools using the pool names in the zone, provided the zone name is prepended to the pool name. Following the previous examples, pool creation might look something like this:

```
# ceph osd pool create .us-west.rgw.control 32 32 replicated rgw-service
...
# ceph osd pool create .us-west.users.uid 32 32 replicated rgw-service
```

From previous examples, the **rgw-service** rule represents a CRUSH hierarchy of SAS drives with SSD journals and **rack** as the CRUSH failure domain. See Creating CRUSH Roots, and Creating CRUSH Rules for preceding examples.

See the Ceph Placement Groups (PGs) per Pool Calculator and the Placement Groups chapter in the Storage Strategies guide for details on the number of PGs. See the Create a Pool section in the Storage Strategies guide for details on creating a pool.

NOTE

For service pools the suggested PG count from the calculator is substantially less than the target PGs per OSD. Ensure that step 3 of the calculator specifies the correct number of OSDs.

Generally, the **.rgw.root** pool and the service pools should use the same CRUSH hierarchy and use at least **node** as the failure domain in the CRUSH rule. Like the **.rgw.root** pool, the service pools should use **replicated** for data durability, **NOT erasure**.

7.6. CREATING DATA PLACEMENT STRATEGIES

The Ceph Object Gateway has a default storage policy called **default-placement**. If the cluster has only one storage policy, the **default-placement** policy will suffice. This default placement policy is referenced from the zone group configuration and defined in the zone configuration.

See Storage Policies section in the Red Hat Ceph Storage 3 Ceph Object Gateway Guide for Red Hat Enterprise Linux for additional details.

For clusters that support multiple use cases, such as IOPS-optimized, throughput-optimized or capacity-optimized, a set of placement targets in the zone group configuration and a set of placement pools in the zone configuration represent each storage policy.

The examples in the following sections illustrate how to create a storage policy and make it the default policy. This example also assumes the default policy will use a throughput-optimized hardware profile. Topics include:

- Creating an Index Pool
- Creating a Data Pool
- Creating a Data Extra Pool
- Configuring Placement Targets in a Zone Group
- Configuring Placement Pools in a Zone
- Data Placement Summary

7.6.1. Creating an Index Pool

By default, Ceph Object Gateway maps a bucket’s objects to an index, which enables a gateway client to request a list of objects in a bucket among other things. While common use cases may involve quotas where users have a bucket and a limited number of objects per bucket, buckets can store innumerable objects. When buckets store millions of objects or more, index performance benefits substantially from using high performance storage media such as SSD or NVMe drives to store its data. Additionally, bucket sharding also dramatically improves performance.

See the Ceph Placement Groups (PGs) per Pool Calculator and the Placement Groups chapter in the Storage Strategies guide for details on the number of PGs. See the Create a Pool section in the Storage Strategies guide for details on creating a pool.

NOTE

The PG per Pool Calculator recommends a smaller number of PGs per pool for the index pool; however, the PG count is approximately twice the number of PGs as the service pools.

To create an index pool, execute **ceph osd pool create** with the pool name, the number of PGs and PGPs, the **replicated** data durability method, and the name of the rule. For RHCS 3.1 and later releases using **FileStore**, refer to Considering Expected Object Count and consider specifying an expected number of objects for the pool. For example:

```
# ceph osd pool create .us-west.rgw.buckets.index 64 64 replicated rgw-index [expected-num-objects]
```

For Red Hat Ceph Storage 3.1 and later releases using **FileStore**, replace **[expected-num-objects]** with the expected number of objects. The **rgw-index** rule represents a CRUSH hierarchy of high performance SSD or NVMe drives or partitions and **rack** as the CRUSH failure domain. See Selecting Media for Indexes, Creating CRUSH Roots, and Creating CRUSH Rules for additional examples.

IMPORTANT

If buckets will store more than 100k objects, configure bucket sharding to ensure that index performance doesn't degrade as the number of objects in the bucket increases. See the Configuring Bucket Sharding section in the Ceph Object Gateway Guide for Red Hat Enterprise Linux. Also see the Bucket Index Resharding section in the Ceph Object Gateway Guide for Red Hat Enterprise Linux for details on resharding a bucket if the original configuration is no longer suitable.

7.6.2. Creating a Data Pool

The data pool is where Ceph Object Gateway stores the object data for a particular storage policy. The data pool should have a full complement of PGs, not the reduced number of PGs for service pools. The data pool **SHOULD** consider using erasure coding, as it is substantially more efficient than replication and can significantly reduce the capacity requirements while maintaining data durability.

To use erasure coding, create an erasure code profile. See the Erasure Code Profiles section in the Storage Strategies Guide for more details.

IMPORTANT

Choosing the correct profile is important because you cannot change the profile after you create the pool. To modify a profile, you must create a new pool with a different profile and migrate the objects from the old pool to the new pool.

The default configuration is two data chunks and one encoding chunk, which means only one OSD can be lost. For higher resiliency, consider a larger number of data and encoding chunks. For example, some large very scale systems use 8 data chunks and 3 encoding chunks, which allows three OSDs to fail without losing data.

IMPORTANT

Each data and encoding chunk SHOULD get stored on a different node or host at a minimum. For smaller clusters, this makes using **rack** impractical as the minimum CRUSH failure domain when using a larger number of data and encoding chunks. Consequently, it is common for the data pool to use a separate CRUSH hierarchy with **host** as the minimum CRUSH failure domain. Red Hat recommends **host** as the minimum failure domain. If erasure code chunks get stored on OSDs within the same host, a host failure such as a failed journal or network card could lead to data loss.

To create a data pool, execute **ceph osd pool create** with the pool name, the number of PGs and PGPs, the **erasure** data durability method, the erasure code profile and the name of the rule. For RHCS 3.1 and later releases using **FileStore**, refer to Considering Expected Object Count and consider specifying an expected number of objects for the pool. For example:

```
# ceph osd pool create .us-west.rgw.buckets.throughput 8192 8192 erasure 8k3m rgw-throughput
[expected-num-objects]
```

For RHCS 3.1 and later releases using **FileStore**, replace **[expected-num-objects]** with the expected number of objects. The **rgw-throughput** rule represents a CRUSH hierarchy of SAS drives with SSD journals and **host** as the CRUSH failure domain. See Creating CRUSH Roots, and Creating CRUSH Rules for preceding examples.

7.6.3. Creating a Data Extra Pool

The **data_extra_pool** is for data that cannot use erasure coding. For example, multi-part uploads allow uploading a large object such as a movie in multiple parts. These parts must first be stored without erasure coding. Erasure coding will apply to the whole object, not the partial uploads.

NOTE

The PG per Pool Calculator recommends a smaller number of PGs per pool for the **data_extra_pool**; however, the PG count is approximately twice the number of PGs as the service pools and the same as the bucket index pool.

To create a data extra pool, execute **ceph osd pool create** with the pool name, the number of PGs and PGPs, the **replicated** data durability method, and the name of the rule. For example:

```
# ceph osd pool create .us-west.rgw.buckets.non-ec 64 64 replicated rgw-service
```

7.6.4. Configuring Placement Targets in a Zone Group

Once the pools are created, create the placement target in the zone group. To retrieve the zone group, execute the following to output the zone group configuration to a file called **zonegroup.json**:

```
# radosgw-admin zonegroup get [--rgw-zonegroup=<zonegroup>] > zonegroup.json
```

The file contents will look something like this:

```
{
  "id": "90b28698-e7c3-462c-a42d-4aa780d24eda",
  "name": "us",
  "api_name": "us",
  "is_master": "true",
  "endpoints": [
    "http:\/\/rgw1:80"
  ],
  "hostnames": [],
  "hostnames_s3website": [],
  "master_zone": "9248cab2-afe7-43d8-a661-a40bf316665e",
  "zones": [
      {
        "id": "9248cab2-afe7-43d8-a661-a40bf316665e",
        "name": "us-east",
        "endpoints": [
            "http:\/\/rgw1"
        ],
        "log_meta": "true",
        "log_data": "true",
        "bucket_index_max_shards": 0,
        "read_only": "false"
      },
      {
        "id": "d1024e59-7d28-49d1-8222-af101965a939",
        "name": "us-west",
        "endpoints": [
            "http:\/\/rgw2:80"
        ],
        "log_meta": "false",
        "log_data": "true",
        "bucket_index_max_shards": 0,
        "read_only": "false"
      }
  ],
  "placement_targets": [
      {
        "name": "default-placement",
        "tags": []
      }
  ],
  "default_placement": "default-placement",
  "realm_id": "ae031368-8715-4e27-9a99-0c9468852cfe"
}
```

The **placement_targets** section will list each storage policy. By default, it will contain a placement target called **default-placement**. The default placement target is identified immediately after the **placement_targets** section.

Assuming a placement target called **throughput-optimized**, with **throughput-optimized** as the default target, the **placement_targets** section and the **default_placement** setting of the zone group configuration should be modified to something like this:

```
{
  ...
```

```
    "placement_targets": [
        {
          "name": "throughput-optimized",
          "tags": []
        }
    ],
    "default_placement": "throughput-optimized",
    ...
  }
```

Finally, set the zone group configuration with the settings from the modified **zonegroup.json** file; then, update the period. For example:

```
# radosgw-admin zonegroup set [--rgw-zonegroup=<zonegroup>] --infile zonegroup.json
# radosgw-admin period update --commit
```

7.6.5. Configuring Placement Pools in a Zone

Once the zone group has the new **throughput-optimized** placement target, map the placement pools for **throughput-optimized** in the zone configuration. This step will replace the mapping for **default-placement** to its associated pools with a **throughput-optimized** set of placement pools.

Execute the Get a Zone procedure to see the pool names.

```
# radosgw-admin zone get [--rgw-zone=<zone>] > zone.json
```

Assuming a zone named **us-west**, the file contents will look something like this:

```
{ "domain_root": ".rgw.root",
  "control_pool": ".us-west.rgw.control",
  "gc_pool": ".us-west.rgw.gc",
  "log_pool": ".us-west.log",
  "intent_log_pool": ".us-west.intent-log",
  "usage_log_pool": ".us-west.usage",
  "user_keys_pool": ".us-west.users.keys",
  "user_email_pool": ".us-west.users.email",
  "user_swift_pool": ".us-west.users.swift",
  "user_uid_pool": ".us-west.users.uid",
  "system_key": { "access_key": "", "secret_key": ""},
  "placement_pools": [
    {  "key": "default-placement",
       "val": { "index_pool": ".us-west.rgw.buckets.index",
                "data_pool": ".us-west.rgw.buckets",
                "data_extra_pool": ".us-west.rgw.buckets.non-ec"
                "index_type": 0
              }
    }
  ]
}
```

The **placement_pools** section of the zone configuration defines sets of placement pools. Each set of placement pools defines a storage policy. Modify the file to remove the **default-placement** entry, and replace it with a **throughput-optimized** entry with the pools created in the preceding steps. For example:

```
{
...
"placement_pools": [
    {  "key": "throughput-optimized",
       "val": { "index_pool": ".us-west.rgw.buckets.index",
                "data_pool": ".us-west.rgw.buckets.throughput"}
                "data_extra_pool": ".us-west.rgw.buckets.non-ec",
                "index_type": 0
    }
  ]
}
```

Finally, set the zone configuration with the settings from the modified **zone.json** file; then, update the period. For example:

```
# radosgw-admin zone set --rgw-zone={zone-name} --infile zone.json
# radosgw-admin period update --commit
```

NOTE

The **index_pool** points to the index pool and CRUSH hierarchy with SSDs or other high-performance storage, the **data_pool** points to a pool with a full complement of PGs, and a CRUSH hierarchy of high-throughput host bus adapters, SAS drives and SSDs for journals.

7.6.6. Data Placement Summary

When processing client requests, the Ceph Object Gateway will use the new **throughput-optimized** target as the default storage policy. Use this procedure to establish the same target in different zones and zone groups in a multi-site configuration, replacing the zone name for the pools as appropriate.

Use this procedure to establish additional storage policies. The naming for each target and set of placement pools is arbitrary. It could be **fast**, **streaming**, **cold-storage** or any other suitable name. However, each set must have a corresponding entry under **placement_targets** in the zone group, and one of the targets **MUST** be referenced in the **default_placement** setting; and, the zone must have a corresponding set of pools configured for each policy.

Client requests will always use the default target, unless the client request specifies **X-Storage-Policy** and a different target. See Create a Container for an object gateway client usage example.

CHAPTER 8. CONFIGURING GATEWAYS

The final steps in preparing the Ceph Object Gateway for production involve configuring Civetweb, firewall ports, the DNS and load balancers. Topics include:

- Configuring Civetweb
- Configuring Firewall Ports
- Configuring DNS Wildcards
- Configuring Load Balancers

8.1. CONFIGURING CIVETWEB

Depending on the choices made during installation of the Ceph Object Gateway, the Ceph configuration file will already have entries for each instance of the Ceph Object Gateway with additional modifications from the steps involved in Creating a Realm.

The most common configuration change from the default configuration is changing the default Ansible configured port of **8080** to another port such as **80**. See Changing the CivetWeb port.

There are additional settings particular to Civetweb. See Civetweb Configuration Options for details.

There are additional settings which may be overridden. See Object Gateway Configuration Reference for details.

NOTE

The section on Additional Use Cases will provide detailed configuration examples for using Ceph Object Gateway with third party components.

8.2. CONFIGURING FIREWALL PORTS

When changing the default port for Civetweb, ensure that the corresponding ports are open for client access. For details, see the Configuring the Firewall for Red Hat Ceph Storage section in the Red Hat Ceph Storage 3 Installation Guide for Red Hat Enterprise Linux.

8.3. CONFIGURING DNS WILDCARDS

S3-style subdomains incorporate the bucket name as a CNAME extension. Add a wildcard to the DNS to facilitate S3-style subdomains. For details, see the Adding a Wildcard to DNS section in the Red Hat Ceph Storage 3 Ceph Object Gateway Guide for Red Hat Enterprise Linux.

8.4. CONFIGURING LOAD BALANCERS

A zone will typically have multiple instances of a Ceph Object Gateway to handle production loads and to maintain high availability. Production clusters typically use a load balancer to allocate requests among gateway instances.

Additionally, earlier versions of Civetweb do not support HTTPS. A load balancer can be configured to accept SSL requests, terminate the SSL connection and pass the request over HTTP to the gateway instances.

Ceph Storage aims to maintain high availability. For this reason, Red Hat recommends using HAProxy or keepalived. For details, see the HAProxy/keepalived Configuration section in the Ceph Object Gateway Guide for Red Hat Enterprise Linux.

CHAPTER 9. ADDITIONAL USE CASES

Once the cluster is up and running, there are additional use cases to consider.

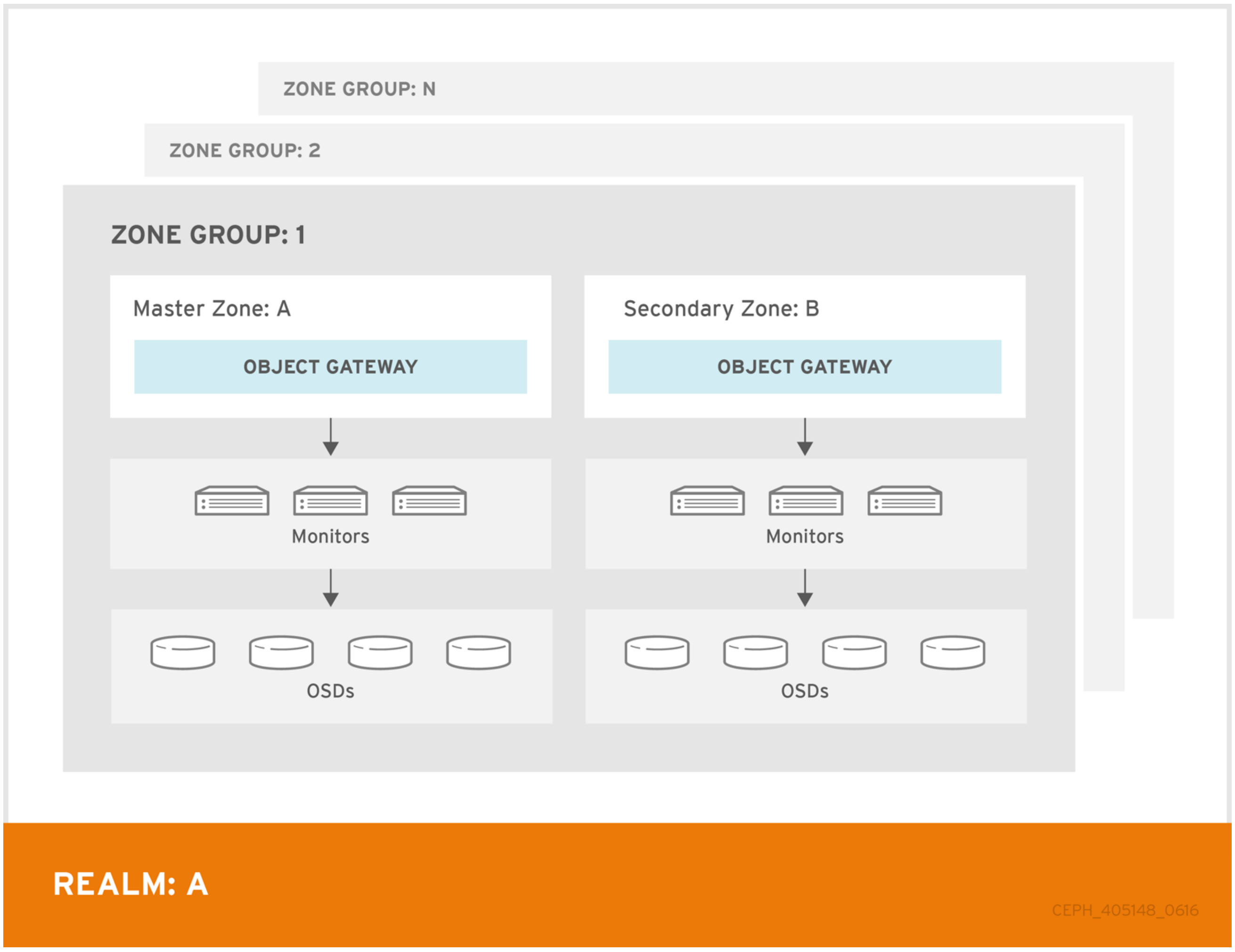
- Expanding the Cluster with Multi-Site
- Migrating Data with NFS-Ganesha
- Configuring the Cluster for Static Webhosting
- Configuring the Cluster with LDAP/AD
- Configuring the Cluster to use Keystone

9.1. EXPANDING THE CLUSTER WITH MULTISITE

When developing storage strategies, the procedure for Creating a Realm ensured that the cluster is already configured to use multi-site with its own realm, master zone group and master zone.

A typical production cluster will have a secondary zone with its own Ceph Storage Cluster in a separate physical location to act as a backup in the event of a disaster. To set up a secondary zone, repeat the procedures in this guide. Generally, the secondary zone should have the same hardware configuration and sizing as the master zone. See Configuring a Secondary Zone for additional details.

Adding a secondary zone adds Failover and Disaster Recovery capabilities to the cluster.



9.2. MIGRATING DATA WITH NFS GANESHA

If the Ceph Object Gateway and Ceph Storage Cluster replaces a filesystem-based storage solution, consider using Ceph's NFS-Ganesha solution to migrate data from the file system into Ceph Object Gateway.

See Exporting the Namespace to NFS-Ganesha chapter in the Ceph Object Gateway Guide for Red Hat Enterprise Linux.

9.3. CONFIGURING THE CLUSTER FOR STATIC WEBHOSTING

Traditional web hosting sometimes involves setting up a web server for each website, which can use resources inefficiently when content doesn't change dynamically.

Ceph Object Gateway can host static web sites in S3 buckets—that is, sites that do not use server-side services like PHP, servlets, databases, nodejs and the like. This approach is substantially more economical than setting up VMs with web servers for each site.

See Configuring Gateways for Static Web Hosting for additional details.

9.4. CONFIGURING THE CLUSTER FOR LDAP/AD

Organizations deploying Ceph Object Gateway for their users and applications may choose to use Light-weight Directory Access Protocol (LDAP) or Microsoft Active Directory (AD) to authenticate with the Ceph Object Gateway in lieu of creating Ceph Object Gateway users.

Using LDAP/AD means that Ceph Object Gateway can integrate with an organizations LDAP/AD single sign-on initiatives.

For details, see the Ceph Object Gateway with LDAP/AD Guide for Red Hat Ceph Storage 3.

9.5. CONFIGURING THE CLUSTER TO USE OPENSTACK KEYSTONE

When deploying the Ceph Object Gateway in lieu of OpenStack Swift, it is possible to configure the gateway to use OpenStack Keystone to authenticate users in lieu of creating Ceph Object Gateway users.

For details, see the Using Keystone to Authenticate Ceph Object Gateway Users guide for Red Hat Ceph Storage 3.

CHAPTER 10. USING NVME WITH LVM OPTIMALLY

1. Summary
   The procedures below demonstrate how to deploy Ceph for Object Gateway usage optimally when using high speed NVMe based SSDs (this applies to SATA SSDs too). Journals and bucket indexes will be placed together on high speed storage devices, which can increase performance compared to having all journals on one device. This configuration requires setting **osd_scenario** to **lvm**.

   Procedures for two example configurations are provided:

   - One NVMe device and at least four HDDs using one bucket index: One NVMe device
   - Two NVMe devices and at least four HDDs using two bucket indexes: Two NVMe devices

2. Details
   The most basic Ceph setup uses the **osd_scenario** setting of **collocated**. This stores the OSD data and its journal on one storage device together (they are "co-located"). Typical server configurations include both HDDs and SSDs. Since HDDs are usually larger than SSDs, in a collocated configuration to utitlize the most storage space an HDD would be chosen, putting both the OSD data and journal on it alone. However, the journal should ideally be on a faster SSD. Another option is using the **osd_scenario** setting of **non-collocated**. This allows configuration of dedicated devices for journals, so you can put the OSD data on HDDs and the journals on SSDs.

   In addition to OSD data and journals, when using Object Gateway a bucket index needs to be stored on a device. In this case Ceph is often configured so that HDDs hold the OSD data, one SSD holds the journals, and another SSD holds the bucket indexes. This can create highly imbalanced situations where the SSD with all the journals becomes saturated while the SSD with bucket indexes is underutilized.

   The solution is to set **osd_scenario** to **lvm** and use Logical Volume Manager (LVM) to divide up single SSD devices for more than one purpose. This allows journals and bucket indexes to exist side by side on a single device. Most importantly, it allows journals to exist on more than one SSD, spreading the intense IO data transfer of the journals across more than one device.

   The normal Ansible playbooks provided by the **ceph-ansible** RPM used to install Ceph (site.yml, osds.yml, etc.) don’t support using one device for more than one purpose.

   In the future the normal Ansible playbooks will support using one device for more than one purpose. In the meantime the playbooks **lv-create.yml** and **lv-vars.yaml** are being provided to facilitate creating the required Logicial Volumes (LVs) for optimal SSD usage. After **lv-create.yml** is run **site.yml** can be run normally and it will use the newly created LVs.

   IMPORTANT

   These procedures only apply to the FileStore storage backend, not the newer BlueStore storage backend.

10.1. USING ONE NVME DEVICE

Follow this procedure to deploy Ceph for Object Gateway usage with one NVMe device.

10.1.1. Purge Any Existing Ceph cluster

If Ceph is already configured, purge it in order to start over. An ansible playbook file named **purge-cluster.yml** is provided for this purpose.

```
$ ansible-playbook purge-cluster.yml
```

For more information on how to use **purge-cluster.yml** see *Purging a Ceph Cluster by Using Ansible* in the Installation Guide for Red Hat Enterprise Linux or Installation Guide for Ubuntu depending on your chosen Linux distribution.

IMPORTANT

Purging the cluster may not be enough to prepare the servers for redeploying Ceph using the following procedures. Any file system, GPT, RAID, or other signatures on storage devices used by Ceph may cause problems. Instructions to remove any signatures using **wipefs** are provided under Run The lv-create.yml Ansible Playbook.

10.1.2. Configure The Cluster for Normal Installation

Setting aside any NVMe and/or LVM considerations, configure the cluster as you would normally but stop before running **ansible-playbook site.yml**. Afterwards, the cluster installation configuration will be adjusted specifically for optimal NVMe/LVM usage to support the Object Gateway. Only at that time should **ansible-playbook site.yml** be run.

To configure the cluster for normal installation consult the Installation Guide for Red Hat Enterprise Linux or Installation Guide for Ubuntu depending on your chosen Linux distribution. In particular, complete the steps in Installing a Red Hat Ceph Storage Cluster through Step 9 creating an Ansible log directory. Stop before Step 10 when **ansible-playbook site.yml** is run.

IMPORTANT

Do not run **ansible-playbook site.yml** until all the steps after this and before Install Ceph for NVMe and Verify Success have been completed.

10.1.3. Identify The NVMe and HDD Devices

Use **lsblk** to identify the NVMe and HDD devices connected to the server. Example output from **lsblk** is listed below:

```
[root@c04-h05-6048r ~]# lsblk
NAME    MAJ:MIN RM   SIZE RO TYPE  MOUNTPOINT
sda       8:0    0 465.8G  0 disk
├─sda1    8:1    0     4G  0 part
│ └─md1   9:1    0     4G  0 raid1 [SWAP]
├─sda2    8:2    0   512M  0 part
│ └─md0   9:0    0   512M  0 raid1 /boot
└─sda3    8:3    0 461.3G  0 part
  └─md2   9:2    0 461.1G  0 raid1 /
sdb       8:16   0 465.8G  0 disk
├─sdb1    8:17   0     4G  0 part
│ └─md1   9:1    0     4G  0 raid1 [SWAP]
├─sdb2    8:18   0   512M  0 part
│ └─md0   9:0    0   512M  0 raid1 /boot
└─sdb3    8:19   0 461.3G  0 part
  └─md2   9:2    0 461.1G  0 raid1 /
```

```
sdc       8:32   0   1.8T  0 disk
sdd       8:48   0   1.8T  0 disk
sde       8:64   0   1.8T  0 disk
sdf       8:80   0   1.8T  0 disk
sdg       8:96   0   1.8T  0 disk
sdh       8:112  0   1.8T  0 disk
sdi       8:128  0   1.8T  0 disk
sdj       8:144  0   1.8T  0 disk
sdk       8:160  0   1.8T  0 disk
sdl       8:176  0   1.8T  0 disk
sdm       8:192  0   1.8T  0 disk
sdn       8:208  0   1.8T  0 disk
sdo       8:224  0   1.8T  0 disk
sdp       8:240  0   1.8T  0 disk
sdq      65:0    0   1.8T  0 disk
sdr      65:16   0   1.8T  0 disk
sds      65:32   0   1.8T  0 disk
sdt      65:48   0   1.8T  0 disk
sdu      65:64   0   1.8T  0 disk
sdv      65:80   0   1.8T  0 disk
sdw      65:96   0   1.8T  0 disk
sdx      65:112  0   1.8T  0 disk
sdy      65:128  0   1.8T  0 disk
sdz      65:144  0   1.8T  0 disk
sdaa     65:160  0   1.8T  0 disk
sdab     65:176  0   1.8T  0 disk
sdac     65:192  0   1.8T  0 disk
sdad     65:208  0   1.8T  0 disk
sdae     65:224  0   1.8T  0 disk
sdaf     65:240  0   1.8T  0 disk
sdag     66:0    0   1.8T  0 disk
sdah     66:16   0   1.8T  0 disk
sdai     66:32   0   1.8T  0 disk
sdaj     66:48   0   1.8T  0 disk
sdak     66:64   0   1.8T  0 disk
sdal     66:80   0   1.8T  0 disk
nvme0n1 259:0    0 745.2G  0 disk
nvme1n1 259:1    0 745.2G  0 disk
```

In this example the following raw block devices will be used:

NVMe devices

1. **/dev/nvme0n1**

HDD devices

1. **/dev/sdc**
2. **/dev/sdd**
3. **/dev/sde**
4. **/dev/sdf**

The file **lv_vars.yaml** configures logical volume creation on the chosen devices. It creates journals on NVMe, an NVMe based bucket index, and HDD based OSDs. The actual creation of logical volumes is initiated by **lv-create.yml**, which reads **lv_vars.yaml**.

That file should only have one NVMe device referenced in it at a time. For information on using Ceph with two NVMe devices optimally see Using Two NVMe Devices .

10.1.4. Add The Devices to lv_vars.yaml

1. As **root**, navigate to the **/usr/share/ceph-ansible/** directory:

```
# cd /usr/share/ceph-ansible
```

2. As **root**, copy the **lv_vars.yaml** Ansible playbook to the current directory:

```
# cp infrastructure-playbooks/vars/lv_vars.yaml .
```

3. Edit the file so it includes the following lines:

```
nvme_device: /dev/nvme0n1
hdd_devices:
  - /dev/sdc
  - /dev/sdd
  - /dev/sde
  - /dev/sdf
```

10.1.5. Run The lv-create.yml Ansible Playbook

The purpose of the **lv-create.yml** playbook is to create logical volumes for the object gateway bucket index, and journals, on a single NVMe. It does this by using **osd_scenario=lvm** as opposed to using **osd_scenario=non-collocated**. The **lv-create.yml** Ansible playbook makes it easier to configure Ceph in this way by automating some of the complex LVM creation and configuration.

1. As **root**, copy the **lv-create.yml** Ansible playbook to the current directory:

```
# cp infrastructure-playbooks/lv-create.yml .
```

2. Ensure the storage devices are raw
   Before running **lv-create.yml** to create the logical volumes on the NVMe devices and HDD devices, ensure there are no file system, GPT, RAID, or other signatures on them.

   If they are not raw, when you run **lv-create.yml** it may fail with the following error:

```
device /dev/sdc excluded by a filter
```

3. Wipe storage device signatures (optional)
   If the devices have signatures you can use **wipefs** to erase them.

   An example of using **wipefs** to erase the devices is shown below:

```
[root@c04-h01-6048r ~]# wipefs -a /dev/sdc
/dev/sdc: 8 bytes were erased at offset 0x00000200 (gpt): 45 46 49 20 50 41 52 54
/dev/sdc: 8 bytes were erased at offset 0x1d19ffffe00 (gpt): 45 46 49 20 50 41 52 54
```

```
/dev/sdc: 2 bytes were erased at offset 0x000001fe (PMBR): 55 aa
/dev/sdc: calling ioclt to re-read partition table: Success
[root@c04-h01-6048r ~]# wipefs -a /dev/sdd
/dev/sdd: 8 bytes were erased at offset 0x00000200 (gpt): 45 46 49 20 50 41 52 54
/dev/sdd: 8 bytes were erased at offset 0x1d19ffffe00 (gpt): 45 46 49 20 50 41 52 54
/dev/sdd: 2 bytes were erased at offset 0x000001fe (PMBR): 55 aa
/dev/sdd: calling ioclt to re-read partition table: Success
[root@c04-h01-6048r ~]# wipefs -a /dev/sde
/dev/sde: 8 bytes were erased at offset 0x00000200 (gpt): 45 46 49 20 50 41 52 54
/dev/sde: 8 bytes were erased at offset 0x1d19ffffe00 (gpt): 45 46 49 20 50 41 52 54
/dev/sde: 2 bytes were erased at offset 0x000001fe (PMBR): 55 aa
/dev/sde: calling ioclt to re-read partition table: Success
[root@c04-h01-6048r ~]# wipefs -a /dev/sdf
/dev/sdf: 8 bytes were erased at offset 0x00000200 (gpt): 45 46 49 20 50 41 52 54
/dev/sdf: 8 bytes were erased at offset 0x1d19ffffe00 (gpt): 45 46 49 20 50 41 52 54
/dev/sdf: 2 bytes were erased at offset 0x000001fe (PMBR): 55 aa
/dev/sdf: calling ioclt to re-read partition table: Success
```

4. Run the **lv-teardown.yml** Ansible playbook:
   Always run **lv-teardown.yml** before running **lv-create.yml**:

   As **root**, copy the **lv-teardown.yml** Ansible playbook to the current directory:

   ```
   # cp infrastructure-playbooks/lv-teardown.yml .
   ```

   Run the **lv-teardown.yml** Ansible playbook:

   ```
   $ ansible-playbook lv-teardown.yml
   ```

   WARNING

   Proceed with caution when running the **lv-teardown.yml** Ansible script. It destroys data. Ensure you have backups of any important data.

5. Run the **lv-create.yml** Ansible playbook:

   ```
   $ ansible-playbook lv-create.yml
   ```

6. Once **lv-create.yml** completes without error continue to the next section to verify it worked properly.

10.1.6. Verify LVM Configuration

1. Review **lv-created.log**
   Once the **lv-create.yml** Ansible playbook completes successfully, configuration information will be written to **lv-created.log**. Later this information will be copied into **group_vars/osds.yml**. Open **lv-created.log** and look for information similar to the below example:

```
- data: ceph-bucket-index-1
  data_vg: ceph-nvme-vg-nvme0n1
  journal: ceph-journal-bucket-index-1-nvme0n1
  journal_vg: ceph-nvme-vg-nvme0n1
- data: ceph-hdd-lv-sdc
  data_vg: ceph-hdd-vg-sdc
  journal: ceph-journal-sdc
  journal_vg: ceph-nvme-vg-nvme0n1
- data: ceph-hdd-lv-sdd
  data_vg: ceph-hdd-vg-sdd
  journal: ceph-journal-sdd
  journal_vg: ceph-nvme-vg-nvme0n1
- data: ceph-hdd-lv-sde
  data_vg: ceph-hdd-vg-sde
  journal: ceph-journal-sde
  journal_vg: ceph-nvme-vg-nvme0n1
- data: ceph-hdd-lv-sdf
  data_vg: ceph-hdd-vg-sdf
  journal: ceph-journal-sdf
  journal_vg: ceph-nvme-vg-nvme0n1
```

2. Review LVM configuration

Based on the example of one NVMe device and four HDDs the following Logical Volumes (LVs) should be created:

One journal LV per HDD placed on NVMe (four LVs on /dev/nvme0n1)

One data LV per HDD placed on each HDD (one LV per HDD)

One journal LV for bucket index placed on NVMe (one LV on /dev/nvme0n1)

One data LV for bucket index placed on NVMe (one LV on /dev/nvme0n1)

The LVs can be seen in **lsblk** and **lvscan** output. In the example explained above, there should be ten LVs for Ceph. As a rough sanity check you could count the Ceph LVs to make sure there are at least ten, but ideally you would make sure the appropriate LVs were created on the right storage devices (NVMe vs HDD).

Example output from **lsblk** is shown below:

```
[root@c04-h01-6048r ~]# lsblk
NAME                                                 MAJ:MIN RM   SIZE RO TYPE  MOUNTPOINT
sda                                                    8:0    0 465.8G  0 disk
├─sda1                                                 8:1    0     4G  0 part
│ └─md1                                                9:1    0     4G  0 raid1 [SWAP]
├─sda2                                                 8:2    0   512M  0 part
│ └─md0                                                9:0    0   512M  0 raid1 /boot
└─sda3                                                 8:3    0 461.3G  0 part
  └─md2                                                9:2    0 461.1G  0 raid1 /
sdb                                                    8:16   0 465.8G  0 disk
├─sdb1                                                 8:17   0     4G  0 part
│ └─md1                                                9:1    0     4G  0 raid1 [SWAP]
├─sdb2                                                 8:18   0   512M  0 part
│ └─md0                                                9:0    0   512M  0 raid1 /boot
└─sdb3                                                 8:19   0 461.3G  0 part
```

```
  └─md2                                        9:2    0 461.1G  0 raid1 /
sdc                                          8:32   0   1.8T  0 disk
└─ceph--hdd--vg--sdc-ceph--hdd--lv--sdc                 253:6    0   1.8T  0 lvm
sdd                                          8:48   0   1.8T  0 disk
└─ceph--hdd--vg--sdd-ceph--hdd--lv--sdd                 253:7    0   1.8T  0 lvm
sde                                          8:64   0   1.8T  0 disk
└─ceph--hdd--vg--sde-ceph--hdd--lv--sde                 253:8    0   1.8T  0 lvm
sdf                                          8:80   0   1.8T  0 disk
└─ceph--hdd--vg--sdf-ceph--hdd--lv--sdf                 253:9    0   1.8T  0 lvm
sdg                                          8:96   0   1.8T  0 disk
sdh                                          8:112  0   1.8T  0 disk
sdi                                          8:128  0   1.8T  0 disk
sdj                                          8:144  0   1.8T  0 disk
sdk                                          8:160  0   1.8T  0 disk
sdl                                          8:176  0   1.8T  0 disk
sdm                                          8:192  0   1.8T  0 disk
sdn                                          8:208  0   1.8T  0 disk
sdo                                          8:224  0   1.8T  0 disk
sdp                                          8:240  0   1.8T  0 disk
sdq                                         65:0    0   1.8T  0 disk
sdr                                         65:16   0   1.8T  0 disk
sds                                         65:32   0   1.8T  0 disk
sdt                                         65:48   0   1.8T  0 disk
sdu                                         65:64   0   1.8T  0 disk
sdv                                         65:80   0   1.8T  0 disk
sdw                                         65:96   0   1.8T  0 disk
sdx                                         65:112  0   1.8T  0 disk
sdy                                         65:128  0   1.8T  0 disk
sdz                                         65:144  0   1.8T  0 disk
sdaa                                        65:160  0   1.8T  0 disk
sdab                                        65:176  0   1.8T  0 disk
sdac                                        65:192  0   1.8T  0 disk
sdad                                        65:208  0   1.8T  0 disk
sdae                                        65:224  0   1.8T  0 disk
sdaf                                        65:240  0   1.8T  0 disk
sdag                                        66:0    0   1.8T  0 disk
sdah                                        66:16   0   1.8T  0 disk
sdai                                        66:32   0   1.8T  0 disk
sdaj                                        66:48   0   1.8T  0 disk
sdak                                        66:64   0   1.8T  0 disk
sdal                                        66:80   0   1.8T  0 disk
nvme0n1                                    259:0    0 745.2G  0 disk
├─ceph--nvme--vg--nvme0n1-ceph--journal--bucket--index--1--nvme0n1 253:0    0   5.4G  0
lvm
├─ceph--nvme--vg--nvme0n1-ceph--journal--sdc            253:1    0   5.4G  0 lvm
├─ceph--nvme--vg--nvme0n1-ceph--journal--sdd            253:2    0   5.4G  0 lvm
├─ceph--nvme--vg--nvme0n1-ceph--journal--sde            253:3    0   5.4G  0 lvm
├─ceph--nvme--vg--nvme0n1-ceph--journal--sdf            253:4    0   5.4G  0 lvm
└─ceph--nvme--vg--nvme0n1-ceph--bucket--index--1        253:5    0 718.4G  0 lvm
nvme1n1                                    259:1    0 745.2G  0 disk
```

Example **lvscan** output is below:

```
[root@c04-h01-6048r ~]# lvscan
  ACTIVE            '/dev/ceph-hdd-vg-sdf/ceph-hdd-lv-sdf' [<1.82 TiB] inherit
  ACTIVE            '/dev/ceph-hdd-vg-sde/ceph-hdd-lv-sde' [<1.82 TiB] inherit
  ACTIVE            '/dev/ceph-hdd-vg-sdd/ceph-hdd-lv-sdd' [<1.82 TiB] inherit
  ACTIVE            '/dev/ceph-nvme-vg-nvme0n1/ceph-journal-bucket-index-1-nvme0n1' [5.37
GiB] inherit
  ACTIVE            '/dev/ceph-nvme-vg-nvme0n1/ceph-journal-sdc' [5.37 GiB] inherit
  ACTIVE            '/dev/ceph-nvme-vg-nvme0n1/ceph-journal-sdd' [5.37 GiB] inherit
  ACTIVE            '/dev/ceph-nvme-vg-nvme0n1/ceph-journal-sde' [5.37 GiB] inherit
  ACTIVE            '/dev/ceph-nvme-vg-nvme0n1/ceph-journal-sdf' [5.37 GiB] inherit
  ACTIVE            '/dev/ceph-nvme-vg-nvme0n1/ceph-bucket-index-1' [<718.36 GiB] inherit
  ACTIVE            '/dev/ceph-hdd-vg-sdc/ceph-hdd-lv-sdc' [<1.82 TiB] inherit
```

10.1.7. Edit The osds.yml and all.yml Ansible Playbooks

1. Copy the previously mentioned configuration information from **lv-created.log** into **group_vars/osds.yml** under the **lvm_volumes:** line.

2. Set **osd_scenario:** to **lvm**:

```
osd_scenario: lvm
```

3. Set **osd_objectstore: filestore** in **all.yml** and **osds.yml**.
   The **osds.yml** file should look similar to this:

```
# Variables here are applicable to all host groups NOT roles

osd_objectstore: filestore
osd_scenario: lvm
lvm_volumes:
  - data: ceph-bucket-index-1
    data_vg: ceph-nvme-vg-nvme0n1
    journal: ceph-journal-bucket-index-1-nvme0n1
    journal_vg: ceph-nvme-vg-nvme0n1
  - data: ceph-hdd-lv-sdc
    data_vg: ceph-hdd-vg-sdc
    journal: ceph-journal-sdc
    journal_vg: ceph-nvme-vg-nvme0n1
  - data: ceph-hdd-lv-sdd
    data_vg: ceph-hdd-vg-sdd
    journal: ceph-journal-sdd
    journal_vg: ceph-nvme-vg-nvme0n1
  - data: ceph-hdd-lv-sde
    data_vg: ceph-hdd-vg-sde
    journal: ceph-journal-sde
    journal_vg: ceph-nvme-vg-nvme0n1
  - data: ceph-hdd-lv-sdf
    data_vg: ceph-hdd-vg-sdf
    journal: ceph-journal-sdf
    journal_vg: ceph-nvme-vg-nvme0n1
```

10.1.8. Install Ceph for NVMe and Verify Success

After configuring Ceph for installation to use NVMe with LVM optimally, install it.

1. Run the **site.yml** Ansible playbook to install Ceph

```
$ ansible-playbook -v -i hosts site.yml
```

2. Verify Ceph is running properly after install completes

```
# ceph -s
```

```
# ceph osd tree
```

Example **ceph -s** output showing Ceph is running properly:

```
# ceph -s
 cluster:
   id:     15d31a8c-3152-4fa2-8c4e-809b750924cd
   health: HEALTH_WARN
           Reduced data availability: 32 pgs inactive

 services:
   mon: 3 daemons, quorum b08-h03-r620,b08-h05-r620,b08-h06-r620
   mgr: b08-h03-r620(active), standbys: b08-h05-r620, b08-h06-r620
   osd: 35 osds: 35 up, 35 in

 data:
   pools:   4 pools, 32 pgs
   objects: 0 objects, 0 bytes
   usage:   0 kB used, 0 kB / 0 kB avail
   pgs:     100.000% pgs unknown
            32 unknown
```

Example **ceph osd tree** output showing Ceph is running properly:

```
[root@c04-h01-6048r ~]# ceph osd tree
ID  CLASS WEIGHT   TYPE NAME              STATUS REWEIGHT PRI-AFF
 -1       55.81212 root default
-15        7.97316     host c04-h01-6048r
 13   hdd  1.81799         osd.13             up  1.00000 1.00000
 20   hdd  1.81799         osd.20             up  1.00000 1.00000
 26   hdd  1.81799         osd.26             up  1.00000 1.00000
 32   hdd  1.81799         osd.32             up  1.00000 1.00000
  6   ssd  0.70119         osd.6              up  1.00000 1.00000
 -3        7.97316     host c04-h05-6048r
 12   hdd  1.81799         osd.12             up  1.00000 1.00000
 17   hdd  1.81799         osd.17             up  1.00000 1.00000
 23   hdd  1.81799         osd.23             up  1.00000 1.00000
 29   hdd  1.81799         osd.29             up  1.00000 1.00000
  2   ssd  0.70119         osd.2              up  1.00000 1.00000
-13        7.97316     host c04-h09-6048r
 11   hdd  1.81799         osd.11             up  1.00000 1.00000
 16   hdd  1.81799         osd.16             up  1.00000 1.00000
 22   hdd  1.81799         osd.22             up  1.00000 1.00000
 27   hdd  1.81799         osd.27             up  1.00000 1.00000
  4   ssd  0.70119         osd.4              up  1.00000 1.00000
 -5        7.97316     host c04-h13-6048r
 10   hdd  1.81799         osd.10             up  1.00000 1.00000
 15   hdd  1.81799         osd.15             up  1.00000 1.00000
 21   hdd  1.81799         osd.21            up  1.00000 1.00000
 28   hdd  1.81799         osd.28            up  1.00000 1.00000
  1  ssd  0.70119         osd.1           up  1.00000 1.00000
 -9        7.97316     host c04-h21-6048r
  8  hdd  1.81799         osd.8           up  1.00000 1.00000
 18   hdd  1.81799         osd.18            up  1.00000 1.00000
 25   hdd  1.81799         osd.25            up  1.00000 1.00000
 30   hdd  1.81799         osd.30            up  1.00000 1.00000
  5  ssd  0.70119         osd.5           up  1.00000 1.00000
-11        7.97316     host c04-h25-6048r
  9  hdd  1.81799         osd.9           up  1.00000 1.00000
 14   hdd  1.81799         osd.14            up  1.00000 1.00000
 33   hdd  1.81799         osd.33            up  1.00000 1.00000
 34   hdd  1.81799         osd.34            up  1.00000 1.00000
  0  ssd  0.70119         osd.0           up  1.00000 1.00000
 -7        7.97316     host c04-h29-6048r
  7  hdd  1.81799         osd.7           up  1.00000 1.00000
 19   hdd  1.81799         osd.19            up  1.00000 1.00000
 24   hdd  1.81799         osd.24            up  1.00000 1.00000
 31   hdd  1.81799         osd.31            up  1.00000 1.00000
  3  ssd  0.70119         osd.3           up  1.00000 1.00000
```

Ceph is now set up to use one NVMe device and LVM optimally for Object Storage Gateway.

10.2. USING TWO NVME DEVICES

Follow this procedure to deploy Ceph for Object Gateway usage with two NVMe devices.

10.2.1. Purge Any Existing Ceph Cluster

If Ceph is already configured, purge it in order to start over. An ansible playbook file named **purge-cluster.yml** is provided for this purpose.

```
$ ansible-playbook purge-cluster.yml
```

For more information on how to use **purge-cluster.yml** see *Purging a Ceph Cluster by Using Ansible* in the Installation Guide for Red Hat Enterprise Linux or Installation Guide for Ubuntu depending on your chosen Linux distribution.

IMPORTANT

Purging the cluster may not be enough to prepare the servers for redeploying Ceph using the following procedures. Any file system, GPT, RAID, or other signatures on storage devices used by Ceph may cause problems. Instructions to remove any signatures using **wipefs** are provided under Run The lv-create.yml Ansible Playbook.

10.2.2. Configure The Cluster for Normal Installation

Setting aside any NVMe and/or LVM considerations, configure the cluster as you would normally but stop before running **ansible-playbook site.yml**. Afterwards, the cluster installation configuration will be adjusted specifically for optimal NVMe/LVM usage to support the Object Gateway. Only at that time should **ansible-playbook site.yml** be run.

To configure the cluster for normal installation consult the Installation Guide for Red Hat Enterprise

Linux or Installation Guide for Ubuntu depending on your chosen Linux distribution. In particular, complete the steps in Installing a Red Hat Ceph Storage Cluster through Step 9 creating an Ansible log directory. Stop before Step 10 when **ansible-playbook site.yml** is run.

IMPORTANT

Do not run **ansible-playbook site.yml** until all the steps after this and before Install Ceph for NVMe and Verify Success have been completed.

10.2.3. Identify The NVMe and HDD Devices

Use **lsblk** to identify the NVMe and HDD devices connected to the server. Example output from **lsblk** is listed below:

```
[root@c04-h09-6048r ~]# lsblk
NAME                          MAJ:MIN RM   SIZE RO TYPE MOUNTPOINT
sda                             8:0    0 465.8G  0 disk
├─sda1                          8:1    0   512M  0 part /boot
└─sda2                          8:2    0 465.3G  0 part
  ├─vg_c04--h09--6048r-lv_root 253:0    0 464.8G  0 lvm  /
  └─vg_c04--h09--6048r-lv_swap 253:1    0   512M  0 lvm  [SWAP]
sdb                             8:16   0 465.8G  0 disk
sdc                             8:32   0   1.8T  0 disk
sdd                             8:48   0   1.8T  0 disk
sde                             8:64   0   1.8T  0 disk
sdf                             8:80   0   1.8T  0 disk
sdg                             8:96   0   1.8T  0 disk
sdh                             8:112  0   1.8T  0 disk
sdi                             8:128  0   1.8T  0 disk
sdj                             8:144  0   1.8T  0 disk
sdk                             8:160  0   1.8T  0 disk
sdl                             8:176  0   1.8T  0 disk
sdm                             8:192  0   1.8T  0 disk
sdn                             8:208  0   1.8T  0 disk
sdo                             8:224  0   1.8T  0 disk
sdp                             8:240  0   1.8T  0 disk
sdq                            65:0    0   1.8T  0 disk
sdr                            65:16   0   1.8T  0 disk
sds                            65:32   0   1.8T  0 disk
sdt                            65:48   0   1.8T  0 disk
sdu                            65:64   0   1.8T  0 disk
sdv                            65:80   0   1.8T  0 disk
sdw                            65:96   0   1.8T  0 disk
sdx                            65:112  0   1.8T  0 disk
sdy                            65:128  0   1.8T  0 disk
sdz                            65:144  0   1.8T  0 disk
sdaa                           65:160  0   1.8T  0 disk
sdab                           65:176  0   1.8T  0 disk
sdac                           65:192  0   1.8T  0 disk
sdad                           65:208  0   1.8T  0 disk
sdae                           65:224  0   1.8T  0 disk
sdaf                           65:240  0   1.8T  0 disk
sdag                           66:0    0   1.8T  0 disk
sdah                           66:16   0   1.8T  0 disk
sdai                           66:32   0   1.8T  0 disk
```

```
sdaj                    66:48   0   1.8T  0 disk
sdak                     66:64   0   1.8T  0 disk
sdal                    66:80   0   1.8T  0 disk
nvme0n1                    259:1    0 745.2G  0 disk
nvme1n1                    259:0    0 745.2G  0 disk
```

In this example the following raw block devices will be used:

NVMe devices

1. **/dev/nvme0n1**
2. **/dev/nvme1n1**

HDD devices

1. **/dev/sdc**
2. **/dev/sdd**
3. **/dev/sde**
4. **/dev/sdf**

The file **lv_vars.yaml** configures logical volume creation on the chosen devices. It creates journals on NVMe, an NVMe based bucket index, and HDD based OSDs. The actual creation of logical volumes is initiated by **lv-create.yml**, which reads **lv_vars.yaml**.

That file should only have one NVMe device referenced in it at a time. It should also only reference the HDD devices to be associated with that particular NVMe device. For OSDs that contain more than one NVMe device edit **lv_vars.yaml** for each NVMe and run **lv-create.yml** repeatedly for each NVMe. This is explained below.

In the example this means **lv-create.yml** will first be run on **/dev/nvme0n1** and then again on **/dev/nvme1n1**.

10.2.4. Add The Devices to lv_vars.yaml

1. As **root**, navigate to the **/usr/share/ceph-ansible/** directory:

   ```
   # cd /usr/share/ceph-ansible
   ```

2. As **root**, copy the **lv_vars.yaml** Ansible playbook to the current directory:

   ```
   # cp infrastructure-playbooks/vars/lv_vars.yaml .
   ```

3. For the first run edit the file so it includes the following lines:

   ```
   nvme_device: /dev/nvme0n1
   hdd_devices:
     - /dev/sdc
     - /dev/sdd
   ```

The journal size, number of bucket indexes, their sizes and names, and the bucket indexes' journal names can all be adjusted in **lv_vars.yaml**. See the comments within the file for more information.

10.2.5. Run The lv-create.yml Ansible Playbook

The purpose of the **lv-create.yml** playbook is to create logical volumes for the object gateway bucket index, and journals, on a single NVMe. It does this by using **osd_scenario=lvm** as opposed to using **osd_scenario=non-collocated**. The **lv-create.yml** Ansible playbook makes it easier to configure Ceph in this way by automating some of the complex LVM creation and configuration.

1. As **root**, copy the **lv-create.yml** Ansible playbook to the current directory:

   ```
   # cp infrastructure-playbooks/lv-create.yml .
   ```

2. Ensure the storage devices are raw
   Before running **lv-create.yml** to create the logical volumes on the NVMe devices and HDD devices, ensure there are no file system, GPT, RAID, or other signatures on them.

   If they are not raw, when you run **lv-create.yml** it may fail with the following error:

   ```
   device /dev/sdc excluded by a filter
   ```

3. Wipe storage device signatures (optional)
   If the devices have signatures you can use **wipefs** to erase them.

   An example of using **wipefs** to erase the devices is shown below:

   ```
   [root@c04-h01-6048r ~]# wipefs -a /dev/sdc
   /dev/sdc: 8 bytes were erased at offset 0x00000200 (gpt): 45 46 49 20 50 41 52 54
   /dev/sdc: 8 bytes were erased at offset 0x1d19ffffe00 (gpt): 45 46 49 20 50 41 52 54
   /dev/sdc: 2 bytes were erased at offset 0x000001fe (PMBR): 55 aa
   /dev/sdc: calling ioclt to re-read partition table: Success
   [root@c04-h01-6048r ~]# wipefs -a /dev/sdd
   /dev/sdd: 8 bytes were erased at offset 0x00000200 (gpt): 45 46 49 20 50 41 52 54
   /dev/sdd: 8 bytes were erased at offset 0x1d19ffffe00 (gpt): 45 46 49 20 50 41 52 54
   /dev/sdd: 2 bytes were erased at offset 0x000001fe (PMBR): 55 aa
   /dev/sdd: calling ioclt to re-read partition table: Success
   [root@c04-h01-6048r ~]# wipefs -a /dev/sde
   /dev/sde: 8 bytes were erased at offset 0x00000200 (gpt): 45 46 49 20 50 41 52 54
   /dev/sde: 8 bytes were erased at offset 0x1d19ffffe00 (gpt): 45 46 49 20 50 41 52 54
   /dev/sde: 2 bytes were erased at offset 0x000001fe (PMBR): 55 aa
   /dev/sde: calling ioclt to re-read partition table: Success
   [root@c04-h01-6048r ~]# wipefs -a /dev/sdf
   /dev/sdf: 8 bytes were erased at offset 0x00000200 (gpt): 45 46 49 20 50 41 52 54
   /dev/sdf: 8 bytes were erased at offset 0x1d19ffffe00 (gpt): 45 46 49 20 50 41 52 54
   /dev/sdf: 2 bytes were erased at offset 0x000001fe (PMBR): 55 aa
   /dev/sdf: calling ioclt to re-read partition table: Success
   ```

4. Run the **lv-teardown.yml** Ansible playbook:
   Always run **lv-teardown.yml** before running **lv-create.yml**:

   As **root**, copy the **lv-teardown.yml** Ansible playbook to the current directory:

   ```
   # cp infrastructure-playbooks/lv-teardown.yml .
   ```

Run the **lv-teardown.yml** Ansible playbook:

```
$ ansible-playbook lv-teardown.yml
```

> **WARNING**
>
> Proceed with caution when running the **lv-teardown.yml** Ansible script. It destroys data. Ensure you have backups of any important data.

5. Run the **lv-create.yml** Ansible playbook:

```
$ ansible-playbook lv-create.yml
```

10.2.6. Copy First NVMe LVM Configuration

1. Review **lv-created.log**
   Once the **lv-create.yml** Ansible playbook completes successfully, configuration information will be written to **lv-created.log**. Open **lv-created.log** and look for information similar to the below example:

```
  - data: ceph-bucket-index-1
    data_vg: ceph-nvme-vg-nvme0n1
    journal: ceph-journal-bucket-index-1-nvme0n1
    journal_vg: ceph-nvme-vg-nvme0n1
  - data: ceph-hdd-lv-sdc
    data_vg: ceph-hdd-vg-sdc
    journal: ceph-journal-sdc
    journal_vg: ceph-nvme-vg-nvme0n1
  - data: ceph-hdd-lv-sdd
    data_vg: ceph-hdd-vg-sdd
    journal: ceph-journal-sdd
    journal_vg: ceph-nvme-vg-nvme0n1
```

2. Copy this information into **group_vars/osds.yml** under **lvm_volumes:**.

10.2.7. Run The lv-create.yml Playbook on NVMe device two

The following instructions are abbreviated steps to set up a second NVMe device. Consult the related steps above for further context if needed.

1. Modify **lv-vars.yaml** to use the second NVMe and associated HDDs.
   Following the previous example, **lv-vars.yaml** will now have the following devices set:

```
nvme_device: /dev/nvme1n1
hdd_devices:
  - /dev/sde
  - /dev/sdf
```

2. Run **lv-teardown.yml**:

```
$ ansible-playbook lv-teardown.yml
```

3. Run **lv-create.yml** again

```
$ ansible-playbook lv-create.yml
```

10.2.8. Copy Second NVMe LVM Configuration

1. Review **lv-created.log**
   Once the **lv-create.yml** Ansible playbook completes successfully, configuration information will be written to **lv-created.log**. Open **lv-created.log** and look for information similar to the below example:

```
  - data: ceph-bucket-index-1
    data_vg: ceph-nvme-vg-nvme1n1
    journal: ceph-journal-bucket-index-1-nvme1n1
    journal_vg: ceph-nvme-vg-nvme1n1
  - data: ceph-hdd-lv-sde
    data_vg: ceph-hdd-vg-sde
    journal: ceph-journal-sde
    journal_vg: ceph-nvme-vg-nvme1n1
  - data: ceph-hdd-lv-sdf
    data_vg: ceph-hdd-vg-sdf
    journal: ceph-journal-sdf
    journal_vg: ceph-nvme-vg-nvme1n1
```

2. Copy this information into **group_vars/osds.yml** under the already entered information under **lvm_volumes:**.

10.2.9. Verify LVM Configuration

1. Review LVM Configuration
   Based on the example of two NVMe device and four HDDs the following Logical Volumes (LVs) should be created:

   One journal LV per HDD placed on both NVMe devices (two LVs on /dev/nvme0n1, two on /dev/nvme1n1)

   One data LV per HDD placed on each HDD (one LV per HDD)

   One journal LV per bucket index placed on NVMe (one LV on /dev/nvme0n1, one LV on /dev/nvme1n1)

   One data LV per bucket index placed on both NVMe devices (one LV on /dev/nvme0n1, one LV on /dev/nvme1n1)

   The LVs can be seen in **lsblk** and **lvscan** output. In the example explained above, there should be twelve LVs for Ceph. As a rough sanity check you could count the Ceph LVs to make sure there are at least twelve, but ideally you would make sure the appropriate LVs were created on the right storage devices (NVMe vs HDD).

   Example output from lsblk is shown below:

```
[root@c04-h01-6048r ~]# lsblk
NAME                                                 MAJ:MIN RM   SIZE RO TYPE  MOUNTPOINT
sda                                                8:0    0 465.8G  0 disk
├─sda1                                               8:1    0     4G  0 part
│ └─md1                                               9:1    0     4G  0 raid1 [SWAP]
├─sda2                                               8:2    0   512M  0 part
│ └─md0                                               9:0    0   512M  0 raid1 /boot
└─sda3                                               8:3    0 461.3G  0 part
  └─md2                                               9:2    0 461.1G  0 raid1 /
sdb                                                8:16   0 465.8G  0 disk
├─sdb1                                               8:17   0     4G  0 part
│ └─md1                                               9:1    0     4G  0 raid1 [SWAP]
├─sdb2                                               8:18   0   512M  0 part
│ └─md0                                               9:0    0   512M  0 raid1 /boot
└─sdb3                                               8:19   0 461.3G  0 part
  └─md2                                               9:2    0 461.1G  0 raid1 /
sdc                                                8:32   0   1.8T  0 disk
└─ceph--hdd--vg--sdc-ceph--hdd--lv--sdc                        253:4    0   1.8T  0 lvm
sdd                                                8:48   0   1.8T  0 disk
└─ceph--hdd--vg--sdd-ceph--hdd--lv--sdd                        253:5    0   1.8T  0 lvm
sde                                                8:64   0   1.8T  0 disk
└─ceph--hdd--vg--sde-ceph--hdd--lv--sde                        253:10   0   1.8T  0 lvm
sdf                                                8:80   0   1.8T  0 disk
└─ceph--hdd--vg--sdf-ceph--hdd--lv--sdf                        253:11   0   1.8T  0 lvm
sdg                                                8:96   0   1.8T  0 disk
sdh                                                8:112  0   1.8T  0 disk
sdi                                                8:128  0   1.8T  0 disk
sdj                                                8:144  0   1.8T  0 disk
sdk                                                8:160  0   1.8T  0 disk
sdl                                                8:176  0   1.8T  0 disk
sdm                                                8:192  0   1.8T  0 disk
sdn                                                8:208  0   1.8T  0 disk
sdo                                                8:224  0   1.8T  0 disk
sdp                                                8:240  0   1.8T  0 disk
sdq                                                65:0    0   1.8T  0 disk
sdr                                                65:16   0   1.8T  0 disk
sds                                                65:32   0   1.8T  0 disk
sdt                                                65:48   0   1.8T  0 disk
sdu                                                65:64   0   1.8T  0 disk
sdv                                                65:80   0   1.8T  0 disk
sdw                                                65:96   0   1.8T  0 disk
sdx                                                65:112  0   1.8T  0 disk
sdy                                                65:128  0   1.8T  0 disk
sdz                                                65:144  0   1.8T  0 disk
sdaa                                               65:160  0   1.8T  0 disk
sdab                                               65:176  0   1.8T  0 disk
sdac                                               65:192  0   1.8T  0 disk
sdad                                               65:208  0   1.8T  0 disk
sdae                                               65:224  0   1.8T  0 disk
sdaf                                               65:240  0   1.8T  0 disk
sdag                                               66:0    0   1.8T  0 disk
sdah                                               66:16   0   1.8T  0 disk
sdai                                               66:32   0   1.8T  0 disk
sdaj                                               66:48   0   1.8T  0 disk
sdak                                               66:64   0   1.8T  0 disk
sdal                                               66:80   0   1.8T  0 disk
```

```
nvme0n1                                                        259:0    0 745.2G  0 disk
├─ceph--nvme--vg--nvme0n1-ceph--journal--bucket--index--1--nvme0n1 253:0    0   5.4G  0
lvm
├─ceph--nvme--vg--nvme0n1-ceph--journal--sdc                  253:1    0   5.4G  0 lvm
├─ceph--nvme--vg--nvme0n1-ceph--journal--sdd                  253:2    0   5.4G  0 lvm
└─ceph--nvme--vg--nvme0n1-ceph--bucket--index--1               253:3    0 729.1G  0 lvm
nvme1n1                                                        259:1    0 745.2G  0 disk
├─ceph--nvme--vg--nvme1n1-ceph--journal--bucket--index--1--nvme1n1 253:6    0   5.4G  0
lvm
├─ceph--nvme--vg--nvme1n1-ceph--journal--sde                  253:7    0   5.4G  0 lvm
├─ceph--nvme--vg--nvme1n1-ceph--journal--sdf                  253:8    0   5.4G  0 lvm
└─ceph--nvme--vg--nvme1n1-ceph--bucket--index--1               253:9    0 729.1G  0 lvm
```

Example output from **lvscan** is shown below:

```
[root@c04-h01-6048r ~]# lvscan
  ACTIVE            '/dev/ceph-hdd-vg-sde/ceph-hdd-lv-sde' [<1.82 TiB] inherit
  ACTIVE            '/dev/ceph-hdd-vg-sdc/ceph-hdd-lv-sdc' [<1.82 TiB] inherit
  ACTIVE            '/dev/ceph-hdd-vg-sdf/ceph-hdd-lv-sdf' [<1.82 TiB] inherit
  ACTIVE            '/dev/ceph-nvme-vg-nvme1n1/ceph-journal-bucket-index-1-nvme1n1' [5.37
GiB] inherit
  ACTIVE            '/dev/ceph-nvme-vg-nvme1n1/ceph-journal-sde' [5.37 GiB] inherit
  ACTIVE            '/dev/ceph-nvme-vg-nvme1n1/ceph-journal-sdf' [5.37 GiB] inherit
  ACTIVE            '/dev/ceph-nvme-vg-nvme1n1/ceph-bucket-index-1' [<729.10 GiB] inherit
  ACTIVE            '/dev/ceph-nvme-vg-nvme0n1/ceph-journal-bucket-index-1-nvme0n1' [5.37
GiB] inherit
  ACTIVE            '/dev/ceph-nvme-vg-nvme0n1/ceph-journal-sdc' [5.37 GiB] inherit
  ACTIVE            '/dev/ceph-nvme-vg-nvme0n1/ceph-journal-sdd' [5.37 GiB] inherit
  ACTIVE            '/dev/ceph-nvme-vg-nvme0n1/ceph-bucket-index-1' [<729.10 GiB] inherit
  ACTIVE            '/dev/ceph-hdd-vg-sdd/ceph-hdd-lv-sdd' [<1.82 TiB] inherit
```

10.2.10. Edit The osds.yml and all.yml Ansible Playbooks

1. Set **osd_objectstore** to **filestore**
   In addition to adding the second set of information from **lv-create.log** into **osds.yml**, **osd_objectstore** also needs to be set to **filestore** in both the **osds.yml** and **all.yml** files.

   The line should look like this in both **osds.yml** and **all.yml**:

   ```
   osd_objectstore: filestore
   ```

2. Set **osd_scenario** to **lvm** in **osds.yml**

   The osds.yml file should look similar to the following example:

   ```
   # Variables here are applicable to all host groups NOT roles

   osd_objectstore: filestore
   osd_scenario: lvm
   lvm_volumes:
     - data: ceph-bucket-index-1
       data_vg: ceph-nvme-vg-nvme0n1
       journal: ceph-journal-bucket-index-1-nvme0n1
       journal_vg: ceph-nvme-vg-nvme0n1
   ```

```
  - data: ceph-hdd-lv-sdc
    data_vg: ceph-hdd-vg-sdc
    journal: ceph-journal-sdc
    journal_vg: ceph-nvme-vg-nvme0n1
  - data: ceph-hdd-lv-sdd
    data_vg: ceph-hdd-vg-sdd
    journal: ceph-journal-sdd
    journal_vg: ceph-nvme-vg-nvme0n1
  - data: ceph-bucket-index-1
    data_vg: ceph-nvme-vg-nvme1n1
    journal: ceph-journal-bucket-index-1-nvme1n1
    journal_vg: ceph-nvme-vg-nvme1n1
  - data: ceph-hdd-lv-sde
    data_vg: ceph-hdd-vg-sde
    journal: ceph-journal-sde
    journal_vg: ceph-nvme-vg-nvme1n1
  - data: ceph-hdd-lv-sdf
    data_vg: ceph-hdd-vg-sdf
    journal: ceph-journal-sdf
    journal_vg: ceph-nvme-vg-nvme1n1
```

10.2.11. Install Ceph for NVMe and Verify Success

1. Run the **site.yml** Ansible playbook to install Ceph

```
$ ansible-playbook -v -i hosts site.yml
```

2. Verify Ceph is running properly after install completes

```
# ceph -s
```

```
# ceph osd tree
```

Example **ceph -s** output showing Ceph is running properly:

```
# ceph -s
  cluster:
    id:     9ba22f4c-b53f-4c49-8c72-220aaf567c2b
    health: HEALTH_WARN
            Reduced data availability: 32 pgs inactive

  services:
    mon: 3 daemons, quorum b08-h03-r620,b08-h05-r620,b08-h06-r620
    mgr: b08-h03-r620(active), standbys: b08-h05-r620, b08-h06-r620
    osd: 42 osds: 42 up, 42 in

  data:
    pools:   4 pools, 32 pgs
    objects: 0 objects, 0 bytes
    usage:   0 kB used, 0 kB / 0 kB avail
    pgs:     100.000% pgs unknown
             32 unknown
```

Example **ceph osd tree** output showing Ceph is running properly:

```
[root@c04-h01-6048r ~]# ceph osd tree
ID  CLASS WEIGHT   TYPE NAME              STATUS REWEIGHT PRI-AFF
 -1       60.86740 root default
 -7        8.69534     host c04-h01-6048r
 10   hdd  1.81799         osd.10             up  1.00000 1.00000
 13   hdd  1.81799         osd.13             up  1.00000 1.00000
 21   hdd  1.81799         osd.21             up  1.00000 1.00000
 27   hdd  1.81799         osd.27             up  1.00000 1.00000
  6   ssd  0.71169         osd.6              up  1.00000 1.00000
 15   ssd  0.71169         osd.15             up  1.00000 1.00000
 -3        8.69534     host c04-h05-6048r
  7   hdd  1.81799         osd.7              up  1.00000 1.00000
 20   hdd  1.81799         osd.20             up  1.00000 1.00000
 29   hdd  1.81799         osd.29             up  1.00000 1.00000
 38   hdd  1.81799         osd.38             up  1.00000 1.00000
  4   ssd  0.71169         osd.4              up  1.00000 1.00000
 25   ssd  0.71169         osd.25             up  1.00000 1.00000
-22        8.69534     host c04-h09-6048r
 17   hdd  1.81799         osd.17             up  1.00000 1.00000
 31   hdd  1.81799         osd.31             up  1.00000 1.00000
 35   hdd  1.81799         osd.35             up  1.00000 1.00000
 39   hdd  1.81799         osd.39             up  1.00000 1.00000
  5   ssd  0.71169         osd.5              up  1.00000 1.00000
 34   ssd  0.71169         osd.34             up  1.00000 1.00000
 -9        8.69534     host c04-h13-6048r
  8   hdd  1.81799         osd.8              up  1.00000 1.00000
 11   hdd  1.81799         osd.11             up  1.00000 1.00000
 30   hdd  1.81799         osd.30             up  1.00000 1.00000
 32   hdd  1.81799         osd.32             up  1.00000 1.00000
  0   ssd  0.71169         osd.0              up  1.00000 1.00000
 26   ssd  0.71169         osd.26             up  1.00000 1.00000
-19        8.69534     host c04-h21-6048r
 18   hdd  1.81799         osd.18             up  1.00000 1.00000
 23   hdd  1.81799         osd.23             up  1.00000 1.00000
 36   hdd  1.81799         osd.36             up  1.00000 1.00000
 40   hdd  1.81799         osd.40             up  1.00000 1.00000
  3   ssd  0.71169         osd.3              up  1.00000 1.00000
 33   ssd  0.71169         osd.33             up  1.00000 1.00000
-16        8.69534     host c04-h25-6048r
 16   hdd  1.81799         osd.16             up  1.00000 1.00000
 22   hdd  1.81799         osd.22             up  1.00000 1.00000
 37   hdd  1.81799         osd.37             up  1.00000 1.00000
 41   hdd  1.81799         osd.41             up  1.00000 1.00000
  1   ssd  0.71169         osd.1              up  1.00000 1.00000
 28   ssd  0.71169         osd.28             up  1.00000 1.00000
 -5        8.69534     host c04-h29-6048r
  9   hdd  1.81799         osd.9              up  1.00000 1.00000
 12   hdd  1.81799         osd.12             up  1.00000 1.00000
 19   hdd  1.81799         osd.19             up  1.00000 1.00000
 24   hdd  1.81799         osd.24             up  1.00000 1.00000
  2   ssd  0.71169         osd.2              up  1.00000 1.00000
 14   ssd  0.71169         osd.14             up  1.00000 1.00000
```

Ceph is now set up to use two NVMe devices and LVM optimally for Object Storage Gateway.