Red Hat OpenStack Platform 17.0-Beta

Director Installation and Usage

An end-to-end scenario on using Red Hat OpenStack Platform director to create an OpenStack cloud
An end-to-end scenario on using Red Hat OpenStack Platform director to create an OpenStack cloud

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Install Red Hat OpenStack Platform 17 in an enterprise environment using the Red Hat OpenStack Platform director. This includes installing the director, planning your environment, and creating an OpenStack environment with the director.
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Red Hat is committed to replacing problematic language in our code, documentation, and web properties. We are beginning with these four terms: master, slave, blacklist, and whitelist. Because of the enormity of this endeavor, these changes will be implemented gradually over several upcoming releases. For more details, see our CTO Chris Wright’s message.
CHAPTER 1. INTRODUCTION TO DIRECTOR

The Red Hat OpenStack Platform (RHOSP) director is a toolset for installing and managing a complete RHOSP environment. Director is based primarily on the OpenStack project TripleO. With director you can install a fully-operational, lean, and robust RHOSP environment that can provision and control bare metal systems to use as OpenStack nodes.

Director uses two main concepts: an undercloud and an overcloud. First you install the undercloud, and then use the undercloud as a tool to install and configure the overcloud.

### 1.1. UNDERSTANDING THE UNDERCLOUD

The undercloud is the main management node that contains the Red Hat OpenStack Platform director toolset. It is a single-system OpenStack installation that includes components for provisioning and managing the OpenStack nodes that form your OpenStack environment (the overcloud). The components that form the undercloud have multiple functions:

**Environment planning**
- The undercloud includes planning functions that you can use to create and assign certain node roles. The undercloud includes a default set of node roles that you can assign to specific nodes: Compute, Controller, and various Storage roles. You can also design custom roles. Additionally, you can select which Red Hat OpenStack Platform services to include on each node role, which provides a method to model new node types or isolate certain components on their own host.

**Bare metal system control**
- The undercloud uses the out-of-band management interface, usually Intelligent Platform Management Interface (IPMI), of each node for power management control and a PXE-based service to discover hardware attributes and install OpenStack on each node. You can use this feature to provision bare metal systems as OpenStack nodes. For a full list of power management drivers, see [Chapter 30, Power management drivers](#).

**Orchestration**
- The undercloud contains a set of YAML templates that represent a set of plans for your environment. The undercloud imports these plans and follows their instructions to create the resulting OpenStack environment. The plans also include hooks that you can use to incorporate your own customizations as certain points in the environment creation process.

**Undercloud components**
- The undercloud uses OpenStack components as its base tool set. Each component operates within a separate container on the undercloud:
• OpenStack Identity (keystone) - Provides authentication and authorization for the director components.

• OpenStack Bare Metal (ironic) and OpenStack Compute (nova) - Manages bare metal nodes.

• OpenStack Networking (neutron) and Open vSwitch - Control networking for bare metal nodes.

• OpenStack Image Service (glance) - Stores images that director writes to bare metal machines.

• OpenStack Orchestration (heat) and Puppet - Provides orchestration of nodes and configuration of nodes after director writes the overcloud image to disk.

• OpenStack Messaging Service (zaqar) - Provides a messaging service for the OpenStack Workflow Service.

• OpenStack Object Storage (swift) - Provides object storage for various OpenStack Platform components, including:
  - Image storage for OpenStack Image Service
  - Introspection data for OpenStack Bare Metal
  - Deployment plans for OpenStack Workflow Service

1.2. UNDERSTANDING THE OVERCLOUD

The overcloud is the resulting Red Hat OpenStack Platform (RHOSP) environment that the undercloud creates. The overcloud consists of multiple nodes with different roles that you define based on the OpenStack Platform environment that you want to create. The undercloud includes a default set of overcloud node roles:

Controller

Controller nodes provide administration, networking, and high availability for the OpenStack environment. A recommended OpenStack environment contains three Controller nodes together in a high availability cluster.

A default Controller node role supports the following components. Not all of these services are enabled by default. Some of these components require custom or pre-packaged environment files to enable:

• OpenStack Dashboard (horizon)

• OpenStack Identity (keystone)

• OpenStack Compute (nova) API

• OpenStack Networking (neutron)

• OpenStack Image Service (glance)

• OpenStack Block Storage (cinder)

• OpenStack Object Storage (swift)
• OpenStack Orchestration (heat)
• OpenStack Shared File Systems (manila)
• OpenStack Bare Metal (ironic)
• OpenStack Load Balancing-as-a-Service (octavia)
• OpenStack Key Manager (barbican)
• MariaDB
• Open vSwitch
• Pacemaker and Galera for high availability services.

Compute
Compute nodes provide computing resources for the OpenStack environment. You can add more Compute nodes to scale out your environment over time. A default Compute node contains the following components:

• OpenStack Compute (nova)
• KVM/QEMU
• Open vSwitch

Storage
Storage nodes provide storage for the OpenStack environment. The following list contains information about the various types of Storage node in RHOSP:

• Ceph Storage nodes - Used to form storage clusters. Each node contains a Ceph Object Storage Daemon (OSD). Additionally, director installs Ceph Monitor onto the Controller nodes in situations where you deploy Ceph Storage nodes as part of your environment.

• Block storage (cinder) - Used as external block storage for highly available Controller nodes. This node contains the following components:
  • OpenStack Block Storage (cinder) volume
  • OpenStack Telemetry agents
  • Open vSwitch.

• Object storage (swift) - These nodes provide an external storage layer for OpenStack Swift. The Controller nodes access object storage nodes through the Swift proxy. Object storage nodes contain the following components:
  • OpenStack Object Storage (swift) storage
  • OpenStack Telemetry agents
  • Open vSwitch.
1.3. UNDERSTANDING HIGH AVAILABILITY IN RED HAT OPENSTACK PLATFORM

The Red Hat OpenStack Platform (RHOSP) director uses a Controller node cluster to provide highly available services to your OpenStack Platform environment. For each service, director installs the same components on all Controller nodes and manages the Controller nodes together as a single service. This type of cluster configuration provides a fallback in the event of operational failures on a single Controller node. This provides OpenStack users with a certain degree of continuous operation.

The OpenStack Platform director uses some key pieces of software to manage components on the Controller node:

- **Pacemaker** - Pacemaker is a cluster resource manager. Pacemaker manages and monitors the availability of OpenStack components across all nodes in the cluster.
- **HAProxy** - Provides load balancing and proxy services to the cluster.
- **Galera** - Replicates the RHOSP database across the cluster.
- **Memcached** - Provides database caching.

**NOTE**

- From version 13 and later, you can use director to deploy High Availability for Compute Instances (Instance HA). With Instance HA you can automate evacuating instances from a Compute node when the Compute node fails.

1.4. UNDERSTANDING CONTAINERIZATION IN RED HAT OPENSTACK PLATFORM

Each OpenStack Platform service on the undercloud and overcloud runs inside an individual Linux container on their respective node. This containerization provides a method to isolate services, maintain the environment, and upgrade Red Hat OpenStack Platform (RHOSP).

Red Hat OpenStack Platform 17.0-beta supports installation on the Red Hat Enterprise Linux 9.0 operating system. Red Hat OpenStack Platform previously used Docker to manage containerization. OpenStack Platform 17.0-beta uses these tools for OpenStack Platform deployment and upgrades.

**Podman**

Pod Manager (Podman) is a container management tool. It implements almost all Docker CLI commands, not including commands related to Docker Swarm. Podman manages pods, containers, and container images. Podman can manage resources without a daemon running in the background. For more information about Podman, see the [Podman website](#).

**Buildah**

Buildah specializes in building Open Containers Initiative (OCI) images, which you use in conjunction with Podman. Buildah commands replicate the contents of a Dockerfile. Buildah also provides a lower-level `coreutils` interface to build container images, so that you do not require a Dockerfile to build containers. Buildah also uses other scripting languages to build container images without requiring a daemon.
For more information about Buildah, see the [Buildah website](#).

**Skopeo**
Skopeo provides operators with a method to inspect remote container images, which helps directors collect data when it pulls images. Additional features include copying container images from one registry to another and deleting images from registries.

Red Hat supports the following methods for managing container images for your overcloud:

- Pulling container images from the Red Hat Container Catalog to the `image-serve` registry on the undercloud and then pulling the images from the `image-serve` registry. When you pull images to the undercloud first, you avoid multiple overcloud nodes simultaneously pulling container images over an external connection.

- Pulling container images from your Satellite 6 server. You can pull these images directly from the Satellite because the network traffic is internal.

This guide contains information about configuring your container image registry details and performing basic container operations.

1.5. WORKING WITH CEPH STORAGE IN RED HAT OPENSTACK PLATFORM

It is common for large organizations that use Red Hat OpenStack Platform (RHOSP) to serve thousands of clients or more. Each OpenStack client is likely to have their own unique needs when consuming block storage resources. Deploying glance (images), cinder (volumes), and nova (Compute) on a single node can become impossible to manage in large deployments with thousands of clients. Scaling OpenStack externally resolves this challenge.

However, there is also a practical requirement to virtualize the storage layer with a solution like Red Hat Ceph Storage so that you can scale the RHOSP storage layer from tens of terabytes to petabytes, or even exabytes of storage. Red Hat Ceph Storage provides this storage virtualization layer with high availability and high performance while running on commodity hardware. While virtualization might seem like it comes with a performance penalty, Ceph stripes block device images as objects across the cluster, meaning that large Ceph Block Device images have better performance than a standalone disk. Ceph Block devices also support caching, copy-on-write cloning, and copy-on-read cloning for enhanced performance.

For more information about Red Hat Ceph Storage, see Red Hat Ceph Storage.

NOTE

For multi-architecture clouds, Red Hat supports only pre-installed or external Ceph implementation. For more information, see Integrating an Overcloud with an Existing Red Hat Ceph Cluster and Section 7.9, “Configuring the CPU architecture for the overcloud.”
CHAPTER 2. PLANNING YOUR UNDERCLOUD

Before you configure and install director on the undercloud, you must plan your undercloud host to ensure it meets certain requirements.

2.1. CONTAINERIZED UNDERCLOUD

The undercloud is the node that controls the configuration, installation, and management of your final Red Hat OpenStack Platform (RHOSP) environment, which is called the overcloud. The undercloud itself uses OpenStack Platform components in the form of containers to create a toolset called director. This means that the undercloud pulls a set of container images from a registry source, generates configuration for the containers, and runs each OpenStack Platform service as a container. As a result, the undercloud provides a containerized set of services that you can use as a toolset to create and manage your overcloud.

Since both the undercloud and overcloud use containers, both use the same architecture to pull, configure, and run containers. This architecture is based on the OpenStack Orchestration service (heat) for provisioning nodes and uses Ansible to configure services and containers. It is useful to have some familiarity with heat and Ansible to help you troubleshoot issues that you might encounter.

2.2. PREPARING YOUR UNDERCLOUD NETWORKING

The undercloud requires access to two main networks:

- The **Provisioning or Control Plane network** which is the network that director uses to provision your nodes and access them over SSH when executing Ansible configuration. This network also enables SSH access from the undercloud to overcloud nodes. The undercloud contains DHCP services for introspection and provisioning other nodes on this network, which means that no other DHCP services should exist on this network. The director configures the interface for this network.

- The **External network**, which enables access to OpenStack Platform repositories, container image sources, and other servers such as DNS servers or NTP servers. Use this network for standard access the undercloud from your workstation. You must manually configure an interface on the undercloud to access the external network.

The undercloud requires a minimum of 2 x 1 Gbps Network Interface Cards: one for the **Provisioning or Control Plane network** and one for the **External network**.

When you plan your network, review the following guidelines:

- Red Hat recommends using one network for provisioning and the control plane and another network for the data plane.

- The provisioning and control plane network can be configured on top of a Linux bond or on individual interfaces. If you use a Linux bond, configure it as an active-backup bond type.
  - On non-controller nodes, the amount of traffic is relatively low on provisioning and control plane networks, and they do not require high bandwidth or load balancing.
  - On Controllers, the provisioning and control plane networks need additional bandwidth. The reason for increased bandwidth is that Controllers serve many nodes in other roles. More bandwidth is also required when frequent changes are made to the environment.
For best performance, Controllers with more than 50 compute nodes—or if more than four bare metal nodes are provisioned simultaneously—should have 4–10 times the bandwidth than the interfaces on the non-controller nodes.

- The undercloud should have a higher bandwidth connection to the provisioning network when more than 50 overcloud nodes are provisioned.
- Do not use the same Provisioning or Control Plane NIC as the one that you use to access the director machine from your workstation. The director installation creates a bridge by using the Provisioning NIC, which drops any remote connections. Use the External NIC for remote connections to the director system.
- The Provisioning network requires an IP range that fits your environment size. Use the following guidelines to determine the total number of IP addresses to include in this range:
  
  - Include at least one temporary IP address for each node that connects to the Provisioning network during introspection.
  - Include at least one permanent IP address for each node that connects to the Provisioning network during deployment.
  - Include an extra IP address for the virtual IP of the overcloud high availability cluster on the Provisioning network.
  - Include additional IP addresses within this range for scaling the environment.
- To prevent a Controller node network card or network switch failure disrupting overcloud services availability, ensure that the keystone admin endpoint is located on a network that uses bonded network cards or networking hardware redundancy. If you move the keystone endpoint to a different network, such as internal_api, ensure that the undercloud can reach the VLAN or subnet. For more information, see the Red Hat Knowledgebase solution How to migrate Keystone Admin Endpoint to internal_api network.

### 2.3. DETERMINING ENVIRONMENT SCALE

Before you install the undercloud, determine the scale of your environment. Include the following factors when you plan your environment:

**How many nodes do you want to deploy in your overcloud?**

The undercloud manages each node within an overcloud. Provisioning overcloud nodes consumes resources on the undercloud. You must provide your undercloud with enough resources to adequately provision and control all of your overcloud nodes.

**How many simultaneous operations do you want the undercloud to perform?**

Most OpenStack services on the undercloud use a set of workers. Each worker performs an operation specific to that service. Multiple workers provide simultaneous operations. The default number of workers on the undercloud is determined by halving the total CPU thread count on the undercloud. In this instance, thread count refers to the number of CPU cores multiplied by the hyper-threading value. For example, if your undercloud has a CPU with 16 threads, then the director services spawn 8 workers by default. Director also uses a set of minimum and maximum caps by default:

<table>
<thead>
<tr>
<th>Service</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>OpenStack Orchestration (heat)</td>
<td>4</td>
<td>24</td>
</tr>
</tbody>
</table>
The undercloud has the following minimum CPU and memory requirements:

- An 8-thread 64-bit x86 processor with support for the Intel 64 or AMD64 CPU extensions. This provides 4 workers for each undercloud service.
- A minimum of 24 GB of RAM.
  - The `ceph-ansible` playbook consumes 1 GB resident set size (RSS) for every 10 hosts that the undercloud deploys. If you want to use a new or existing Ceph cluster in your deployment, you must provision the undercloud RAM accordingly.

To use a larger number of workers, increase the vCPUs and memory of your undercloud using the following recommendations:

- **Minimum**: Use 1.5 GB of memory for each thread. For example, a machine with 48 threads requires 72 GB of RAM to provide the minimum coverage for 24 heat workers and 12 workers for other services.
- **Recommended**: Use 3 GB of memory for each thread. For example, a machine with 48 threads requires 144 GB of RAM to provide the recommended coverage for 24 heat workers and 12 workers for other services.

## 2.4. UNDERCLOUD DISK SIZING

The recommended minimum undercloud disk size is **100 GB** of available disk space on the root disk:

- 20 GB for container images
- 10 GB to accommodate QCOW2 image conversion and caching during the node provisioning process
- 70 GB+ for general usage, logging, metrics, and growth

## 2.5. VIRTUALIZATION SUPPORT

Red Hat only supports a virtualized undercloud on the following platforms:

<table>
<thead>
<tr>
<th>Platform</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kernel-based Virtual Machine (KVM)</td>
<td>Hosted by Red Hat Enterprise Linux, as listed on Certified Red Hat Hypervisors.</td>
</tr>
<tr>
<td>Red Hat Virtualization</td>
<td>Hosted by Red Hat Virtualization 4.x, as listed on Certified Red Hat Hypervisors.</td>
</tr>
<tr>
<td>Microsoft Hyper-V</td>
<td>Hosted by versions of Hyper-V as listed on the Red Hat Customer Portal Certification Catalogue.</td>
</tr>
</tbody>
</table>
Virtual Machine Requirements

Resource requirements for a virtual undercloud are similar to those of a bare metal undercloud. You should consider the various tuning options when provisioning such as network model, guest CPU capabilities, storage backend, storage format, and caching mode.

Network Considerations

Note the following network considerations for your virtualized undercloud:

Power Management

The undercloud VM requires access to the overcloud nodes’ power management devices. This is the IP address set for the pm_addr parameter when registering nodes.

Provisioning network

The NIC used for the provisioning (ctlplane) network requires the ability to broadcast and serve DHCP requests to the NICs of the overcloud’s bare metal nodes. As a recommendation, create a bridge that connects the VM’s NIC to the same network as the bare metal NICs.

NOTE

A common problem occurs when the hypervisor technology blocks the undercloud from transmitting traffic from an unknown address.

- If using Red Hat Enterprise Virtualization, disable anti-mac-spoofing to prevent this.
- If using VMware ESX or ESXi, allow forged transmits to prevent this.

You must power off and on the director VM after you apply these settings. Rebooting the VM is not sufficient.

2.6. CHARACTER ENCODING CONFIGURATION

Red Hat OpenStack Platform has special character encoding requirements as part of the locale settings:

- Use UTF-8 encoding on all nodes. Ensure the LANG environment variable is set to en_US.UTF-8 on all nodes.
- Avoid using non-ASCII characters if you use Red Hat Ansible Tower to automate the creation of Red Hat OpenStack Platform resources.
2.7. CONSIDERATIONS WHEN RUNNING THE UNDERCLOUD WITH A PROXY

Running the undercloud with a proxy has certain limitations, and Red Hat recommends that you use Red Hat Satellite for registry and package management.

However, if your environment uses a proxy, review these considerations to best understand the different configuration methods of integrating parts of Red Hat OpenStack Platform with a proxy and the limitations of each method.

System-wide proxy configuration

Use this method to configure proxy communication for all network traffic on the undercloud. To configure the proxy settings, edit the `/etc/environment` file and set the following environment variables:

- **http_proxy**: The proxy that you want to use for standard HTTP requests.
- **https_proxy**: The proxy that you want to use for HTTPs requests.
- **no_proxy**: A comma-separated list of domains that you want to exclude from proxy communications.

The system-wide proxy method has the following limitations:

- The maximum length of `no_proxy` is 1024 characters due to a fixed size buffer in the `pam_env` PAM module.

**dnf proxy configuration**

Use this method to configure `dnf` to run all traffic through a proxy. To configure the proxy settings, edit the `/etc/dnf/dnf.conf` file and set the following parameters:

- **proxy**: The URL of the proxy server.
- **proxy_username**: The username that you want to use to connect to the proxy server.
- **proxy_password**: The password that you want to use to connect to the proxy server.
- **proxy_auth_method**: The authentication method used by the proxy server.

For more information about these options, run `man dnf.conf`.

The `dnf` proxy method has the following limitations:

- This method provides proxy support only for `dnf`.
- The `dnf` proxy method does not include an option to exclude certain hosts from proxy communication.

**Red Hat Subscription Manager proxy**
Use this method to configure Red Hat Subscription Manager to run all traffic through a proxy. To configure the proxy settings, edit the `/etc/rhsm/rhsm.conf` file and set the following parameters:

**proxy_hostname**
- Host for the proxy.

**proxy_scheme**
- The scheme for the proxy when writing out the proxy to repo definitions.

**proxy_port**
- The port for the proxy.

**proxy_username**
- The username that you want to use to connect to the proxy server.

**proxy_password**
- The password to use for connecting to the proxy server.

**no_proxy**
- A comma-separated list of hostname suffixes for specific hosts that you want to exclude from proxy communication.

For more information about these options, run `man rhsm.conf`.

The Red Hat Subscription Manager proxy method has the following limitations:

- This method provides proxy support only for Red Hat Subscription Manager.
- The values for the Red Hat Subscription Manager proxy configuration override any values set for the system-wide environment variables.

**Transparent proxy**

If your network uses a transparent proxy to manage application layer traffic, you do not need to configure the undercloud itself to interact with the proxy because proxy management occurs automatically. A transparent proxy can help overcome limitations associated with client-based proxy configuration in Red Hat OpenStack Platform.

### 2.8. UNDERCLOUD REPOSITORIES

Red Hat OpenStack Platform 17.0-beta runs on Red Hat Enterprise Linux 9.0. As a result, you must lock the content from these repositories to the respective Red Hat Enterprise Linux version.

**NOTE**

If you synchronize repositories with Red Hat Satellite, you can enable specific versions of the Red Hat Enterprise Linux repositories. However, the repository remains the same despite the version you choose. For example, you can enable the 9.0 version of the BaseOS repository, but the repository name is still `rhel-9-for-x86_64-baseos-eus-rpms` despite the specific version you choose.
WARNING

Any repositories outside the ones specified here are not supported. Unless recommended, do not enable any other products or repositories outside the ones listed in the following tables or else you might encounter package dependency issues. Do not enable Extra Packages for Enterprise Linux (EPEL).

Core repositories

The following table lists core repositories for installing the undercloud.

<table>
<thead>
<tr>
<th>Name</th>
<th>Repository</th>
<th>Description of requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red Hat Enterprise Linux 9 for x86_64 - BaseOS (RPMs)</td>
<td>rhel-9-for-x86_64-baseos-eus-rpms</td>
<td>Base operating system repository for x86_64 systems.</td>
</tr>
<tr>
<td>Extended Update Support (EUS)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Red Hat Enterprise Linux 9 for x86_64 - AppStream (RPMs)</td>
<td>rhel-9-for-x86_64-appstream-eus-rpms</td>
<td>Contains Red Hat OpenStack Platform dependencies.</td>
</tr>
<tr>
<td>Red Hat Enterprise Linux 9 for x86_64 - High Availability (RPMs) Extended Update Support (EUS)</td>
<td>rhel-9-for-x86_64-highavailability-eus-rpms</td>
<td>High availability tools for Red Hat Enterprise Linux. Used for Controller node high availability.</td>
</tr>
<tr>
<td>Red Hat OpenStack Platform Beta for RHEL 9 (RPMs)</td>
<td>openstack-beta-for-rhel-9-x86_64-rpms</td>
<td>Beta Red Hat OpenStack Platform repository, which contains packages for Red Hat OpenStack Platform director.</td>
</tr>
<tr>
<td>Red Hat Fast Datapath for RHEL 9 (RPMS)</td>
<td>fast-datapath-for-rhel-9-x86_64-rpms</td>
<td>Provides Open vSwitch (OVS) packages for OpenStack Platform.</td>
</tr>
</tbody>
</table>
CHAPTER 3. UNDERSTANDING HEAT TEMPLATES

The custom configurations in this guide use heat templates and environment files to define certain aspects of the overcloud. This chapter provides a basic introduction to heat templates so that you can understand the structure and format of these templates in the context of Red Hat OpenStack Platform director.

3.1. HEAT TEMPLATES

Director uses Heat Orchestration Templates (HOT) as the template format for the overcloud deployment plan. Templates in HOT format are usually expressed in YAML format. The purpose of a template is to define and create a stack, which is a collection of resources that OpenStack Orchestration (heat) creates, and the configuration of the resources. Resources are objects in Red Hat OpenStack Platform (RHOSP) and can include compute resources, network configuration, security groups, scaling rules, and custom resources.

A heat template has three main sections:

parameters

These are settings passed to heat, which provide a way to customize a stack, and any default values for parameters without passed values. These settings are defined in the parameters section of a template.

resources

Use the resources section to define the resources, such as compute instances, networks, and storage volumes, that you can create when you deploy a stack using this template. Red Hat OpenStack Platform (RHOSP) contains a set of core resources that span across all components. These are the specific objects to create and configure as part of a stack. RHOSP contains a set of core resources that span across all components. These are defined in the resources section of a template.

outputs

Use the outputs section to declare the output parameters that your cloud users can access after the stack is created. Your cloud users can use these parameters to request details about the stack, such as the IP addresses of deployed instances, or URLs of web applications deployed as part of the stack.

Example of a basic heat template:

```
heat_template_version: 2013-05-23

description: > A very basic Heat template.

parameters:
  key_name:
    type: string
    default: lars
    description: Name of an existing key pair to use for the instance
  flavor:
    type: string
    default: m1.small
    description: Instance type for the instance to be created
  image:
    type: string
    default: cirros
    description: ID or name of the image to use for the instance
```
resources:
  my_instance:
    type: OS::Nova::Server
    properties:
      name: My Cirros Instance
      image: { get_param: image }
      flavor: { get_param: flavor }
      key_name: { get_param: key_name }

output:
  instance_name:
    description: Get the instance's name
    value: { get_attr: [ my_instance, name ] }

This template uses the resource type `type: OS::Nova::Server` to create an instance called `my_instance` with a particular flavor, image, and key that the cloud user specifies. The stack can return the value of `instance_name`, which is called `My Cirros Instance`.

When heat processes a template, it creates a stack for the template and a set of child stacks for resource templates. This creates a hierarchy of stacks that descend from the main stack that you define with your template. You can view the stack hierarchy with the following command:

```
$ openstack stack list --nested
```

### 3.2. ENVIRONMENT FILES

An environment file is a special type of template that you can use to customize your heat templates. You can include environment files in the deployment command, in addition to the core heat templates. An environment file contains three main sections:

- **resource_registry**
  - This section defines custom resource names, linked to other heat templates. This provides a method to create custom resources that do not exist within the core resource collection.

- **parameters**
  - These are common settings that you apply to the parameters of the top-level template. For example, if you have a template that deploys nested stacks, such as resource registry mappings, the parameters apply only to the top-level template and not to templates for the nested resources.

- **parameter Defaults**
  - These parameters modify the default values for parameters in all templates. For example, if you have a heat template that deploys nested stacks, such as resource registry mappings, the parameter defaults apply to all templates.

**IMPORTANT**

Use `parameter_defaults` instead of `parameters` when you create custom environment files for your overcloud, so that your parameters apply to all stack templates for the overcloud.

Example of a basic environment file:

```
resource_registry:
```
This environment file (my_env.yaml) might be included when creating a stack from a certain heat template (my_template.yaml). The my_env.yaml file creates a new resource type called OS::Nova::Server::MyServer. The myserver.yaml file is a heat template file that provides an implementation for this resource type that overrides any built-in ones. You can include the OS::Nova::Server::MyServer resource in your my_template.yaml file.

MyIP applies a parameter only to the main heat template that deploys with this environment file. In this example, MyIP applies only to the parameters in my_template.yaml.

NetworkName applies to both the main heat template, my_template.yaml, and the templates that are associated with the resources that are included in the main template, such as the OS::Nova::Server::MyServer resource and its myserver.yaml template in this example.

NOTE
For RHOSP to use the heat template file as a custom template resource, the file extension must be either .yaml or .template.

3.3. CORE OVERCLOUD HEAT TEMPLATES

Director contains a core heat template collection and environment file collection for the overcloud. This collection is stored in /usr/share/openstack-tripleo-heat-templates.

The main files and directories in this template collection are:

overcloud.j2.yaml
This is the main template file that director uses to create the overcloud environment. This file uses Jinja2 syntax to iterate over certain sections in the template to create custom roles. The Jinja2 formatting is rendered into YAML during the overcloud deployment process.

overcloud-resource-registry-puppet.j2.yaml
This is the main environment file that director uses to create the overcloud environment. It provides a set of configurations for Puppet modules stored on the overcloud image. After director writes the overcloud image to each node, heat starts the Puppet configuration for each node by using the resources registered in this environment file. This file uses Jinja2 syntax to iterate over certain sections in the template to create custom roles. The Jinja2 formatting is rendered into YAML during the overcloud deployment process.

roles_data.yaml
This file contains the definitions of the roles in an overcloud and maps services to each role.

network_data.yaml
This file contains the definitions of the networks in an overcloud and their properties such as subnets, allocation pools, and VIP status. The default network_data.yaml file contains the default networks: External, Internal Api, Storage, Storage Management, Tenant, and Management. You can create a custom network_data.yaml file and add it to your openstack overcloud deploy command with the -n option.

plan-environment.yaml
This file contains the definitions of the metadata for your overcloud plan. This includes the plan name, main template to use, and environment files to apply to the overcloud.

**capabilities-map.yaml**

This file contains a mapping of environment files for an overcloud plan.

**deployment**

This directory contains heat templates. The `overcloud-resource-registry-puppet.j2.yaml` environment file uses the files in this directory to drive the application of the Puppet configuration on each node.

**environments**

This directory contains additional heat environment files that you can use for your overcloud creation. These environment files enable extra functions for your resulting Red Hat OpenStack Platform (RHOSP) environment. For example, the directory contains an environment file to enable Cinder NetApp backend storage (`cinder-netapp-config.yaml`).

**network**

This directory contains a set of heat templates that you can use to create isolated networks and ports.

**puppet**

This directory contains templates that control Puppet configuration. The `overcloud-resource-registry-puppet.j2.yaml` environment file uses the files in this directory to drive the application of the Puppet configuration on each node.

**puppet/services**

This directory contains legacy heat templates for all service configuration. The templates in the `deployment` directory replace most of the templates in the `puppet/services` directory.

**extraconfig**

This directory contains templates that you can use to enable extra functionality.

**firstboot**

This directory contains example `first_boot` scripts that director uses when initially creating the nodes.

### 3.4. PLAN ENVIRONMENT METADATA

You can define metadata for your overcloud plan in a plan environment metadata file. Director applies metadata during the overcloud creation, and when importing and exporting your overcloud plan.

A plan environment metadata file includes the following parameters:

**version**

The version of the template.

**name**

The name of the overcloud plan and the container in OpenStack Object Storage (swift) that you want to use to store the plan files.

**template**

The core parent template that you want to use for the overcloud deployment. This is most often `overcloud.yaml`, which is the rendered version of the `overcloud.yaml.j2` template.

**environments**

Defines a list of environment files that you want to use. Specify the name and relative locations of each environment file with the `path` sub-parameter.
parameter_defaults
A set of parameters that you want to use in your overcloud. This functions in the same way as the `parameter_defaults` section in a standard environment file.

passwords
A set of parameters that you want to use for overcloud passwords. This functions in the same way as the `parameter_defaults` section in a standard environment file. Usually, the director populates this section automatically with randomly generated passwords.

The following snippet is an example of the syntax of a plan environment file:

```yaml
version: 1.0
name: myovercloud
description: 'My Overcloud Plan'
template: overcloud.yaml
environments:
  - path: overcloud-resource-registry-puppet.yaml
  - path: environments/containers-default-parameters.yaml
  - path: user-environment.yaml
parameter_defaults:
  ControllerCount: 1
  ComputeCount: 1
  OvercloudComputeFlavor: compute
  OvercloudControllerFlavor: control
workflow_parameters:
  tripleo.derive_params.v1.derive_parameters:
    num_phy_cores_per_numa_node_for_pmd: 2
```

You can include the plan environment metadata file with the `openstack overcloud deploy` command with the `-p` option:

```bash
(undercloud) $ openstack overcloud deploy --templates \
  -p /my-plan-environment.yaml \
  [OTHER OPTIONS]
```

You can also view plan metadata for an existing overcloud plan with the following command:

```bash
(undercloud) $ openstack object save overcloud plan-environment.yaml --file -
```

### 3.5. INCLUDING ENVIRONMENT FILES IN OVERCLOUD CREATION

Include environment files in the deployment command with the `-e` option. You can include as many environment files as necessary. However, the order of the environment files is important as the parameters and resources that you define in subsequent environment files take precedence. For example, you have two environment files that contain a common resource type `OS::TripleO::NodeExtraConfigPost`, and a common parameter `TimeZone`:

```
environment-file-1.yaml

resource_registry:
  OS::TripleO::NodeExtraConfigPost: /home/stack/templates/template-1.yaml
```

```
environment-file-2.yaml

resource_registry:
  OS::TripleO::NodeExtraConfigPost: /home/stack/templates/template-2.yaml
```
parameter_defaults:
  RabbitFDLimit: 65536
  TimeZone: 'Japan'

environment-file-2.yaml

resource_registry:
  OS::TripleO::NodeExtraConfigPost: /home/stack/templates/template-2.yaml

parameter_defaults:
  TimeZone: 'Hongkong'

You include both environment files in the deployment command:

```
$ openstack overcloud deploy --templates -e environment-file-1.yaml -e environment-file-2.yaml
```

The `openstack overcloud deploy` command runs through the following process:

1. Loads the default configuration from the core heat template collection.
2. Applies the configuration from `environment-file-1.yaml`, which overrides any common settings from the default configuration.
3. Applies the configuration from `environment-file-2.yaml`, which overrides any common settings from the default configuration and `environment-file-1.yaml`.

This results in the following changes to the default configuration of the overcloud:

- `OS::TripleO::NodeExtraConfigPost` resource is set to `/home/stack/templates/template-2.yaml`, as defined in `environment-file-2.yaml`.
- `TimeZone` parameter is set to `Hongkong`, as defined in `environment-file-2.yaml`.
- `RabbitFDLimit` parameter is set to `65536`, as defined in `environment-file-1.yaml`. `environment-file-2.yaml` does not change this value.

You can use this mechanism to define custom configuration for your overcloud without values from multiple environment files conflicting.

### 3.6. USING CUSTOMIZED CORE HEAT TEMPLATES

When creating the overcloud, director uses a core set of heat templates located in `/usr/share/openstack-tripleo-heat-templates`. If you want to customize this core template collection, use the following Git workflows to manage your custom template collection:

**Procedure**

- Create an initial Git repository that contains the heat template collection:
  
  a. Copy the template collection to the `/home/stack/templates` directory:

  ```bash
  $ cd ~/templates
  $ cp -r /usr/share/openstack-tripleo-heat-templates .
  ```
b. Change to the custom template directory and initialize a Git repository:

   ```
   $ cd ~/templates/openstack-tripleo-heat-templates
   $ git init .
   ```

c. Configure your Git user name and email address:

   ```
   $ git config --global user.name "<USER_NAME>"
   $ git config --global user.email "<EMAIL_ADDRESS>"
   ```

   Replace `<USER_NAME>` with the user name that you want to use. Replace `<EMAIL_ADDRESS>` with your email address.

d. Stage all templates for the initial commit:

   ```
   $ git add *
   ```

e. Create an initial commit:

   ```
   $ git commit -m "Initial creation of custom core heat templates"
   ```

   This creates an initial `master` branch that contains the latest core template collection. Use this branch as the basis for your custom branch and merge new template versions to this branch.

   - Use a custom branch to store your changes to the core template collection. Use the following procedure to create a `my-customizations` branch and add customizations:

     a. Create the `my-customizations` branch and switch to it:

        ```
        $ git checkout -b my-customizations
        ```

     b. Edit the files in the custom branch.

     c. Stage the changes in git:

        ```
        $ git add [edited files]
        ```

     d. Commit the changes to the custom branch:

        ```
        $ git commit -m "[Commit message for custom changes]"
        ```

        This adds your changes as commits to the `my-customizations` branch. When the `master` branch updates, you can rebase `my-customizations` off `master`, which causes git to add these commits on to the updated template collection. This helps track your customizations and replay them on future template updates.

   - When you update the undercloud, the `openstack-tripleo-heat-templates` package might also receive updates. When this occurs, you must also update your custom template collection:

     a. Save the `openstack-tripleo-heat-templates` package version as an environment variable:

        ```
        $ export PACKAGE=$(rpm -qV openstack-tripleo-heat-templates)
        ```
b. Change to your template collection directory and create a new branch for the updated templates:

   ```bash
   $ cd ~/templates/openstack-tripleo-heat-templates
   $ git checkout -b $PACKAGE
   ```

c. Remove all files in the branch and replace them with the new versions:

   ```bash
   $ git rm -rf *
   $ cp -r /usr/share/openstack-tripleo-heat-templates/* .
   ```

d. Add all templates for the initial commit:

   ```bash
   $ git add *
   ```

e. Create a commit for the package update:

   ```bash
   $ git commit -m "Updates for $PACKAGE"
   ```

f. Merge the branch into master. If you use a Git management system (such as GitLab), use the management workflow. If you use git locally, merge by switching to the **master** branch and run the **git merge** command:

   ```bash
   $ git checkout master
   $ git merge $PACKAGE
   ```

The **master** branch now contains the latest version of the core template collection. You can now rebase the **my-customization** branch from this updated collection.

* Update the **my-customization** branch:

  a. Change to the **my-customizations** branch:

     ```bash
     $ git checkout my-customizations
     ```

  b. Rebase the branch off **master**:

     ```bash
     $ git rebase master
     ```

     This updates the **my-customizations** branch and replays the custom commits made to this branch.

  c. Resolve any conflicts that occur during the rebase:

     a. Check which files contain the conflicts:

        ```bash
        $ git status
        ```

     b. Resolve the conflicts of the template files identified.

     c. Add the resolved files:

        ```bash
        $ git add [resolved files]
        ```
d. Continue the rebase:

```bash
$ git rebase --continue
```

- Deploy the custom template collection:
  a. Ensure that you have switched to the **my-customization** branch:

```bash
git checkout my-customizations
```

b. Run the `openstack overcloud deploy` command with the `--templates` option to specify your local template directory:

```bash
$ openstack overcloud deploy --templates /home/stack/templates/openstack-tripleo-heat-templates [OTHER OPTIONS]
```

**NOTE**

Director uses the default template directory (`/usr/share/openstack-tripleo-heat-templates`) if you specify the `--templates` option without a directory.

**IMPORTANT**

Red Hat recommends using the methods in Chapter 5, *Configuration hooks* instead of modifying the heat template collection.

### 3.7. JINJA2 RENDERING

The core heat templates in `/usr/share/openstack-tripleo-heat-templates` contain a number of files that have the `j2.yaml` file extension. These files contain Jinja2 template syntax and director renders these files to their static heat template equivalents that have the `.yaml` extension. For example, the main `overcloud.j2.yaml` file renders into `overcloud.yaml`. Director uses the resulting `overcloud.yaml` file.

The Jinja2-enabled heat templates use Jinja2 syntax to create parameters and resources for iterative values. For example, the `overcloud.j2.yaml` file contains the following snippet:

```yaml
parameters:
    ...
    {% for role in roles %}
    ...
    {{role.name}}Count:
    description: Number of {{role.name}} nodes to deploy
    type: number
    default: {{role.CountDefault|default(0)}}
    ...
    {% endfor %}

When director renders the Jinja2 syntax, director iterates over the roles defined in the `roles_data.yaml` file and populates the `{{role.name}}Count` parameter with the name of the role. The default `roles_data.yaml` file contains five roles and results in the following parameters from our example:

- **ControllerCount**
- ComputeCount
- BlockStorageCount
- ObjectStorageCount
- CephStorageCount

A example rendered version of the parameter looks like this:

```yaml
parameters:
  ControllerCount:
    description: Number of Controller nodes to deploy
    type: number
    default: 1
```

Director renders Jinja2-enabled templates and environment files only from within the directory of your core heat templates. The following use cases demonstrate the correct method to render the Jinja2 templates.

Use case 1: Default core templates

Template directory: `/usr/share/openstack-tripleo-heat-templates/`


Director uses the default core template location (`--templates`) and renders the `network-isolation.j2.yaml` file into `network-isolation.yaml`. When you run the `openstack overcloud deploy` command, use the `-e` option to include the name of the rendered `network-isolation.yaml` file.

```
$ openstack overcloud deploy --templates
  -e /usr/share/openstack-tripleo-heat-templates/environments/network-isolation.yaml
```

Use case 2: Custom core templates

Template directory: `/home/stack/tripleo-heat-templates`


Director uses a custom core template location (`--templates /home/stack/tripleo-heat-templates`) and director renders the `network-isolation.j2.yaml` file within the custom core templates into `network-isolation.yaml`. When you run the `openstack overcloud deploy` command, use the `-e` option to include the name of the rendered `network-isolation.yaml` file.

```
$ openstack overcloud deploy --templates /home/stack/tripleo-heat-templates
  -e /home/stack/tripleo-heat-templates/environments/network-isolation.yaml
```

Use case 3: Incorrect usage

Template directory: `/usr/share/openstack-tripleo-heat-templates/`

Director uses a custom core template location (--templates /home/stack/tripleo-heat-templates). However, the chosen network-isolation.j2.yaml is not located within the custom core templates, so it will not render into network-isolation.yaml. This causes the deployment to fail.

Processing Jinja2 syntax into static templates

Use the process-templates.py script to render the Jinja2 syntax of the openstack-tripleo-heat-templates into a set of static templates. To render a copy of the openstack-tripleo-heat-templates collection with the process-templates.py script, change to the openstack-tripleo-heat-templates directory:

```
$ cd /usr/share/openstack-tripleo-heat-templates
```

Run the process-templates.py script, which is located in the tools directory, along with the -o option to define a custom directory to save the static copy:

```
$ ./tools/process-templates.py -o ~/openstack-tripleo-heat-templates-rendered
```

This converts all Jinja2 templates to their rendered YAML versions and saves the results to ~/openstack-tripleo-heat-templates-rendered.
CHAPTER 4. HEAT PARAMETERS

Each heat template in the director template collection contains a parameters section. This section contains definitions for all parameters specific to a particular overcloud service. This includes the following:

- `overcloud.j2.yaml` - Default base parameters
- `roles_data.yaml` - Default parameters for composable roles
- `deployment/*.yaml` - Default parameters for specific services

You can modify the values for these parameters using the following method:

1. Create an environment file for your custom parameters.
2. Include your custom parameters in the `parameter_defaults` section of the environment file.
3. Include the environment file with the `openstack overcloud deploy` command.

4.1. EXAMPLE 1: CONFIGURING THE TIME ZONE

The Heat template for setting the timezone (`puppet/services/time/timezone.yaml`) contains a `TimeZone` parameter. If you leave the `TimeZone` parameter blank, the overcloud sets the time to UTC as a default.

To obtain lists of timezones run the `timedatectl list-timezones` command. The following example command retrieves the timezones for Asia:

```
$ sudo timedatectl list-timezones|grep "Asia"
```

After you identify your timezone, set the `TimeZone` parameter in an environment file. The following example environment file sets the value of `TimeZone` to `Asia/Tokyo`:

```
parameter_defaults:
    TimeZone: 'Asia/Tokyo'
```

4.2. EXAMPLE 2: CONFIGURING RABBITMQ FILE DESCRIPTOR LIMIT

For certain configurations, you might need to increase the file descriptor limit for the RabbitMQ server. Use the `deployment/rabbitmq/rabbitmq-container-puppet.yaml` heat template to set a new limit in the `RabbitFDLimit` parameter. Add the following entry to an environment file:

```
parameter_defaults:
    RabbitFDLimit: 65536
```

4.3. EXAMPLE 3: ENABLING AND DISABLING PARAMETERS

You might need to initially set a parameter during a deployment, then disable the parameter for a future deployment operation, such as updates or scaling operations. For example, to include a custom RPM during the overcloud creation, include the following entry in an environment file:
To disable this parameter from a future deployment, it is not sufficient to remove the parameter. Instead, you must set the parameter to an empty value:

```
    parameter_defaults:
        DeployArtifactURLs: []
```

This ensures the parameter is no longer set for subsequent deployments operations.

### 4.4. EXAMPLE 4: ROLE-BASED PARAMETERS

Use the `[ROLE]Parameters` parameters, replacing `[ROLE]` with a composable role, to set parameters for a specific role.

For example, director configures `sshd` on both Controller and Compute nodes. To set a different `sshd` parameters for Controller and Compute nodes, create an environment file that contains both the `ControllerParameters` and `ComputeParameters` parameter and set the `sshd` parameters for each specific role:

```
    parameter_defaults:
        ControllerParameters:
            BannerText: "This is a Controller node"
        ComputeParameters:
            BannerText: "This is a Compute node"
```

### 4.5. IDENTIFYING PARAMETERS THAT YOU WANT TO MODIFY

Red Hat OpenStack Platform director provides many parameters for configuration. In some cases, you might experience difficulty identifying a certain option that you want to configure, and the corresponding director parameter. If there is an option that you want to configure with director, use the following workflow to identify and map the option to a specific overcloud parameter:

1. Identify the option that you want to configure. Make a note of the service that uses the option.

2. Check the corresponding Puppet module for this option. The Puppet modules for Red Hat OpenStack Platform are located under `/etc/puppet/modules` on the director node. Each module corresponds to a particular service. For example, the `keystone` module corresponds to the OpenStack Identity (keystone).
   - If the Puppet module contains a variable that controls the chosen option, move to the next step.
   - If the Puppet module does not contain a variable that controls the chosen option, no hieradata exists for this option. If possible, you can set the option manually after the overcloud completes deployment.

3. Check the core heat template collection for the Puppet variable in the form of hieradata. The templates in `deployment/*` usually correspond to the Puppet modules of the same services. For example, the `deployment/keystone/keystone-container-puppet.yaml` template provides hieradata to the `keystone` module.
If the heat template sets hieradata for the Puppet variable, the template should also disclose the director-based parameter that you can modify.

If the heat template does not set hieradata for the Puppet variable, use the configuration hooks to pass the hieradata using an environment file. See Section 5.5, “Puppet: Customizing hieradata for roles” for more information on customizing hieradata.

Procedure

1. To change the notification format for OpenStack Identity (keystone), use the workflow and complete the following steps:
   a. Identify the OpenStack parameter that you want to configure (notification_format).
   b. Search the keystone Puppet module for the notification_format setting:

   ```bash
   $ grep notification_format /etc/puppet/modules/keystone/manifests/*
   ```

   In this case, the keystone module manages this option using the keystone::notification_format variable.
   c. Search the keystone service template for this variable:

   ```bash
   $ grep "keystone::notification_format" /usr/share/openstack-tripleo-heat-templates/deployment/keystone/keystone-container-puppet.yaml
   ```

   The output shows that director uses the KeystoneNotificationFormat parameter to set the keystone::notification_format hieradata.

   The following table shows the eventual mapping:

<table>
<thead>
<tr>
<th>Director parameter</th>
<th>Puppet hieradata</th>
<th>OpenStack Identity (keystone) option</th>
</tr>
</thead>
<tbody>
<tr>
<td>KeystoneNotificationFormat</td>
<td>keystone::notification_format</td>
<td>notification_format</td>
</tr>
</tbody>
</table>

   You set the KeystoneNotificationFormat in an overcloud environment file, which then sets the notification_format option in the keystone.conf file during the overcloud configuration.
CHAPTER 5. CONFIGURATION HOOKS

Use configuration hooks to inject your own custom configuration functions into the overcloud deployment process. You can create hooks to inject custom configuration before and after the main overcloud services configuration, and hooks for modifying and including Puppet-based configuration.

5.1. FIRST BOOT: CUSTOMIZING FIRST BOOT CONFIGURATION

Director uses `cloud-init` to perform configuration on all nodes after the initial creation of the overcloud. You can use the `NodeUserData` resource types to call `cloud-init`.

- **OS::TripleO::NodeUserData**
  - `cloud-init` configuration to apply to all nodes.
- **OS::TripleO::Controller::NodeUserData**
  - `cloud-init` configuration to apply to Controller nodes.
- **OS::TripleO::Compute::NodeUserData**
  - `cloud-init` configuration to apply to Compute nodes.
- **OS::TripleO::CephStorage::NodeUserData**
  - `cloud-init` configuration to apply to Ceph Storage nodes.
- **OS::TripleO::ObjectStorage::NodeUserData**
  - `cloud-init` configuration to apply to Object Storage nodes.
- **OS::TripleO::BlockStorage::NodeUserData**
  - `cloud-init` configuration to apply to Block Storage nodes.
- **OS::TripleO::[ROLE]::NodeUserData**
  - `cloud-init` configuration to apply to custom nodes. Replace `[ROLE]` with the composable role name.

In this example, update the nameserver with a custom IP address on all nodes:

**Procedure**

1. Create a basic heat template `~/templates/nameserver.yaml` that runs a script to append the `resolv.conf` file on each node with a specific nameserver. You can use the `OS::TripleO::MultipartMime` resource type to send the configuration script.

   ```yaml
   heat_template_version: 2014-10-16
   description: >
     Extra hostname configuration
   resources:
     user_data:
       type: OS::Heat::MultipartMime
       properties:
         parts:
           - config: {get_resource: nameserver_config}
   nameserver_config:
     type: OS::Heat::SoftwareConfig
     properties:
       config: |
   ```
#!/bin/bash

echo "nameserver 192.168.1.1" >> /etc/resolv.conf

outputs:
  OS::stack_id:
    value: {get_resource: userdata}

2. Create an environment file ~/templates/firstboot.yaml that registers your heat template as the OS::TripleO::NodeUserData resource type.

resource_registry:
  OS::TripleO::NodeUserData: /home/stack/templates/nameserver.yaml

3. To add the first boot configuration to your overcloud, add the environment file to the stack, along with your other environment files:

   $ openstack overcloud deploy --templates \
   ... \
   -e /home/stack/templates/firstboot.yaml \ 
   ...

   This adds the configuration to all nodes when they are first created and boot for the first time. Subsequent inclusion of these templates, such as updating the overcloud stack, does not run these scripts.

   **IMPORTANT**

   You can only register the NodeUserData resources to one heat template per resource. Subsequent usage overrides the heat template to use.

### 5.2. PRE-CONFIGURATION: CUSTOMIZING SPECIFIC OVERCLOUD ROLES

The overcloud uses Puppet for the core configuration of OpenStack components. Director provides a set of hooks that you can use to perform custom configuration for specific node roles after the first boot completes and before the core configuration begins. These hooks include:

   **IMPORTANT**

   Previous versions of this document used the OS::TripleO::Tasks::*PreConfig resources to provide pre-configuration hooks on a per role basis. The heat template collection requires dedicated use of these hooks, which means that you should not use them for custom use. Instead, use the OS::TripleO::*ExtraConfigPre hooks outlined here.

**OS::TripleO::ControllerExtraConfigPre**

Additional configuration applied to Controller nodes before the core Puppet configuration.

**OS::TripleO::ComputeExtraConfigPre**

Additional configuration applied to Compute nodes before the core Puppet configuration.

**OS::TripleO::CephStorageExtraConfigPre**

Additional configuration applied to Ceph Storage nodes before the core Puppet configuration.

**OS::TripleO::ObjectStorageExtraConfigPre**

Additional configuration applied to Object Storage nodes before the core Puppet configuration.
Additional configuration applied to Object Storage nodes before the core Puppet configuration.

**OS::TripleO::BlockStorageExtraConfigPre**

Additional configuration applied to Block Storage nodes before the core Puppet configuration.

**OS::TripleO::[ROLE]ExtraConfigPre**

Additional configuration applied to custom nodes before the core Puppet configuration. Replace **[ROLE]** with the composable role name.

In this example, append the `resolv.conf` file on all nodes of a particular role with a variable nameserver:

**Procedure**

1. Create a basic heat template `~/templates/nameserver.yaml` that runs a script to write a variable nameserver to the `resolv.conf` file of a node:

```yaml
heat_template_version: 2014-10-16

description: >
    Extra hostname configuration

parameters:
    server:
        type: string
    nameserver_ip:
        type: string
    DeployIdentifier:
        type: string

resources:
    CustomExtraConfigPre:
        type: OS::Heat::SoftwareConfig
        properties:
            group: script
            config:
                str_replace:
                    template: |
                    #!/bin/sh
                    echo "nameserver _NAMESERVER_IP_" > /etc/resolv.conf
                    params:
                        _NAMESERVER_IP_: {get_param: nameserver_ip}

    CustomExtraDeploymentPre:
        type: OS::Heat::SoftwareDeployment
        properties:
            server: {get_param: server}
            config: {get_resource: CustomExtraConfigPre}
            actions: ['CREATE', 'UPDATE']
            input_values:
                deploy_identifier: {get_param: DeployIdentifier}

outputs:
    deploy_stdout:
        description: Deployment reference, used to trigger pre-deploy on changes
        value: {get_attr: [CustomExtraDeploymentPre, deploy_stdout]}
```
In this example, the resources section contains the following parameters:

**CustomExtraConfigPre**
This defines a software configuration. In this example, we define a Bash script and heat replaces \_\_NAMESERVER\_\_IP\_\_ with the value stored in the nameserver_ip parameter.

**CustomExtraDeploymentPre**
This executes a software configuration, which is the software configuration from the CustomExtraConfigPre resource. Note the following:

- The config parameter references the CustomExtraConfigPre resource so that heat knows which configuration to apply.

- The server parameter retrieves a map of the overcloud nodes. This parameter is provided by the parent template and is mandatory in templates for this hook.

- The actions parameter defines when to apply the configuration. In this case, you want to apply the configuration when the overcloud is created. Possible actions include CREATE, UPDATE, DELETE, SUSPEND, and RESUME.

- input_values contains a parameter called deploy_identifier, which stores the DeployIdentifier from the parent template. This parameter provides a timestamp to the resource for each deployment update to ensure that the resource reapplies on subsequent overcloud updates.

2. Create an environment file `~/templates/pre_config.yaml` that registers your heat template to the role-based resource type. For example, to apply the configuration only to Controller nodes, use the ControllerExtraConfigPre hook:

```
resource_registry:
  OS::TripleO::ControllerExtraConfigPre: /home/stack/templates/nameserver.yaml

parameter_defaults:
  nameserver_ip: 192.168.1.1
```

3. Add the environment file to the stack, along with your other environment files:

```
$ openstack overcloud deploy --templates \
... \
-e /home/stack/templates/pre_config.yaml \
... 
```

This applies the configuration to all Controller nodes before the core configuration begins on either the initial overcloud creation or subsequent updates.

**IMPORTANT**
You can register each resource to only one heat template per hook. Subsequent usage overrides the heat template to use.

### 5.3. PRE-CONFIGURATION: CUSTOMIZING ALL OVERCLOUD ROLES
The overcloud uses Puppet for the core configuration of OpenStack components. Director provides a hook that you can use to configure all node types after the first boot completes and before the core configuration begins:

**OS::TripleO::NodeExtraConfig**

Additional configuration applied to all nodes roles before the core Puppet configuration.

In this example, append the `resolv.conf` file on each node with a variable nameserver:

**Procedure**

1. Create a basic heat template `~/templates/nameserver.yaml` that runs a script to append the `resolv.conf` file of each node with a variable nameserver:

   ```yaml
   heat_template_version: 2014-10-16
   
   description: >
   Extra hostname configuration
   
   parameters:
   server:
     type: string
   nameserver_ip:
     type: string
   DeployIdentifier:
     type: string
   
   resources:
   CustomExtraConfigPre:
     type: OS::Heat::SoftwareConfig
     properties:
       group: script
       config:
         str_replace:
           template: |
           #!/bin/sh
           echo "nameserver _NAMESERVER_IP_" >> /etc/resolv.conf
           params:
           _NAMESERVER_IP_: {get_param: nameserver_ip}
   
   CustomExtraDeploymentPre:
     type: OS::Heat::SoftwareDeployment
     properties:
       server: {get_param: server}
       config: {get_resource: CustomExtraConfigPre}
       actions: ['CREATE','UPDATE']
       input_values:
       deploy_identifier: {get_param: DeployIdentifier}
   
   outputs:
   deploy_stdout:
     description: Deployment reference, used to trigger pre-deploy on changes
     value: {get_attr: [CustomExtraDeploymentPre, deploy_stdout]}
   ```

In this example, the `resources` section contains the following parameters:
CustomExtraConfigPre
This parameter defines a software configuration. In this example, you define a Bash script and heat replaces _NAMESERVER_IP_ with the value stored in the nameserver_ip parameter.

CustomExtraDeploymentPre
This parameter executes a software configuration, which is the software configuration from the CustomExtraConfigPre resource. Note the following:

- The config parameter references the CustomExtraConfigPre resource so that heat knows which configuration to apply.
- The server parameter retrieves a map of the overcloud nodes. This parameter is provided by the parent template and is mandatory in templates for this hook.
- The actions parameter defines when to apply the configuration. In this case, you only apply the configuration when the overcloud is created. Possible actions include CREATE, UPDATE, DELETE, SUSPEND, and RESUME.
- The input_values parameter contains a sub-parameter called deploy_identifier, which stores the DeployIdentifier from the parent template. This parameter provides a timestamp to the resource for each deployment update to ensure that the resource reapplies on subsequent overcloud updates.

2. Create an environment file `~/templates/pre_config.yaml` that registers your heat template as the OS::TripleO::NodeExtraConfig resource type.

```yaml
resource_registry:
  OS::TripleO::NodeExtraConfig: /home/stack/templates/nameserver.yaml

parameter_defaults:
  nameserver_ip: 192.168.1.1
```

3. Add the environment file to the stack, along with your other environment files:

```
$ openstack overcloud deploy --templates ...
  ...-e /home/stack/templates/pre_config.yaml ...
```

This applies the configuration to all nodes before the core configuration begins on either the initial overcloud creation or subsequent updates.

**IMPORTANT**
You can register the OS::TripleO::NodeExtraConfig to only one heat template. Subsequent usage overrides the heat template to use.

5.4. POST-CONFIGURATION: CUSTOMIZING ALL OVERCLOUD ROLES
IMPORTANT

Previous versions of this document used the OS::TripleO::Tasks::*PostConfig resources to provide post-configuration hooks on a per role basis. The heat template collection requires dedicated use of these hooks, which means that you should not use them for custom use. Instead, use the OS::TripleO::NodeExtraConfigPost hook outlined here.

A situation might occur where you have completed the creation of your overcloud but you want to add additional configuration to all roles, either on initial creation or on a subsequent update of the overcloud. In this case, use the following post-configuration hook:

OS::TripleO::NodeExtraConfigPost

Additional configuration applied to all nodes roles after the core Puppet configuration.

In this example, append the resolv.conf file on each node with a variable nameserver:

Procedure

1. Create a basic heat template ~/templates/nameserver.yaml that runs a script to append the resolv.conf file of each node with a variable nameserver:

```yaml
heat_template_version: 2014-10-16

description: >
   Extra hostname configuration

parameters:
  servers:
    type: json
  nameserver_ip:
    type: string
  DeployIdentifier:
    type: string
  EndpointMap:
    default: {}
    type: json

resources:
  CustomExtraConfig:
    type: OS::Heat::SoftwareConfig
    properties:
      group: script
      config:
        str_replace:
          template: |
            #!/bin/sh
            echo "nameserver _NAMESERVER_IP_" >> /etc/resolv.conf
          params:
            _NAMESERVER_IP_: {get_param: nameserver_ip}

  CustomExtraDeployments:
    type: OS::Heat::SoftwareDeploymentGroup
    properties:
      servers: {get_param: servers}
```
In this example, the `resources` section contains the following parameters:

**CustomExtraConfig**
This defines a software configuration. In this example, you define a Bash script and heat replaces `_NAMESERVER_IP_` with the value stored in the `nameserver_ip` parameter.

**CustomExtraDeployments**
This executes a software configuration, which is the software configuration from the `CustomExtraConfig` resource. Note the following:

- The `config` parameter references the `CustomExtraConfig` resource so that heat knows which configuration to apply.
- The `servers` parameter retrieves a map of the overcloud nodes. This parameter is provided by the parent template and is mandatory in templates for this hook.
- The `actions` parameter defines when to apply the configuration. In this case, you want apply the configuration when the overcloud is created. Possible actions include `CREATE`, `UPDATE`, `DELETE`, `SUSPEND`, and `RESUME`.
- `input_values` contains a parameter called `deploy_identifier`, which stores the `DeployIdentifier` from the parent template. This parameter provides a timestamp to the resource for each deployment update to ensure that the resource reapplies on subsequent overcloud updates.

2. Create an environment file `~/templates/post_config.yaml` that registers your heat template as the `OS::TripleO::NodeExtraConfigPost` resource type.

```yaml
resource_registry:
OS::TripleO::NodeExtraConfigPost: /home/stack/templates/nameserver.yaml

parameter_defaults:
  nameserver_ip: 192.168.1.1
```

3. Add the environment file to the stack, along with your other environment files:

```
$ openstack overcloud deploy --templates \
  ... \
  -e /home/stack/templates/post_config.yaml \
  ...
```

This applies the configuration to all nodes after the core configuration completes on either initial overcloud creation or subsequent updates.

**IMPORTANT**
You can register the `OS::TripleO::NodeExtraConfigPost` to only one heat template. Subsequent usage overrides the heat template to use.
5.5. PUPPET: CUSTOMIZING HIERADATA FOR ROLES

The heat template collection contains a set of parameters that you can use to pass extra configuration to certain node types. These parameters save the configuration as hieradata for the Puppet configuration on the node:

- **ControllerExtraConfig**
  - Configuration to add to all Controller nodes.
- **ComputeExtraConfig**
  - Configuration to add to all Compute nodes.
- **BlockStorageExtraConfig**
  - Configuration to add to all Block Storage nodes.
- **ObjectStorageExtraConfig**
  - Configuration to add to all Object Storage nodes.
- **CephStorageExtraConfig**
  - Configuration to add to all Ceph Storage nodes.
- **[ROLE]ExtraConfig**
  - Configuration to add to a composable role. Replace [ROLE] with the composable role name.
- **ExtraConfig**
  - Configuration to add to all nodes.

**Procedure**

1. To add extra configuration to the post-deployment configuration process, create an environment file that contains these parameters in the `parameter_defaults` section. For example, to increase the reserved memory for Compute hosts to 1024 MB and set the VNC keymap to Japanese, use the following entries in the `ComputeExtraConfig` parameter:

   ```yaml
   parameter_defaults:
   ComputeExtraConfig:
     nova::compute::reserved_host_memory: 1024
     nova::compute::vnc_keymap: ja
   ```

2. Include this environment file in the `openstack overcloud deploy` command, along with any other environment files relevant to your deployment.

   **IMPORTANT**
   
   You can define each parameter only once. Subsequent usage overrides previous values.

5.6. PUPPET: CUSTOMIZING HIERADATA FOR INDIVIDUAL NODES

You can set Puppet hieradata for individual nodes using the heat template collection:

**Procedure**

1. Identify the system UUID from the introspection data for a node:
$ openstack baremetal introspection data save 9dcc87ae-4c6d-4ede-81a5-9b20d7dc4a14 | 
jq .extra.system.product.uuid

This command returns a system UUID. For example:

"f5055c6c-477f-47fb-afe5-95c6928c407f"

2. Create an environment file to define node-specific hieradata and register the `per_node.yaml` template to a pre-configuration hook. Include the system UUID of the node that you want to configure in the `NodeDataLookup` parameter:

```
resource_registry:
  OS::TripleO::ComputeExtraConfigPre: /usr/share/openstack-tripleo-heat-templates/puppet/extraconfig/pre_deploy/per_node.yaml
parameter_defaults:
  NodeDataLookup: 
    "f5055c6c-477f-47fb-afe5-95c6928c407f":
    
"nova::compute::vcpu_pin_set": [ "2", "3" ]
```

3. Include this environment file in the `openstack overcloud deploy` command, along with any other environment files relevant to your deployment.

The `per_node.yaml` template generates a set of hieradata files on nodes that correspond to each system UUID and contains the hieradata that you define. If a UUID is not defined, the resulting hieradata file is empty. In this example, the `per_node.yaml` template runs on all Compute nodes as defined by the `OS::TripleO::ComputeExtraConfigPre` hook, but only the Compute node with system UUID `f5055c6c-477f-47fb-afe5-95c6928c407f` receives hieradata.

You can use this mechanism to tailor each node according to specific requirements.

For more information about `NodeDataLookup`, see `Altering the disk layout in Ceph Storage nodes` in the `Deploying an overcloud with containerized Red Hat Ceph` guide.

### 5.7. PUPPET: APPLYING CUSTOM MANIFESTS

In certain circumstances, you might want to install and configure some additional components on your overcloud nodes. You can achieve this with a custom Puppet manifest that applies to nodes after the main configuration completes. As a basic example, you might want to install `motd` on each node.

**Procedure**

1. Create a heat template `~/templates/custom_puppet_config.yaml` that launches Puppet configuration.

```
heat_template_version: 2014-10-16

description: >
  Run Puppet extra configuration to set new MOTD

parameters:
  servers:
    type: json
  DeployIdentifier:
    type: string
  EndpointMap:
```
default: {}

type: json

resources:
ExtraPuppetConfig:
  type: OS::Heat::SoftwareConfig
  properties:
    config: {get_file: motd.pp}
    group: puppet
    options:
      enable_hiera: True
      enable_facter: False

ExtraPuppetDeployments:
  type: OS::Heat::SoftwareDeploymentGroup
  properties:
    config: {get_resource: ExtraPuppetConfig}
    servers: {get_param: servers}

This example includes the /home/stack/templates/motd.pp within the template and passes it to nodes for configuration. The motd.pp file contains the Puppet classes necessary to install and configure motd.

2. Create an environment file ~templates/puppet_post_config.yaml that registers your heat template as the OS::TripleO::NodeExtraConfigPost resource type.

    resource_registry:
    OS::TripleO::NodeExtraConfigPost: /home/stack/templates/custom_puppet_config.yaml

3. Include this environment file in the openstack overcloud deploy command, along with any other environment files relevant to your deployment.

    $ openstack overcloud deploy --templates \
    ... \
    -e /home/stack/templates/puppet_post_config.yaml \
    ... 

    This applies the configuration from motd.pp to all nodes in the overcloud.
CHAPTER 6. PREPARING FOR DIRECTOR INSTALLATION

To install and configure director, you must complete some preparation tasks to ensure you have registered the undercloud to the Red Hat Customer Portal or a Red Hat Satellite server, you have installed the director packages, and you have configured a container image source for the director to pull container images during installation.

6.1. PREPARING THE UNDERCLOUD

Before you can install director, you must complete some basic configuration on the host machine.

**Procedure**

1. Log in to your undercloud as the *root* user.

2. Create the *stack* user:

   ```bash
   [root@director ~]# useradd stack
   ```

3. Set a password for the user:

   ```bash
   [root@director ~]# passwd stack
   ```

4. Disable password requirements when using *sudo*:

   ```bash
   [root@director ~]# echo "stack ALL=(root) NOPASSWD:ALL" | tee -a /etc/sudoers.d/stack
   [root@director ~]# chmod 0440 /etc/sudoers.d/stack
   ```

5. Switch to the new *stack* user:

   ```bash
   [root@director ~]# su - stack
   [stack@director ~]$ 
   ```

6. Create directories for system images and heat templates:

   ```bash
   [stack@director ~]$ mkdir ~/images
   [stack@director ~]$ mkdir ~/templates
   ```

   Director uses system images and heat templates to create the overcloud environment. Red Hat recommends creating these directories to help you organize your local file system.

7. Check the base and full hostname of the undercloud:

   ```bash
   [stack@director ~]$ hostname
   [stack@director ~]$ hostname -f
   ```

   If either of the previous commands do not report the correct fully-qualified hostname or report an error, use `hostnamectl` to set a hostname:

   ```bash
   [stack@director ~]$ sudo hostnamectl set-hostname undercloud.example.com
   [stack@director ~]$ sudo hostnamectl set-hostname --transient undercloud.example.com
   ```
8. If you are not using a DNS server that can resolve the fully qualified domain name (FQDN) of the undercloud host, edit the `/etc/hosts` and include an entry for the system hostname. The IP address in `/etc/hosts` must match the address that you plan to use for your undercloud public API. For example, if the system uses `undercloud.example.com` as the FQDN and uses `10.0.0.1` for its IP address, add the following line to the `/etc/hosts` file:

```
10.0.0.1 undercloud.example.com undercloud
```

9. If you plan for the Red Hat OpenStack Platform director to be on a separate domain than the overcloud or its identity provider, then you must add the additional domains to `/etc/resolv.conf`:

```
search overcloud.com idp.overcloud.com
```

### 6.2. REGISTERING THE UNDERCLOUD AND ATTACHING SUBSCRIPTIONS

Before you can install director, you must run `subscription-manager` to register the undercloud and attach a valid Red Hat OpenStack Platform subscription.

**Procedure**

1. Log in to your undercloud as the `stack` user.

2. Register your system either with the Red Hat Content Delivery Network or with a Red Hat Satellite. For example, run the following command to register the system to the Content Delivery Network. Enter your Customer Portal user name and password when prompted:

```
[stack@director ~]$ sudo subscription-manager register
```

3. Find the entitlement pool ID for Red Hat OpenStack Platform (RHOSP) director:

```
[stack@director ~]$ sudo subscription-manager list --available --all --matches="Red Hat OpenStack"
Subscription Name:   Name of SKU
Provides:            Red Hat Single Sign-On
                      Red Hat Enterprise Linux Workstation
                      Red Hat CloudForms
                      Red Hat OpenStack
                      Red Hat Software Collections (for RHEL Workstation)
                      Red Hat Virtualization
SKU:                 SKU-Number
Contract:            Contract-Number
Pool ID:             Valid-Pool-Number-123456
Provides Management: Yes
Available:           1
Suggested:           1
Service Level:       Support-level
Service Type:        Service-Type
Subscription Type:   Sub-type
Ends:                End-date
System Type:         Physical
```

4. Locate the Pool ID value and attach the Red Hat OpenStack Platform 17.0-beta entitlement:
5. Lock the undercloud to Red Hat Enterprise Linux 9.0:

$ sudo subscription-manager release --set=9.0

6.3. ENABLING REPOSITORIES FOR THE UNDERCLOUD

Enable the repositories that are required for the undercloud, and update the system packages to the latest versions.

Procedure

1. Log in to your undercloud as the **stack** user.

2. Disable all default repositories, and enable the required Red Hat Enterprise Linux repositories:

   [stack@director ~]$ sudo subscription-manager repos --disable=* 
   [stack@director ~]$ sudo subscription-manager repos --enable=rhel-8-for-x86_64-baseos-eus-rpms --enable=rhel-8-for-x86_64-appstream-eus-rpms --enable=rhel-8-for-x86_64-highavailability-eus-rpms --enable=ansible-2.9-for-rhel-8-x86_64-rpms --enable=openstack-beta-for-rhel-8-x86_64-rpms --enable=fast-datapath-for-rhel-8-x86_64-rpms 

   These repositories contain packages that the director installation requires.

3. Set the **container-tools** repository module to version **3.0**:

   [stack@director ~]$ sudo dnf module reset container-tools 
   [stack@director ~]$ sudo dnf module enable -y container-tools:3.0

4. Perform an update on your system to ensure that you have the latest base system packages:

   [stack@director ~]$ sudo dnf update -y 
   [stack@director ~]$ sudo reboot

6.4. INSTALLING DIRECTOR PACKAGES

Install packages relevant to Red Hat OpenStack Platform director.

Procedure

1. Install the command line tools for director installation and configuration:

   [stack@director ~]$ sudo dnf install -y python3-tripleoclient

6.5. INSTALLING CEPH-ANSIBLE

The **ceph-ansible** package is required when you use Ceph Storage with Red Hat OpenStack Platform.

Procedure
1. Enable the Ceph Tools repository:

   [stack@director ~]$ sudo subscription-manager repos --enable=rhceph-4-tools-for-rhel-8-x86_64-rpms

2. Install the ceph-ansible package:

   [stack@director ~]$ sudo dnf install -y ceph-ansible

### 6.6. PREPARING CONTAINER IMAGES

The undercloud installation requires an environment file to determine where to obtain container images and how to store them. Generate and customize this environment file that you can use to prepare your container images.

**NOTE**

If you need to configure specific container image versions for your undercloud, you must pin the images to a specific version. For more information, see [Pinning container images for the undercloud](#).

**Procedure**

1. Log in to your undercloud host as the **stack** user.

2. Generate the default container image preparation file:

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

   This command includes the following additional options:

   - **--local-push-destination** sets the registry on the undercloud as the location for container images. This means that director pulls the necessary images from the Red Hat Container Catalog and pushes them to the registry on the undercloud. Director uses this registry as the container image source. To pull directly from the Red Hat Container Catalog, omit this option.

   - **--output-env-file** is an environment file name. The contents of this file include the parameters for preparing your container images. In this case, the name of the file is **containers-prepare-parameter.yaml**.

      **NOTE**

      You can use the same **containers-prepare-parameter.yaml** file to define a container image source for both the undercloud and the overcloud.

3. Modify the **containers-prepare-parameter.yaml** to suit your requirements.

### 6.7. CONTAINER IMAGE PREPARATION PARAMETERS
The default file for preparing your containers (containers-prepare-parameter.yaml) contains the `ContainerImagePrepare` heat parameter. This parameter defines a list of strategies for preparing a set of images:

```yaml
parameter_defaults:
  ContainerImagePrepare:
    - (strategy one)
    - (strategy two)
    - (strategy three)
    ...
```

Each strategy accepts a set of sub-parameters that defines which images to use and what to do with the images. The following table contains information about the sub-parameters that you can use with each `ContainerImagePrepare` strategy:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>excludes</td>
<td>List of regular expressions to exclude image names from a strategy.</td>
</tr>
<tr>
<td>includes</td>
<td>List of regular expressions to include in a strategy. At least one image name must match an existing image. All <code>excludes</code> are ignored if <code>includes</code> is specified.</td>
</tr>
<tr>
<td>modify_append_tag</td>
<td>String to append to the tag for the destination image. For example, if you pull an image with the tag 17.0-beta.0-5.161 and set the <code>modify_append_tag</code> to <code>- hotfix</code>, the director tags the final image as 17.0-beta.0-5.161-hotfix.</td>
</tr>
<tr>
<td>modify_only_with_labels</td>
<td>A dictionary of image labels that filter the images that you want to modify. If an image matches the labels defined, the director includes the image in the modification process.</td>
</tr>
<tr>
<td>modify_role</td>
<td>String of ansible role names to run during upload but before pushing the image to the destination registry.</td>
</tr>
<tr>
<td>modify_vars</td>
<td>Dictionary of variables to pass to <code>modify_role</code>.</td>
</tr>
</tbody>
</table>

---

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<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
</table>
| push_destination  | Defines the namespace of the registry that you want to push images to during the upload process.  
|                   | - If set to **true**, the `push_destination` is set to the undercloud registry namespace using the hostname, which is the recommended method.  
|                   | - If set to **false**, the push to a local registry does not occur and nodes pull images directly from the source.  
|                   | - If set to a custom value, director pushes images to an external local registry.  
|                   | If you set this parameter to **false** in production environments while pulling images directly from Red Hat Container Catalog, all overcloud nodes will simultaneously pull the images from the Red Hat Container Catalog over your external connection, which can cause bandwidth issues. Only use **false** to pull directly from a Red Hat Satellite Server hosting the container images.  
|                   | If the `push_destination` parameter is set to **false** or is not defined and the remote registry requires authentication, set the **ContainerImageRegistryLogin** parameter to **true** and include the credentials with the **ContainerImageRegistryCredentials** parameter. |
| pull_source       | The source registry from where to pull the original container images.        |
| set               | A dictionary of **key**: **value** definitions that define where to obtain the initial images. |
| tag_from_label    | Use the value of specified container image metadata labels to create a tag for every image and pull that tagged image. For example, if you set **tag_from_label**: `{version}-{release}`, director uses the **version** and **release** labels to construct a new tag. For one container, **version** might be set to 17.0-beta.0 and **release** might be set to **5.161**, which results in the tag `17.0-beta.0-5.161`. Director uses this parameter only if you have not defined **tag** in the **set** dictionary. |
IMPORTANT

When you push images to the undercloud, use `push_destination: true` instead of `push_destination: UNDERCLOUD_IP:PORT`. The `push_destination: true` method provides a level of consistency across both IPv4 and IPv6 addresses.

The `set` parameter accepts a set of `key: value` definitions:

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ceph_image</td>
<td>The name of the Ceph Storage container image.</td>
</tr>
<tr>
<td>ceph_namespace</td>
<td>The namespace of the Ceph Storage container image.</td>
</tr>
<tr>
<td>ceph_tag</td>
<td>The tag of the Ceph Storage container image.</td>
</tr>
<tr>
<td>ceph_alertmanager_image</td>
<td>The name, namespace, and tag of the Ceph Storage Alert Manager container image.</td>
</tr>
<tr>
<td>ceph_alertmanager_namespace</td>
<td></td>
</tr>
<tr>
<td>ceph_alertmanager_tag</td>
<td></td>
</tr>
<tr>
<td>ceph_grafana_image</td>
<td>The name, namespace, and tag of the Ceph Storage Grafana container image.</td>
</tr>
<tr>
<td>ceph_grafana_namespace</td>
<td></td>
</tr>
<tr>
<td>ceph_grafana_tag</td>
<td></td>
</tr>
<tr>
<td>ceph_node_exporter_image</td>
<td>The name, namespace, and tag of the Ceph Storage Node Exporter container image.</td>
</tr>
<tr>
<td>ceph_node_exporter_namespace</td>
<td></td>
</tr>
<tr>
<td>ceph_node_exporter_tag</td>
<td></td>
</tr>
<tr>
<td>ceph_prometheus_image</td>
<td>The name, namespace, and tag of the Ceph Storage Prometheus container image.</td>
</tr>
<tr>
<td>ceph_prometheus_namespace</td>
<td></td>
</tr>
<tr>
<td>ceph_prometheus_tag</td>
<td></td>
</tr>
<tr>
<td>name_prefix</td>
<td>A prefix for each OpenStack service image.</td>
</tr>
<tr>
<td>name_suffix</td>
<td>A suffix for each OpenStack service image.</td>
</tr>
<tr>
<td>namespace</td>
<td>The namespace for each OpenStack service image.</td>
</tr>
<tr>
<td>neutron_driver</td>
<td>The driver to use to determine which OpenStack Networking (neutron) container to use. Use a null value to set to the standard <code>neutron-server</code> container. Set to <code>ovn</code> to use OVN-based containers.</td>
</tr>
</tbody>
</table>
6.8. GUIDELINES FOR CONTAINER IMAGE TAGGING

The Red Hat Container Registry uses a specific version format to tag all Red Hat OpenStack Platform container images. This format follows the label metadata for each container, which is **version-release**.

**version**

Corresponds to a major and minor version of Red Hat OpenStack Platform. These versions act as streams that contain one or more releases.

**release**

Corresponds to a release of a specific container image version within a version stream.

For example, if the latest version of Red Hat OpenStack Platform is 17.0.0 and the release for the container image is 5.161, then the resulting tag for the container image is 17.0.0-5.161.

The Red Hat Container Registry also uses a set of major and minor **version** tags that link to the latest release for that container image version. For example, both 17.0 and 17.0.0 link to the latest **release** in the 17.0.0 container stream. If a new minor release of 17.0 occurs, the 17.0 tag links to the latest **release** for the new minor release stream while the 17.0.0 tag continues to link to the latest **release** within the 17.0.0 stream.

The **ContainerImagePrepare** parameter contains two sub-parameters that you can use to determine which container image to download. These sub-parameters are the **tag** parameter within the **set** dictionary, and the **tag_from_label** parameter. Use the following guidelines to determine whether to use **tag** or **tag_from_label**.

- The default value for **tag** is the major version for your OpenStack Platform version. For this version it is 17.0. This always corresponds to the latest minor version and release.

  ```yaml
  parameter_defaults:
  ContainerImagePrepare:
    - set:
      ... 
      tag: 17.0 
      ...
  ```

- To change to a specific minor version for OpenStack Platform container images, set the tag to a minor version. For example, to change to 17.0.2, set **tag** to 17.0.2.

  ```yaml
  parameter_defaults:
  ```

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>tag</strong></td>
<td>Sets a specific tag for all images from the source. If not defined, director uses the Red Hat OpenStack Platform version number as the default value. This parameter takes precedence over the <strong>tag_from_label</strong> value.</td>
</tr>
</tbody>
</table>

**NOTE**

The container images use multi-stream tags based on the Red Hat OpenStack Platform version. This means that there is no longer a **latest** tag.
ContainerImagePrepare:
  - set:
    ... 
    tag: 17.0.2 
    ...

- When you set tag, director always downloads the latest container image release for the version set in tag during installation and updates.

- If you do not set tag, director uses the value of tag_from_label in conjunction with the latest major version.

  parameter_defaults:
  ContainerImagePrepare:
    - set:
      ... 
      # tag: 17.0 
      ...
      tag_from_label: '{version}-{release}'

- The tag_from_label parameter generates the tag from the label metadata of the latest container image release it inspects from the Red Hat Container Registry. For example, the labels for a certain container might use the following version and release metadata:

  "Labels": {
    "release": "5.161",
    "version": "17.0.0",
    ...
  }

- The default value for tag_from_label is {version}-{release}, which corresponds to the version and release metadata labels for each container image. For example, if a container image has 17.0.0 set for version and 5.161 set for release, the resulting tag for the container image is 17.0.0-5.161.

- The tag parameter always takes precedence over the tag_from_label parameter. To use tag_from_label, omit the tag parameter from your container preparation configuration.

- A key difference between tag and tag_from_label is that director uses tag to pull an image only based on major or minor version tags, which the Red Hat Container Registry links to the latest image release within a version stream, while director uses tag_from_label to perform a metadata inspection of each container image so that director generates a tag and pulls the corresponding image.

### 6.9. Obtaining Container Images from Private Registries

The registry.redhat.io registry requires authentication to access and pull images. To authenticate with registry.redhat.io and other private registries, include the ContainerImageRegistryCredentials and ContainerImageRegistryLogin parameters in your containers-prepare-parameter.yaml file.

**ContainerImageRegistryCredentials**

Some container image registries require authentication to access images. In this situation, use the ContainerImageRegistryCredentials parameter in your containers-prepare-parameter.yaml environment file. The ContainerImageRegistryCredentials parameter uses a set of keys based on the
private registry URL. Each private registry URL uses its own key and value pair to define the username (key) and password (value). This provides a method to specify credentials for multiple private registries.

```
parameter_defaults:
  ContainerImagePrepare:
    - push_destination: true
      set:
        namespace: registry.redhat.io/...
        ...
  ContainerImageRegistryCredentials:
    registry.redhat.io:
      my_username: my_password
```

In the example, replace `my_username` and `my_password` with your authentication credentials. Instead of using your individual user credentials, Red Hat recommends creating a registry service account and using those credentials to access `registry.redhat.io` content.

To specify authentication details for multiple registries, set multiple key-pair values for each registry in `ContainerImageRegistryCredentials`:

```
parameter_defaults:
  ContainerImagePrepare:
    - push_destination: true
      set:
        namespace: registry.redhat.io/...
        ...
    - push_destination: true
      set:
        namespace: registry.internalsite.com/...
        ...
  ContainerImageRegistryCredentials:
    registry.redhat.io:
      myuser: 'p@55w0rd!'
    registry.internalsite.com:
      myuser2: '0th3rp@55w0rd!'
      '192.0.2.1:8787':
        myuser3: '@n0th3rp@55w0rd!'
```

**IMPORTANT**

The default `ContainerImagePrepare` parameter pulls container images from `registry.redhat.io`, which requires authentication.

For more information, see Red Hat Container Registry Authentication.

**ContainerImageRegistryLogin**

The `ContainerImageRegistryLogin` parameter is used to control whether an overcloud node system needs to log in to the remote registry to fetch the container images. This situation occurs when you want the overcloud nodes to pull images directly, rather than use the undercloud to host images.

You must set `ContainerImageRegistryLogin` to `true` if `push_destination` is set to false or not used for a given strategy.
parameter_defaults:
  ContainerImagePrepare:
  - push_destination: false
    set:
      namespace: registry.redhat.io/...

  ContainerImageRegistryCredentials:
    registry.redhat.io:
      myuser: 'p@55w0rd!'
    ContainerImageRegistryLogin: true

However, if the overcloud nodes do not have network connectivity to the registry hosts defined in `ContainerImageRegistryCredentials` and you set `ContainerImageRegistryLogin` to `true`, the deployment might fail when trying to perform a login. If the overcloud nodes do not have network connectivity to the registry hosts defined in the `ContainerImageRegistryCredentials`, set `push_destination` to `true` and `ContainerImageRegistryLogin` to `false` so that the overcloud nodes pull images from the undercloud.

```
parameter_defaults:
  ContainerImagePrepare:
  - push_destination: true
    set:
      namespace: registry.redhat.io/...

  ContainerImageRegistryCredentials:
    registry.redhat.io:
      myuser: 'p@55w0rd!'
    ContainerImageRegistryLogin: false
```

6.10. LAYERING IMAGE PREPARATION ENTRIES

The value of the `ContainerImagePrepare` parameter is a YAML list. This means that you can specify multiple entries.

The following example demonstrates two entries where director uses the latest version of all images except for the `nova-api` image, which uses the version tagged with `16.2.1-hotfix`:

```
parameter_defaults:
  ContainerImagePrepare:
  - tag_from_label: "{version}-{release}"  
    push_destination: true
    excludes:
      - nova-api
    set:
      namespace: registry.redhat.io/rhosp-beta
      name_prefix: openstack-
      name_suffix: 
      tag:16.2
  - push_destination: true
    includes:
      - nova-api
```
The `includes` and `excludes` parameters use regular expressions to control image filtering for each entry. The images that match the `includes` strategy take precedence over `excludes` matches. The image name must match the `includes` or `excludes` regular expression value to be considered a match.

A similar technique is used if your Block Storage (cinder) driver requires a vendor supplied cinder-volume image known as a plugin. If your Block Storage driver requires a plugin, see Deploying a vendor plugin in the Advanced Overcloud Customization guide.

### 6.11. EXCLUDING CEPH STORAGE CONTAINER IMAGES

The default overcloud role configuration uses the default Controller, Compute, and Ceph Storage roles. However, if you use the default role configuration to deploy an overcloud without Ceph Storage nodes, director still pulls the Ceph Storage container images from the Red Hat Container Registry because the images are included as a part of the default configuration.

If your overcloud does not require Ceph Storage containers, you can configure director to not pull the Ceph Storage containers images from the Red Hat Container Registry.

**Procedure**

1. Edit the `containers-prepare-parameter.yaml` file to exclude the Ceph Storage containers:

   ```yaml
   parameter_defaults:
     ContainerImagePrepare:
       - push_destination: true
         excludes:
           - ceph
           - prometheus
   set:
     ...
   ``

   The `excludes` parameter uses regular expressions to exclude any container images that contain the `ceph` or `prometheus` strings.

2. Save the `containers-prepare-parameter.yaml` file.

### 6.12. MODIFYING IMAGES DURING PREPARATION

It is possible to modify images during image preparation, and then immediately deploy the overcloud with modified images.

**NOTE**

Red Hat OpenStack Platform (RHOSP) director supports modifying images during preparation for RHOSP containers, not for Ceph containers.

Scenarios for modifying images include:

- As part of a continuous integration pipeline where images are modified with the changes being tested before deployment.
As part of a development workflow where local changes must be deployed for testing and development.

When changes must be deployed but are not available through an image build pipeline. For example, adding proprietary add-ons or emergency fixes.

To modify an image during preparation, invoke an Ansible role on each image that you want to modify. The role takes a source image, makes the requested changes, and tags the result. The prepare command can push the image to the destination registry and set the heat parameters to refer to the modified image.

The Ansible role `tripleo-modify-image` conforms with the required role interface and provides the behaviour necessary for the modify use cases. Control the modification with the modify-specific keys in the `ContainerImagePrepare` parameter:

- `modify_role` specifies the Ansible role to invoke for each image to modify.
- `modify_append_tag` appends a string to the end of the source image tag. This makes it obvious that the resulting image has been modified. Use this parameter to skip modification if the `push_destination` registry already contains the modified image. Change `modify_append_tag` whenever you modify the image.
- `modify_vars` is a dictionary of Ansible variables to pass to the role.

To select a use case that the `tripleo-modify-image` role handles, set the `tasks_from` variable to the required file in that role.

While developing and testing the `ContainerImagePrepare` entries that modify images, run the image prepare command without any additional options to confirm that the image is modified as you expect:

```
sudo openstack tripleo container image prepare \
  -e ~/containers-prepare-parameter.yaml
```

**IMPORTANT**

To use the `openstack tripleo container image prepare` command, your undercloud must contain a running `image-serve` registry. As a result, you cannot run this command before a new undercloud installation because the `image-serve` registry will not be installed. You can run this command after a successful undercloud installation.

### 6.13. UPDATING EXISTING PACKAGES ON CONTAINER IMAGES

**NOTE**

Red Hat OpenStack Platform (RHOSP) director supports updating existing packages on container images for RHOSP containers, not for Ceph containers.

**Procedure**

- The following example `ContainerImagePrepare` entry updates in all packages on the container images by using the dnf repository configuration of the undercloud host:

  ```yaml
  ContainerImagePrepare:
  - push_destination: true
  ```
6.14. INSTALLING ADDITIONAL RPM FILES TO CONTAINER IMAGES

You can install a directory of RPM files in your container images. This is useful for installing hotfixes, local package builds, or any package that is not available through a package repository.

**NOTE**

Red Hat OpenStack Platform (RHOSP) director supports installing additional RPM files to container images for RHOSP containers, not for Ceph containers.

**Procedure**

- The following example `ContainerImagePrepare` entry installs some hotfix packages on only the `nova-compute` image:

```
ContainerImagePrepare:
  - push_destination: true
  ...
  includes:
  - nova-compute
    modify_role: tripleo-modify-image
    modify_append_tag: "-hotfix"
    modify_vars:
      tasks_from: rpm_install.yml
      rpms_path: /home/stack/nova-hotfix-pkgs
  ...
```

6.15. MODIFYING CONTAINER IMAGES WITH A CUSTOM DOCKERFILE

You can specify a directory that contains a Dockerfile to make the required changes. When you invoke the `tripleo-modify-image` role, the role generates a `Dockerfile.modified` file that changes the `FROM` directive and adds extra `LABEL` directives.

**NOTE**

Red Hat OpenStack Platform (RHOSP) director supports modifying container images with a custom Dockerfile for RHOSP containers, not for Ceph containers.

**Procedure**

1. The following example runs the custom Dockerfile on the `nova-compute` image:

```
ContainerImagePrepare:
  - push_destination: true
```
... includes:
- nova-compute
modify_role: tripleo-modify-image
modify_append_tag: "-hotfix"
modify_vars:
tasks_from: modify_image.yml
modify_dir_path: /home/stack/nova-custom
...

2. The following example shows the /home/stack/nova-custom/Dockerfile file. After you run any USER root directives, you must switch back to the original image default user:

FROM registry.redhat.io/rhosp-beta/openstack-nova-compute:latest

USER "root"

COPY customize.sh /tmp/
RUN /tmp/customize.sh

USER "nova"

6.16. PREPARING A SATELLITE SERVER FOR CONTAINER IMAGES

Red Hat Satellite 6 offers registry synchronization capabilities. This provides a method to pull multiple images into a Satellite server and manage them as part of an application life cycle. The Satellite also acts as a registry for other container-enabled systems to use. For more information about managing container images, see Managing Container Images in the Red Hat Satellite 6 Content Management Guide.

The examples in this procedure use the hammer command line tool for Red Hat Satellite 6 and an example organization called ACME. Substitute this organization for your own Satellite 6 organization.

NOTE

This procedure requires authentication credentials to access container images from registry.redhat.io. Instead of using your individual user credentials, Red Hat recommends creating a registry service account and using those credentials to access registry.redhat.io content. For more information, see "Red Hat Container Registry Authentication".

Procedure

1. Create a list of all container images:

   $ sudo podman search --limit 1000 "registry.redhat.io/rhosp-beta/openstack" --format="{{ .Name }}" | sort > satellite_images
   $ sudo podman search --limit 1000 "registry.redhat.io/rhceph" | grep rhceph-4-dashboard-rhel8
   $ sudo podman search --limit 1000 "registry.redhat.io/rhceph" | grep rhceph-4-rhel8
   $ sudo podman search --limit 1000 "registry.redhat.io/openshift" | grep ose-prometheus

   a. You need the following ose-prometheus containers:
2. Copy the `satellite_images` file to a system that contains the Satellite 6 `hammer` tool. Alternatively, use the instructions in the *Hammer CLI Guide* to install the `hammer` tool to the undercloud.

3. Run the following `hammer` command to create a new product (OSP16.1 Containers) in your Satellite organization:

   ```bash
   $ hammer product create \
   --organization "ACME" \
   --name "OSP Containers"
   
   This custom product will contain your images.
   
4. Add the overcloud container images from the `satellite_images` file:

   ```bash
   $ while read IMAGE; do \
   IMAGE_NAME=$(echo $IMAGE | cut -d"/" -f3 | sed "s/openstack-//g") ; \
   IMAGE_NOURL=$(echo $IMAGE | sed "s/registry.redhat.io//g") ; \
   hammer repository create \
   --organization "ACME" \ 
   --product "OSP Containers" \ 
   --content-type docker \ 
   --url https://registry.redhat.io \ 
   --docker-upstream-name $IMAGE_NOURL \ 
   --upstream-username USERNAME \ 
   --upstream-password PASSWORD \ 
   --name $IMAGE_NAME ; done < satellite_images
   
5. Add the Ceph Storage 4 container image:

   ```bash
   $ hammer repository create \
   --organization "ACME" \ 
   --product "OSP Containers" \ 
   --content-type docker \ 
   --url https://registry.redhat.io \ 
   --docker-upstream-name rhceph/rhceph-4-rhel8 \ 
   --upstream-username USERNAME \ 
   --upstream-password PASSWORD \ 
   --name rhceph-4-rhel8
   
6. Synchronize the container images:

   ```bash
   $ hammer product synchronize \
   --organization "ACME" \
   --name "OSP Containers"
   
   Wait for the Satellite server to complete synchronization.
NOTE

Depending on your configuration, `hammer` might ask for your Satellite server username and password. You can configure `hammer` to automatically login using a configuration file. For more information, see the Authentication section in the Hammer CLI Guide.

7. If your Satellite 6 server uses content views, create a new content view version to incorporate the images and promote it along environments in your application life cycle. This largely depends on how you structure your application lifecycle. For example, if you have an environment called `production` in your lifecycle and you want the container images to be available in that environment, create a content view that includes the container images and promote that content view to the `production` environment. For more information, see Managing Content Views.

8. Check the available tags for the `base` image:

```
$ hammer docker tag list --repository "base" \ 
--organization "ACME" \ 
--lifecycle-environment "production" \ 
--product "OSP Containers"
```

This command displays tags for the OpenStack Platform container images within a content view for a particular environment.

9. Return to the undercloud and generate a default environment file that prepares images using your Satellite server as a source. Run the following example command to generate the environment file:

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

- `--output-env-file` is an environment file name. The contents of this file include the parameters for preparing your container images for the undercloud. In this case, the name of the file is `containers-prepare-parameter.yaml`.

10. Edit the `containers-prepare-parameter.yaml` file and modify the following parameters:

- `push_destination` - Set this to `true` or `false` depending on your chosen container image management strategy. If you set this parameter to `false`, the overcloud nodes pull images directly from the Satellite. If you set this parameter to `true`, the director pulls the images from the Satellite to the undercloud registry and the overcloud pulls the images from the undercloud registry.

- `namespace` - The URL and port of the registry on the Satellite server. The default registry port on Red Hat Satellite is 5000.

- `name_prefix` - The prefix is based on a Satellite 6 convention. This differs depending on whether you use content views:
  - If you use content views, the structure is `[org]-[environment]-[content view]-[product]`. For example: `acme-production-myosp16-osp_containers-`.
  - If you do not use content views, the structure is `[org]-[product]`. For example: `acme-osp_containers-`.
- **ceph_namespace, ceph_image, ceph_tag** - If you use Ceph Storage, include these additional parameters to define the Ceph Storage container image location. Note that `ceph_image` now includes a Satellite-specific prefix. This prefix is the same value as the `name_prefix` option.

The following example environment file contains Satellite-specific parameters:

```yaml
parameter_defaults:
  ContainerImagePrepare:
    push_destination: false
  set:
    ceph_image: acme-production-myosp16_1-osp_containers-rhceph-4
    ceph_namespace: satellite.example.com:5000
    ceph_tag: latest
    name_prefix: acme-production-myosp16_1-osp_containers-
    name_suffix: "
    namespace: satellite.example.com:5000
    neutron_driver: null
    tag: '17.0'
...
```

**NOTE**

To use a specific container image version stored on your Red Hat Satellite Server, set the `tag` key-value pair to the specific version in the `set` dictionary. For example, to use the 17.0.2 image stream, set `tag: 17.0.2` in the `set` dictionary.

You must define the `containers-prepare-parameter.yaml` environment file in the `undercloud.conf` configuration file, otherwise the undercloud uses the default values:

```yaml
container_images_file = /home/stack/containers-prepare-parameter.yaml
```
CHAPTER 7. INSTALLING DIRECTOR ON THE UNDERCLOUD

To configure and install director, set the appropriate parameters in the `undercloud.conf` file and run the undercloud installation command. After you have installed director, import the overcloud images that director will use to write to bare metal nodes during node provisioning.

7.1. CONFIGURING DIRECTOR

The director installation process requires certain settings in the `undercloud.conf` configuration file, which director reads from the home directory of the `stack` user. Complete the following steps to copy default template as a foundation for your configuration.

Procedure

1. Copy the default template to the home directory of the `stack` user’s:

   [stack@director ~]$ cp \\
   /usr/share/python-tripleoclient/undercloud.conf.sample \\
   ~/undercloud.conf

2. Edit the `undercloud.conf` file. This file contains settings to configure your undercloud. If you omit or comment out a parameter, the undercloud installation uses the default value.

7.2. DIRECTOR CONFIGURATION PARAMETERS

The following list contains information about parameters for configuring the `undercloud.conf` file. Keep all parameters within their relevant sections to avoid errors.

**IMPORTANT**

At minimum, you must set the `container_images_file` parameter to the environment file that contains your container image configuration. Without this parameter properly set to the appropriate file, director cannot obtain your container image rule set from the `ContainerImagePrepare` parameter nor your container registry authentication details from the `ContainerImageRegistryCredentials` parameter.

**Defaults**

The following parameters are defined in the `[DEFAULT]` section of the `undercloud.conf` file:

**additional_architectures**

A list of additional (kernel) architectures that an overcloud supports. Currently the overcloud supports `ppc64le` architecture in addition to the default `x86_64` architecture.

**NOTE**

When you enable support for ppc64le, you must also set `ipxe_enabled` to `False`. For more information on configuring your undercloud with multiple CPU architectures, see Configuring a multiple CPU architecture overcloud.

**certificate_generation_ca**

The `certmonger` nickname of the CA that signs the requested certificate. Use this option only if you
have set the `generate_service_certificate` parameter. If you select the local CA, certmonger extracts the local CA certificate to `/etc/pki/ca-trust/source/anchors/cm-local-ca.pem` and adds the certificate to the trust chain.

**clean_nodes**
Defines whether to wipe the hard drive between deployments and after introspection.

**cleanup**
Cleanup temporary files. Set this to `False` to leave the temporary files used during deployment in place after you run the deployment command. This is useful for debugging the generated files or if errors occur.

**container.cli**
The CLI tool for container management. Leave this parameter set to `podman`. Red Hat Enterprise Linux 9.0 only supports `podman`.

**container.healthcheck_disabled**
Disables containerized service health checks. Red Hat recommends that you enable health checks and leave this option set to `false`.

**container.images_file**
Heat environment file with container image information. This file can contain the following entries:

- Parameters for all required container images
- The `ContainerImagePrepare` parameter to drive the required image preparation. Usually the file that contains this parameter is named `containers-prepare-parameter.yaml`.

**container.insecure.registries**
A list of insecure registries for `podman` to use. Use this parameter if you want to pull images from another source, such as a private container registry. In most cases, `podman` has the certificates to pull container images from either the Red Hat Container Catalog or from your Satellite Server if the undercloud is registered to Satellite.

**container.registry_mirror**
An optional `registry-mirror` configured that `podman` uses.

**custom.env.files**
Additional environment files that you want to add to the undercloud installation.

**deployment_user**
The user who installs the undercloud. Leave this parameter unset to use the current default user `stack`.

**discovery.default.driver**
Sets the default driver for automatically enrolled nodes. Requires the `enable_node_discovery` parameter to be enabled and you must include the driver in the `enabled_hardware_types` list.

**enable.ironic; enable.ironic_inspector; enable.nova; enable.tempest; enable.validations**
Defines the core services that you want to enable for director. Leave these parameters set to `true`.

**enable.node_discovery**
Automatically enroll any unknown node that PXE-boots the introspection ramdisk. New nodes use the `fake` driver as a default but you can set `discovery.default_driver` to override. You can also use introspection rules to specify driver information for newly enrolled nodes.

**enable.novajoin**
Defines whether to install the `novajoin` metadata service in the undercloud.

**enable.routed_networks**
Defines whether to enable support for routed control plane networks.

enable_swift_encryption
Defines whether to enable Swift encryption at-rest.

enable_telemetry
Defines whether to install OpenStack Telemetry services (gnocchi, aodh, panko) in the undercloud. Set the enable_telemetry parameter to true if you want to install and configure telemetry services automatically. The default value is false, which disables telemetry on the undercloud. This parameter is required if you use other products that consume metrics data, such as Red Hat CloudForms.

**WARNING**
RBAC is not supported by every component. The Alarming service (aodh) and Gnocchi do not take secure RBAC rules into account.

enabled_hardware_types
A list of hardware types that you want to enable for the undercloud.

generate_service_certificate
Defines whether to generate an SSL/TLS certificate during the undercloud installation, which is used for the undercloud_service_certificate parameter. The undercloud installation saves the resulting certificate /etc/pki/tls/certs/undercloud-[undercloud_public_vip].pem. The CA defined in the certificate_generation_ca parameter signs this certificate.

heat_container_image
URL for the heat container image to use. Leave unset.

heat_native
Run host-based undercloud configuration using heat-all. Leave as true.

hieradata_override
Path to hieradata override file that configures Puppet hieradata on the director, providing custom configuration to services beyond the undercloud.conf parameters. If set, the undercloud installation copies this file to the /etc/puppet/hieradata directory and sets it as the first file in the hierarchy. For more information about using this feature, see Configuring hieradata on the undercloud.

inspection_extras
Defines whether to enable extra hardware collection during the inspection process. This parameter requires the python-hardware or python-hardware-detect packages on the introspection image.

inspection_interface
The bridge that director uses for node introspection. This is a custom bridge that the director configuration creates. The LOCAL_INTERFACE attaches to this bridge. Leave this as the default br-ctlplane.

inspection_runbench
Runs a set of benchmarks during node introspection. Set this parameter to true to enable the benchmarks. This option is necessary if you intend to perform benchmark analysis when inspecting the hardware of registered nodes.

ipa_otp
Defines the one-time password to register the undercloud node to an IPA server. This is required when `enable_novajoin` is enabled.

**ipv6_address_mode**

IPv6 address configuration mode for the undercloud provisioning network. The following list contains the possible values for this parameter:

- `dhcppv6-stateless` - Address configuration using router advertisement (RA) and optional information using DHCPv6.
- `dhcppv6-stateful` - Address configuration and optional information using DHCPv6.

**ipxe_enabled**

Defines whether to use iPXE or standard PXE. The default is `true`, which enables iPXE. Set this parameter to `false` to use standard PXE. For PowerPC deployments, or for hybrid PowerPC and x86 deployments, set this value to `false`.

**local_interface**

The chosen interface for the director Provisioning NIC. This is also the device that director uses for DHCP and PXE boot services. Change this value to your chosen device. To see which device is connected, use the `ip addr` command. For example, this is the result of an `ip addr` command:

```
2:  em0:  <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP qlen 1000
    link/ether 52:54:00:75:24:09 brd ff:ff:ff:ff:ff:ff
    inet 192.168.122.178/24 brd 192.168.122.255 scope global dynamic em0
       valid_lft 3462sec preferred_lft 3462sec
    inet6 fe80::5054:ff:fe75:2409/64 scope link
       valid_lft forever preferred_lft forever
3:  em1:  <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc noop state DOWN
    link/ether 42:0b:c2:a5:c1:26 brd ff:ff:ff:ff:ff:ff
```

In this example, the External NIC uses `em0` and the Provisioning NIC uses `em1`, which is currently not configured. In this case, set the `local_interface` to `em1`. The configuration script attaches this interface to a custom bridge defined with the `inspection_interface` parameter.

**local_ip**

The IP address defined for the director Provisioning NIC. This is also the IP address that director uses for DHCP and PXE boot services. Leave this value as the default `192.168.24.1/24` unless you use a different subnet for the Provisioning network, for example, if this IP address conflicts with an existing IP address or subnet in your environment.

For IPv6, the local IP address prefix length must be `/64` to support both stateful and stateless connections.

**local_mtu**

The maximum transmission unit (MTU) that you want to use for the `local_interface`. Do not exceed 1500 for the undercloud.

**local_subnet**

The local subnet that you want to use for PXE boot and DHCP interfaces. The `local_ip` address should reside in this subnet. The default is `ctlplane-subnet`.

**net_config_override**

Path to network configuration override template. If you set this parameter, the undercloud uses a JSON or YAML format template to configure the networking with `os-net-config` and ignores the
network parameters set in `undercloud.conf`. Use this parameter when you want to configure bonding or add an option to the interface. For more information about customizing undercloud network interfaces, see Configuring undercloud network interfaces.

**networks_file**
- Networks file to override for heat.

**output_dir**
- Directory to output state, processed heat templates, and Ansible deployment files.

**overcloud_domain_name**
- The DNS domain name that you want to use when you deploy the overcloud.

**NOTE**
When you configure the overcloud, you must set the CloudDomain parameter to a matching value. Set this parameter in an environment file when you configure your overcloud.

**roles_file**
- The roles file that you want to use to override the default roles file for undercloud installation. It is highly recommended to leave this parameter unset so that the director installation uses the default roles file.

**scheduler_max_attempts**
- The maximum number of times that the scheduler attempts to deploy an instance. This value must be greater or equal to the number of bare metal nodes that you expect to deploy at once to avoid potential race conditions when scheduling.

**service_principal**
- The Kerberos principal for the service using the certificate. Use this parameter only if your CA requires a Kerberos principal, such as in FreeIPA.

**subnets**
- List of routed network subnets for provisioning and introspection. The default value includes only the ctlplane-subnet subnet. For more information, see Subnets.

**templates**
- Heat templates file to override.

**undercloud_admin_host**
- The IP address or hostname defined for director Admin API endpoints over SSL/TLS. The director configuration attaches the IP address to the director software bridge as a routed IP address, which uses the /32 netmask.

If the `undercloud_admin_host` is not in the same IP network as the `local_ip`, you must set the ControlVirtualInterface parameter to the interface on which you want the admin APIs on the undercloud to listen. By default, the admin APIs listen on the br-ctlplane interface. Set the ControlVirtualInterface parameter in a custom environment file, and include the custom environment file in the `undercloud.conf` file by configuring the custom_env_files parameter.

For information about customizing undercloud network interfaces, see Configuring undercloud network interfaces.

**undercloud_debug**
- Sets the log level of undercloud services to DEBUG. Set this value to true to enable DEBUG log level.
undercloud_enable_selinux

Enable or disable SELinux during the deployment. It is highly recommended to leave this value set to true unless you are debugging an issue.

undercloud_hostname

Defines the fully qualified host name for the undercloud. If set, the undercloud installation configures all system host name settings. If left unset, the undercloud uses the current host name, but you must configure all system host name settings appropriately.

undercloud_log_file

The path to a log file to store the undercloud install and upgrade logs. By default, the log file is install-undercloud.log in the home directory. For example, /home/stack/install-undercloud.log.

undercloud_nameservers

A list of DNS nameservers to use for the undercloud hostname resolution.

undercloud_ntp_servers

A list of network time protocol servers to help synchronize the undercloud date and time.

undercloud_public_host

The IP address or hostname defined for director Public API endpoints over SSL/TLS. The director configuration attaches the IP address to the director software bridge as a routed IP address, which uses the /32 netmask.

If the undercloud_public_host is not in the same IP network as the local_ip, you must set the PublicVirtualInterface parameter to the public-facing interface on which you want the public APIs on the undercloud to listen. By default, the public APIs listen on the br-ctlplane interface. Set the PublicVirtualInterface parameter in a custom environment file, and include the custom environment file in the undercloud.conf file by configuring the custom_env_files parameter.

For information about customizing undercloud network interfaces, see Configuring undercloud network interfaces.

undercloud_service_certificate

The location and filename of the certificate for OpenStack SSL/TLS communication. Ideally, you obtain this certificate from a trusted certificate authority. Otherwise, generate your own self-signed certificate.

undercloud_timezone

Host timezone for the undercloud. If you do not specify a timezone, director uses the existing timezone configuration.

undercloud_update_packages

Defines whether to update packages during the undercloud installation.

Subnets

Each provisioning subnet is a named section in the undercloud.conf file. For example, to create a subnet called ctlplane-subnet, use the following sample in your undercloud.conf file:

```plaintext
[ctlplane-subnet]
cidr = 192.168.24.0/24
dhcp_start = 192.168.24.5
dhcp_end = 192.168.24.24
inspection_iprange = 192.168.24.100,192.168.24.120
gateway = 192.168.24.1
masquerade = true
```
You can specify as many provisioning networks as necessary to suit your environment.

**IMPORTANT**
Director cannot change the IP addresses for a subnet after director creates the subnet.

cidr
The network that director uses to manage overcloud instances. This is the Provisioning network, which the undercloud neutron service manages. Leave this as the default **192.168.24.0/24** unless you use a different subnet for the Provisioning network.

masquerade
Defines whether to masquerade the network defined in the **cidr** for external access. This provides the Provisioning network with a degree of network address translation (NAT) so that the Provisioning network has external access through director.

**NOTE**
The director configuration also enables IP forwarding automatically using the relevant **sysctl** kernel parameter.

dhcp_start; dhcp_end
The start and end of the DHCP allocation range for overcloud nodes. Ensure that this range contains enough IP addresses to allocate your nodes.

dhcp_exclude
IP addresses to exclude in the DHCP allocation range.

dns_nameservers
DNS nameservers specific to the subnet. If no nameservers are defined for the subnet, the subnet uses nameservers defined in the **undercloud_nameservers** parameter.

gateway
The gateway for the overcloud instances. This is the undercloud host, which forwards traffic to the External network. Leave this as the default **192.168.24.1** unless you use a different IP address for director or want to use an external gateway directly.

host_routes
Host routes for the Neutron-managed subnet for the overcloud instances on this network. This also configures the host routes for the **local_subnet** on the undercloud.

inspection_iprange
Temporary IP range for nodes on this network to use during the inspection process. This range must not overlap with the range defined by **dhcp_start** and **dhcp_end** but must be in the same IP subnet.

Modify the values of these parameters to suit your configuration. When complete, save the file.

### 7.3. CONFIGURING THE UNDERCLOUD WITH ENVIRONMENT FILES

You configure the main parameters for the undercloud through the **undercloud.conf** file. You can also perform additional undercloud configuration with an environment file that contains heat parameters.

Procedure

2. Edit this file and include your heat parameters. For example, to enable debugging for certain OpenStack Platform services include the following snippet in the `custom-undercloud-params.yaml` file:

```
parameter_defaults:
  Debug: True
```

Save this file when you have finished.

3. Edit your `undercloud.conf` file and scroll to the `custom_env_files` parameter. Edit the parameter to point to your `custom-undercloud-params.yaml` environment file:

```
custom_env_files = /home/stack/templates/custom-undercloud-params.yaml
```

**NOTE**

You can specify multiple environment files using a comma-separated list.

The director installation includes this environment file during the next undercloud installation or upgrade operation.

### 7.4. COMMON HEAT PARAMETERS FOR UNDERCLOUD CONFIGURATION

The following table contains some common heat parameters that you might set in a custom environment file for your undercloud.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AdminPassword</td>
<td>Sets the undercloud admin user password.</td>
</tr>
<tr>
<td>AdminEmail</td>
<td>Sets the undercloud admin user email address.</td>
</tr>
<tr>
<td>Debug</td>
<td>Enables debug mode.</td>
</tr>
</tbody>
</table>

Set these parameters in your custom environment file under the `parameter_defaults` section:

```
parameter_defaults:
  Debug: True
  AdminPassword: "myp@ssw0rd!"
  AdminEmail: "admin@example.com"
```

### 7.5. CONFIGURING HIERADATA ON THE UNDERCLOUD

You can provide custom configuration for services beyond the available `undercloud.conf` parameters by configuring Puppet hieradata on the director.
Procedure

1. Create a hieradata override file, for example, `/home/stack/hieradata.yaml`.

2. Add the customized hieradata to the file. For example, add the following snippet to modify the Compute (nova) service parameter `force_raw_images` from the default value of `True` to `False`:

   ```yaml
   nova::compute::force_raw_images: False
   ```

   If there is no Puppet implementation for the parameter you want to set, then use the following method to configure the parameter:

   ```yaml
   nova::config::nova_config:
     DEFAULT/<parameter_name>:
       value: <parameter_value>
   ```

   For example:

   ```yaml
   nova::config::nova_config:
     DEFAULT/network_allocate_retries:
       value: 20
     ironic/serial_console_state_timeout:
       value: 15
   ```

3. Set the `hieradata_override` parameter in the `undercloud.conf` file to the path of the new `/home/stack/hieradata.yaml` file:

   ```ini
   hieradata_override = /home/stack/hieradata.yaml
   ```

7.6. CONFIGURING THE UNDERCLOUD FOR BARE METAL PROVISIONING OVER IPV6

If you have IPv6 nodes and infrastructure, you can configure the undercloud and the provisioning network to use IPv6 instead of IPv4 so that director can provision and deploy Red Hat OpenStack Platform onto IPv6 nodes. However, there are some considerations:

- Dual stack IPv4/6 is not available.
- Tempest validations might not perform correctly.
- IPv4 to IPv6 migration is not available during upgrades.

Modify the `undercloud.conf` file to enable IPv6 provisioning in Red Hat OpenStack Platform.

Prerequisites

- An IPv6 address on the undercloud. For more information, see Configuring an IPv6 address on the undercloud in the IPv6 Networking for the Overcloud guide.

Procedure

1. Open your `undercloud.conf` file.

2. Specify the IPv6 address mode as either stateless or stateful:
Replace `<address_mode>` with `dhcpv6-stateless` or `dhcpv6-stateful`, based on the mode that your NIC supports.

**NOTE**

When you use the stateful address mode, the firmware, chain loaders, and operating systems might use different algorithms to generate an ID that the DHCP server tracks. DHCPv6 does not track addresses by MAC, and does not provide the same address back if the identifier value from the requester changes but the MAC address remains the same. Therefore, when you use stateful DHCPv6 you must also complete the next step to configure the network interface.

3. If you configured your undercloud to use stateful DHCPv6, specify the network interface to use for bare metal nodes:

```ini
[DEFAULT]
ipv6_address_mode = dhcpv6-stateful
ironic_enabled_network_interfaces = neutron,flat
...
```

4. Optional: Set the default network interface for bare metal nodes:

```ini
[DEFAULT]
...
ironic_default_network_interface = neutron
...
```

5. Specify whether or not the undercloud should create a router on the provisioning network:

```ini
[DEFAULT]
...
enable_routed_networks: <true/false>
...
```

- Replace `<true/false>` with `true` to enable routed networks and prevent the undercloud creating a router on the provisioning network. When `true`, the data center router must provide router advertisements.
- Replace `<true/false>` with `false` to disable routed networks and create a router on the provisioning network.

6. Configure the local IP address, and the IP address for the director Admin API and Public API endpoints over SSL/TLS:

```ini
[DEFAULT]
...
local_ip = <ipv6_address>
```
CHAPTER 7. INSTALLING DIRECTOR ON THE UNDERCLOUD

undercloud_admin_host = <ipv6_address>
undercloud_public_host = <ipv6_address>
...

Replace <ipv6_address> with the IPv6 address of the undercloud.

7. Optional: Configure the provisioning network that director uses to manage instances:

[ctlplane-subnet]
cidr = <ipv6_address>/<ipv6_prefix>
...

- Replace <ipv6_address> with the IPv6 address of the network to use for managing instances when not using the default provisioning network.
- Replace <ipv6_prefix> with the IP address prefix of the network to use for managing instances when not using the default provisioning network.

8. Configure the DHCP allocation range for provisioning nodes:

[ctlplane-subnet]
cidr = <ipv6_address>/<ipv6_prefix>
dhcp_start = <ipv6_address_dhcp_start>
dhcp_end = <ipv6_address_dhcp_end>
...

- Replace <ipv6_address_dhcp_start> with the IPv6 address of the start of the network range to use for the overcloud nodes.
- Replace <ipv6_address_dhcp_end> with the IPv6 address of the end of the network range to use for the overcloud nodes.

9. Optional: Configure the gateway for forwarding traffic to the external network:

[ctlplane-subnet]
cidr = <ipv6_address>/<ipv6_prefix>
dhcp_start = <ipv6_address_dhcp_start>
dhcp_end = <ipv6_address_dhcp_end>
gateway = <ipv6_gateway_address>
...

Replace <ipv6_gateway_address> with the IPv6 address of the gateway when not using the default gateway.

10. Configure the DHCP range to use during the inspection process:

[ctlplane-subnet]
cidr = <ipv6_address>/<ipv6_prefix>
dhcp_start = <ipv6_address_dhcp_start>
dhcp_end = <ipv6_address_dhcp_end>
gateway = <ipv6_gateway_address>
inspection_iprange = <ipv6_address_inspection_start>,<ipv6_address_inspection_end>
...

Replace <ipv6_address_inspection_start> with the IPv6 address of the start of the inspection IP range.
Replace <ipv6_address_inspection_end> with the IPv6 address of the end of the inspection IP range.
- Replace `<ipv6_address_inspection_start>` with the IPv6 address of the start of the network range to use during the inspection process.

- Replace `<ipv6_address_inspection_end>` with the IPv6 address of the end of the network range to use during the inspection process.

### NOTE

This range must not overlap with the range defined by `dhcp_start` and `dhcp_end`, but must be in the same IP subnet.

11. Configure an IPv6 nameserver for the subnet:

```yaml
[ctlplane-subnet]
cidr = <ipv6_address>/<ipv6_prefix>
dhcp_start = <ipv6_address_dhcp_start>
dhcp_end = <ipv6_address_dhcp_end>
gateway = <ipv6_gateway_address>
inspection_iprange = <ipv6_address_inspection_start>,<ipv6_address_inspection_end>
dns_nameservers = <ipv6_dns>
```

Replace `<ipv6_dns>` with the DNS nameservers specific to the subnet.

### 7.7. CONFIGURING UNDERCLOUD NETWORK INTERFACES

Include custom network configuration in the `undercloud.conf` file to install the undercloud with specific networking functionality. For example, some interfaces might not have DHCP. In this case, you must disable DHCP for these interfaces in the `undercloud.conf` file so that `os-net-config` can apply the configuration during the undercloud installation process.

#### Procedure

1. Log in to the undercloud host.

2. Create a new file `undercloud-os-net-config.yaml` and include the network configuration that you require.
   For more information, see Network interface reference in the Advanced Overcloud Customization guide.

Here is an example:

```yaml
network_config:
  - name: br-ctlplane
type: ovs_bridge
use_dhcp: false
dns_servers: 192.168.122.1
domain: lab.example.com
ovs_extra:
  - "br-set-external-id br-ctlplane bridge-id br-ctlplane"
addresses:
  - ip_netmask: 172.20.0.1/26
members:
  - type: interface
    name: nic2
```
To create a network bond for a specific interface, use the following sample:

```yaml
network_config:
  - name: br-ctlplane
    type: ovs_bridge
    use_dhcp: false
    dns_servers: 192.168.122.1
    domain: lab.example.com
    ovs_extra:
      - "br-set-external-id br-ctlplane bridge-id br-ctlplane"
    addresses:
      - ip_netmask: 172.20.0.1/26
    members:
      - name: bond-ctlplane
        type: linux_bond
        use_dhcp: false
        bonding_options: "mode=active-backup"
        mtu: 1500
        members:
          - type: interface
            name: nic2
          - type: interface
            name: nic3
```

3. Include the path to the `undercloud-os-net-config.yaml` file in the `net_config_override` parameter in the `undercloud.conf` file:

```ini
[DEFAULT]
...
net_config_override=undercloud-os-net-config.yaml
...
```

**NOTE**

Director uses the file that you include in the `net_config_override` parameter as the template to generate the `/etc/os-net-config/config.yaml` file. `os-net-config` manages the interfaces that you define in the template, so you must perform all undercloud network interface customization in this file.

4. Install the undercloud.

**Verification**

- After the undercloud installation completes successfully, verify that the `/etc/os-net-config/config.yaml` file contains the relevant configuration:

```yaml
network_config:
  - name: br-ctlplane
    type: ovs_bridge
    use_dhcp: false
    dns_servers: 192.168.122.1
    domain: lab.example.com
    ovs_extra:
      - "br-set-external-id br-ctlplane bridge-id br-ctlplane"
```
addresses:
- ip_netmask: 172.20.0.1/26
members:
- type: interface
  name: nic2

7.8. INSTALLING DIRECTOR

Complete the following steps to install director and perform some basic post-installation tasks.

Procedure

1. Run the following command to install director on the undercloud:

   [stack@director ~]$ openstack undercloud install

   This command launches the director configuration script. Director installs additional packages
   and configures its services according to the configuration in the undercloud.conf. This script
   takes several minutes to complete.

   The script generates two files:

   - undercloud-passwords.conf - A list of all passwords for the director services.
   - stackrc - A set of initialization variables to help you access the director command line tools.

2. The script also starts all OpenStack Platform service containers automatically. You can check
   the enabled containers with the following command:

   [stack@director ~]$ sudo podman ps

3. To initialize the stack user to use the command line tools, run the following command:

   [stack@director ~]$ source ~/stackrc

   The prompt now indicates that OpenStack commands authenticate and execute against the
   undercloud;

   (undercloud) [stack@director ~]$ 

   The director installation is complete. You can now use the director command line tools.

7.9. CONFIGURING THE CPU ARCHITECTURE FOR THE OVERCLOUD

Red Hat OpenStack Platform (RHOSP) configures the CPU architecture of an overcloud as x86_64 by
default. You can also deploy overcloud Compute nodes on POWER (ppc64le) hardware. For the
Compute node cluster, you can use the same architecture, or use a combination of x86_64 and ppc64le
systems.

NOTE

The undercloud, Controller nodes, Ceph Storage nodes, and all other systems are
supported only on x86_64 hardware.
7.9.1. Configuring POWER (ppc64le) as the single CPU architecture for the overcloud

The default CPU architecture of the Compute nodes on an overcloud is x86_64. To deploy overcloud Compute nodes on POWER (ppc64le) hardware, you can change the architecture to ppc64le.

Procedure

1. Disable iPXE in the `undercloud.conf` file:

   ```
   [DEFAULT]
   ipxe_enabled = False
   ```

   **NOTE**
   For RHOSP 16.2.1 and earlier, this configuration causes any x86_64 nodes in your deployment to also boot in PXE/legacy mode. To configure a multiple CPU architecture for your overcloud, see Configuring a multiple CPU architecture overcloud.

2. Install the undercloud:

   ```
   [stack@director ~]$ openstack undercloud install
   ```

   For more information, see Installing director on the undercloud.

3. Wait until the installation script completes.

4. Obtain and upload the images for the overcloud nodes. For more information, see Obtaining images for overcloud nodes.

7.9.2. Configuring a multiple CPU architecture overcloud

For RHOSP 16.2.2 and later, you can configure your undercloud to support both PXE and iPXE boot modes when your architecture includes both POWER (ppc64le) and x86_64 UEFI nodes.

**NOTE**
When your architecture includes POWER (ppc64le) nodes, RHOSP 16.2.1 and earlier supports only PXE boot.

Procedure

1. Enable iPXE in the `undercloud.conf` file:

   ```
   [DEFAULT]
   ipxe_enabled = True
   ```

2. Create a custom environment file for the undercloud, `undercloud_noIronicIPXEEnabled.yaml`.

3. To change the default Bare Metal Provisioning service (ironic) iPXE setting to PXE, add the following configuration to `undercloud_noIronicIPXEEnabled.yaml`:
parameter_defaults:
  IronicIPXEEnabled: false
  IronicInspectorIPXEEnabled: true

4. If your architecture includes ppc64le nodes, add the following configuration to `undercloud_noIronicIPXEEnabled.yaml` to disable the boot timeout:

```
parameter_defaults:
  ExtraConfig:
    ironic::config::ironic_config:
      ipmi/disable_boot_timeout:
        value: 'false'
```

5. Include the custom environment file in the `undercloud.conf` file:

```
[DEFAULT]
...
custom_env_files = undercloud_noIronicIPXEEnabled.yaml
```

6. Install the undercloud:

```
[stack@director ~]$ openstack undercloud install
```

For more information, see Installing director on the undercloud.

7. Wait until the installation script completes.

8. Register your overcloud nodes:

```
(undercloud)$ openstack overcloud node import ~/nodes.json
```

For more information on registering overcloud nodes, see Registering nodes for the overcloud.

9. Wait for the node registration and configuration to complete.

10. Confirm that director has successfully registered the nodes:

```
(undercloud)$ openstack baremetal node list
```

11. Check the existing capabilities of each registered node:

```
$ openstack baremetal node show <node> -f json -c properties | jq .properties.capabilities
```

12. Set the boot mode to uefi for each registered node by adding `boot_mode:uefi` to the existing capabilities of the node:

```
$ openstack baremetal node set --property capabilities="boot_mode:uefi,<capability_1>,...,<capability_n>" <node>
```

- Replace `<node>` with the ID of the bare metal node.
- Replace `<capability_1>`, and all capabilities up to `<capability_n>`, with each capability that you retrieved in step 6.
13. Obtain and upload the images for the overcloud nodes. For more information, see Multiple CPU architecture overcloud images.

14. Set the boot mode for each node:
   - For legacy/PXE:
     
     ```bash
     $ openstack baremetal node set --boot-interface pxe <node_name>
     ```
   - For iPXE:
     
     ```bash
     $ openstack baremetal node set --boot-interface ipxe <node_name>
     ```

### 7.9.3. Using Ceph Storage in a multi-architecture overcloud

When you configure access to external Ceph in a multi-architecture cloud, set the `CephAnsiblePlaybook` parameter to `/usr/share/ceph-ansible/site.yml.sample` and include your client key and other Ceph-specific parameters.

For example:

```yaml
parameter_defaults:
  CephAnsiblePlaybook: /usr/share/ceph-ansible/site.yml.sample
  CephClientKey: AQDLOh1VgEp6FRAAFzT7Zw+Y9V6JJEzQAsRnRQ==
  CephClusterFSID: 4b5c8c0a-ff60-454b-a1b4-9747aa737d19
  CephExternalMonHost: 172.16.1.7, 172.16.1.8
```

### 7.9.4. Using composable services in a multi-architecture overcloud

The following services typically form part of the Controller node and are available for use in custom roles as Technology Preview:

- Block Storage service (cinder)
- Image service (glance)
- Identity service (keystone)
- Networking service (neutron)
- Object Storage service (swift)

**NOTE**

Red Hat does not support features in Technology Preview.

For more information about composable services, see `composable services and custom roles` in the Advanced Overcloud Customization guide. Use the following example to understand how to move the listed services from the Controller node to a dedicated ppc64le node:

```bash
(undercloud) [stack@director ~]$ rsync -a /usr/share/openstack-tripleo-heat-templates/. ~/templates
(undercloud) [stack@director ~]$ cd ~/templates/roles
(undercloud) [stack@director roles]$ cat <<EO_TEMPLATE >ControllerPPC64LE.yaml
```

---

81
# Role: ControllerPPC64LE

- name: ControllerPPC64LE

description: Controller role that has all the controller services loaded and handles Database, Messaging and Network functions.

CountDefault: 1

tags:
- primary
- controller

networks:
- External
- InternalApi
- Storage
- StorageMgmt
- Tenant

# For systems with both IPv4 and IPv6, you may specify a gateway network for each, such as ['ControlPlane', 'External']

default_route_networks: ['External']

HostnameFormatDefault: %stackname%-controllerppc64le-%index%'

ImageDefault: ppc64le-overcloud-full

ServicesDefault:
- OS::TripleO::Services::Aide
- OS::TripleO::Services::AuditD
- OS::TripleO::Services::CACerts
- OS::TripleO::Services::CephClient
- OS::TripleO::Services::CephExternal
- OS::TripleO::Services::CertmongerUser
- OS::TripleO::Services::CinderApi
- OS::TripleO::Services::CinderBackendDellPs
- OS::TripleO::Services::CinderBackendDellSc
- OS::TripleO::Services::CinderBackendDellEMCUUnity
- OS::TripleO::Services::CinderBackendDellEMCVMAXISCSI
- OS::TripleO::Services::CinderBackendDellEMCVNX
- OS::TripleO::Services::CinderBackendDellEMCXTREMIOISCSI
- OS::TripleO::Services::CinderBackendNetApp
- OS::TripleO::Services::CinderBackendScaleIO
- OS::TripleO::Services::CinderBackendVRTSHyperScale
- OS::TripleO::Services::CinderBackup
- OS::TripleO::Services::CinderHPELeftHandISCSI
- OS::TripleO::Services::CinderScheduler
- OS::TripleO::Services::CinderVolume
- OS::TripleO::Services::Collectd
- OS::TripleO::Services::Docker
- OS::TripleO::Services::Fluentd
- OS::TripleO::Services::GlanceApi
- OS::TripleO::Services::GlanceRegistry
- OS::TripleO::Services::Ipsess
- OS::TripleO::Services::Isccsid
- OS::TripleO::Services::Kernel
- OS::TripleO::Services::Keystone
- OS::TripleO::Services::LoginDefs
- OS::TripleO::Services::MySQLClient
- OS::TripleO::Services::NeutronApi
- OS::TripleO::Services::NeutronBgpVpnApi
7.10. OBTAINING IMAGES FOR OVERCLOUD NODES

Director requires several disk images to provision overcloud nodes:

- An introspection kernel and ramdisk for bare metal system introspection over PXE boot.
- A deployment kernel and ramdisk for system provisioning and deployment.
- An overcloud kernel, ramdisk, and full image, which form a base overcloud system that director writes to the hard disk of the node.

You can obtain and install the images you need based on your CPU architecture. You can also obtain and install a basic image to provision a bare OS when you do not want to run any other Red Hat OpenStack Platform (RHOSP) services or consume one of your subscription entitlements.
7.10.1. Single CPU architecture overcloud images

Your Red Hat OpenStack Platform (RHOSP) installation includes packages that provide you with the following overcloud images for director:

- overcloud-full
- overcloud-full-initrd
- overcloud-full-vmlinuz

These images are necessary for deployment of the overcloud with the default CPU architecture, x86-64. Importing these images into director also installs introspection images on the director PXE server.

Procedure

1. Log in to the undercloud as the stack user.

2. Source the stackrc file:

   [stack@director ~]$ source ~/stackrc

3. Install the rhosp-director-images and rhosp-director-images-ipa-x86_64 packages:

   (undercloud) [stack@director ~]$ sudo dnf install rhosp-director-images rhosp-director-images-ipa-x86_64

4. Create the images directory in the home directory of the stack user (/home/stack/images).

   (undercloud) [stack@director ~]$ mkdir /home/stack/images

5. Extract the images archives to the images directory:

   (undercloud) [stack@director ~]$ cd ~/images
   (undercloud) [stack@director images]$ for i in /usr/share/rhosp-director-images/overcloud-full-latest-16.2.tar /usr/share/rhosp-director-images/ironic-python-agent-latest-16.2.tar; do tar -xvf $i; done

6. Import the images into director:

   (undercloud) [stack@director images]$ openstack overcloud image upload --image-path /home/stack/images/

7. Verify that the images are uploaded:

   (undercloud) [stack@director images]$ openstack image list

<table>
<thead>
<tr>
<th>ID</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>ef793cd0-e65c-456a-a675-63cd57610bd5</td>
<td>overcloud-full</td>
</tr>
<tr>
<td>9a51a6cb-4670-40de-b64b-b70f4dd44152</td>
<td>overcloud-full-initrd</td>
</tr>
<tr>
<td>4f7e33f4-d617-47c1-b36f-cbe90f132e5d</td>
<td>overcloud-full-vmlinuz</td>
</tr>
</tbody>
</table>
8. Verify that director has copied the introspection PXE images to /var/lib/ironic/httpboot:

```
(undercloud) [stack@director images]$ ls -l /var/lib/ironic/httpboot
total 417296
-rwxr-xr-x. 1 root  root    6639920 Jan 29 14:48 agent.kernel
-rw-r--r--. 1 root  root  420656424 Jan 29 14:48 agent.ramdisk
-rw-r--r--. 1 42422 42422       758 Jan 29 14:29 boot.ipxe
-rw-r--r--. 1 42422 42422       488 Jan 29 14:16 inspector.ipxe
```

### 7.10.2. Multiple CPU architecture overcloud images

Your Red Hat OpenStack Platform (RHOSP) installation includes packages that provide you with the following images that are necessary for deployment of the overcloud with the default CPU architecture, x86-64:

- **overcloud-full**
- **overcloud-full-initrd**
- **overcloud-full-vmlinuz**

Your RHOSP installation also includes packages that provide you with the following images that are necessary for deployment of the overcloud with the POWER (ppc64le) CPU architecture:

- **ppc64le-overcloud-full**

Importing these images into director also installs introspection images on the director PXE server.

**Procedure**

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

   ```
   [stack@director ~]$ source ~/stackrc
   ```
3. Install the **rhosp-director-images-all** package:

   ```
   (undercloud) [stack@director ~]$ sudo dnf install rhosp-director-images-all
   ```
4. Extract the archives to an architecture specific directory in the **images** directory in the home directory of the **stack** user (/home/stack/images):

   ```
   (undercloud) [stack@director images]$ for arch in x86_64 ppc64le ; do mkdir $arch ; done
   (undercloud) [stack@director images]$ for arch in x86_64 ppc64le ; do for i in /usr/share/rhosp-director-images/overcloud-full-latest-16.1-$arch.tar /usr/share/rhosp-director-images/ironic-python-agent-latest-16.1-$arch.tar ; do tar -C $arch -xf $i ; done ; done
   ```
5. Import the images into director:

   ```
   (undercloud) [stack@director images]$ cd ~/images
   (undercloud) [stack@director images]$ openstack overcloud image upload --image-path
   ```
6. Verify that the images are uploaded:

```
(undercloud) [stack@director images]$ openstack image list
```

<table>
<thead>
<tr>
<th>ID</th>
<th>Name</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>6a6096ba-8f79-4343-b77c-4349f7b94960</td>
<td>overcloud-full</td>
<td>active</td>
</tr>
<tr>
<td>de2a1bde-9351-40d2-bbd7-7ce9d6eb50d8</td>
<td>overcloud-full-initrd</td>
<td>active</td>
</tr>
<tr>
<td>67073533-dd2a-4a95-8e8b-0f108f031092</td>
<td>overcloud-full-vmlinuz</td>
<td>active</td>
</tr>
<tr>
<td>f0fedcd0-3f28-4b44-9c88-619419007a03</td>
<td>ppc64le-overcloud-full</td>
<td>active</td>
</tr>
</tbody>
</table>

(undercloud) [stack@director images]$ ls -l /var/lib/ironic/tftpboot

```
/var/lib/ironic/tftpboot/ppc64le/:
```

```
-rwxr-xr-. 1 root root 6385968 Aug  8 19:35 agent.kernel
-rw-r--r--. 1 root root 425530268 Aug  8 19:35 agent.ramdisk
-rwxr-xr-. 1 42422 42422 20832 Aug  8 02:08 chain.c32
-rwxr--r--. 1 42422 42422 715584 Aug  8 02:06 ipxe.efi
-rw-r--r--. 1 42422 42422 22 Aug  8 02:06 map-file
```

```
7. Verify that director has copied the introspection PXE images to /var/lib/ironic/tftpboot:
```

```
(undercloud) [stack@director images]$ ls -l /var/lib/ironic/tftpboot
```

```
/var/lib/ironic/tftpboot:
```

```
total 422624
-rw-xr-xr-. 1 root root 6385968 Aug  8 19:35 agent.kernel
-rw-r--r--. 1 root root 425530268 Aug  8 19:35 agent.ramdisk
-rwxr-xr-. 1 42422 42422 20832 Aug  8 02:08 chain.c32
-rwxr--r--. 1 42422 42422 715584 Aug  8 02:06 ipxe.efi
-rw-r--r--. 1 42422 42422 22 Aug  8 02:06 map-file
```

```
/var/lib/ironic/tftpboot/ppc64le/:
```

```
total 457204
-rw-xr-xr-. 1 root root 6385968 Aug  8 19:35 agent.kernel
-rw-r--r--. 1 root root 425530268 Aug  8 19:35 agent.ramdisk
-rw-r--r--. 1 42422 42422 20832 Aug  8 02:08 chain.c32
```

7.10.3. Enabling multiple CPU architectures on container images

If your Red Hat OpenStack Platform (RHOSP) deployment has a multiple CPU architecture, and it uses container images, you must update the container images to enable multiple architectures.

**Procedure**

1. Log in to the undercloud as the **stack** user.
2. Source the `stackrc` file:

```
[stack@director ~]$ source ~/stackrc
```

3. Add the additional architectures to the `containers-prepare-parameter.yaml` file to enable multiple architectures:

```
parameter_defaults:
  ContainerImageRegistryLogin: true
  AdditionalArchitectures: [list_of_architectures]
  ContainerImagePrepare:
    - push_destination: true
    ...
```

Replace `<list_of_architectures>` with a comma-separated list of the architectures supported by your overcloud environment, for example, `[ppc64le]`.

4. Prepare and upload the containers:

```
$ openstack tripleo container image prepare \
  -e ~/containers-prepare-parameter.yaml
```

### 7.10.4. Minimal overcloud image

You can use the `overcloud-minimal` image to provision a bare OS where you do not want to run any other Red Hat OpenStack Platform (RHOSP) services or consume one of your subscription entitlements.

Your RHOSP installation includes the `overcloud-minimal` package that provides you with the following overcloud images for director:

- `overcloud-minimal`
- `overcloud-minimal-initrd`
- `overcloud-minimal-vmlinuz`

**NOTE**

The default `overcloud-full.qcow2` image is a flat partition image. However, you can also import and use whole disk images. For more information, see Chapter 25, Creating whole-disk images.

**Procedure**

1. Log in to the undercloud as the `stack` user.

2. Source the `stackrc` file:

```
[stack@director ~]$ source ~/stackrc
```

3. Install the `overcloud-minimal` package:

```
(undercloud) [stack@director ~]$ sudo dnf install rhosp-director-images-minimal
```
4. Extract the images archives to the images directory in the home directory of the stack user (/home/stack/images):

(undercloud) [stack@director ~]$ cd ~/images
(undercloud) [stack@director images]$ tar xf /usr/share/rhosp-director-images/overcloud-minimal-latest-16.2.tar

5. Import the images into director:

(undercloud) [stack@director images]$ openstack overcloud image upload --image-path /home/stack/images/ --os-image-name overcloud-minimal.qcow2

6. Verify that the images are uploaded:

(undercloud) [stack@director images]$ openstack image list

<table>
<thead>
<tr>
<th>ID</th>
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</tr>
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</tr>
<tr>
<td>4f7e33f4-d617-47c1-b36f-cbe90f132e5d</td>
<td>overcloud-full-vmlinuz</td>
</tr>
<tr>
<td>32cf6771-b5df-4498-8f02-c3bd8bb93fdd</td>
<td>overcloud-minimal</td>
</tr>
<tr>
<td>600035af-dbb-4985-8b24-a4e9da149ae5</td>
<td>overcloud-minimal-initrd</td>
</tr>
<tr>
<td>d45b0071-8006-472b-bbcc-458899e0d801</td>
<td>overcloud-minimal-vmlinuz</td>
</tr>
</tbody>
</table>

7.11. SETTING A NAMESERVER FOR THE CONTROL PLANE

If you intend for the overcloud to resolve external hostnames, such as cdn.redhat.com, set a nameserver on the overcloud nodes. For a standard overcloud without network isolation, the nameserver is defined using the undercloud control plane subnet. Complete the following procedure to define nameservers for the environment.

Procedure

1. Source the stackrc file to enable the director command line tools:

   [stack@director ~]$ source ~/stackrc

2. Set the nameservers for the ctlplane-subnet subnet:

   (undercloud) [stack@director images]$ openstack subnet set --dns-nameserver [nameserver1-ip] --dns-nameserver [nameserver2-ip] ctlplane-subnet

   Use the --dns-nameserver option for each nameserver.

3. View the subnet to verify the nameserver:

   (undercloud) [stack@director images]$ openstack subnet show ctlplane-subnet

   +-------------------+-----------------------------------------------+
   | Field             | Value                                         |
   +-------------------+-----------------------------------------------+
   | ...               |                                               |

Red Hat OpenStack Platform 17.0-Beta Director Installation and Usage
IMPORTANT

If you aim to isolate service traffic onto separate networks, the overcloud nodes must use the `DnsServers` parameter in your network environment files. You must also set the control plane nameserver and the `DnsServers` parameter to the same DNS server.

### 7.12. UPDATING THE UNDERCLOUD CONFIGURATION

If you need to change the undercloud configuration to suit new requirements, you can make changes to your undercloud configuration after installation, edit the relevant configuration files and re-run the `openstack undercloud install` command.

**Procedure**

1. Modify the undercloud configuration files. For example, edit the `undercloud.conf` file and add the `idrac` hardware type to the list of enabled hardware types:

   ```
   enabled_hardware_types = ipmi,redfish,idrac
   ```

2. Run the `openstack undercloud install` command to refresh your undercloud with the new changes:

   ```
   [stack@director ~]$ openstack undercloud install
   ```

   Wait until the command runs to completion.

3. Initialize the `stack` user to use the command line tools:

   ```
   [stack@director ~]$ source ~/stackrc
   ```

   The prompt now indicates that OpenStack commands authenticate and execute against the undercloud:

   ```
   (undercloud) [stack@director ~]$
   ```

4. Verify that director has applied the new configuration. For this example, check the list of enabled hardware types:

   ```
   (undercloud) [stack@director ~]$ openstack baremetal driver list
   +---------------------+----------------------+
   | Supported driver(s) | Active host(s)       |
   +---------------------+----------------------+
   | idrac               | director.example.com |
   | ipmi                | director.example.com |
   | redfish             | director.example.com |
   +---------------------+----------------------+
   ```

The undercloud re-configuration is complete.
7.13. UNDERCLOUD CONTAINER REGISTRY

Red Hat Enterprise Linux 9.0 no longer includes the `docker-distribution` package, which installed a Docker Registry v2. To maintain the compatibility and the same level of feature, the director installation creates an Apache web server with a vhost called `image-serve` to provide a registry. This registry also uses port 8787/TCP with SSL disabled. The Apache-based registry is not containerized, which means that you must run the following command to restart the registry:

```
$ sudo systemctl restart httpd
```

You can find the container registry logs in the following locations:

- `/var/log/httpd/image_serve_access.log`
- `/var/log/httpd/image_serve_error.log`

The image content is served from `/var/lib/image-serve`. This location uses a specific directory layout and `apache` configuration to implement the pull function of the registry REST API.

The Apache-based registry does not support `podman push` nor `buildah push` commands, which means that you cannot push container images using traditional methods. To modify images during deployment, use the container preparation workflow, such as the `ContainerImagePrepare` parameter. To manage container images, use the container management commands:

```
openstack tripleo container image list
    Lists all images stored on the registry.
openstack tripleo container image show
    Show metadata for a specific image on the registry.
openstack tripleo container image push
    Push an image from a remote registry to the undercloud registry.
openstack tripleo container image delete
    Delete an image from the registry.
```
CHAPTER 8. INSTALLING UNDERCLOUD MINIONS

You can deploy additional undercloud minions to scale OpenStack Platform director services across multiple hosts, which helps the performance when you deploy large overclouds. This feature is optional.

IMPORTANT

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

8.1. UNDERCLOUD MINION

An undercloud minion provides additional heat-engine and ironic-conductor services on a separate host. These additional services support the undercloud with orchestration and provisioning operations. The distribution of undercloud operations across multiple hosts provides more resources to run an overcloud deployment, which can result in potentially faster and larger deployments.

8.2. UNDERCLOUD MINION REQUIREMENTS

Service requirements

The scaled heat-engine and ironic-conductor services on an undercloud minion use a set of workers. Each worker performs operations specific to that service. Multiple workers provide simultaneous operations. The default number of workers on the minion is determined by halving the total CPU thread count of the minion host. In this instance, total thread count is the number of CPU cores multiplied by the hyper-threading value. For example, if your minion has a CPU with 16 threads, then the minion spawns 8 workers for each service by default. The minion also uses a set of minimum and maximum caps by default:

<table>
<thead>
<tr>
<th>Service</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>heat-engine</td>
<td>4</td>
<td>24</td>
</tr>
<tr>
<td>ironic-conductor</td>
<td>2</td>
<td>12</td>
</tr>
</tbody>
</table>

An undercloud minion has the following minimum CPU and memory requirements:

- An 8-thread 64-bit x86 processor with support for the Intel 64 or AMD64 CPU extensions. This processor provides 4 workers for each undercloud service.
- A minimum of 16 GB of RAM.

To use a larger number of workers, increase the vCPUs and memory count on the undercloud using a ratio of 2 GB of RAM for each CPU thread. For example, a machine with 48 threads must have 96 GB of RAM. This provides coverage for 24 heat-engine workers and 12 ironic-conductor workers.

Container image requirements

An undercloud minion does not host an internal container image registry. As a result, you must configure the minion to use one of the following methods to obtain container images:
8.3. PREPARING A MINION

Before you can install a minion, you must complete some basic configuration on the host machine:

- A non-root user to execute commands.
- A resolvable hostname
- A Red Hat subscription
- The command line tools for image preparation and minion installation

Procedure

1. Log in to the minion host as the root user.

2. Create the stack user:

   ```
   [root@minion ~]# useradd stack
   ```

3. Set a password for the stack user:

   ```
   [root@minion ~]# passwd stack
   ```

4. Disable password requirements when using sudo:

   ```
   [root@minion ~]# echo "stack ALL=(root) NOPASSWD:ALL" | tee -a /etc/sudoers.d/stack
   [root@minion ~]# chmod 0440 /etc/sudoers.d/stack
   ```

5. Switch to the new stack user:

   ```
   [root@minion ~]# su - stack
   [stack@minion ~]$ 
   ```

6. Check the base and full hostname of the minion:

   ```
   [stack@minion ~]$ hostname
   [stack@minion ~]$ hostname -f
   ```

   If either of the previous commands do not report the correct fully-qualified hostname or report an error, use hostnamectl to set a hostname:

   ```
   [stack@minion ~]$ sudo hostnamectl set-hostname minion.example.com
   [stack@minion ~]$ sudo hostnamectl set-hostname --transient minion.example.com
   ```
7. Edit the `/etc/hosts` file and include an entry for the system hostname. For example, if the system is named `minion.example.com` and uses the IP address `10.0.0.1`, add the following line to the `/etc/hosts` file:

```
10.0.0.1  minion.example.com  manager
```

8. Register your system either with the Red Hat Content Delivery Network or Red Hat Satellite. For example, run the following command to register the system to the Content Delivery Network. Enter your Customer Portal user name and password when prompted:

```
[stack@minion ~]$ sudo subscription-manager register
```

9. Find the entitlement pool ID for Red Hat OpenStack Platform (RHOSP) director:

```
[stack@minion ~]$ sudo subscription-manager list --available --all --matches="Red Hat OpenStack"
Subscription Name:   Name of SKU
Provides:            Red Hat Single Sign-On
                      Red Hat Enterprise Linux Workstation
                      Red Hat CloudForms
                      Red Hat OpenStack
                      Red Hat Software Collections (for RHEL Workstation)
                      Red Hat Virtualization
SKU:                 SKU-Number
Contract:            Contract-Number
Pool ID:             Valid-Pool-Number-123456
Provides Management: Yes
Available:           1
Suggested:           1
Service Level:       Support-level
Service Type:        Service-Type
Subscription Type:   Sub-type
Ends:                End-date
System Type:         Physical
```

10. Locate the Pool ID value and attach the Red Hat OpenStack Platform 17.0-beta entitlement:

```
[stack@minion ~]$ sudo subscription-manager attach --pool=Valid-Pool-Number-123456
```

11. Disable all default repositories, and then enable the required Red Hat Enterprise Linux repositories:

```
[stack@minion ~]$ sudo subscription-manager repos --disable=*  
[stack@minion ~]$ sudo subscription-manager repos --enable=rhel-8-for-x86_64-baseos-eus-rpms --enable=rhel-8-for-x86_64-appstream-eus-rpms --enable=rhel-8-for-x86_64-highavailability-eus-rpms --enable=ansible-2.9-for-rhel-8-x86_64-rpms --enable=openstack-beta-for-rhel-8-x86_64-rpms --enable=fast-datapath-for-rhel-8-x86_64-rpms
```

These repositories contain packages that the minion installation requires.

12. Perform an update on your system to ensure that you have the latest base system packages:

```
[stack@minion ~]$ sudo dnf update -y  
[stack@minion ~]$ sudo reboot
13. Install the command line tools for minion installation and configuration:

```
[stack@minion ~]$ sudo dnf install -y python3-tripleoclient
```

### 8.4. COPYING THE UNDERCLOUD CONFIGURATION FILES TO THE MINION

The minion requires some configuration files from the undercloud so that the minion installation can configure the minion services and register them with director:

- `tripleo-undercloud-outputs.yaml`
- `tripleo-undercloud-passwords.yaml`

**Procedure**

1. Log in to your undercloud as the **stack** user.

2. Copy the files from the undercloud to the minion:

   ```
   $ scp ~/tripleo-undercloud-outputs.yaml ~/tripleo-undercloud-passwords.yaml
   stack@<minion-host>:~/.
   ```

   Replace `<minion-host>` with the hostname or IP address of the minion.

### 8.5. COPYING THE UNDERCLOUD CERTIFICATE AUTHORITY

If the undercloud uses SSL/TLS for endpoint encryption, the minion host must contain the certificate authority that signed the undercloud SSL/TLS certificates. Depending on your undercloud configuration, this certificate authority is one of the following:

- An external certificate authority whose certificate is preloaded on the minion host. No action is required.

- A director-generated self-signed certificate authority, which the director creates at `/etc/pki/ca-trust/source/anchors/cm-local-ca.pem`. Copy this file to the minion host and include the file as a part of the trusted certificate authorities for the minion host. This procedure uses this file as an example.

- A custom self-signed certificate authority, which you create with OpenSSL. Examples in this document refer to this file as `ca.crt.pem`. Copy this file to the minion host and include the file as a part of the trusted certificate authorities for the minion host.

**Procedure**

1. Log in to the minion host as the **root** user.

2. Copy the certificate authority file from the undercloud to the minion:

   ```
   [root@minion ~]# scp 
   root@<undercloud-host>:/etc/pki/ca-trust/source/anchors/cm-local-ca.pem \
   /etc/pki/ca-trust/source/anchors/undercloud-ca.pem
   ```

   Replace `<undercloud-host>` with the hostname or IP address of the undercloud.
3. Update the trusted certificate authorities for the minion host:

```
[root@minion ~]# update-ca-trust enable
[root@minion ~]# update-ca-trust extract
```

### 8.6. CONFIGURING THE MINION

The minion installation process requires certain settings in the `minion.conf` configuration file, which the minion reads from the home directory of the `stack` user. Complete the following steps to use the default template as a foundation for your configuration.

**Procedure**

1. Log in to the minion host as the `stack` user.

2. Copy the default template to the home directory of the `stack` user:

   ````
   [stack@minion ~]$ cp /usr/share/python-tripleoclient/minion.conf.sample ~/minion.conf
   ````

3. Edit the `minion.conf` file. This file contains settings to configure your minion. If you omit or comment out a parameter, the minion installation uses the default value. Review the following recommended parameters:

   - **minion_hostname**, which you set to the hostname of the minion.
   - **minion_local_interface**, which you set to the interface that connects to the undercloud through the Provisioning Network.
   - **minion_local_ip**, which you set to a free IP address on the Provisioning Network.
   - **minion_nameservers**, which you set to the DNS nameservers so that the minion can resolve hostnames.
   - **enable_ironic_conductor**, which defines whether to enable the `ironic-conductor` service.
   - **enable_heat_engine**, which defines whether to enable the `heat-engine` service.

**NOTE**

The default `minion.conf` file enables only the `heat-engine` service on the minion. To enable the `ironic-conductor` service, set the `enable_ironic_conductor` parameter to `true`.

### 8.7. MINION CONFIGURATION PARAMETERS

The following list contains information about parameters for configuring the `minion.conf` file. Keep all parameters within their relevant sections to avoid errors.

**Defaults**

The following parameters are defined in the `[DEFAULT]` section of the `minion.conf` file:

- `cleanup`
Cleanup temporary files. Set this parameter to False to leave the temporary files used during deployment in place after the command is run. This is useful for debugging the generated files or if errors occur.

**container_cli**

The CLI tool for container management. Leave this parameter set to podman. Red Hat Enterprise Linux 9.0 only supports podman.

**container_healthcheck_disabled**

Disables containerized service health checks. Red Hat recommends that you enable health checks and leave this option set to false.

**container_images_file**

Heat environment file with container image information. This file can contain the following entries:

- Parameters for all required container images
- The ContainerImagePrepare parameter to drive the required image preparation. Usually the file that contains this parameter is named containers-prepare-parameter.yaml.

**container_insecure_registries**

A list of insecure registries for podman to use. Use this parameter if you want to pull images from another source, such as a private container registry. In most cases, podman has the certificates to pull container images from either the Red Hat Container Catalog or from your Satellite server if the minion is registered to Satellite.

**container_registry_mirror**

An optional registry-mirror configured that podman uses.

**custom_env_files**

Additional environment file that you want to add to the minion installation.

**deployment_user**

The user who installs the minion. Leave this parameter unset to use the current default user stack.

**enable_heat_engine**

Defines whether to install the heat engine on the minion. The default is true.

**enable_ironic_conductor**

Defines whether to install the ironic conductor service on the minion. The default value is false. Set this value to true to enable the ironic conductor service.

**heat_container_image**

URL for the heat container image that you want to use. Leave unset.

**heat_native**

Use native heat templates. Leave as true.

**hieradata_override**

Path to hieradata override file that configures Puppet hieradata on the director, providing custom configuration to services beyond the minion.conf parameters. If set, the minion installation copies this file to the /etc/puppet/hieradata directory and sets it as the first file in the hierarchy.

**minion_debug**

Set this value to true to enable the DEBUG log level for minion services.

**minion_enable_selinux**

Enable or disable SELinux during the deployment. It is highly recommended to leave this value set to true unless you are debugging an issue.
minion_enable_validations
Enable validation services on the minion.

minion_hostname
Defines the fully qualified host name for the minion. If set, the minion installation configures all system host name settings. If left unset, the minion uses the current host name, but you must configure all system host name settings appropriately.

minion_local_interface
The chosen interface for the Provisioning NIC on the undercloud. This is also the device that the minion uses for DHCP and PXE boot services. Change this value to your chosen device. To see which device is connected, use the `ip addr` command. For example, this is the result of an `ip addr` command:

```
2: eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP qlen 1000
    link/ether 52:54:00:75:24:09 brd ff:ff:ff:ff:ff:ff
    inet 192.168.122.178/24 brd 192.168.122.255 scope global dynamic eth0
        valid_lft 3462sec preferred_lft 3462sec
    inet6 fe80::5054:ff:fe75:2409/64 scope link
        valid_lft forever preferred_lft forever
3: eth1: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc noop state DOWN
    link/ether 42:0b:c2:a5:c1:26 brd ff:ff:ff:ff:ff:ff
```

In this example, the External NIC uses `eth0` and the Provisioning NIC uses `eth1`, which is currently not configured. In this case, set the `local_interface` to `eth1`. The configuration script attaches this interface to a custom bridge defined with the `inspection_interface` parameter.

minion_local_ip
The IP address defined for the Provisioning NIC on the undercloud. This is also the IP address that the minion uses for DHCP and PXE boot services. Leave this value as the default `192.168.24.1/24` unless you use a different subnet for the Provisioning network, for example, if the default IP address conflicts with an existing IP address or subnet in your environment.

minion_local_mtu
The maximum transmission unit (MTU) that you want to use for the `local_interface`. Do not exceed 1500 for the minion.

minion_log_file
The path to a log file where you want to store the minion install and upgrade logs. By default, the log file is `install-minion.log` in the home directory. For example, `/home/stack/install-minion.log`.

minion_nameservers
A list of DNS nameservers to use for the minion hostname resolution.

minion_ntp_servers
A list of network time protocol servers to help synchronize the minion date and time.

minion_password_file
The file that contains the passwords for the minion to connect to undercloud services. Leave this parameter set to the `tripleo-undercloud-passwords.yaml` file copied from the undercloud.

minion_service_certificate
The location and filename of the certificate for OpenStack SSL/TLS communication. Ideally, you obtain this certificate from a trusted certificate authority. Otherwise, generate your own self-signed certificate.

minion_timezone
Host timezone for the minion. If you do not specify a timezone, the minion uses the existing timezone configuration.

**minion_undercloud_output_file**

The file that contains undercloud configuration information that the minion can use to connect to undercloud services. Leave this parameter set to the `tripleo-undercloud-outputs.yaml` file copied from the undercloud.

**net_config_override**

The path to a network configuration override template. If you set this parameter, the minion uses a JSON format template to configure the networking with `os-net-config` and ignores the network parameters set in `minion.conf`. See `/usr/share/python-tripleoclient/minion.conf.sample` for an example.

**networks_file**

Networks file to override for `heat`.

**output_dir**

Directory to output state, processed heat templates, and Ansible deployment files.

**roles_file**

The roles file that you want to use to override the default roles file for minion installation. It is highly recommended to leave this parameter unset so that the minion installation uses the default roles file.

**templates**

Heat templates file to override.

### 8.8. INSTALLING THE MINION

Complete the following steps to install the minion.

**Procedure**

1. Log in to the minion host as the `stack` user.

2. Run the following command to install the minion:

   ```bash
   [stack@minion ~]$ openstack undercloud minion install
   ```

   This command launches the configuration script for the minion, installs additional packages, and configures minion services according to the configuration in the `minion.conf` file. This script takes several minutes to complete.

### 8.9. VERIFYING THE MINION INSTALLATION

Complete the following steps to confirm a successful minion installation.

**Procedure**

1. Log in to your undercloud as the `stack` user.

2. Source the `stackrc` file:

   ```bash
   [stack@director ~]$ source ~/stackrc
   ```
3. If you enabled the heat engine service on the minion, verify that the **heat-engine** service from the minion appears on the undercloud service list:

```
[stack@director ~]$ openstack orchestration service list
```

The command output displays a table with **heat-engine** workers for both the undercloud and any minions.

4. If you enabled the ironic conductor service on the minion, verify that the **ironic-conductor** service from the minion appears on the undercloud service list:

```
[stack@director ~]$ openstack baremetal conductor list
```

The command output displays a table with **ironic-conductor** services for both the undercloud and any minions.
CHAPTER 9. PLANNING YOUR OVERCLOUD

The following section contains some guidelines for planning various aspects of your Red Hat OpenStack Platform (RHOSP) environment. This includes defining node roles, planning your network topology, and storage.

IMPORTANT

Do not rename your overcloud nodes after they have been deployed. Renaming a node after deployment creates issues with instance management.

9.1. NODE ROLES

Director includes the following default node types to build your overcloud:

**Controller**

Provides key services for controlling your environment. This includes the dashboard (horizon), authentication (keystone), image storage (glance), networking (neutron), orchestration (heat), and high availability services. A Red Hat OpenStack Platform (RHOSP) environment requires three Controller nodes for a highly available production-level environment.

**NOTE**

Use environments with one Controller node only for testing purposes, not for production. Environments with two Controller nodes or more than three Controller nodes are not supported.

**Compute**

A physical server that acts as a hypervisor and contains the processing capabilities required to run virtual machines in the environment. A basic RHOSP environment requires at least one Compute node.

**Ceph Storage**

A host that provides Red Hat Ceph Storage. Additional Ceph Storage hosts scale into a cluster. This deployment role is optional.

**Swift Storage**

A host that provides external object storage to the OpenStack Object Storage (swift) service. This deployment role is optional.

The following table contains some examples of different overclouds and defines the node types for each scenario.

<table>
<thead>
<tr>
<th></th>
<th>Controller</th>
<th>Compute</th>
<th>Ceph Storage</th>
<th>Swift Storage</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small overcloud</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>Medium overcloud</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>6</td>
</tr>
</tbody>
</table>
Medium overcloud with additional object storage | 3 | 3 | - | 3 | 9

Medium overcloud with Ceph Storage cluster | 3 | 3 | 3 | - | 9

In addition, consider whether to split individual services into custom roles. For more information about the composable roles architecture, see “Composable Services and Custom Roles” in the Advanced Overcloud Customization guide.

Table 9.2. Node Deployment Roles for Proof of Concept Deployment

<table>
<thead>
<tr>
<th></th>
<th>Undercloud</th>
<th>Controller</th>
<th>Compute</th>
<th>Ceph Storage</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proof of concept</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
</tbody>
</table>

**WARNING**

The Red Hat OpenStack Platform maintains an operational Ceph Storage cluster during day-2 operations. Therefore, some day-2 operations, such as upgrades or minor updates of the Ceph Storage cluster, are not possible in deployments with fewer than three MONs or three storage nodes. If you use a single Controller node or a single Ceph Storage node, day-2 operations will fail.

### 9.2. OVERCLOUD NETWORKS

It is important to plan the networking topology and subnets in your environment so that you can map roles and services to communicate with each other correctly. Red Hat OpenStack Platform (RHOSP) uses the Openstack Networking (neutron) service, which operates autonomously and manages software-based networks, static and floating IP addresses, and DHCP.

By default, director configures nodes to use the **Provisioning / Control Plane** for connectivity. However, it is possible to isolate network traffic into a series of composable networks, that you can customize and assign services.

In a typical RHOSP installation, the number of network types often exceeds the number of physical network links. To connect all the networks to the proper hosts, the overcloud uses VLAN tagging to deliver more than one network on each interface. Most of the networks are isolated subnets but some networks require a Layer 3 gateway to provide routing for Internet access or infrastructure network connectivity. If you use VLANs to isolate your network traffic types, you must use a switch that supports 802.1Q standards to provide tagged VLANs.
It is recommended that you deploy a project network (tunneled with GRE or VXLAN) even if you intend to use a neutron VLAN mode with tunneling disabled at deployment time. This requires minor customization at deployment time and leaves the option available to use tunnel networks as utility networks or virtualization networks in the future. You still create Tenant networks using VLANs, but you can also create VXLAN tunnels for special-use networks without consuming tenant VLANs. It is possible to add VXLAN capability to a deployment with a Tenant VLAN, but it is not possible to add a Tenant VLAN to an existing overcloud without causing disruption.

Director also includes a set of templates that you can use to configure NICs with isolated composable networks. The following configurations are the default configurations:

- **Single NIC configuration** - One NIC for the Provisioning network on the native VLAN and tagged VLANs that use subnets for the different overcloud network types.
- **Bonded NIC configuration** - One NIC for the Provisioning network on the native VLAN and two NICs in a bond for tagged VLANs for the different overcloud network types.
- **Multiple NIC configuration** - Each NIC uses a subnet for a different overcloud network type.

You can also create your own templates to map a specific NIC configuration.

The following details are also important when you consider your network configuration:

- During the overcloud creation, you refer to NICs using a single name across all overcloud machines. Ideally, you should use the same NIC on each overcloud node for each respective network to avoid confusion. For example, use the primary NIC for the Provisioning network and the secondary NIC for the OpenStack services.
- Set all overcloud systems to PXE boot off the Provisioning NIC, and disable PXE boot on the External NIC and any other NICs on the system. Also ensure that the Provisioning NIC has PXE boot at the top of the boot order, ahead of hard disks and CD/DVD drives.
- All overcloud bare metal systems require a supported power management interface, such as an Intelligent Platform Management Interface (IPMI), so that director can control the power management of each node.
- Make a note of the following details for each overcloud system: the MAC address of the Provisioning NIC, the IP address of the IPMI NIC, IPMI username, and IPMI password. This information is useful later when you configure the overcloud nodes.
- If an instance must be accessible from the external internet, you can allocate a floating IP address from a public network and associate the floating IP with an instance. The instance retains its private IP but network traffic uses NAT to traverse through to the floating IP address. Note that a floating IP address can be assigned only to a single instance rather than multiple private IP addresses. However, the floating IP address is reserved for use only by a single tenant, which means that the tenant can associate or disassociate the floating IP address with a particular instance as required. This configuration exposes your infrastructure to the external internet and you must follow suitable security practices.
- To mitigate the risk of network loops in Open vSwitch, only a single interface or a single bond can be a member of a given bridge. If you require multiple bonds or interfaces, you can configure multiple bridges.
Red Hat recommends using DNS hostname resolution so that your overcloud nodes can connect to external services, such as the Red Hat Content Delivery Network and network time servers.

Red Hat recommends that the Provisioning interface, External interface, and any floating IP interfaces be left at the default MTU of 1500. Connectivity problems are likely to occur otherwise. This is because routers typically cannot forward jumbo frames across Layer 3 boundaries.

NOTE
You can virtualize the overcloud control plane if you are using Red Hat Virtualization (RHV). For more information, see xref:assemblyreatingvirtualizedcontrolplanes\[.*\].

9.3. OVERCLOUD STORAGE

NOTE
Using LVM on a guest instance that uses a back end cinder-volume of any driver or back-end type results in issues with performance, volume visibility and availability, and data corruption. Use an LVM filter to mitigate visibility, availability, and data corruption issues. For more information, see section 2 Block Storage and Volumes in the Storage Guide and KCS article 3213311, "Using LVM on a cinder volume exposes the data to the compute host."

Director includes different storage options for the overcloud environment:

Ceph Storage nodes
Director creates a set of scalable storage nodes using Red Hat Ceph Storage. The overcloud uses these nodes for the following storage types:

• **Images** - The Image service (glance) manages images for virtual machines. Images are immutable. OpenStack treats images as binary blobs and downloads them accordingly. You can use the Image service (glance) to store images in a Ceph Block Device.

• **Volumes** - OpenStack manages volumes with the Block Storage service (cinder). The Block Storage service (cinder) volumes are block devices. OpenStack uses volumes to boot virtual machines, or to attach volumes to running virtual machines. You can use the Block Storage service to boot a virtual machine using a copy-on-write clone of an image.

• **File Systems** - Openstack manages shared file systems with the Shared File Systems service (manila). Shares are backed by file systems. You can use manila to manage shares backed by a CephFS file system with data on the Ceph Storage nodes.

• **Guest Disks** - Guest disks are guest operating system disks. By default, when you boot a virtual machine with the Compute service (nova), the virtual machine disk appears as a file on the filesystem of the hypervisor (usually under /var/lib/nova/instances/<uuid>/). Every virtual machine inside Ceph can be booted without using the Block Storage service (cinder). As a result, you can perform maintenance operations easily with the live-migration process. Additionally, if your hypervisor fails, it is also convenient to trigger nova evacuate and run the virtual machine elsewhere.
IMPORTANT

For information about supported image formats, see Image Service in the Creating and Managing Images guide.

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

Swift Storage nodes

Director creates an external object storage node. This is useful in situations where you need to scale or replace Controller nodes in your overcloud environment but need to retain object storage outside of a high availability cluster.

9.4. OVERCLOUD SECURITY

Your OpenStack Platform implementation is only as secure as your environment. Follow good security principles in your networking environment to ensure that you control network access properly:

- Use network segmentation to mitigate network movement and isolate sensitive data. A flat network is much less secure.
- Restrict services access and ports to a minimum.
- Enforce proper firewall rules and password usage.
- Ensure that SELinux is enabled.

For more information about securing your system, see the following Red Hat guides:

- Security Hardening for Red Hat Enterprise Linux 8
- Using SELinux for Red Hat Enterprise Linux 8

9.5. OVERCLOUD HIGH AVAILABILITY

To deploy a highly-available overcloud, director configures multiple Controller, Compute and Storage nodes to work together as a single cluster. In case of node failure, an automated fencing and re-spawning process is triggered based on the type of node that failed. For more information about overcloud high availability architecture and services, see High Availability Deployment and Usage.

NOTE

Deploying a highly available overcloud without STONITH is not supported. You must configure a STONITH device for each node that is a part of the Pacemaker cluster in a highly available overcloud. For more information on STONITH and Pacemaker, see Fencing in a Red Hat High Availability Cluster and Support Policies for RHEL High Availability Clusters.

You can also configure high availability for Compute instances with director (Instance HA). This high availability mechanism automates evacuation and re-spawning of instances on Compute nodes in case of node failure. The requirements for Instance HA are the same as the general overcloud requirements, but you must perform a few additional steps to prepare your environment for the deployment. For more information about Instance HA and installation instructions, see the High Availability for Compute Instances guide.
9.6. CONTROLLER NODE REQUIREMENTS

Controller nodes host the core services in a Red Hat OpenStack Platform environment, such as the Dashboard (horizon), the back-end database server, the Identity service (keystone) authentication, and high availability services.

**Processor**

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

**Memory**

The minimum amount of memory is 32 GB. However, the amount of recommended memory depends on the number of vCPUs, which is based on the number of CPU cores multiplied by hyper-threading value. Use the following calculations to determine your RAM requirements:

- **Controller RAM minimum calculation:**
  - Use 1.5 GB of memory for each vCPU. For example, a machine with 48 vCPUs should have 72 GB of RAM.

- **Controller RAM recommended calculation:**
  - Use 3 GB of memory for each vCPU. For example, a machine with 48 vCPUs should have 144 GB of RAM

For more information about measuring memory requirements, see “Red Hat OpenStack Platform Hardware Requirements for Highly Available Controllers” on the Red Hat Customer Portal.

**Disk Storage and layout**

A minimum amount of 50 GB storage is required if the Object Storage service (swift) is not running on the Controller nodes. However, the Telemetry and Object Storage services are both installed on the Controllers, with both configured to use the root disk. These defaults are suitable for deploying small overclouds built on commodity hardware. These environments are typical of proof-of-concept and test environments. You can use these defaults to deploy overclouds with minimal planning, but they offer little in terms of workload capacity and performance.

In an enterprise environment, however, the defaults could cause a significant bottleneck because Telemetry accesses storage constantly. This results in heavy disk I/O usage, which severely impacts the performance of all other Controller services. In this type of environment, you must plan your overcloud and configure it accordingly.

Red Hat provides several configuration recommendations for both Telemetry and Object Storage. For more information, see Deployment Recommendations for Specific Red Hat OpenStack Platform Services.

**Network Interface Cards**

A minimum of 2 x 1 Gbps Network Interface Cards. Use additional network interface cards for bonded interfaces or to delegate tagged VLAN traffic.

**Power management**

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

**Virtualization support**

Red Hat supports virtualized Controller nodes only on Red Hat Virtualization platforms. For more information, see xref:assembly_creating-virtualized-control-planes\[.*\].
9.7. COMPUTE NODE REQUIREMENTS

Compute nodes are responsible for running virtual machine instances after they are launched. Compute nodes require bare metal systems that support hardware virtualization. Compute nodes must also have enough memory and disk space to support the requirements of the virtual machine instances that they host.

Processor
- 64-bit x86 processor with support for the Intel 64 or AMD64 CPU extensions, and the AMD-V or Intel VT hardware virtualization extensions enabled. It is recommended that this processor has a minimum of 4 cores.
- IBM POWER 8 processor.

Memory
A minimum of 6 GB of RAM for the host operating system, plus additional memory to accommodate for the following considerations:
- Add additional memory that you intend to make available to virtual machine instances.
- Add additional memory to run special features or additional resources on the host, such as additional kernel modules, virtual switches, monitoring solutions, and other additional background tasks.
- If you intend to use non-uniform memory access (NUMA), Red Hat recommends 8GB per CPU socket node or 16 GB per socket node if you have more than 256 GB of physical RAM.
- Configure at least 4 GB of swap space.

Disk space
A minimum of 50 GB of available disk space.

Network Interface Cards
A minimum of one 1 Gbps Network Interface Cards, although it is recommended to use at least two NICs in a production environment. Use additional network interface cards for bonded interfaces or to delegate tagged VLAN traffic.

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

9.8. CEPH STORAGE NODE REQUIREMENTS

If you use Red Hat OpenStack Platform (RHOSP) director to create Red Hat Ceph Storage nodes, there are additional requirements.

For information about how to select a processor, memory, network interface cards (NICs), and disk layout for Ceph Storage nodes, see Hardware selection recommendations for Red Hat Ceph Storage in the Red Hat Ceph Storage Hardware Guide.

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

RHOSP director uses cephadm, which does not support installing the OSD on the root disk of Ceph Storage nodes. This means that you need at least two disks for a supported Ceph Storage node.

Ceph Storage nodes and RHEL compatibility

- RHOSP 17.0-beta is supported on RHEL 9.0. However, hosts that are mapped to the Ceph Storage role update to the latest major RHEL release. Before upgrading to RHOSP 16.1 and later, review the Red Hat Knowledgebase article Red Hat Ceph Storage: Supported configurations.

Placement Groups (PGs)

Ceph Storage uses placement groups (PGs) to facilitate dynamic and efficient object tracking at scale. In the case of OSD failure or cluster rebalancing, Ceph can move or replicate a placement group and its contents, which means a Ceph Storage cluster can rebalance and recover efficiently.

When Ceph is initially deployed with the openstack overcloud ceph deploy command, the PG and replica count settings are not changed from the defaults unless the parameters osd_pool_default_size, osd_pool_default_pg_num, osd_pool_default_pgp_num are included in an initial Ceph configuration file. This configuration file is passed using the --config option. They can also be modified after openstack overcloud ceph deploy is run.

When the openstack overcloud deploy command is used, a pool is created for each OpenStack Platform service that is enabled by including the associated Heat environment. For example, a command such as the following will create pools for Nova (vms), Cinder (volumes) and Glance (images):

```
openstack overcloud deploy --templates -e /usr/share/openstack-tripleo-heat-templates/environments/cephadm/cephadm-rbd-only.yaml
```

If the -e environments/cinder-backup.yaml option was included in the above command, then a pool called backups would also be created.

By default, each pool has pg_autoscale_mode enabled. It is not necessary to directly set a PG number per pool. However, even with this mode enabled, it is recommended to set the target_size_ratio (or pg_num) per pool to minimize data rebalancing. To control the target_size_ratio per pool, create a Heat environment file the defines the configuration.

The following provides the example contents of such a file.

```
CephPools:
  - name: volumes
    target_size_ratio: 0.4
    application: rbd
  - name: images
    target_size_ratio: 0.1
    application: rbd
  - name: vms
    target_size_ratio: 0.3
    application: rbd
```

If this file was saved as pools.yaml, it would be deployed with the openstack overcloud deploy command with the -e pools.yaml option.
In the above example, it is assumed that the percentage of data used per service will be:

- Cinder volumes - 40%
- Glance images - 10%
- Nova vms - 30%
- Free space for other pools - 20%

Set these values based on your expected usage. If you do not override the `CephPools` parameter, each pool has Ceph’s default PG number. Though the autoscaler will adjust this number automatically over time based on usage, the data will be moved within the cluster. This uses computational resources.

If you prefer to set a PG number instead of a target size ratio, replace `target_size_ratio` in the example above with `pg_num`. Use a different integer per pool based on your expected usage.

See the [Red Hat Ceph Storage Hardware Guide](https://access.redhat.com/documentation/en-us/red_hat_ceph_storage/3/html) for Red Hat Ceph Storage processor, network interface card, and power management interface recommendations.

For more information about installing an overcloud with a Ceph Storage cluster, see the [Deploying an Overcloud with Containerized Red Hat Ceph](https://access.redhat.com/documentation/en-us/red_hat_ceph_storage/3/html) guide.

### 9.9. OBJECT STORAGE NODE REQUIREMENTS

Object Storage nodes provide an object storage layer for the overcloud. The Object Storage proxy is installed on Controller nodes. The storage layer requires bare metal nodes with multiple disks on each node.

**Processor**

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

**Memory**

Memory requirements depend on the amount of storage space. Use at minimum 1 GB of memory for each 1 TB of hard disk space. For optimal performance, it is recommended to use 2 GB for each 1 TB of hard disk space, especially for workloads with files smaller than 100GB.

**Disk space**

Storage requirements depend on the capacity needed for the workload. It is recommended to use SSD drives to store the account and container data. The capacity ratio of account and container data to objects is approximately 1 per cent. For example, for every 100TB of hard drive capacity, provide 1TB of SSD capacity for account and container data.

However, this depends on the type of stored data. If you want to store mostly small objects, provide more SSD space. For large objects (videos, backups), use less SSD space.

**Disk layout**

The recommended node configuration requires a disk layout similar to the following example:

- `/dev/sda` - The root disk. Director copies the main overcloud image to the disk.
- `/dev/sdb` - Used for account data.
- `/dev/sdc` - Used for container data.
- `/dev/sdd` and onward - The object server disks. Use as many disks as necessary for your storage requirements.
Network Interface Cards
A minimum of 2 x 1 Gbps Network Interface Cards. Use additional network interface cards for bonded interfaces or to delegate tagged VLAN traffic.

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

9.10. OVERCLOUD REPOSITORIES

Red Hat OpenStack Platform 17.0-beta runs on Red Hat Enterprise Linux 9.0. As a result, you must lock the content from these repositories to the respective Red Hat Enterprise Linux version.

NOTE
If you synchronize repositories with Red Hat Satellite, you can enable specific versions of the Red Hat Enterprise Linux repositories. However, the repository remains the same despite the version you choose. For example, you can enable the 9.0 version of the BaseOS repository, but the repository name is still `rhel-9-for-x86_64-baseos-eus-rpms` despite the specific version you choose.

WARNING
Any repositories outside the ones specified here are not supported. Unless recommended, do not enable any other products or repositories outside the ones listed in the following tables or else you might encounter package dependency issues. Do not enable Extra Packages for Enterprise Linux (EPEL).

Controller node repositories
The following table lists core repositories for Controller nodes in the overcloud.

<table>
<thead>
<tr>
<th>Name</th>
<th>Repository</th>
<th>Description of requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red Hat Enterprise Linux 9 for x86_64 - BaseOS (RPMs) Extended Update Support (EUS)</td>
<td><code>rhel-9-for-x86_64-baseos-eus-rpms</code></td>
<td>Base operating system repository for x86_64 systems.</td>
</tr>
<tr>
<td>Red Hat Enterprise Linux 9 for x86_64 - AppStream (RPMs)</td>
<td><code>rhel-9-for-x86_64-appstream-eus-rpms</code></td>
<td>Contains Red Hat OpenStack Platform dependencies.</td>
</tr>
<tr>
<td>Red Hat Enterprise Linux 9 for x86_64 - High Availability (RPMs) Extended Update Support (EUS)</td>
<td><code>rhel-9-for-x86_64-highavailability-eus-rpms</code></td>
<td>High availability tools for Red Hat Enterprise Linux.</td>
</tr>
<tr>
<td>Red Hat OpenStack Platform Beta for RHEL 9 x86_64 (RPMs)</td>
<td><code>openstack-beta-for-rhel-9-x86_64-rpms</code></td>
<td>Beta Red Hat OpenStack Platform repository.</td>
</tr>
<tr>
<td>Name</td>
<td>Repository</td>
<td>Description of requirement</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>-------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Red Hat Fast Datapath for RHEL 9 (RPMS)</td>
<td>fast-datapath-for-rhel-9-x86_64-rpms</td>
<td>Provides Open vSwitch (OVS) packages for OpenStack Platform.</td>
</tr>
<tr>
<td>Red Hat Ceph Storage Tools 5 for RHEL 9 x86_64 (RPMs)</td>
<td>rhceph-5-tools-for-rhel-9-x86_64-rpms</td>
<td>Tools for Red Hat Ceph Storage 5 for Red Hat Enterprise Linux 9.</td>
</tr>
</tbody>
</table>

**Compute node repositories**

The following table lists core repositories for Compute nodes in the overcloud.

<table>
<thead>
<tr>
<th>Name</th>
<th>Repository</th>
<th>Description of requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red Hat Enterprise Linux 9 for x86_64 - BaseOS (RPMs) Extended Update Support (EUS)</td>
<td>rhel-9-for-x86_64-baseos-eus-rpms</td>
<td>Base operating system repository for x86_64 systems.</td>
</tr>
<tr>
<td>Red Hat Enterprise Linux 9 for x86_64 - AppStream (RPMs)</td>
<td>rhel-9-for-x86_64-appstream-eus-rpms</td>
<td>Contains Red Hat OpenStack Platform dependencies.</td>
</tr>
<tr>
<td>Red Hat Enterprise Linux 9 for x86_64 - High Availability (RPMs) Extended Update Support (EUS)</td>
<td>rhel-9-for-x86_64-highavailability-eus-rpms</td>
<td>High availability tools for Red Hat Enterprise Linux.</td>
</tr>
<tr>
<td>Red Hat OpenStack Platform Beta for RHEL 9 x86_64 (RPMs)</td>
<td>openstack-beta-for-rhel-9-x86_64-rpms</td>
<td>Beta Red Hat OpenStack Platform repository.</td>
</tr>
<tr>
<td>Red Hat Fast Datapath for RHEL 9 (RPMS)</td>
<td>fast-datapath-for-rhel-9-x86_64-rpms</td>
<td>Provides Open vSwitch (OVS) packages for OpenStack Platform.</td>
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<tr>
<td>Red Hat Ceph Storage Tools 5 for RHEL 9 x86_64 (RPMs)</td>
<td>rhceph-5-tools-for-rhel-9-x86_64-rpms</td>
<td>Tools for Red Hat Ceph Storage 5 for Red Hat Enterprise Linux 9.</td>
</tr>
</tbody>
</table>

**Real Time Compute repositories**

The following table lists repositories for Real Time Compute (RTC) functionality.

<table>
<thead>
<tr>
<th>Name</th>
<th>Repository</th>
<th>Description of requirement</th>
</tr>
</thead>
</table>
### Red Hat Enterprise Linux 9 for x86_64 - Real Time (RPMs)

**rhel-9-for-x86_64-rt-rpms**

Repository for Real Time KVM (RT-KVM). Contains packages to enable the real time kernel. Enable this repository for all Compute nodes targeted for RT-KVM. NOTE: You need a separate subscription to a **Red Hat OpenStack Platform for Real Time** SKU to access this repository.

### Red Hat Enterprise Linux 9 for x86_64 - Real Time for NFV (RPMs)

**rhel-9-for-x86_64-nfv-rpms**

Repository for Real Time KVM (RT-KVM) for NFV. Contains packages to enable the real time kernel. Enable this repository for all NFV Compute nodes targeted for RT-KVM. NOTE: You need a separate subscription to a **Red Hat OpenStack Platform for Real Time** SKU to access this repository.

### Ceph Storage node repositories

The following table lists Ceph Storage related repositories for the overcloud.

<table>
<thead>
<tr>
<th>Name</th>
<th>Repository</th>
<th>Description of requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red Hat Enterprise Linux 9 for x86_64 - BaseOS (RPMs)</td>
<td>rhel-9-for-x86_64-baseos-rpms</td>
<td>Base operating system repository for x86_64 systems.</td>
</tr>
<tr>
<td>Red Hat Enterprise Linux 9 for x86_64 - AppStream (RPMs)</td>
<td>rhel-9-for-x86_64-appstream-rpms</td>
<td>Contains Red Hat OpenStack Platform dependencies.</td>
</tr>
<tr>
<td>Red Hat OpenStack Platform Beta for RHEL 9 x86_64 (RPMs)</td>
<td>openstack-beta-for-rhel-9-x86_64-rpms</td>
<td>Red Hat OpenStack Platform Beta repository, which contains packages for Red Hat OpenStack Platform director as well as packages to help director configure Red Hat Ceph Storage nodes.</td>
</tr>
<tr>
<td>Red Hat Ceph Storage Tools 5 for RHEL 9 x86_64 (RPMs)</td>
<td>rcehp-4-tools-for-rhel-9-x86_64-rpms</td>
<td>Tools for Red Hat Ceph Storage 5 for Red Hat Enterprise Linux 9.</td>
</tr>
</tbody>
</table>
### 9.11. NODE PROVISIONING AND CONFIGURATION

You provision the overcloud nodes for your Red Hat OpenStack Platform (RHOSP) environment by using either the OpenStack Bare Metal (ironic) service, or an external tool. When your nodes are provisioned, you configure them by using director.

**Provisioning with the OpenStack Bare Metal (ironic) service**

Provisioning overcloud nodes by using the Bare Metal service is the standard provisioning method. For more information, see [Provisioning bare metal overcloud nodes](#).

**Provisioning with an external tool**

You can use an external tool, such as Red Hat Satellite, to provision overcloud nodes. This is useful if you want to create an overcloud without power management control, use networks that have DHCP/PXE boot restrictions, or if you want to use nodes that have a custom partitioning layout that does not rely on the QCOW2 `overcloud-hardened-uefi-full` image. This provisioning method does not use the OpenStack Bare Metal service (ironic) for managing nodes. For more information, see [Configuring a basic overcloud with pre-provisioned nodes](#).

---

<table>
<thead>
<tr>
<th>Name</th>
<th>Repository</th>
<th>Description of requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red Hat Fast Datapath for RHEL 9 (RPMS)</td>
<td><code>fast-datapath-for-rhel-9-x86_64-rpms</code></td>
<td>Provides Open vSwitch (OVS) packages for OpenStack Platform. If you are using OVS on Ceph Storage nodes, add this repository to the network interface configuration (NIC) templates.</td>
</tr>
</tbody>
</table>
To configure the physical network for your overcloud, create the following configuration files:

- The network configuration file, `network_data.yaml`, that follows the structure defined in the network data schema.
- The network interface controllers (NICs) configuration files, by using the NIC template file in Jinja2 ansible format, `j2`.

## 10.1. EXAMPLE NETWORK CONFIGURATION FILES

The following are examples of the network data schema for IPv4, IPv6, and a dual stack.

The dual IPv4/IPv6 network example has two subnets per-segment, one for IPv4 and the other for IPv6. You can create a single neutron port with an IP address in each subnet. Use the `ipv6` parameter controls to bind services to the IPv6 or IPv4 subnet. By default `ipv6` is set to `false`.

### 10.1.1. Example network data schema for IPv4

```yaml
.. code-block:: yaml

  - name: Storage
    name_lower: storage                     (optional, default: name.lower())
    admin_state_up: false                   (optional, default: false)
    dns_domain: storage.localdomain.        (optional, default: undef)
    mtu: 1442                               (optional, default: 1500)
    shared: false                           (optional, default: false)
    service_net_map_replace: storage        (optional, default: undef)
    ipv6: true                              (optional, default: false)
    vip: true                               (optional, default: false)
    subnets:
      subnet01:
        ip_subnet: 172.18.1.0/24
        gateway_ip: 172.18.1.254            (optional, default: undef)
        allocation_pools:                   (optional, default: [])
        - start: 172.18.1.10
        - end: 172.18.1.250
        enable_dhcp: false                  (optional, default: false)
        routes:                             (optional, default: [])
        - destination: 172.18.0.0/24
        nexthop: 172.18.1.254
        vlan: 21                            (optional, default: undef)
        physical_network: storage_subnet01  (optional, default: {{name.lower}}_{{subnet name}})
```
network_type: flat                  (optional, default: flat)
segmentation_id: 21                 (optional, default: undef)
subnet02:
    ip_subnet: 172.18.0.0/24
    gateway_ip: 172.18.0.254       (optional, default: undef)
    allocation_pools:       (optional, default: [])
        - start: 172.18.0.10
        - end: 172.18.0.250
    enable_dhcp: false       (optional, default: false)
    routes:                 (optional, default: [])
        - destination: 172.18.1.0/24
        - nexthop: 172.18.0.254
    vlan: 20                  (optional, default: undef)
    physical_network: storage_subnet02  (optional, default: {{name.lower}}_{{subnet name}})
    network_type: flat                  (optional, default: flat)
    segmentation_id: 20                 (optional, default: undef)

10.1.2. Example network data schema for IPv6

```yaml
- name: Storage
  name_lower: storage
  admin_state_up: false
  dns_domain: storage.localdomain.
  mtu: 1442
  shared: false
  vip: true
subnets:
    subnet01:
        ipv6_subnet: 2001:db8:a::/64
        gateway_ipv6: 2001:db8:a::1
        ipv6_allocation_pools:
            - start: 2001:db8:a::0010
            - end: 2001:db8:a::fff9
        enable_dhcp: false
        routes_ipv6:
            - destination: 2001:db8:b::/64
            - nexthop: 2001:db8:a::1
        ipv6_address_mode: null
        ipv6_ra_mode: null
        vlan: 21
        physical_network: storage_subnet01  (optional, default: {{name.lower}}_{{subnet name}})
        network_type: flat                  (optional, default: flat)
        segmentation_id: 21                 (optional, default: undef)
    subnet02:
        ipv6_subnet: 2001:db8:b::/64
        gateway_ipv6: 2001:db8:b::1
        ipv6_allocation_pools:
            - start: 2001:db8:b::0010
            - end: 2001:db8:b::fff9
        enable_dhcp: false
        routes_ipv6:
            - destination: 2001:db8:a::/64
            - nexthop: 2001:db8:b::1
        ipv6_address_mode: null
```
ipv6_ra_mode: null

vlan: 20

physical_network: storage_subnet02 (optional, default: {{name.lower}}_{{subnet name}})

network_type: flat (optional, default: flat)

segmentation_id: 20 (optional, default: undef)

10.1.3. Example network data schema for a dual stack

```yaml
- name: Storage
  name_lower: storage
  admin_state_up: false
  dns_domain: storage.localdomain.
  mtu: 1442
  shared: false
  ipv6: true (default ipv6: false)
  vip: true
  subnets:
    subnet01:
      ip_subnet: 172.18.1.0/24
      gateway_ip: 172.18.1.254
      allocation_pools:
        - start: 172.18.1.10
          end: 172.18.1.250
      routes:
        - destination: 172.18.0.0/24
          nexthop: 172.18.1.254
      ipv6_subnet: 2001:db8:a::/64
      gateway_ipv6: 2001:db8:a::1
      ipv6_allocation_pools:
        - start: 2001:db8:a::0010
          end: 2001:db8:a::fff9
      routes_ipv6:
        - destination: 2001:db8:b::/64
          nexthop: 2001:db8:a::1
      vlan: 21
    subnet02:
      ip_subnet: 172.18.0.0/24
      gateway_ip: 172.18.0.254
      allocation_pools:
        - start: 172.18.0.10
          end: 172.18.0.250
      routes:
        - destination: 172.18.1.0/24
          nexthop: 172.18.0.254
      ipv6_subnet: 2001:db8:b::/64
      gateway_ipv6: 2001:db8:b::1
      ipv6_allocation_pools:
        - start: 2001:db8:b::0010
          end: 2001:db8:b::fff9
      routes_ipv6:
        - destination: 2001:db8:a::/64
          nexthop: 2001:db8:b::1
      vlan: 20
```
10.2. NETWORK ISOLATION

Red Hat OpenStack Platform (RHOSP) provides isolated overcloud networks so that you can host specific types of network traffic in isolation. Traffic is assigned to specific network interfaces or bonds. Using bonds provides fault tolerance and, if the correct bonding protocols are used, can also provide load sharing. If no isolated networks are configured, RHOSP uses the provisioning network for all services.

Network configuration consists of two parts: the parameters applied to the network as a whole, and the templates used to configure the network interfaces on the deployed nodes.

You can create the following isolated networks for your RHOSP deployment:

**IPMI**
- Network used for power management of nodes. This network is predefined before the installation of the undercloud.

**Provisioning**
- Director uses this network for deployment and management. The provisioning network is normally configured on a dedicated interface. The initial deployment uses DHCP with PXE, then the network is converted to static IP. By default, PXE boot must occur on the native VLAN, although some system controllers allow booting from a VLAN. The compute and storage nodes use the provisioning interface as their default gateway for DNS, NTP, and system maintenance.

**Internal API**
- The Internal API network is used for communication between the RHOSP services using API communication, RPC messages, and database communication.

**Tenant**
- The Networking service (neutron) provides each tenant (project) with their own networks using one of the following methods:
  - VLAN segregation, where each tenant network is a network VLAN.
  - Tunneling (through VXLAN or GRE).

Network traffic is isolated within each tenant network. Each tenant network has an IP subnet associated with it, and network namespaces means that multiple tenant networks can use the same address range without causing conflicts.

**Storage**
- Network used for block Storage, NFS, iSCSI, and others. Ideally, this would be isolated to an entirely separate switch fabric for performance reasons.

**Storage Management**
- OpenStack Object Storage (swift) uses this network to synchronize data objects between participating replica nodes. The proxy service acts as the intermediary interface between user requests and the underlying storage layer. The proxy receives incoming requests and locates the necessary replica to retrieve the requested data. Services that use a Ceph backend connect over the Storage Management network, since they do not interact with Ceph directly but rather use the frontend service. Note that the RBD driver is an exception, as this traffic connects directly to Ceph.

**External**
- Hosts the OpenStack Dashboard (horizon) for graphical system management, the public APIs for OpenStack services, and performs SNAT for incoming traffic destined for instances.

**Floating IP**
Allows incoming traffic to reach instances using 1-to-1 IP address mapping between the floating IP address, and the IP address actually assigned to the instance in the tenant network. If hosting the Floating IPs on a VLAN separate from external, you can trunk the Floating IP VLAN to the Controller nodes and add the VLAN through the Networking Service (neutron) after overcloud creation. This provides a means to create multiple Floating IP networks attached to multiple bridges. The VLANs are trunked but are not configured as interfaces. Instead, the Networking Service (neutron) creates an OVS port with the VLAN segmentation ID on the chosen bridge for each Floating IP network.

NOTE

The provisioning network must be a native VLAN, the other networks can be trunked.

The undercloud can be used as a default gateway. However, all traffic is behind an IP masquerade NAT (Network Address Translation), and is not reachable from the rest of the RHOSP network. The undercloud is also a single point of failure for the overcloud default route. If there is an external gateway configured on a router device on the provisioning network, the undercloud neutron DHCP server can offer that service instead.

10.2.1. Networks required for each role

You can create tenant networks by using VLANs, but you can create VXLAN tunnels for special use without consuming tenant VLANs. It is possible to add VXLAN capability to a deployment with a tenant VLAN, but is it not possible to add a tenant VLAN to a deployed overcloud without serious disruption.

The following table details the isolated networks that are attached to each role:

<table>
<thead>
<tr>
<th>Role</th>
<th>Network</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controller</td>
<td>provisioning, internal API, storage, storage management, tenant, external</td>
</tr>
<tr>
<td>Compute</td>
<td>provisioning, internal API, storage, tenant</td>
</tr>
<tr>
<td>Ceph Storage</td>
<td>provisioning, internal API, storage, tenant</td>
</tr>
<tr>
<td>Cinder Storage</td>
<td>provisioning, internal API, storage, storage management</td>
</tr>
<tr>
<td>Swift Storage</td>
<td>provisioning, internal API, storage, storage management</td>
</tr>
</tbody>
</table>

10.2.2. Network definition file configuration options

Use the following tables to understand the available options for configuring your network definition file, `network_data.yaml`, in YAML format:

Table 10.1. Network data YAML options

<table>
<thead>
<tr>
<th>Name</th>
<th>Option</th>
<th>Type</th>
<th>Default value</th>
</tr>
</thead>
<tbody>
<tr>
<td>name</td>
<td>Name of the network.</td>
<td>string</td>
<td></td>
</tr>
<tr>
<td>Name</td>
<td>Option</td>
<td>Type</td>
<td>Default value</td>
</tr>
<tr>
<td>------------</td>
<td>------------------------------------------------------------------------</td>
<td>--------</td>
<td>---------------</td>
</tr>
<tr>
<td>name_lower</td>
<td>Optional: Lower case name of the network.</td>
<td>string</td>
<td>name.lower()</td>
</tr>
<tr>
<td>dns_domain</td>
<td>Optional: DNS domain name for the network.</td>
<td>string</td>
<td></td>
</tr>
<tr>
<td>mtu</td>
<td>Maximum Transmission Unit (MTU).</td>
<td>number</td>
<td>1600</td>
</tr>
<tr>
<td>ipv6</td>
<td>Optional: Set to true if using IPv6.</td>
<td>Boolean</td>
<td>false</td>
</tr>
<tr>
<td>vip</td>
<td>Create a VIP on the network.</td>
<td>Boolean</td>
<td>false</td>
</tr>
<tr>
<td>subnets</td>
<td>Contains the subnets for the network.</td>
<td>dictionary</td>
<td></td>
</tr>
</tbody>
</table>

Table 10.2. Network data YAML option for subnet definition

<table>
<thead>
<tr>
<th>Name</th>
<th>Option</th>
<th>Type / Element</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>ip_subnet</td>
<td>IPv4 CIDR block notation.</td>
<td>string</td>
<td>192.0.5.0/24</td>
</tr>
<tr>
<td>ipv6_subnet</td>
<td>IPv6 CIDR block notation.</td>
<td>string</td>
<td>2001:db6:fd00:1000::/64</td>
</tr>
<tr>
<td>gateway_ip</td>
<td>Optional: Gateway IPv4 address.</td>
<td>string</td>
<td>192.0.5.1</td>
</tr>
</tbody>
</table>
| allocation_pools | Start and end address for the subnet. | list / dictionary | start: 192.0.5.100
                            |                                        | end: 192.0.5.150                   |
| ipv6_allocation_pools | Start and end address for the subnet. | list / dictionary | start: 2001:db6:fd00:1000:100::1
<pre><code>                        |                                        | end: 2001:db6:fd00:1000:150::1     |
</code></pre>
<table>
<thead>
<tr>
<th>Name</th>
<th>Option</th>
<th>Type / Element</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>routes</td>
<td>List of IPv4 networks that require routing through the network gateway.</td>
<td>list / dictionary</td>
<td></td>
</tr>
<tr>
<td>routes_ipv6</td>
<td>List of IPv6 networks that require routing through the network gateway.</td>
<td>list / dictionary</td>
<td></td>
</tr>
<tr>
<td>vlan</td>
<td>Optional: VLAN ID for the network.</td>
<td>number</td>
<td></td>
</tr>
</tbody>
</table>

**NOTE**

The `routes` and `routes_ipv6` options contain two suboptions: `destination` and `nexthop`. Both options are of type string.

```
routes:
- destination: 198.51.100.0/24
  nexthop: 192.0.5.1
- destination: 203.0.113.0/24
  nexthost: 192.0.5.1

routes:
- destination: 2001:db6:fd00:2000::/64
  nexthop: 2001:db6:fd00:1000:100::1
- destination: 2001:db6:fd00:3000::/64
  nexthost: 2001:db6:fd00:1000:100::1
```

Table 10.3. YAML data options for network virtual IPs

<table>
<thead>
<tr>
<th>Name</th>
<th>Option</th>
<th>Type / Element</th>
<th>Default value</th>
</tr>
</thead>
<tbody>
<tr>
<td>network</td>
<td>Neutron network name.</td>
<td>string</td>
<td></td>
</tr>
<tr>
<td>ip_address</td>
<td>Optional: Pre-defined fixed IP address.</td>
<td>string</td>
<td></td>
</tr>
<tr>
<td>subnet</td>
<td>Neutron subnet name. Specifies the subnet for the virtual IP neutron port. Required for deployments using routed networks.</td>
<td>string</td>
<td></td>
</tr>
</tbody>
</table>
### 10.2.3. Configuring network isolation

To enable and configure network isolation, you must add the required elements to the `network_data.yaml` configuration file.

#### Procedure

1. Create your network YAML definition file:

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

2. Update the options in your `network_data.yaml` file to match the requirements for your overcloud networking environment:

   ```yaml
   - name: Storage
     name_lower: storage
     vip: true
     mtu: 1500
     subnets:
       storage_subnet:
         ip_subnet: 172.16.1.0/24
         allocation_pools:
           - start: 172.16.1.4
             end: 172.16.1.250
         vlan: 30

   - name: StorageMgmt
     name_lower: storage_mgmt
     vip: true
     mtu: 1500
     subnets:
       storage_mgmt_subnet:
         ip_subnet: 172.16.3.0/24
         allocation_pools:
           - start: 172.16.3.4
             end: 172.16.3.250
         vlan: 40

   - name: InternalApi
     name_lower: internal_api
     vip: true
     mtu: 1500
   ```
subnets:
  internal_api_subnet:
    ip_subnet: 172.16.2.0/24
    allocation_pools:
      - start: 172.16.2.4
        end: 172.16.2.250
    vlan: 20
  - name: Tenant
    vip: false  # Tenant network does not use VIPs
    mtu: 1500
    name_lower: tenant
  subnets:
    tenant_subnet:
      ip_subnet: 172.16.0.0/24
      allocation_pools:
        - start: 172.16.0.4
          end: 172.16.0.250
      vlan: 50
      - name: External
        name_lower: external
        vip: true
        mtu: 1500
      subnets:
        external_subnet:
          ip_subnet: 10.0.0.0/24
          allocation_pools:
            - start: 10.0.0.4
              end: 10.0.0.250
          gateway_ip: 10.0.0.1
          vlan: 10

10.3. COMPOSABLE NETWORKS

You can create custom composable networks if you want to host specific network traffic on different networks. Director provides a default network topology with network isolation enabled. You can find this configuration in the default-network-isolation configuration file in tripleo-heat-templates.

The overcloud uses the following pre-defined set of network segments by default:

- Internal API
- Storage
- Storage management
- Tenant
- External

You can use composable networks to add networks for various services. For example, if you have a network that is dedicated to NFS traffic, you can present it to multiple roles.

Director supports the creation of custom networks during the deployment and update phases. You can use these additional networks for bare metal nodes, system management, or to create separate networks for different roles. You can also use them to create multiple sets of networks for split deployments where traffic is routed between networks.
10.3.1. Adding a composable network

Use composable networks to add networks for various services. For example, if you have a network that is dedicated to storage backup traffic, you can present the network to multiple roles.

Networks are defined in the `network_data.yaml` configuration file. You can find a sample file in the `/usr/share/openstack-tripleo-heat-templates/network-data-samples` directory.

Procedure

1. Copy the default `network_data.yaml` file:

   ```bash
   $ cp /usr/share/openstack-tripleo-heat-templates/network-data-samples/network_data.yaml
   /home/stack/templates/network_data.yaml
   ```

2. Edit your `network_data.yaml` configuration file and add a section for your new network:

   ```yaml
   - name: StorageBackup
     vip: false
     name_lower: storage_backup
     subnets:
       storage_backup_subnet:
         ip_subnet: 172.16.6.0/24
         allocation_pools:
           - start: 172.16.6.4
           - end: 172.16.6.250
         gateway_ip: 172.16.6.1
   ```

You can use the following parameters in your `network_data.yaml` file:

- **name**
  Sets the name of the network.

- **vip**
  Enables the creation of a virtual IP address on the network

- **name_lower**
  Sets the lowercase version of the name, which director maps to respective networks assigned to roles in the `roles_data.yaml` file.

- **subnets**
  One or more subnet definitions.

- **subnet_name**
  Sets the name of the subnet.

- **ip_subnet**
  Sets the IPv4 subnet in CIDR format.

- **allocation_pools**
  Sets the IP range for the IPv4 subnet.

- **gateway_ip**
  Sets the gateway for the network.

- **vlan**
  Sets the VLAN ID for the network.
3. Copy the default `vip_data.yaml` file:

   ```
cp /usr/share/openstack-tripleo-heat-templates/network-data-samples/vip-data-default-
   network-isolation.yaml /home/stack/templates/vip_data.yaml
   ```

4. Edit your `vip_data.yaml` configuration file. The virtual IP data is a list of virtual IP address definitions, each containing the name of the network where the IP address is allocated.

   ```
   - network: storage_mgmt
dns_name: overcloud
   - network: internal_api
dns_name: overcloud
   - network: storage
dns_name: overcloud
   - network: external
dns_name: overcloud
   - network: ctlplane
dns_name: overcloud
   ```

   You can use the following parameters in your `vip_data.yaml` file:

   - **network**
     Sets the neutron network name. This is the only required parameter.

   - **ip_address**
     Sets the IP address of the VIP.

   - **subnet**
     Sets the neutron subnet name. Use to specify the subnet when creating the virtual IP neutron port. This parameter is required when your deployment uses routed networks.

   - **dns-name**
     Sets the FQDN (Fully Qualified Domain Name)

   - **name**
     Sets the virtual IP name.

5. Copy a sample network configuration template. Jinja2 templates are used to define NIC configuration templates. Browse the examples provided in the `/usr/share/ansible/roles/tripleo_network_config/templates/` directory, if one of the examples matches your requirements, use it. If the examples do not match your requirements, copy a sample configuration file, and modify it for your needs:

   ```
cp -r /usr/share/ansible/roles/tripleo_network_config/templates/single_nic_vlans.j2
/home/stack/templates/single_nic_vlans.j2
   ```

6. Edit your `single_nic_vlans.j2` configuration file:

   ```
---
{% set mtu_list = [ctlplane_mtu] %}
{% for network in role_networks %}
{{ mtu_list.append(lookup('vars', networks_lower[network] ~ '_mtu')) }}
{% endfor %}
{% set min_viable_mtu = mtu_list | max %}

network_config:
- type: ovs_bridge
```
name: {{ neutron_physical_bridge_name }}
mtu: {{ min_viable_mtu }}
use_dhcp: false
dns_servers: {{ ctlplane_dns_nameservers }}
domain: {{ dns_search_domains }}
addresses:
- ip_netmask: {{ ctlplane_ip }}/{{ ctlplane_subnet_cidr }}
routes: {{ ctlplane_host_routes }}
members:
- type: interface
  name: nic1
  mtu: {{ min_viable_mtu }}
  # force the MAC address of the bridge to this interface
  primary: true
{% for network in role_networks %}
- type: vlan
  mtu: {{ lookup('vars', networks_lower[\network] ~ '_mtu') }}
  vlan_id: {{ lookup('vars', networks_lower[\network] ~ '_vlan_id') }}
  addresses:
    - ip_netmask:
      {{ lookup('vars', networks_lower[\network] ~ '_ip') }}/{{ lookup('vars', networks_lower[\network] ~ '_cidr') }}
    routes: {{ lookup('vars', networks_lower[\network] ~ '_host_routes') }}
{% endfor %}

7. Create or update an existing environment file to enable your custom NIC configuration templates.

    parameter_defaults:
    ControllerNetworkConfigTemplate: '/home/stack/templates/single_nic_vlans.j2'
    CephStorageNetworkConfigTemplate: '/home/stack/templates/single_nic_vlans_storage.j2'
    ComputeNetworkConfigTemplate: '/home/stack/templates/single_nic_vlans.j2'

8. Provision the overcloud networks. This action generates an output file which will be used as an environment file when deploying the overcloud:

    (undercloud)$ openstack overcloud network provision --output <deployment_file> /home/stack/templates/<networks_definition_file>.yaml

    • Replace <networks_definition_file> with the name of your networks definition file, for example, network_data.yaml.

    • Replace <deployment_file> with the name of the heat environment file to generate for inclusion in the deployment command, for example /home/stack/templates/overcloud-networks-deployed.yaml.

9. Provision the network VIPs and generate the vip-deployed-environment.yaml file. You use this file when you deploy the overcloud:

    (overcloud)$ openstack overcloud network vip provision --stack <stack> --output <deployment_file> /home/stack/templates/vip_data.yaml

    • Replace <stack> with the name of stack for which the network VIPs are provisioned. If not specified, the default is overcloud.
• Replace `<deployment_file>` with the name of the heat environment file to generate for inclusion in the deployment command, for example `/home/stack/templates/overcloud-vip-deployed.yaml`.

### 10.3.2. Including a composable network in a role

You can assign composable networks to the overcloud roles defined in your environment. For example, you might include a custom `StorageBackup` network with your Ceph Storage nodes.

#### Procedure

1. If you do not already have a custom `roles_data.yaml` file, copy the default to your home directory:
   ```sh
   $ cp /usr/share/openstack-tripleo-heat-templates/roles_data.yaml /home/stack/templates/roles_data.yaml
   ```

2. Edit the custom `roles_data.yaml` file.

3. Include the network name in the `networks` list for the role that you want to add the network to. For example, to add the `StorageBackup` network to the Ceph Storage role, use the following example snippet:
   ```yaml
   - name: CephStorage
     description: |
       Ceph OSD Storage node role
     networks:
     - Storage
     - StorageMgmt
     - StorageBackup
   ```

4. After you add custom networks to their respective roles, save the file.

When you run the `openstack overcloud deploy` command, include the custom `roles_data.yaml` file using the `-r` option. Without the `-r` option, the deployment command uses the default set of roles with their respective assigned networks.

### 10.3.3. Assigning OpenStack services to composable networks

Each OpenStack service is assigned to a default network type in the resource registry. These services are bound to IP addresses within the network type’s assigned network. Although the OpenStack services are divided among these networks, the number of actual physical networks can differ as defined in the network environment file. You can reassign OpenStack services to different network types by defining a new network map in an environment file, for example `/home/stack/templates/service-reassignments.yaml`. The `ServiceNetMap` parameter determines the network types that you want to use for each service.

For example, you can reassign the Storage Management network services to the Storage Backup Network by modifying the highlighted sections:

```yaml
parameter_defaults:
  ServiceNetMap:
    SwiftMgmtNetwork: storage_backup
    CephClusterNetwork: storage_backup
```
Changing these parameters to `storage_backup` places these services on the Storage Backup network instead of the Storage Management network. This means that you must define a set of `parameter_defaults` only for the Storage Backup network and not the Storage Management network.

Director merges your custom `ServiceNetMap` parameter definitions into a pre-defined list of defaults that it obtains from `ServiceNetMapDefaults` and overrides the defaults. Director returns the full list, including customizations, to `ServiceNetMap`, which is used to configure network assignments for various services.

Service mappings apply to networks that use `vip: true` in the `network_data.yaml` file for nodes that use Pacemaker. The overcloud load balancer redirects traffic from the VIPs to the specific service endpoints.

**NOTE**

You can find a full list of default services in the `ServiceNetMapDefaults` parameter in the `/usr/share/openstack-tripleo-heat-templates/network/service_net_map.j2.yaml` file.

### 10.3.4. Enabling custom composable networks

Use one of the default NIC templates to enable custom composable networks. In this example, use the Single NIC with VLANs template, *(custom_single_nic_vlans)*.

**Procedure**

1. When you run the `openstack overcloud deploy` command, ensure that you include the following files:
   - The custom `custom_network_data.yaml` file.
   - The custom `roles_data.yaml` file with network-to-role assignments.
   - The custom `custom_vip_data.yaml` file.
   - The custom `custom_single_nic_vlans.yaml` file (in this example).
   - The `baremetal_deployment.yaml` configuration file.
   - Any additional environment files related to your network, such as the service reassignments.

For example:

```bash
$ openstack overcloud deploy --templates \
  --networks-file custom_network_data.yaml \
  --vip-file custom_vip_data.yaml \
  --baremetal-deployment baremetal_deployment.yaml \
  --network-config \
  -e custom-net-single-nic-with-vlans.yaml
```

**NOTE**

The `baremetal-deployment.yaml` refers to baremetal which is deployed by the `openstack overcloud deploy` command.
This example command deploys the composable networks, including your additional custom networks, across nodes in your overcloud.

10.3.5. Renaming the default networks

You can use the `network_data.yaml` file to modify the user-visible names of the default networks:

- InternalApi
- External
- Storage
- StorageMgmt
- Tenant

To change these names, do not modify the `name` field. Instead, change the `name_lower` field to the new name for the network and update the ServiceNetMap with the new name.

Procedure

1. In your `network_data.yaml` file, enter new names in the `name_lower` parameter for each network that you want to rename:

   ```yaml
   - name: InternalApi
     name_lower: MyCustomInternalApi
   ```

2. Include the default value of the `name_lower` parameter in the `service_net_map_replace` parameter:

   ```yaml
   - name: InternalApi
     name_lower: MyCustomInternalApi
     service_net_map_replace: internal_api
   ```

10.4. CUSTOM NETWORK INTERFACE TEMPLATES

After you configure Section 10.2, “Network isolation”, you can create a set of custom network interface templates to suit the nodes in your environment. For example, you can include the following files:

- The environment file to enable network isolation (`/usr/share/openstack-tripleo-heat-templates/environments/network-isolation.yaml`).
- The environment file to configure network defaults (`/usr/share/openstack-tripleo-heat-templates/environments/network-environment.yaml`).
- Templates to define your NIC layout for each node. The overcloud core template collection contains a set of defaults for different use cases. To create a custom NIC template, render a default Jinja2 template as the basis for your custom templates.
- A custom environment file to enable NICs. This example uses a custom environment file (`/home/stack/templates/custom-network-configuration.yaml`) that references your custom interface templates.
- Any additional environment files to customize your networking parameters.
If you customize your networks, a custom `network_data.yaml` file.

If you create additional or custom composable networks, a custom `network_data.yaml` file and a custom `roles_data.yaml` file.

**NOTE**

Some of the files in the previous list are Jinja2 format files and have a `.j2.yaml` extension. Director renders these files to `.yaml` versions during deployment.

### 10.4.1. Custom network architecture

The default NIC templates might not suit a specific network configuration. For example, you might want to create your own custom NIC template that suits a specific network layout. You might want to separate the control services and data services on to separate NICs. In this situation, you can map the service to NIC assignments in the following way:

- **NIC1 (Provisioning)**
  - Provisioning / Control Plane

- **NIC2 (Control Group)**
  - Internal API
  - Storage Management
  - External (Public API)

- **NIC3 (Data Group)**
  - Tenant Network (VXLAN tunneling)
  - Tenant VLANs / Provider VLANs
  - Storage
  - External VLANs (Floating IP/SNAT)

- **NIC4 (Management)**
  - Management

### 10.4.2. Rendering default network interface templates for customization

To simplify the configuration of custom interface templates, render the Jinja2 syntax of a default NIC template and use the rendered templates as the basis for your custom configuration.

**Procedure**

1. Render a copy of the `openstack-tripleo-heat-templates` collection with the `process-templates.py` script:

   ```sh
   $ cd /usr/share/openstack-tripleo-heat-templates
   $ ./tools/process-templates.py -o /home/stack/openstack-tripleo-heat-templates-rendered
   ```
This converts all Jinja2 templates to their rendered YAML versions and saves the results to 
/home/stack/openstack-tripleo-heat-templates-rendered.

If you use a custom network file or custom roles file, you can include these files using the -n and 
-r options respectively:

```
$ ./tools/process-templates.py -o /usr/share/openstack-tripleo-heat-templates-rendered -n 
/home/stack/templates/network_data.yaml -r /home/stack/templates/roles_data.yaml
```

2. Copy the multiple NIC example:

```
$ cp -r /usr/share/openstack-tripleo-heat-templates-rendered/network/config/multiple-nics/
/home/stack/templates/custom-nics/
```

3. Edit the template set in custom-nics to suit your own network configuration.

### 10.4.3. Network interface reference

The network interface configuration contains the following parameters:

**Interface**

Defines a single network interface. The configuration defines each interface using either the actual 
interface name ("eth0", "eth1", "enp0s25") or a set of numbered interfaces ("nic1", "nic2", "nic3"): 

```
- type: interface
  name: nic2
```

<table>
<thead>
<tr>
<th>Option</th>
<th>Default</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>name</td>
<td></td>
<td>Name of the interface.</td>
</tr>
<tr>
<td>use_dhcp</td>
<td>False</td>
<td>Use DHCP to get an IP address.</td>
</tr>
<tr>
<td>use_dhcpv6</td>
<td>False</td>
<td>Use DHCP to get a v6 IP address.</td>
</tr>
<tr>
<td>addresses</td>
<td></td>
<td>A list of IP addresses assigned to the interface.</td>
</tr>
<tr>
<td>routes</td>
<td></td>
<td>A list of routes assigned to the interface. For more information, see routes.</td>
</tr>
<tr>
<td>mtu</td>
<td>1500</td>
<td>The maximum transmission unit (MTU) of the connection.</td>
</tr>
<tr>
<td>primary</td>
<td>False</td>
<td>Defines the interface as the primary interface.</td>
</tr>
<tr>
<td>Option</td>
<td>Default</td>
<td>Description</td>
</tr>
<tr>
<td>---------------------</td>
<td>---------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>persist_mapping</td>
<td>False</td>
<td>Write the device alias configuration instead of the system names.</td>
</tr>
<tr>
<td>dhclient_args</td>
<td>None</td>
<td>Arguments that you want to pass to the DHCP client.</td>
</tr>
<tr>
<td>dns_servers</td>
<td>None</td>
<td>List of DNS servers that you want to use for the interface.</td>
</tr>
<tr>
<td>ethtool_opts</td>
<td></td>
<td>Set this option to &quot;rx-flow-hash udp4 sdn&quot; to improve throughput when you use VXLAN on certain NICs.</td>
</tr>
</tbody>
</table>

**vlan**

Defines a VLAN. Use the VLAN ID and subnet passed from the **parameters** section.

For example:

```yaml
- type: vlan
device: nic{{ loop.index + 1 }}
mtu: {{ lookup('vars', networks_lower[network] ~ '_mtu') }}
vlan_id: {{ lookup('vars', networks_lower[network] ~ '_vlan_id') }}
addresses:
  - ip_netmask:
    {{ lookup('vars', networks_lower[network] ~ '_ip') }}/{{ lookup('vars', networks_lower[network] ~ '_cidr') }}
routes: {{ lookup('vars', networks_lower[network] ~ '_host_routes') }}
```

**Table 10.5. vlan options**

<table>
<thead>
<tr>
<th>Option</th>
<th>Default</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>vlan_id</td>
<td></td>
<td>The VLAN ID.</td>
</tr>
<tr>
<td>device</td>
<td></td>
<td>The parent device to attach the VLAN. Use this parameter when the VLAN is not a member of an OVS bridge. For example, use this parameter to attach the VLAN to a bonded interface device.</td>
</tr>
<tr>
<td>use_dhcp</td>
<td>False</td>
<td>Use DHCP to get an IP address.</td>
</tr>
<tr>
<td>use_dhcpv6</td>
<td>False</td>
<td>Use DHCP to get a v6 IP address.</td>
</tr>
<tr>
<td>Option</td>
<td>Default</td>
<td>Description</td>
</tr>
<tr>
<td>-----------------</td>
<td>---------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>addresses</td>
<td></td>
<td>A list of IP addresses assigned to the VLAN.</td>
</tr>
<tr>
<td>routes</td>
<td></td>
<td>A list of routes assigned to the VLAN. For more information, see routes.</td>
</tr>
<tr>
<td>mtu</td>
<td>1500</td>
<td>The maximum transmission unit (MTU) of the connection.</td>
</tr>
<tr>
<td>primary</td>
<td>False</td>
<td>Defines the VLAN as the primary interface.</td>
</tr>
<tr>
<td>persist_mapping</td>
<td>False</td>
<td>Write the device alias configuration instead of the system names.</td>
</tr>
<tr>
<td>dhclient_args</td>
<td>None</td>
<td>Arguments that you want to pass to the DHCP client.</td>
</tr>
<tr>
<td>dns_servers</td>
<td>None</td>
<td>List of DNS servers that you want to use for the VLAN.</td>
</tr>
</tbody>
</table>

**ovs_bond**

Defines a bond in Open vSwitch to join two or more interfaces together. This helps with redundancy and increases bandwidth.

For example:

```yaml
members:
  - type: ovs_bond
    name: bond1
    mtu: {{ min_viable_mtu }}
    ovs_options: {{ bond_interface_ovs_options }}
  members:
    - type: interface
      name: nic2
      mtu: {{ min_viable_mtu }}
      primary: true
    - type: interface
      name: nic3
      mtu: {{ min_viable_mtu }}
```

**Table 10.6. ovs_bond options**

<table>
<thead>
<tr>
<th>Option</th>
<th>Default</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>name</td>
<td></td>
<td>Name of the bond.</td>
</tr>
<tr>
<td>Option</td>
<td>Default</td>
<td>Description</td>
</tr>
<tr>
<td>---------------</td>
<td>---------</td>
<td>---------------------------------------------------------------</td>
</tr>
<tr>
<td>use_dhcp</td>
<td>False</td>
<td>Use DHCP to get an IP address.</td>
</tr>
<tr>
<td>use_dhcpv6</td>
<td>False</td>
<td>Use DHCP to get a v6 IP address.</td>
</tr>
<tr>
<td>addresses</td>
<td></td>
<td>A list of IP addresses assigned to the bond.</td>
</tr>
<tr>
<td>routes</td>
<td></td>
<td>A list of routes assigned to the bond. For more information, see routes.</td>
</tr>
<tr>
<td>mtu</td>
<td>1500</td>
<td>The maximum transmission unit (MTU) of the connection.</td>
</tr>
<tr>
<td>primary</td>
<td>False</td>
<td>Defines the interface as the primary interface.</td>
</tr>
<tr>
<td>members</td>
<td></td>
<td>A sequence of interface objects that you want to use in the bond.</td>
</tr>
<tr>
<td>ovs_options</td>
<td></td>
<td>A set of options to pass to OVS when creating the bond.</td>
</tr>
<tr>
<td>ovs_extra</td>
<td></td>
<td>A set of options to set as the OVS_EXTRA parameter in the network configuration file of the bond.</td>
</tr>
<tr>
<td>defroute</td>
<td>True</td>
<td>Use a default route provided by the DHCP service. Only applies when you enable use_dhcp or use_dhcpv6.</td>
</tr>
<tr>
<td>persist_mapping</td>
<td>False</td>
<td>Write the device alias configuration instead of the system names.</td>
</tr>
<tr>
<td>dhclient_args</td>
<td>None</td>
<td>Arguments that you want to pass to the DHCP client.</td>
</tr>
<tr>
<td>dns_servers</td>
<td>None</td>
<td>List of DNS servers that you want to use for the bond.</td>
</tr>
</tbody>
</table>

**ovs_bridge**

Defines a bridge in Open vSwitch, which connects multiple interface, ovs_bond, and vlan objects together.
The network interface type, `ovs_bridge`, takes a parameter `name`.

**NOTE**

If you have multiple bridges, you must use distinct bridge names other than accepting the default name of `bridge_name`. If you do not use distinct names, then during the converge phase, two network bonds are placed on the same bridge.

If you are defining an OVS bridge for the external tripleo network, then retain the values `bridge_name` and `interface_name` as your deployment framework automatically replaces these values with an external bridge name and an external interface name, respectively.

For example:

```yaml
- type: ovs_bridge
  name: br-bond
  dns_servers: {{ ctlplane_dns_nameservers }}
  domain: {{ dns_search_domains }}
  members:
    - type: ovs_bond
      name: bond1
      mtu: {{ min_viable_mtu }}
      ovs_options: {{ bound_interface_ovs_options }}
      members:
        - type: interface
          name: nic2
          mtu: {{ min_viable_mtu }}
          primary: true
        - type: interface
          name: nic3
          mtu: {{ min_viable_mtu }}
```

**NOTE**

The OVS bridge connects to the Networking service (neutron) server to obtain configuration data. If the OpenStack control traffic, typically the Control Plane and Internal API networks, is placed on an OVS bridge, then connectivity to the neutron server is lost whenever you upgrade OVS, or the OVS bridge is restarted by the admin user or process. This causes some downtime. If downtime is not acceptable in these circumstances, then you must place the Control group networks on a separate interface or bond rather than on an OVS bridge:

- You can achieve a minimal setting when you put the Internal API network on a VLAN on the provisioning interface and the OVS bridge on a second interface.

- To implement bonding, you need at least two bonds (four network interfaces). Place the control group on a Linux bond (Linux bridge). If the switch does not support LACP fallback to a single interface for PXE boot, then this solution requires at least five NICs.

Table 10.7. `ovs_bridge` options
<table>
<thead>
<tr>
<th>Option</th>
<th>Default</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>name</td>
<td></td>
<td>Name of the bridge.</td>
</tr>
<tr>
<td>use_dhcp</td>
<td>False</td>
<td>Use DHCP to get an IP address.</td>
</tr>
<tr>
<td>use_dhcpv6</td>
<td>False</td>
<td>Use DHCP to get a v6 IP address.</td>
</tr>
<tr>
<td>addresses</td>
<td></td>
<td>A list of IP addresses assigned to the bridge.</td>
</tr>
<tr>
<td>routes</td>
<td></td>
<td>A list of routes assigned to the bridge. For more information, see routes.</td>
</tr>
<tr>
<td>mtu</td>
<td>1500</td>
<td>The maximum transmission unit (MTU) of the connection.</td>
</tr>
<tr>
<td>members</td>
<td></td>
<td>A sequence of interface, VLAN, and bond objects that you want to use in the bridge.</td>
</tr>
<tr>
<td>ovs_options</td>
<td></td>
<td>A set of options to pass to OVS when creating the bridge.</td>
</tr>
<tr>
<td>ovs_extra</td>
<td></td>
<td>A set of options to set as the OVS_EXTRA parameter in the network configuration file of the bridge.</td>
</tr>
<tr>
<td>defroute</td>
<td>True</td>
<td>Use a default route provided by the DHCP service. Only applies when you enable use_dhcp or use_dhcpv6.</td>
</tr>
<tr>
<td>persist_mapping</td>
<td>False</td>
<td>Write the device alias configuration instead of the system names.</td>
</tr>
<tr>
<td>dhclient_args</td>
<td>None</td>
<td>Arguments that you want to pass to the DHCP client.</td>
</tr>
<tr>
<td>dns_servers</td>
<td>None</td>
<td>List of DNS servers that you want to use for the bridge.</td>
</tr>
</tbody>
</table>

**linux_bond**

Defines a Linux bond that joins two or more interfaces together. This helps with redundancy and increases bandwidth. Ensure that you include the kernel-based bonding options in the bonding_options parameter.
For example:

- type: linux_bond
  name: bond_api
  mtu: {{ min_viable_mtu }}
  bonding_options: {{ bond_interface_ovs_options }}
  use_dhcp: false
  dns_servers: {{ ctlplane_dns_nameservers }}
  members:
    - type: interface
      name: nic2
      mtu: {{ min_viable_mtu }}
      primary: true
    - type: interface
      name: nic3
      mtu: {{ min_viable_mtu }}

Note that nic2 uses **primary: true** to ensure that the bond uses the MAC address for **nic2**.

Table 10.8. linux_bond options

<table>
<thead>
<tr>
<th>Option</th>
<th>Default</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>name</td>
<td></td>
<td>Name of the bond.</td>
</tr>
<tr>
<td>use_dhcp</td>
<td>False</td>
<td>Use DHCP to get an IP address.</td>
</tr>
<tr>
<td>use_dhcpv6</td>
<td>False</td>
<td>Use DHCP to get a v6 IP address.</td>
</tr>
<tr>
<td>addresses</td>
<td></td>
<td>A list of IP addresses assigned to the bond.</td>
</tr>
<tr>
<td>routes</td>
<td></td>
<td>A list of routes assigned to the bond. See <strong>routes</strong>.</td>
</tr>
<tr>
<td>mtu</td>
<td>1500</td>
<td>The maximum transmission unit (MTU) of the connection.</td>
</tr>
<tr>
<td>primary</td>
<td>False</td>
<td>Defines the interface as the primary interface.</td>
</tr>
<tr>
<td>members</td>
<td></td>
<td>A sequence of interface objects that you want to use in the bond.</td>
</tr>
<tr>
<td>bonding_options</td>
<td></td>
<td>A set of options when creating the bond.</td>
</tr>
<tr>
<td>defroute</td>
<td>True</td>
<td>Use a default route provided by the DHCP service. Only applies when you enable <strong>use_dhcp</strong> or <strong>use_dhcpv6</strong>.</td>
</tr>
</tbody>
</table>
Write the device alias configuration instead of the system names.

Arguments that you want to pass to the DHCP client.

List of DNS servers that you want to use for the bond.

**linux_bridge**

Defines a Linux bridge, which connects multiple **interface**, **linux_bond**, and **vlan** objects together. The external bridge also uses two special values for parameters:

- **bridge_name**, which is replaced with the external bridge name.
- **interface_name**, which is replaced with the external interface.

For example:

```yaml
- type: linux_bridge
  name: bridge_name
  mtu:
    get_attr: [MinViableMtu, value]
  use_dhcp: false
  dns_servers:
    get_param: DnsServers
  domain:
    get_param: DnsSearchDomains
  addresses:
    - ip_netmask:
        list_join:
          - /
            - get_param: ControlPlaneIp
            - get_param: ControlPlaneSubnetCidr
  routes:
    list_concat_unique:
      - get_param: ControlPlaneStaticRoutes
```

**Table 10.9. linux_bridge options**

<table>
<thead>
<tr>
<th>Option</th>
<th>Default</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>name</td>
<td></td>
<td>Name of the bridge.</td>
</tr>
<tr>
<td>use_dhcp</td>
<td>False</td>
<td>Use DHCP to get an IP address.</td>
</tr>
<tr>
<td>use_dhcpv6</td>
<td>False</td>
<td>Use DHCP to get a v6 IP address.</td>
</tr>
<tr>
<td>Option</td>
<td>Default</td>
<td>Description</td>
</tr>
<tr>
<td>-------------</td>
<td>---------</td>
<td>-------------</td>
</tr>
<tr>
<td>addresses</td>
<td></td>
<td>A list of IP addresses assigned to the bridge.</td>
</tr>
<tr>
<td>routes</td>
<td></td>
<td>A list of routes assigned to the bridge. For more information, see routes.</td>
</tr>
<tr>
<td>mtu</td>
<td>1500</td>
<td>The maximum transmission unit (MTU) of the connection.</td>
</tr>
<tr>
<td>members</td>
<td></td>
<td>A sequence of interface, VLAN, and bond objects that you want to use in the bridge.</td>
</tr>
<tr>
<td>defroute</td>
<td>True</td>
<td>Use a default route provided by the DHCP service. Only applies when you enable use_dhcp or use_dhcpv6.</td>
</tr>
<tr>
<td>persist_mapping</td>
<td>False</td>
<td>Write the device alias configuration instead of the system names.</td>
</tr>
<tr>
<td>dhclient_args</td>
<td>None</td>
<td>Arguments that you want to pass to the DHCP client.</td>
</tr>
<tr>
<td>dns_servers</td>
<td>None</td>
<td>List of DNS servers that you want to use for the bridge.</td>
</tr>
</tbody>
</table>

**routes**

Defines a list of routes to apply to a network interface, VLAN, bridge, or bond.

For example:

```
- type: linux_bridge
  name: bridge_name
  ...
  routes: {{ [ctlplane_host_routes] | flatten | unique }}
```

<table>
<thead>
<tr>
<th>Option</th>
<th>Default</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ip_netmask</td>
<td>None</td>
<td>IP and netmask of the destination network.</td>
</tr>
<tr>
<td>Option</td>
<td>Default</td>
<td>Description</td>
</tr>
<tr>
<td>------------</td>
<td>---------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>default</td>
<td>False</td>
<td>Sets this route to a default route. Equivalent to setting <code>ip_netmask: 0.0.0.0/0</code>.</td>
</tr>
<tr>
<td>next_hop</td>
<td>None</td>
<td>The IP address of the router used to reach the destination network.</td>
</tr>
</tbody>
</table>

### 10.4.4. Example network interface layout

The following snippet for an example controller node NIC template demonstrates how to configure the custom network scenario to keep the control group separate from the OVS bridge:

```yaml
network_config:
  - type: interface
    name: nic1
    mtu: {{ ctlplane_mtu }}
    use_dhcp: false
    addresses:
      - ip_netmask: {{ ctlplane_ip }}/{{ ctlplane_subnet_cidr }}
      routes: {{ ctlplane_host_routes }}
    - type: linux_bond
      name: bond_api
      mtu: {{ min_viable_mtu_ctlplane }}
      use_dhcp: false
      bonding_options: {{ bond_interface_ovs_options }}
      dns_servers: {{ ctlplane_dns_nameservers }}
      domain: {{ dns_search_domains }}
      members:
        - type: interface
          name: nic2
          mtu: {{ min_viable_mtu_ctlplane }}
          primary: true
        - type: interface
          name: nic3
          mtu: {{ min_viable_mtu_ctlplane }}
  {% for network in role_networks if not network.startswith('Tenant') %}
    - type: vlan
      device: bond_api
      mtu: {{ lookup('vars', networks_lower[network] ~ '_mtu') }}
      vlan_id: {{ lookup('vars', networks_lower[network] ~ '_vlan_id') }}
      addresses:
        - ip_netmask: {{ lookup('vars', networks_lower[network] ~ '_ip') }}/{{ lookup('vars', networks_lower[network] ~ '_cidr') }}
        routes: {{ lookup('vars', networks_lower[network] ~ '_host_routes') }}
  {% endfor %}
  - type: ovs_bridge
    name: {{ neutron_physical_bridge_name }}
    dns_servers: {{ ctlplane_dns_nameservers }}
    members:
      - type: linux_bond
        name: bond-data
```

Red Hat OpenStack Platform 17.0-Beta Director Installation and Usage
mtu: {{ min_viable_mtu_dataplane }}
bonding_options: {{ bond_interface_ovs_options }}

members:
- type: interface
  name: nic4
  mtu: {{ min_viable_mtu_dataplane }}
  primary: true
- type: interface
  name: nic5
  mtu: {{ min_viable_mtu_dataplane }}

{% for network in role_networks if network.startswith('Tenant') %}
- type: vlan
  device: bond-data
  mtu: {{ lookup('vars', networks_lower[network] ~ '_mtu') }}
  vlan_id: {{ lookup('vars', networks_lower[network] ~ '_vlan_id') }}
  addresses:
    - ip_netmask: {{ lookup('vars', networks_lower[network] ~ '_ip') }}/{{ lookup('vars', networks_lower[network] ~ '_cidr') }}
    routes: {{ [tenant_host_routes] | flatten | unique }}
- type: ovs_bridge
  name: br-bond
  mtu: {{ external_mtu }}
  dns_servers: {{ ctlplane_dns_nameservers }}
  use_dhcp: false
  members:
    - type: interface

This template uses five network interfaces and assigns a number of tagged VLAN devices to the numbered interfaces. On nic4 and nic5, this template creates the OVS bridges.

10.5. ADDITIONAL OVERCLOUD NETWORK CONFIGURATION

This chapter follows on from the concepts and procedures outlined in Section 10.4, “Custom network interface templates” and provides some additional information to help configure parts of your overcloud network.

10.5.1. Configuring custom interfaces

Individual interfaces might require modification. The following example shows the modifications that are necessary to use a second NIC to connect to an infrastructure network with DHCP addresses, and to use another NIC for the bond:

network_config:
  # Add a DHCP infrastructure network to nic2
  - type: interface
    name: nic2
    mtu: {{ tenant_mtu }}
    use_dhcp: true
    primary: true
  - type: vlan
    mtu: {{ tenant_mtu }}
    vlan_id: {{ tenant_vlan_id }}
    addresses:
      - ip_netmask: {{ tenant_ip }}/{{ tenant_cidr }}
      routes: {{ [tenant_host_routes] | flatten | unique }}
  - type: ovs_bridge
    name: br-bond
    mtu: {{ external_mtu }}
    dns_servers: {{ ctlplane_dns_nameservers }}
    use_dhcp: false
    members:
      - type: interface
The network interface template uses either the actual interface name (eth0, eth1, enp0s25) or a set of numbered interfaces (nic1, nic2, nic3). The network interfaces of hosts within a role do not have to be exactly the same when you use numbered interfaces (nic1, nic2, etc.) instead of named interfaces (eth0, eno2, etc.). For example, one host might have interfaces em1 and em2, while another has eno1 and eno2, but you can refer to the NICs of both hosts as nic1 and nic2.

The order of numbered interfaces corresponds to the order of named network interface types:

- **ethX** interfaces, such as eth0, eth1, etc. These are usually onboard interfaces.
- **enoX** interfaces, such as eno0, eno1, etc. These are usually onboard interfaces.
- **enX** interfaces, sorted alpha numerically, such as enp3s0, enp3s1, ens3, etc. These are usually add-on interfaces.

The numbered NIC scheme includes only live interfaces, for example, if the interfaces have a cable attached to the switch. If you have some hosts with four interfaces and some with six interfaces, use nic1 to nic4 and attach only four cables on each host.

You can hardcode physical interfaces to specific aliases so that you can pre-determine which physical NIC maps as nic1 or nic2 and so on. You can also map a MAC address to a specified alias.

**NOTE**

Normally, os-net-config registers only the interfaces that are already connected in an UP state. However, if you hardcode interfaces with a custom mapping file, the interface is registered even if it is in a DOWN state.

Interfaces are mapped to aliases with an environment file. In this example, each node has predefined entries for nic1, nic2, and nic3.
id: "PowerEdge R630"
nic1: em3	nic2: em1	nic3: em2
# Cisco UCS B200-M4"
nodegroup2:
dmiString: "system-product-name"
id: "UCSB-B200-M4"
nic1: enp7s0
nic2: enp6s0

The resulting configuration is applied by os-net-config. On each node, you can see the applied configuration in the interface_mapping section of the /etc/os-net-config/mapping.yaml file.

10.5.2. Configuring routes and default routes

You can set the default route of a host in one of two ways. If the interface uses DHCP and the DHCP server offers a gateway address, the system uses a default route for that gateway. Otherwise, you can set a default route on an interface with a static IP.

Although the Linux kernel supports multiple default gateways, it uses only the gateway with the lowest metric. If there are multiple DHCP interfaces, this can result in an unpredictable default gateway. In this case, it is recommended to set defroute: false for interfaces other than the interface that uses the default route.

For example, you might want a DHCP interface (nic3) to be the default route. Use the following YAML snippet to disable the default route on another DHCP interface (nic2):

```
# No default route on this DHCP interface
- type: interface
  name: nic2
  use_dhcp: true
  defroute: false
# Instead use this DHCP interface as the default route
- type: interface
  name: nic3
  use_dhcp: true
```

**NOTE**

The defroute parameter applies only to routes obtained through DHCP.

To set a static route on an interface with a static IP, specify a route to the subnet. For example, you can set a route to the 10.1.2.0/24 subnet through the gateway at 172.17.0.1 on the Internal API network:

```
- type: vlan
  device: bond1
  vlan_id:
    get_param: InternalApiNetworkVlanID
  addresses:
    - ip_netmask:
        get_param: InternalApiIpSubnet
```
10.5.3. Configuring policy-based routing

To configure unlimited access from different networks on Controller nodes, configure policy-based routing. Policy-based routing uses route tables where, on a host with multiple interfaces, you can send traffic through a particular interface depending on the source address. You can route packets that come from different sources to different networks, even if the destinations are the same.

For example, you can configure a route to send traffic to the Internal API network, based on the source address of the packet, even when the default route is for the External network. You can also define specific route rules for each interface.

Red Hat OpenStack Platform uses the `os-net-config` tool to configure network properties for your overcloud nodes. The `os-net-config` tool manages the following network routing on Controller nodes:

- Routing tables in the `/etc/iproute2/rt_tables` file
- IPv4 rules in the `/etc/sysconfig/network-scripts/rule-{ifname}` file
- IPv6 rules in the `/etc/sysconfig/network-scripts/rule6-{ifname}` file
- Routing table specific routes in the `/etc/sysconfig/network-scripts/route-{ifname}`

Prerequisites

- You have installed the undercloud successfully. For more information, see Installing director in the *Director Installation and Usage* guide.

Procedure

1. Create the `interface` entries in a custom NIC template from the `/home/stack/templates/custom-nics` directory, define a route for the interface, and define rules that are relevant to your deployment:

```yaml
network_config:
  - type: interface
    name: em1
    use_dhcp: false
    addresses:
      - ip_netmask: {{ external_ip }}/{{ external_cidr }}
    routes:
      - default: true
        next_hop: {{ external_gateway_ip }}
      - ip_netmask: {{ external_ip }}/{{ external_cidr }}
        next_hop: {{ external_gateway_ip }}
        route_table: 2
        route_options: metric 100
    rules:
      - rule: "iif em1 table 200"
        comment: "Route incoming traffic to em1 with table 200"
      - rule: "from 192.0.2.0/24 table 200"
```
2. Include your custom NIC configuration and network environment files in the deployment command, along with any other environment files relevant to your deployment:

```bash
$ openstack overcloud deploy --templates \
  -e /home/stack/templates/<custom-nic-template> \
  -e <OTHER_ENVIRONMENT_FILES>
```

**Verification**

- Enter the following commands on a Controller node to verify that the routing configuration is functioning correctly:

  ```
  $ cat /etc/iproute2/rt_tables
  $ ip route
  $ ip rule
  ```

### 10.5.4. Configuring jumbo frames

The Maximum Transmission Unit (MTU) setting determines the maximum amount of data transmitted with a single Ethernet frame. Using a larger value results in less overhead because each frame adds data in the form of a header. The default value is 1500 and using a higher value requires the configuration of the switch port to support jumbo frames. Most switches support an MTU of at least 9000, but many are configured for 1500 by default.

The MTU of a VLAN cannot exceed the MTU of the physical interface. Ensure that you include the MTU value on the bond or interface.

The Storage, Storage Management, Internal API, and Tenant networks can all benefit from jumbo frames.

You can alter the value of the `mtu` in the `jinja2` template or in the `network_data.yaml` file. If you set the value in the `network_data.yaml` file it is rendered during deployment.

---

```yaml
{% set mtu_list = [ctlplane_mtu] %}
{% for network in role_networks %}
  {{ mtu_list.append(lookup('vars', networks_lower[network] ~ '_mtu')) }}
{% endfor %}
{% set min_viable_mtu = mtu_list | max %}
```
network_config:
- type: ovs_bridge
  name: bridge_name
  mtu: {{ min_viable_mtu }}
  use_dhcp: false
  dns_servers: {{ ctlplane_dns_nameservers }}
  domain: {{ dns_search_domains }}
  addresses:
    - ip_netmask: {{ ctlplane_ip }}/{{ ctlplane_subnet_cidr }}
    routes: {{ [ctlplane_host_routes] | flatten | unique }}
  members:
    - type: interface
      name: nic1
      mtu: {{ min_viable_mtu }}
      primary: true
    - type: vlan
      mtu: 9000
      vlan_id: {{ storage_vlan_id }}
      addresses:
        - ip_netmask: {{ storage_ip }}/{{ storage_cidr }}
        routes: {{ [storage_host_routes] | flatten | unique }}
      members:
        - type: interface
          name: nic1
          mtu: {{ min_viable_mtu }}
          primary: true
        - type: vlan
          mtu: 9000
          vlan_id: {{ storage_mgmt_vlan_id }}
          addresses:
            - ip_netmask: {{ storage_mgmt_ip }}/{{ storage_mgmt_cidr }}
            routes: {{ [storage_mgmt_host_routes] | flatten | unique }}
          members:
            - type: interface
              name: nic1
              mtu: {{ min_viable_mtu }}
              primary: true
        - type: vlan
          mtu: 9000
          vlan_id: {{ internal_api_vlan_id }}
          addresses:
            - ip_netmask: {{ internal_api_ip }}/{{ internal_api_cidr }}
            routes: {{ [internal_api_host_routes] | flatten | unique }}
          members:
            - type: interface
              name: nic1
              mtu: {{ min_viable_mtu }}
              primary: true
        - type: vlan
          mtu: 9000
          vlan_id: {{ tenant_vlan_id }}
          addresses:
            - ip_netmask: {{ tenant_ip }}/{{ tenant_cidr }}
            routes: {{ [tenant_host_routes] | flatten | unique }}
          members:
            - type: interface
              name: nic1
              mtu: {{ min_viable_mtu }}
              primary: true
        - type: vlan
          mtu: 9000
          vlan_id: {{ external_vlan_id }}
          addresses:
            - ip_netmask: {{ external_ip }}/{{ external_cidr }}
            routes: {{ [external_host_routes, [{'default': True, 'next_hop': external_gateway_ip}]] | flatten | unique }}
          members:
            - type: interface
              name: nic1
              mtu: {{ min_viable_mtu }}
              primary: true

1. mtu value updated directly in the jinja2 template.
2. mtu value is taken from the network_data.yaml file during deployment.

10.5.5. Configuring ML2/OVN northbound path MTU discovery for jumbo frame fragmentation
If a VM on your internal network sends jumbo frames to an external network, and the maximum transmission unit (MTU) of the internal network exceeds the MTU of the external network, a northbound frame can easily exceed the capacity of the external network.

ML2/OVS automatically handles this oversized packet issue, and ML2/OVN handles it automatically for TCP packets.

But to ensure proper handling of oversized northbound UDP packets in a deployment that uses the ML2/OVN mechanism driver, you need to perform additional configuration steps.

These steps configure ML2/OVN routers to return ICMP “fragmentation needed” packets to the sending VM, where the sending application can break the payload into smaller packets.

**NOTE**

In east/west traffic, a RHOSP ML2/OVN deployment does not support fragmentation of packets that are larger than the smallest MTU on the east/west path. For example:

- VM1 is on Network1 with an MTU of 1300.
- VM2 is on Network2 with an MTU of 1200.
- A ping in either direction between VM1 and VM2 with a size of 1171 or less succeeds. A ping with a size greater than 1171 results in 100 percent packet loss.

With no identified customer requirements for this type of fragmentation, Red Hat has no plans to add support.

**Procedure**

1. Set the following value in the [ovn] section of ml2_conf.ini:

   ```
   ovn Emit need_to_frag = True
   ```

**10.5.6. Configuring the native VLAN on a trunked interface**

If a trunked interface or bond has a network on the native VLAN, the IP addresses are assigned directly to the bridge and there is no VLAN interface.

For example, if the External network is on the native VLAN, a bonded configuration looks like this:

```yaml
network_config:
- type: ovs_bridge
  name: bridge_name
  dns_servers: external.local
  members:
  - type: interface
    name: nic3
    primary: true
  - type: vlan
    vlan_id: {{ tenant_vlan_id }}
    addresses:
      - ip_netmask: {{ external_ip }}/{{ external_cidr }}
```
NOTE

When you move the address or route statements onto the bridge, remove the corresponding VLAN interface from the bridge. Make the changes to all applicable roles. The External network is only on the controllers, so only the controller template requires a change. The Storage network is attached to all roles, so if the Storage network is on the default VLAN, all roles require modifications.

10.5.7. Increasing the maximum number of connections that netfilter tracks

The Red Hat OpenStack Platform (RHOSP) Networking service (neutron) uses netfilter connection tracking to build stateful firewalls and to provide network address translation (NAT) on virtual networks. There are some situations that can cause the kernel space to reach the maximum connection limit and result in errors such as `nf_conntrack: table full, dropping packet`. You can increase the limit for connection tracking (conntrack) and avoid these types of errors. You can increase the conntrack limit for one or more roles, or across all the nodes, in your RHOSP deployment.

Prerequisites

- A successful RHOSP undercloud installation.

Procedure

1. Log in to the undercloud host as the `stack` user.

2. Source the undercloud credentials file:

   ```
   $ source ~/stackrc
   ```

3. Create a custom YAML environment file.

   Example

   ```
   $ vi /home/stack/templates/custom-environment.yaml
   ```

4. Your environment file must contain the keywords `parameter_defaults` and `ExtraSysctlSettings`. Enter a new value for the maximum number of connections that netfilter can track in the variable, `net.nf_contrack_max`.

   Example

   In this example, you can set the conntrack limit across all hosts in your RHOSP deployment:

   ```
   parameter_defaults:
   ExtraSysctlSettings:
     net.nf_contrack_max:
       value: 500000
   ```

   Use the `<role>Parameter` parameter to set the conntrack limit for a specific role:

   ```
   parameter_defaults:
   <role>Parameters:
     ExtraSysctlSettings:
   ```
net.nf_conntrack_max:
  value: <simultaneous_connections>

- Replace `<role>` with the name of the role.
  For example, use **ControllerParameters** to set the conntrack limit for the Controller role, or
  **ComputeParameters** to set the conntrack limit for the Compute role.

- Replace `<simultaneous_connections>` with the quantity of simultaneous connections that
  you want to allow.

Example

In this example, you can set the conntrack limit for only the Controller role in your RHOSP
deployment:

```yaml
parameter_defaults:
  ControllerParameters:
    ExtraSysctlSettings:
      net.nf_conntrack_max:
        value: 500000
```

**NOTE**

The default value for **net.nf_conntrack_max** is **500000** connections. The
maximum value is: **4294967295**.

5. Run the deployment command and include the core heat templates, environment files, and this
new custom environment file.

**IMPORTANT**

The order of the environment files is important as the parameters and resources
defined in subsequent environment files take precedence.

Example

```bash
$ openstack overcloud deploy --templates \
  -e /home/stack/templates/custom-environment.yaml
```

Additional resources

- **Environment files** in the *Director Installation and Usage* guide
- **Including environment files in overcloud creation** in the *Director Installation and Usage* guide

### 10.6. NETWORK INTERFACE BONDING

You can use various bonding options in your custom network configuration.

#### 10.6.1. Network interface bonding for overcloud nodes
You can bundle multiple physical NICs together to form a single logical channel known as a bond. You can configure bonds to provide redundancy for high availability systems or increased throughput.

Red Hat OpenStack Platform supports Open vSwitch (OVS) kernel bonds, OVS-DPDK bonds, and Linux kernel bonds.

### Table 10.10. Supported interface bonding types

<table>
<thead>
<tr>
<th>Bond type</th>
<th>Type value</th>
<th>Allowed bridge types</th>
<th>Allowed members</th>
</tr>
</thead>
<tbody>
<tr>
<td>OVS kernel bonds</td>
<td>ovs_bond</td>
<td>ovs_bridge</td>
<td>interface</td>
</tr>
<tr>
<td>OVS-DPDK bonds</td>
<td>ovs_dpdk_bond</td>
<td>ovs_user_bridge</td>
<td>ovs_dpdk_port</td>
</tr>
<tr>
<td>Linux kernel bonds</td>
<td>linux_bond</td>
<td>ovs_bridge or linux_bridge</td>
<td>interface</td>
</tr>
</tbody>
</table>

**IMPORTANT**

Do not combine `ovs_bridge` and `ovs_user_bridge` on the same node.

### 10.6.2. Creating Open vSwitch (OVS) bonds

You create OVS bonds in your network interface templates. For example, you can create a bond as part of an OVS user space bridge:

- type: ovs_user_bridge
  name: br-dpdk0
  members:
  - type: ovs_dpdk_bond
    name: dpdkbond0
    rx_queue: {{ num_dpdk_interface_rx_queues }}
    members:
    - type: ovs_dpdk_port
      name: dpdk0
      members:
    - type: interface
      name: nic4
    - type: ovs_dpdk_port
      name: dpdk1
      members:
    - type: interface
      name: nic5

In this example, you create the bond from two DPDK ports.

The `ovs_options` parameter contains the bonding options. You can configure a bonding options in a network environment file with the `BondInterfaceOvsOptions` parameter:

```yaml
environment_parameters:
  BondInterfaceOvsOptions: "bond_mode=active_backup"
```
10.6.3. Open vSwitch (OVS) bonding options

You can set various Open vSwitch (OVS) bonding options with the `ovs_options` heat parameter in your NIC template files.

**bond_mode=balance-slb**

Source load balancing (slb) balances flows based on source MAC address and output VLAN, with periodic rebalancing as traffic patterns change. When you configure a bond with the `balance-slb` bonding option, there is no configuration required on the remote switch. The Networking service (neutron) assigns each source MAC and VLAN pair to a link and transmits all packets from that MAC and VLAN through that link. A simple hashing algorithm based on source MAC address and VLAN number is used, with periodic rebalancing as traffic patterns change. The `balance-slb` mode is similar to mode 2 bonds used by the Linux bonding driver. You can use this mode to provide load balancing even when the switch is not configured to use LACP.

**bond_mode=active-backup**

When you configure a bond using `active-backup` bond mode, the Networking service keeps one NIC in standby. The standby NIC resumes network operations when the active connection fails. Only one MAC address is presented to the physical switch. This mode does not require switch configuration, and works when the links are connected to separate switches. This mode does not provide load balancing.

**lACP=[active | passive | off]**

Controls the Link Aggregation Control Protocol (LACP) behavior. Only certain switches support LACP. If your switch does not support LACP, use `bond_mode=balance-slb` or `bond_mode=active-backup`.

**other-config:lacp-fallback-ab=true**

Set active-backup as the bond mode if LACP fails.

**other_config:lacp-time=[fast | slow]**

Set the LACP heartbeat to one second (fast) or 30 seconds (slow). The default is slow.

**other_config:bond-detect-mode=[miimon | carrier]**

Set the link detection to use miimon heartbeats (miimon) or monitor carrier (carrier). The default is carrier.

**other_config:bond-miimon-interval=100**

If using miimon, set the heartbeat interval (milliseconds).

**bond_updelay=1000**

Set the interval (milliseconds) that a link must be up to be activated to prevent flapping.

**other_config:bond-rebalance-interval=10000**

Set the interval (milliseconds) that flows are rebalancing between bond members. Set this value to zero to disable flow rebalancing between bond members.

10.6.4. Using Link Aggregation Control Protocol (LACP) with Open vSwitch (OVS) bonding modes

You can use bonds with the optional Link Aggregation Control Protocol (LACP). LACP is a negotiation protocol that creates a dynamic bond for load balancing and fault tolerance.

Use the following table to understand support compatibility for OVS kernel and OVS-DPDK bonded interfaces in conjunction with LACP options.
IMPORTANT
The OVS/OVS-DPDK `balance-tcp` mode is available as a technology preview only.

IMPORTANT
On control and storage networks, Red Hat recommends that you use Linux bonds with VLAN and LACP, because OVS bonds carry the potential for control plane disruption that can occur when OVS or the neutron agent is restarted for updates, hot fixes, and other events. The Linux bond/LACP/VLAN configuration provides NIC management without the OVS disruption potential.

Table 10.11. LACP options for OVS kernel and OVS-DPDK bond modes

<table>
<thead>
<tr>
<th>Objective</th>
<th>OVS bond mode</th>
<th>Compatible LACP options</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>High availability (active-passive)</td>
<td>active-backup</td>
<td>active, passive, or off</td>
<td></td>
</tr>
<tr>
<td>Increased throughput (active-active)</td>
<td>balance-slb</td>
<td>active, passive, or off</td>
<td>• Performance is affected by extra parsing per packet.</td>
</tr>
<tr>
<td></td>
<td>balance-tcp</td>
<td>active or passive</td>
<td>• There is a potential for vhost-user lock contention.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Tech preview only. Not recommended for use in production.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Recirculation needed for L4 hashing has a performance impact.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• As with balance-slb, performance is affected by extra parsing per packet and there is a potential for vhost-user lock contention.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• LACP must be enabled.</td>
</tr>
</tbody>
</table>
10.6.5. Creating Linux bonds

You create Linux bonds in your network interface templates. For example, you can create a Linux bond that bond two interfaces:

```yaml
- type: linux_bond
  name: bond_api
  mtu: {{ min_viable_mtu_ctlplane }}
  use_dhcp: false
  bonding_options: {{ bond_interface_ovs_options }}
  dns_servers: {{ ctlplane_dns_nameservers }}
  domain: {{ dns_search_domains }}
  members:
    - type: interface
      name: nic2
      mtu: {{ min_viable_mtu_ctlplane }}
      primary: true
    - type: interface
      name: nic3
      mtu: {{ min_viable_mtu_ctlplane }}
```

The `bonding_options` parameter sets the specific bonding options for the Linux bond.

**mode**

Sets the bonding mode, which in the example is **802.3ad** or LACP mode. For more information about Linux bonding modes, see "Upstream Switch Configuration Depending on the Bonding Modes" in the Red Hat Enterprise Linux 8 Configuring and Managing Networking guide.

**lacp_rate**

Defines whether LACP packets are sent every 1 second, or every 30 seconds.

**updelay**

Defines the minimum amount of time that an interface must be active before it is used for traffic. This minimum configuration helps to mitigate port flapping outages.

**miimon**

The interval in milliseconds that is used for monitoring the port state using the MIIMON functionality of the driver.

Use the following additional examples as guides to configure your own Linux bonds:

- **Linux bond set to active-backup mode with one VLAN:**

  ```yaml
  ....
  - type: linux_bond
    name: bond_api
    mtu: {{ min_viable_mtu_ctlplane }}
    use_dhcp: false
    bonding_options: {{ bond_interface_active_backup }}
    dns_servers: {{ ctlplane_dns_nameservers }}
    domain: {{ dns_search_domains }}
    members:
      - type: interface
        name: nic2
        mtu: {{ min_viable_mtu_ctlplane }}
  ```
Red Hat OpenStack Platform 17.0-Beta Director Installation and Usage

primary: true
- type: interface
name: nic3
mtu: {{ min_viable_mtu_ctlplane }}
- type: vlan
mtu: {{ lookup('vars', networks_lower[network] ~ '_mtu') }}
vlan_id: {{ lookup('vars', networks_lower[network] ~ '_vlan_id') }}
addresses:
- ip_netmask:
{{ lookup('vars', networks_lower[network] ~ '_ip') }}/{{ lookup('vars',
networks_lower[network] ~ '_cidr') }}
routes: {{ lookup('vars', networks_lower[network] ~ '_host_routes') }}
Linux bond set to 802.3ad LACP mode with one VLAN:
- type: ovs_bridge
name: br_tenant
mtu: {{ min_viable_mtu_ctlplane }}
use_dhcp: false
bonding_options: {{ bond_interface_active_backup }}
dns_servers: {{ ctlplane_dns_nameservers }}
domain: {{ dns_search_domains }}
members:
- type: linux_bond
name: bond_tenant
mtu: {{ min_viable_mtu_ctlplane }}
bonding_options: "mode=802.3ad updelay=1000 miimon=100"
use_dhcp: false
dns_servers: {{ ctlplane_dns_nameserver }}
members:
- type: interface
name: p1p1
- type: interface
name: p1p2
- type: vlan
mtu: {{ lookup('vars', networks_lower[network] ~ '_mtu') }}
vlan_id: {{ lookup('vars', networks_lower[network] ~ '_vlan_id') }}
addresses:
- ip_netmask:
{{ lookup('vars', networks_lower[network] ~ '_ip') }}/{{ lookup('vars',
networks_lower[network] ~ '_cidr') }}
routes: {{ lookup('vars', networks_lower[network] ~ '_host_routes') }}

10.7. UPDATING THE FORMAT OF YOUR NETWORK CONFIGURATION
FILES
The format of the network configuration yaml files has changed in Red Hat OpenStack Platform
(RHOSP) 17.0. The structure of the network configuration file network_data.yaml has changed, and the
NIC template file format has changed from yaml file format to Jinja2 ansible format, j2.
You can convert your existing network configuration file in your current deployment to the RHOSP 17+
format by using the following conversion tools:
convert_v1_net_data.py

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**10.7.1. Updating the format of your network configuration file**

The format of the network configuration **yaml** file has changed in Red Hat OpenStack Platform (RHOSP) 17.0. You can convert your existing network configuration file in your current deployment to the RHOSP 17+ format by using the `convert_v1_net_data.py` conversion tool.

**Procedure**

1. Download the conversion tool:
   ```
   /usr/share/openstack-tripleo-heat-templates/tools/convert_v1_net_data.py
   ```

2. Convert your RHOSP 16+ network configuration file to the RHOSP 17+ format:
   ```
   $ python3 convert_v1_net_data.py -n <network_config>.yaml
   ```
   Replace `<network_config>` with the name of the existing configuration file that you want to convert, for example, `network_data.yaml`.

**10.7.2. Automatically converting NIC templates to Jinja2 Ansible format**

The NIC template file format has changed from **yaml** file format to Jinja2 Ansible format, **j2**, in Red Hat OpenStack Platform (RHOSP) 17.0.

You can convert your existing NIC template files in your current deployment to the Jinja2 format by using the `convert_heat_nic_config_to_ansible_j2.py` conversion tool.

You can also manually convert your existing NIC template files. For more information, see [Manually converting NIC templates to Jinja2 Ansible format](#).

The files you need to convert include the following:

- Controller NIC templates
- Compute NIC templates
- Any other custom network files

**Procedure**

1. Download the conversion tool:
   ```
   /usr/share/openstack-tripleo-heat-templates/tools/convert_heat_nic_config_to_ansible_j2.py
   ```
2. Convert your Compute and Controller NIC template files, and any other custom network files, to the Jinja2 Ansible format:

```bash
$ python3 convert_heat_nic_config_to_ansible_j2.py
[--stack <overcloud> | --standalone] --networks_file <network_config.yaml> 
<network_template>.yaml
```

- Replace `<overcloud>` with the name or UUID of the overcloud stack. If `--stack` is not specified, the stack defaults to `overcloud`.

**NOTE**

You can use the `--stack` option only on your RHOSP 16 deployment because it requires the Orchestration service (heat) to be running on the undercloud node. Starting with RHOSP 17, RHOSP deployments use ephemeral heat, which runs the Orchestration service in a container. If the Orchestration service is not available, or you have no stack, then use the `--standalone` option instead of `--stack`.

- Replace `<network_config.yaml>` with the name of the configuration file that describes the network deployment, for example, `network_data.yaml`.

- Replace `<network_template>` with the name of the network configuration file you want to convert.

Repeat this command until you have converted all your custom network configuration files. The `convert_heat_nic_config_to_ansible_j2.py` script generates a `.j2` file for each `yaml` file you pass to it for conversion.

3. Inspect each generated `.j2` file to ensure the configuration is correct and complete for your environment, and manually address any comments generated by the tool that highlight where the configuration could not be converted. For more information about manually converting the NIC configuration to Jinja2 format, see [Heat parameter to Ansible variable mappings](#).

4. Configure the `*NetworkConfigTemplate` parameters in your `network-environment.yaml` file to point to the generated `.j2` files:

```yaml
parameter_defaults:
  ControllerNetworkConfigTemplate: '/home/stack/templates/custom-nics/controller.j2'
  ComputeNetworkConfigTemplate: '/home/stack/templates/custom-nics/compute.j2'
```

5. Delete the `resource_registry` mappings from your `network-environment.yaml` file for the old network configuration files:

```yaml
resource_registry:
  OS::TripleO::Compute::Net::SoftwareConfig: /home/stack/templates/nic-configs/compute.yaml
  OS::TripleO::Controller::Net::SoftwareConfig: /home/stack/templates/nic-configs/controller.yaml
```

10.7.3. Manually converting NIC templates to Jinja2 Ansible format
The NIC template file format has changed from YAML file format to Jinja2 Ansible format, `j2`, in Red Hat OpenStack Platform (RHOSP) 17.0.

You can manually convert your existing NIC template files.

You can also convert your existing NIC template files in your current deployment to the Jinja2 format by using the `convert_heat_nic_config_to_ansible_j2.py` conversion tool. For more information, see [Automatically converting NIC templates to Jinja2 ansible format](#).

The files you need to convert include the following:

- Controller NIC templates
- Compute NIC templates
- Any other custom network files

**Procedure**

1. Create a Jinja2 template. You can create a new template by using the `os-net-config` schema, or copy and edit an example template from the `/usr/share/ansible/roles/tripleo_network_config/templates/` directory on the undercloud node.

2. Replace the heat intrinsic functions with Jinja2 filters. For example, use the following filter to calculate the `min_viable_mtu`:

   ```
   {% set mtu_list = [ctlplane_mtu] %}
   {% for network in role_networks %}
   {{ mtu_list.append(lookup('vars', networks_lower[network] ~ '_mtu')) }}
   {% endfor %}
   {% set min_viable_mtu = mtu_list | max %}
   ```

3. Use Ansible variables to configure the network properties for your deployment. You can configure each individual network manually, or programatically configure each network by iterating over `role_networks`:

   - To manually configure each network, replace each `get_param` function with the equivalent Ansible variable. For example, if your current deployment configures `vlan_id` by using `get_param: InternalApiNetworkVlanID`, then add the following configuration to your template:

     ```
     vlan_id: {{ internal_api_vlan_id }}
     ```

     **Table 10.12. Example network property mapping from heat parameters to Ansible*vars**
To programatically configure each network, add a Jinja2 for-loop structure to your template that retrieves the available networks by their role name by using `role_networks`.

Example

```yaml
{% for network in role_networks %}
- type: vlan
  mtu: {{ lookup('vars', networks_lower[network] ~ '_mtu') }}
  vlan_id: {{ lookup('vars', networks_lower[network] ~ '_vlan_id') }}
  addresses:
    - ip_netmask: {{ lookup('vars', networks_lower[network] ~ '_ip') }}/{{ lookup('vars', networks_lower[network] ~ '_cidr') }}
  routes: {{ lookup('vars', networks_lower[network] ~ '_host_routes') }}
{% endfor %}
```

For a full list of the mappings from the heat parameter to the Ansible `vars` equivalent, see Heat parameter to Ansible variable mappings.

4. Configure the `NetworkConfigTemplate` parameters in your `network-environment.yaml` file to point to the generated `.j2` files:

```yaml
parameter_defaults:
  ControllerNetworkConfigTemplate: '/home/stack/templates/custom-nics/controller.j2'
  ComputeNetworkConfigTemplate: '/home/stack/templates/custom-nics/compute.j2'
```

5. Delete the `resource_registry` mappings from your `network-environment.yaml` file for the old network configuration files:

```yaml
resource_registry:
  OS::TripleO::Compute::Net::SoftwareConfig: /home/stack/templates/nic-configs/compute.yaml
  OS::TripleO::Controller::Net::SoftwareConfig: /home/stack/templates/nic-configs/controller.yaml
```

10.7.4. Heat parameter to Ansible variable mappings
The NIC template file format has changed from yam file format to Jinja2 ansible format, j2, in Red Hat OpenStack Platform (RHOSP) 17.0.

To manually convert your existing NIC template files to Jinja2 ansible format, you must use Ansible variables to configure the network properties for your deployment. For example, if your current deployment configures vlan_id by using get_param: InternalApiNetworkVlanID, then replace it with the following configuration in your new Jinja2 template:

```
vlan_id: {{ internal_api_vlan_id }}
```

The following table lists the available mappings from the heat parameter to the Ansible vars equivalent.

<table>
<thead>
<tr>
<th>Heat parameter</th>
<th>Ansible vars</th>
</tr>
</thead>
<tbody>
<tr>
<td>BondInterfaceOvsOptions</td>
<td>{{ bond_interface_ovs_options }}</td>
</tr>
<tr>
<td>ControlPlaneIp</td>
<td>{{ ctlplane_ip }}</td>
</tr>
<tr>
<td>ControlPlaneSubnetCidr</td>
<td>{{ ctlplane_subnet_cidr }}</td>
</tr>
<tr>
<td>ControlPlaneDefaultRoute</td>
<td>{{ ctlplane_gateway_ip }}</td>
</tr>
<tr>
<td>ControlPlaneStaticRoutes</td>
<td>{{ ctlplane_host_routes }}</td>
</tr>
<tr>
<td>ControlPlaneMtu</td>
<td>{{ ctlplane_mtu }}</td>
</tr>
<tr>
<td>DnsServers</td>
<td>{{ ctlplane_dns_nameservers }}</td>
</tr>
<tr>
<td>DnsSearchDomains</td>
<td>{{ dns_search_domains }}</td>
</tr>
<tr>
<td>NumDpdkInterfaceRxQueues</td>
<td>{{ num_dpdk_interface_rx_queues }}</td>
</tr>
<tr>
<td>&lt;network_name&gt;IpSubnet</td>
<td>{{ &lt;network_name&gt;_vlan_ip }}/{{&lt;network_name&gt;_cidr}}</td>
</tr>
<tr>
<td>&lt;network_name&gt;NetworkVlanID</td>
<td>{{ &lt;network_name&gt;_vlan_id }}</td>
</tr>
<tr>
<td>&lt;network_name&gt;Mtu</td>
<td>{{ &lt;network_name&gt;_mtu }}</td>
</tr>
<tr>
<td>&lt;network_name&gt;InterfaceDefaultRoute</td>
<td>{{ &lt;network_name&gt;_gateway_ip }}</td>
</tr>
<tr>
<td>&lt;network_name&gt;InterfaceRoutes</td>
<td>{{ &lt;network_name&gt;_host_routes }}</td>
</tr>
</tbody>
</table>

Configuring a heat parameter that is not listed in the table

To configure a heat parameter that is not listed in the table, you must configure the parameter as a {{role.name}}ExtraGroupVars. After you have configured the parameter as a
The `{role.name()}ExtraGroupVars` parameter, you can then use it in your new template. For example, to configure the `StorageSupernet` parameter, add the following configuration to your network configuration file:

```yaml
parameter_defaults:
  ControllerExtraGroupVars:
    storage_supernet: 172.16.0.0/16
```

You can then add `{{ storage_supernet }}` to your Jinja2 template.

### Converting the Ansible variable syntax to programatically configure each network

When you use a Jinja2 for-loop structure to retrieve the available networks by their role name by iterating over `role_networks`, you need to retrieve the lower case name for each network role to prepend to each property. Use the following structure to convert the Ansible `vars` from the above table to the required syntax:

```python
{{ lookup('vars', networks_lower[network] ~ '_<property>') }}
```

Replace `<property>` with the property that you are setting, for example, `ip`, `vlan_id`, or `mtu`.

For example, to populate the value for each `NetworkVlanID` dynamically, replace `{{<network_name>_vlan_id }}` with the following configuration:

```python
{{ lookup('vars', networks_lower[network] ~ '_vlan_id') }}
```

### 10.7.5. Changes to the network data schema

The network data schema was updated in Red Hat OpenStack Platform (RHOSP) 17. The main differences between the network data schema used in RHOSP 16 and earlier, and network data schema used in RHOSP 17 and later, are as follows:

- The base subnet has been moved to the `subnets` map. This aligns the configuration for non-routed and routed deployments, such as spine-leaf networking.
- The `enabled` option is no longer used to ignore disabled networks. Instead, you must remove disabled networks from the configuration file.
- The `compat_name` option is no longer required as the heat resource that used it has been removed.
- The following parameters are no longer valid at the network level: `ip_subnet`, `gateway_ip`, `allocation_pools`, `routes`, `ipv6_subnet`, `gateway_ipv6`, `ipv6_allocation_pools`, and `routes_ipv6`. These parameters are still used at the subnet level.
- A new parameter, `physical_network`, has been introduced, that is used to create ironic ports in metalsmith.
- New parameters `network_type` and `segmentation_id` replace `{{network.name}()}NetValueSpecs` used to set the network type to `vlan`.
- The following parameters have been deprecated in RHOSP 17:
  - `{{network.name}()}NetCidr`
  - `{{network.name}()}SubnetName`
- {{network.name}}Network
- {{network.name}}AllocationPools
- {{network.name}}Routes
- {{network.name}}SubnetCidr_{{subnet}}
- {{network.name}}AllocationPools_{{subnet}}
- {{network.name}}Routes_{{subnet}}
To create an overcloud you must perform the following tasks:

1. Provision the network resources for your physical networks:
   a. If you are deploying network isolation or a custom composable network, then create a network definition file in YAML format.
   b. Run the network provisioning command, including the network definition file.
   c. Create a network Virtual IP (VIP) definition file in YAML format.
   d. Run the network VIP provisioning command, including the network VIP definition file.

2. Provision your bare metal nodes:
   a. Create a node definition file in YAML format.
   b. Run the bare-metal node provisioning command, including the node definition file.

3. Deploy your overcloud:
   a. Run the deployment command, including the heat environment files that the provisioning commands generate.

11.1. PROVISIONING THE OVERCLOUD NETWORKS

To configure the network resources for your Red Hat OpenStack Platform (RHOSP) physical network environment, you must perform the following tasks:

1. Configure and provision the network resources for your overcloud.

2. Configure and provision the network Virtual IPs for your overcloud.

11.1.1. Configuring and provisioning overcloud network definitions

You configure the physical network for your overcloud in a network definition file in YAML format. The provisioning process creates a heat environment file from your network definition file that contains your network specifications. When you deploy your overcloud, include this heat environment file in the deployment command.

Prerequisites
The undercloud is installed. For more information, see Installing director.

Procedure

1. Source the `stackrc` undercloud credential file:

   ```bash
   $ source ~/stackrc
   ```

2. Copy the sample network definition template you require from `/usr/share/openstack-tripleo-heat-templates/network-data-samples` to your environment file directory:

   ```bash
   (undercloud)$ cp /usr/share/openstack-tripleo-heat-templates/network-data-samples/default-network-isolation.yaml /home/stack/templates/network_data.yaml
   ```

3. Optional: Configure your network definition file for your network environment. For example, you can update the external network definition:

   ```yaml
   - name: External
     name_lower: external
     vip: true
     mtu: 1500
     subnets:
       external_subnet:
         ip_subnet: 10.0.0.0/24
         allocation_pools:
         - start: 10.0.0.4
         - end: 10.0.0.250
         gateway_ip: 10.0.0.1
         vlan: 10
   ```

4. Configure any other networks and network attributes for your environment. For more information about the properties you can use to configure network attributes in your network definition file, see Configuring overcloud networking.

5. Provision the overcloud networks:

   ```bash
   (undercloud)$ openstack overcloud network provision \
   --output  <deployment_file> \
   /home/stack/templates/<networks_definition_file>.yaml
   ```

   - Replace `<networks_definition_file>` with the name of your networks definition file, for example, `network_data.yaml`.

   - Replace `<deployment_file>` with the name of the heat environment file to generate for inclusion in the deployment command, for example `/home/stack/templates/overcloud-networks-deployed.yaml`.

6. When the network provisioning is complete, you can use the following commands to check the created networks and subnets:

   ```bash
   (undercloud)$ openstack network list
   (undercloud)$ openstack subnet list
   (undercloud)$ openstack network show <network>
   (undercloud)$ openstack subnet show <subnet>
   ```
Replace `<network>` with the name or UUID of the network you want to check.

Replace `<subnet>` with the name or UUID of the subnet you want to check.

**Next steps**

- Configuring and provisioning network VIPs for the overcloud

### 11.1.2. Configuring and provisioning network VIPs for the overcloud

You configure the network Virtual IPs (VIPS) for your overcloud in a network VIP definition file in YAML format. The provisioning process creates a heat environment file from your VIP definition file that contains your VIP specifications. When you deploy your overcloud, include this heat environment file in the deployment command.

**Prerequisites**

- The undercloud is installed. For more information, see Installing director.

**Procedure**

1. Source the `stackrc` undercloud credential file:

   ```bash
   $ source ~/stackrc
   ```

2. Copy the sample network VIP definition template you require from `/usr/share/openstack-tripleo-heat-templates/network-data-samples` to your environment file directory:

   ```bash
   ```

3. Optional: Configure your VIP definition file for your environment. For example, the following defines the external network and control plane VIPs:

   ```yaml
   - network: external
dns_name: overcloud
   - network: ctlplane
dns_name: overcloud
   ```

4. Configure any other network VIP attributes for your environment. For more information about the properties you can use to configure VIP attributes in your VIP definition file, see Adding a composable network.

5. Provision the network VIPs:

   ```bash
   (undercloud)$ openstack overcloud network vip provision
   --stack <stack>
   --output <deployment_file>
   /home/stack/templates/vip_data.yaml
   ```

   - Replace `<stack>` with the name of stack for which the network VIPs are provisioned. If not specified, the default is `overcloud`.
Replace `<deployment_file>` with the name of the heat environment file to generate for inclusion in the deployment command, for example `/home/stack/templates/overcloud-vip-deployed.yaml`.

6. When the network VIP provisioning is complete, you can use the following commands to check the created VIPs:

   (undercloud)$ openstack port list
   (undercloud)$ openstack port show `<port>`

   Replace `<port>` with the name or UUID of the port you want to check.

Next steps

- Provisioning bare metal overcloud nodes

### 11.2. PROVISIONING BARE METAL OVERCLOUD NODES

To configure a Red Hat OpenStack Platform (RHOSP) environment, you must perform the following tasks:

1. Register the bare-metal nodes for your overcloud.
2. Provide director with an inventory of the hardware of the bare-metal nodes.
3. Configure the quantity, attributes, and network layout of the bare-metal nodes in a node definition file.
4. Assign each bare metal node a resource class that matches the node to its designated role.

You can also perform additional optional tasks, such as matching profiles to designate overcloud nodes.

#### 11.2.1. Registering nodes for the overcloud

Director requires a node definition template that specifies the hardware and power management details of your nodes. You can create this template in JSON format, `nodes.json`, or YAML format, `nodes.yaml`.

**Procedure**

1. Create a template named `nodes.json` or `nodes.yaml` that lists your nodes. Use the following JSON and YAML template examples to understand how to structure your node definition template:

   **Example JSON template**

   ```json
   {
   "nodes": [
   "ports": [
   "address": "aa:aa:aa:aa:aa:aa",
   "physical_network": "ctlplane",
   "local_link_connection": {
   "switch_id": "52:54:00:00:00:00",
   "port_id": "p0"
   }]
   }]
   ```
Example YAML template

```
- name: "node01",
  cpu: 4,
  memory: "6144",
  disk: "40",
  arch: "x86_64",
  pm_type: "ipmi",
  pm_user: "admin",
  pm_password: "p@55w0rd!",
  pm_addr: "192.168.24.205"
}

- ports: [{
    physical_network: "ctlplane",
    local_link_connection:
      switch_id: "52:54:00:00:00:00",
      port_id: "p0"
  }]

- name: "node02",
  cpu: 4,
  memory: "6144",
  disk: "40",
  arch: "x86_64",
  pm_type: "ipmi",
  pm_user: "admin",
  pm_password: "p@55w0rd!",
  pm_addr: "192.168.24.206"
```
This template contains the following attributes:

name
The logical name for the node.

pm_type
The power management driver that you want to use. This example uses the IPMI driver (ipmi).

NOTE
IPMI is the preferred supported power management driver. For more information about supported power management types and their options, see Chapter 30, Power management drivers. If these power management drivers do not work as expected, use IPMI for your power management.

pm_user; pm_password
The IPMI username and password.

pm_addr
The IP address of the IPMI device.

pm_port (Optional)
The port to access the specific IPMI device.

address
(Optional) A list of MAC addresses for the network interfaces on the node. Use only the MAC address for the Provisioning NIC of each system.

physical_network
(Optional) The physical network that is connected to the Provisioning NIC.

local_link_connection
(Optional) If you use IPv6 provisioning and LLDP does not correctly populate the local link connection during introspection, you must include fake data with the switch_id and port_id fields in the local_link_connection parameter. For more information on how to include fake data, see Using director introspection to collect bare metal node hardware information.

cpu
(Optional) The number of CPUs on the node.

memory
(Optional) The amount of memory in MB.

disk
(Optional) The size of the hard disk in GB.
arch

(Optional) The system architecture.

**IMPORTANT**

When building a multi-architecture cloud, the `arch` key is mandatory to distinguish nodes using `x86_64` and `ppc64le` architectures.

2. After you create the template, run the following commands to verify the formatting and syntax:

```
$ source ~/stackrc
(undercloud)$ openstack overcloud node import --validate-only ~/nodes.json
```

**IMPORTANT**

You must also include the `--http-boot /var/lib/ironic/tftpboot/` option for multi-architecture nodes.

3. Save the file to the home directory of the `stack` user (`/home/stack/nodes.json`), then run the following commands to import the template to director:

```
(undercloud)$ openstack overcloud node import ~/nodes.json
```

This command registers each node from the template into director.

4. Wait for the node registration and configuration to complete. When complete, confirm that director has successfully registered the nodes:

```
(undercloud)$ openstack baremetal node list
```

### 11.2.2. Creating an inventory of the bare-metal node hardware

Director needs the hardware inventory of the nodes in your Red Hat OpenStack Platform (RHOSP) deployment for profile tagging, benchmarking, and manual root disk assignment.

You can provide the hardware inventory to director by using one of the following methods:

- **Automatic**: You can use director’s introspection process, which collects the hardware information from each node. This process boots an introspection agent on each node. The introspection agent collects hardware data from the node and sends the data back to director. Director stores the hardware data in the OpenStack internal database.

- **Manual**: You can manually configure a basic hardware inventory for each bare metal machine. This inventory is stored in the Bare Metal Provisioning service (ironic) and is used to manage and deploy the bare-metal machines.

**NOTE**

You must use director’s automatic introspection process if you use `derive_params.yaml` for your overcloud, which requires introspection data to be present. For more information on `derive_params.yaml`, see Workflows and derived parameters.
The director automatic introspection process provides the following advantages over the manual method for setting the Bare Metal Provisioning service ports:

- Introspection records all of the connected ports in the hardware information, including the port to use for PXE boot if it is not already configured in nodes.yaml.
- Introspection sets the local_link_connection attribute for each port if the attribute is discoverable using LLDP. When you use the manual method, you must configure local_link_connection for each port when you register the nodes.
- Introspection sets the physical_network attribute for the Bare Metal Provisioning service ports when deploying a spine-and-leaf or DCN architecture.

11.2.2.1. Using director introspection to collect bare metal node hardware information

After you register a physical machine as a bare metal node, you can automatically add its hardware details and create ports for each of its Ethernet MAC addresses by using director introspection.

**TIP**

As an alternative to automatic introspection, you can manually provide director with the hardware information for your bare metal nodes. For more information, see Manually configuring bare metal node hardware information.

**Prerequisites**

- You have registered the bare-metal nodes for your overcloud.

**Procedure**

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

   (undercloud) [stack@undercloud-0 ~]$ source ~/stackrc

3. Run the pre-introspection validation group to check the introspection requirements:

   (undercloud) [stack@undercloud-0 ~]$ openstack tripleo validator run --group pre-introspection

4. Review the results of the validation report.
5. Optional: Review detailed output from a specific validation:

   (undercloud) [stack@undercloud-0 ~]$ openstack tripleo validator show run --full <validation>

Replace `<validation>` with the UUID of the specific validation from the report that you want to review.
6. Inspect the hardware attributes of each node. You can inspect the hardware attributes of all nodes, or specific nodes:

   - Inspect the hardware attributes of all nodes:
     
     (undercloud) [stack@undercloud-0 ~]$ openstack overcloud node introspect --all-manageable --provide
     
     - Use the --all-manageable option to introspect only the nodes that are in a managed state. In this example, all nodes are in a managed state.
     
     - Use the --provide option to reset all nodes to an available state after introspection.

   - Inspect the hardware attributes of specific nodes:
     
     (undercloud) [stack@undercloud-0 ~]$ openstack overcloud node introspect --provide <node1> [node2] [noden]
     
     - Use the --provide option to reset all the specified nodes to an available state after introspection.
     
     - Replace <node1>, [node2], and all nodes up to [noden] with the UUID of each node that you want to introspect.

7. Monitor the introspection progress logs in a separate terminal window:

   (undercloud) [stack@undercloud-0 ~]$ sudo tail -f /var/log/containers/ironic-inspector/ironic-inspector.log

IMPORTANT

Ensure that the introspection process runs to completion. Introspection usually takes 15 minutes for bare metal nodes. However, incorrectly sized introspection networks can cause it to take much longer, which can result in the introspection failing.

8. Optional: If you have configured your undercloud for bare metal provisioning over IPv6, then you need to also check that LLDP has set the local_link_connection for Bare Metal Provisioning service (ironic) ports:

   $ openstack baremetal port list --long -c UUID -c "Node UUID" -c "Local Link Connection"

   - If the Local Link Connection field is empty for the port on your bare metal node, you must populate the local_link_connection value manually with fake data. The following example sets the fake switch ID to 52:54:00:00:00:00, and the fake port ID to p0:
$ openstack baremetal port set <port_uuid> \
   --local-link-connection switch_id=52:54:00:00:00:00 \
   --local-link-connection port_id=p0

- Verify that the Local Link Connection field contains the fake data:

$ openstack baremetal port list --long -c UUID -c "Node UUID" -c "Local Link Connection"

After the introspection completes, all nodes change to an available state.

11.2.2.2. Manually configuring bare-metal node hardware information

After you register a physical machine as a bare metal node, you can manually add its hardware details and create bare-metal ports for each of its Ethernet MAC addresses. You must create at least one bare-metal port before deploying the overcloud.

TIP

As an alternative to manual introspection, you can use the automatic director introspection process to collect the hardware information for your bare metal nodes. For more information, see Using director introspection to collect bare metal node hardware information.

Prerequisites

- You have registered the bare-metal nodes for your overcloud.
- You have configured local_link_connection for each port on the registered nodes in nodes.json. For more information, see Registering nodes for the overcloud.

Procedure

1. Log in to the undercloud host as the stack user.

2. Source the overcloud credentials file:

   (undercloud)$ source ~/overcloudrc

3. Set the boot option to local for each registered node by adding boot_option:local to the capabilities of the node:

   $ openstack baremetal node set --property capabilities="boot_option:local" <node>

   Replace <node> with the ID of the bare metal node.

4. Specify the deploy kernel and deploy ramdisk for the node driver:

   $ openstack baremetal node set <node> \
      --driver-info deploy_kernel=<kernel_file> \
      --driver-info deploy_ramdisk=<initramfs_file>

   - Replace <node> with the ID of the bare metal node.
5. Update the node properties to match the hardware specifications on the node:

```
$ openstack baremetal node set <node> \
   --property cpus=<cpu> \
   --property memory_mb=<ram> \
   --property local_gb=<disk> \
   --property cpu_arch=<arch>
```

- Replace `<node>` with the ID of the bare metal node.
- Replace `<cpu>` with the number of CPUs.
- Replace `<ram>` with the RAM in MB.
- Replace `<disk>` with the disk size in GB.
- Replace `<arch>` with the architecture type.

6. Optional: Specify the IPMI cipher suite for each node:

```
$ openstack baremetal node set <node> \
   --driver-info ipmi_cipher_suite=<version>
```

- Replace `<node>` with the ID of the bare metal node.
- Replace `<version>` with the cipher suite version to use on the node. Set to one of the following valid values:
  - 3 - The node uses the AES-128 with SHA1 cipher suite.
  - 17 - The node uses the AES-128 with SHA256 cipher suite.

7. Optional: If you have multiple disks, set the root device hints to inform the deploy ramdisk which disk to use for deployment:

```
$ openstack baremetal node set <node> \
   --property root_device='"<property>": "<value>"'
```

- Replace `<node>` with the ID of the bare metal node.
- Replace `<property>` and `<value>` with details about the disk that you want to use for deployment, for example `root_device='{"size": "128"}'`

RHOSP supports the following properties:

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

**NOTE**

If you specify more than one property, the device must match all of those properties.

8. Inform the Bare Metal Provisioning service of the node network card by creating a port with the MAC address of the NIC on the provisioning network:

```bash
$ openstack baremetal port create --node <node_uuid> <mac_address>
```

- Replace `<node>` with the unique ID of the bare metal node.
- Replace `<mac_address>` with the MAC address of the NIC used to PXE boot.

9. Validate the configuration of the node:

```bash
$ openstack baremetal node validate <node>
```

<table>
<thead>
<tr>
<th>Interface</th>
<th>Result</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>boot</td>
<td>False</td>
<td>Cannot validate image information for node</td>
</tr>
<tr>
<td></td>
<td></td>
<td>a02178db-1550-4244-a2b7-d7035c743a9b</td>
</tr>
<tr>
<td></td>
<td></td>
<td>because one or more parameters are missing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>from its instance_info. Missing are:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>['ramdisk', 'kernel', 'image_source']</td>
</tr>
<tr>
<td>console</td>
<td>None</td>
<td>not supported</td>
</tr>
<tr>
<td>deploy</td>
<td>False</td>
<td>Cannot validate image information for node</td>
</tr>
<tr>
<td></td>
<td></td>
<td>a02178db-1550-4244-a2b7-d7035c743a9b</td>
</tr>
<tr>
<td></td>
<td></td>
<td>because one or more parameters are missing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>from its instance_info. Missing are:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>['ramdisk', 'kernel', 'image_source']</td>
</tr>
<tr>
<td>inspect</td>
<td>None</td>
<td>not supported</td>
</tr>
<tr>
<td>management</td>
<td>True</td>
<td></td>
</tr>
<tr>
<td>network</td>
<td>True</td>
<td></td>
</tr>
<tr>
<td>power</td>
<td>True</td>
<td></td>
</tr>
<tr>
<td>raid</td>
<td>True</td>
<td></td>
</tr>
<tr>
<td>storage</td>
<td>True</td>
<td></td>
</tr>
</tbody>
</table>

The validation output Result indicates the following:
False: The interface has failed validation. If the reason provided includes missing the `instance_info` parameters ["ramdisk", "kernel", and "image_source"], this might be because the Compute service populates those missing parameters at the beginning of the deployment process, therefore they have not been set at this point. If you are using a whole disk image, then you might need to only set `image_source` to pass the validation.

True: The interface has passed validation.

None: The interface is not supported for your driver.

11.2.3. Provisioning bare metal nodes for the overcloud

To provision your bare metal nodes, you define the quantity and attributes of the bare metal nodes that you want to deploy in a node definition file in YAML format, and assign overcloud roles to these nodes. You also define the network layout of the nodes.

The provisioning process creates a heat environment file from your node definition file. This heat environment file contains the node specifications you configured in your node definition file, including node count, predictive node placement, custom images, and custom NICs. When you deploy your overcloud, include this file in the deployment command. The provisioning process also provisions the port resources for all networks defined for each node or role in the node definition file.

Prerequisites

- The undercloud is installed. For more information, see Installing director.
- The bare metal nodes are registered, introspected, and available for provisioning and deployment. For more information, see Registering nodes for the overcloud and Creating an inventory of the bare metal node hardware.

Procedure

1. Source the `stackrc` undercloud credential file:

   ```bash
   $ source ~/stackrc
   ```

2. Create the `overcloud-baremetal-deploy.yaml` node definition file and define the node count for each role that you want to provision. For example, to provision three Controller nodes and three Compute nodes, add the following configuration to your `overcloud-baremetal-deploy.yaml` file:

   ```yaml
   - name: Controller
     count: 3
   - name: Compute
     count: 3
   ```

3. Optional: Configure predictive node placements. For example, use the following configuration to provision three Controller nodes on nodes `node00`, `node01`, and `node02`, and three Compute nodes on `node04`, `node05`, and `node06`:

   ```yaml
   - name: Controller
     count: 3
     instances:
     - hostname: overcloud-controller-0
   name: node00
   ```
- hostname: overcloud-controller-1
  name: node01
- hostname: overcloud-controller-2
  name: node02
- name: Compute
count: 3
instances:
- hostname: overcloud-novacompute-0
  name: node04
- hostname: overcloud-novacompute-1
  name: node05
- hostname: overcloud-novacompute-2
  name: node06

4. Optional: By default, the provisioning process uses the *overcloud-hardened-uefi-full* image. You can change the image used on specific nodes, or the image used for all nodes for a role:

**Specific nodes**

- name: Controller
count: 3
instances:
- hostname: overcloud-controller-0
  name: node00
  image:
    href: overcloud-custom
- hostname: overcloud-controller-1
  name: node01
  image:
    href: overcloud-full-custom
- hostname: overcloud-controller-2
  name: node02
  image:
    href: overcloud-full-custom

**All nodes for a role**

- name: Controller
count: 3
defaults:
  image:
    href: overcloud-custom
instances:
- hostname: overcloud-controller-0
  name: node00
- hostname: overcloud-controller-1
  name: node01
- hostname: overcloud-controller-2
  name: node02

5. Define the network layout for each role, or for each node. For example, use the following configuration to provision the networks for the Controller and Compute roles:

- name: Controller
count: 3
6. If you use the Object Storage service (swift) and the whole disk overcloud image, **overcloud-hardened-uefi-full**, you need to configure the size of the `/srv` partition based on the size of your disk and your storage requirements for `/var` and `/srv`. For more information, see Configuring whole disk partitions for the Object Storage service.

7. Define any other attributes that you want to assign to your nodes. For more information about the properties you can use to configure node attributes in your node definition file, see Bare metal node provisioning attributes.

8. Provision the overcloud nodes:

```
(undercloud)$ openstack overcloud node provision \
   --stack <stack> \
   --network-config \
   --output <deployment_file> \ 
   /home/stack/templates/overcloud_baremetal_deployment.yaml
```

- Replace `<stack>` with the name of stack for which the bare-metal nodes are provisioned. If not specified, the default is **overcloud**.

- Include the `--network-config` optional argument to provide the network definitions to the **cli-overcloud-network-provision.yaml** Ansible playbook. You must include this option to run any Ansible playbooks included in your node definition file.
• Replace `<deployment_file>` with the name of the heat environment file to generate for inclusion in the deployment command, for example `/home/stack/templates/overcloud-baremetal-deployed.yaml`.

9. Monitor the provisioning progress in a separate terminal. When provisioning is successful, the node state changes from available to active:

   (undercloud)$ watch openstack baremetal node list

10. Use the `metalsmith` tool to obtain a unified view of your nodes, including allocations and ports:

   (undercloud)$ metalsmith list

11. Verify the association of nodes to hostnames:

   (undercloud)$ openstack baremetal allocation list

Next steps

• Configuring and deploying the overcloud

11.2.4. Bare metal node provisioning attributes

Use the following tables to understand the available properties for configuring node attributes, and the values that are available for you to use when you provision bare-metal nodes with the `openstack baremetal node provision` command.

• Role properties: Use the role properties to define each role.

• Default and instance properties for each role: Use the default or instance properties to specify the selection criteria for allocating nodes from the pool of available nodes, and to set attributes and network configuration properties on the bare-metal nodes.

For example bare-metal node definition files, see `/usr/share/openstack-tripleo-heat-templates/baremetal-samples` on your undercloud.

Table 11.1. Role properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>name</td>
<td>(Mandatory) Role name.</td>
</tr>
<tr>
<td>count</td>
<td>The number of nodes that you want to provision for this role. The default value is 1.</td>
</tr>
<tr>
<td>defaults</td>
<td>A dictionary of default values for instances entry properties. An instances entry property overrides any defaults that you specify in the defaults parameter.</td>
</tr>
</tbody>
</table>
**instances**
A dictionary of values that you can use to specify attributes for specific nodes. For more information about supported properties in the `instances` parameter, see **defaults** and **instances** properties. The number of nodes defined must not be greater than the value of the `count` parameter.

**hostname_format**
Overrides the default hostname format for this role. The default generated hostname is derived from the overcloud stack name, the role, and an incrementing index, all in lower case. For example, the default format for the Controller role is `%stackname%-controller-%index%`. Only the Compute role does not follow the role name rule. The Compute default format is `%stackname%-novacompute-%index%`.

**ansible_playbooks**
A dictionary of values for Ansible playbooks and Ansible variables. The playbooks are run against the role instances after node provisioning, prior to the node network configuration. For more information about specifying Ansible playbooks, see **ansible_playbooks** properties.

---

**Table 11.2. defaults and instances properties**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>hostname</strong></td>
<td>(instances only) Specifies the hostname of the node that the instance properties apply to. The hostname is derived from the <strong>hostname_format</strong> property. You can use custom hostnames.</td>
</tr>
<tr>
<td><strong>name</strong></td>
<td>(instances only) The name of the node that you want to provision.</td>
</tr>
<tr>
<td><strong>image</strong></td>
<td>Details of the image that you want to provision onto the node. For information about supported <strong>image</strong> properties, see <strong>image</strong> properties.</td>
</tr>
<tr>
<td><strong>capabilities</strong></td>
<td>Selection criteria to match the node capabilities.</td>
</tr>
<tr>
<td><strong>config_drive</strong></td>
<td>Add data and first-boot commands to the config-drive passed to the node. For more information, see <strong>config_drive</strong> properties.</td>
</tr>
<tr>
<td><strong>managed</strong></td>
<td>Set to <strong>true</strong> (default) to provision the instance with metalsmith. Set to <strong>false</strong> to handle the instance as pre-provisioned.</td>
</tr>
<tr>
<td><strong>networks</strong></td>
<td>List of dictionaries that represent instance networks. For more information about configuring network attributes, see <strong>network</strong> properties.</td>
</tr>
<tr>
<td><strong>network_config</strong></td>
<td>Link to the network configuration file for the role or instance. For more information about configuring the link to the network configuration file, see <strong>network_config</strong> properties.</td>
</tr>
<tr>
<td><strong>profile</strong></td>
<td>Selection criteria to for profile matching. For more information, see <strong>Designating overcloud nodes for roles by matching profiles</strong></td>
</tr>
</tbody>
</table>
**provisioned**
Set to **true** (default) to provision the node. Set to **false** to unprovision a node. For more information, see Scaling down bare metal nodes.

**resource_class**
Selection criteria to match the resource class of the node. The default value is **baremetal**. For more information, see Designating overcloud nodes for roles by matching resource classes.

**root_size_gb**
Size of the root partition in GiB. The default value is **49**.

**swap_size_mb**
Size of the swap partition in MiB.

**traits**
A list of traits as selection criteria to match the node traits.

---

**Table 11.3. image properties**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>href</strong></td>
<td>Specifies the image reference, or URL of the root partition or whole disk image that you want to provision onto the node. Supported URL schemes: <strong>file://</strong>, <strong>http://</strong>, and <strong>https://</strong>. If the value is not a valid URL, it must be a valid image reference.</td>
</tr>
<tr>
<td><strong>checksum</strong></td>
<td>Specifies the MD5 checksum of the root partition or whole disk image. Required when the <strong>href</strong> is a URL.</td>
</tr>
<tr>
<td><strong>kernel</strong></td>
<td>Specifies the image reference or URL of the kernel image. Use this property only for partition images.</td>
</tr>
<tr>
<td><strong>ramdisk</strong></td>
<td>Specifies the image reference or URL of the ramdisk image. Use this property only for partition images.</td>
</tr>
</tbody>
</table>

---

**Table 11.4. network properties**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>fixed_ip</strong></td>
<td>The specific IP address that you want to use for this network.</td>
</tr>
<tr>
<td><strong>network</strong></td>
<td>The network where you want to create the network port.</td>
</tr>
<tr>
<td><strong>subnet</strong></td>
<td>The subnet where you want to create the network port.</td>
</tr>
<tr>
<td><strong>port</strong></td>
<td>Existing port to use instead of creating a new port.</td>
</tr>
</tbody>
</table>
**Table 11.5. network_config properties**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>vif</td>
<td>Set to <strong>true</strong> on the provisioning network (<strong>ctlplane</strong>) to attach the network as a virtual interface (VIF). Set to <strong>false</strong> to create the Networking service API resource without a VIF attachment.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>template</td>
<td>Specifies the Ansible J2 NIC configuration template to use when applying node network configuration. For information on configuring the NIC template, see Configuring overcloud networking.</td>
</tr>
<tr>
<td>physical_bridge_name</td>
<td>The name of the OVS bridge to create for accessing external networks. The default bridge name is <strong>br-ex</strong>.</td>
</tr>
<tr>
<td>public_interface_name</td>
<td>Specifies the name of the interface to add to the public bridge. The default interface is <strong>nic1</strong>.</td>
</tr>
<tr>
<td>network_config_update</td>
<td>Set to <strong>true</strong> to apply network configuration changes on update. Disabled by default.</td>
</tr>
<tr>
<td>net_config_data_lookup</td>
<td>Specifies the NIC mapping configuration, <strong>os-net-config</strong>, for each node or node group.</td>
</tr>
<tr>
<td>default_route_network</td>
<td>The network to use for the default route. The default route network is <strong>ctlplane</strong></td>
</tr>
<tr>
<td>networks_skip_config</td>
<td>List of networks to skip when configuring the node networking.</td>
</tr>
<tr>
<td>dns_search_domains</td>
<td>A list of DNS search domains to be added to <strong>resolv.conf</strong>, in order.</td>
</tr>
<tr>
<td>bond_interface_options</td>
<td>The OVS options or bonding options to use for the bond interface, for example, <strong>lacp=active</strong> and <strong>bond_mode=balance-slb</strong> for OVS bonds, and <strong>mode=4</strong> for Linux bonds.</td>
</tr>
</tbody>
</table>

**Table 11.6. config_drive properties**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>cloud_config</td>
<td>Dictionary of <strong>cloud-init</strong> cloud configuration data for tasks to run on node boot.</td>
</tr>
<tr>
<td>meta_data</td>
<td>Extra metadata to include with the config-drive <strong>cloud-init</strong> metadata. The metadata is added to the generated metadata set on the role name: <strong>public_keys</strong>, <strong>uuid</strong>, <strong>name</strong>, <strong>hostname</strong>, and <strong>instance-type</strong>. <strong>Cloud-init</strong> makes this metadata available as instance data.</td>
</tr>
</tbody>
</table>
Table 11.7. `ansible_playbooks` properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>playbook</td>
<td>The path to the Ansible playbook, relative to the roles definition YAML file.</td>
</tr>
<tr>
<td>extra_vars</td>
<td>Extra Ansible variables to set when running the playbook. Use the following syntax to specify extra variables:</td>
</tr>
<tr>
<td></td>
<td>ansible_playbooks:</td>
</tr>
</tbody>
</table>
|                |     - playbook: a_playbook.yaml  
|                |     extra_vars:  
|                |     param1: value1  
|                |     param2: value2  

For example, to grow the LVM volumes of any node deployed with the whole disk overcloud image `overcloud-hardened-uefi-full.qcow2`, add the following extra variable to your playbook property:

```yaml
ansible_playbooks:
    - playbook: /usr/share/ansible/tripleo-playbooks/cli-overcloud-node-growvols.yaml
      extra_vars:  
      growvols_args: >  
      /=8GB  
      /tmp=1GB  
      /var/log=10GB  
      /var/log/audit=2GB  
      /home=1GB  
      /var=100%
```

11.2.5. Designating overcloud nodes for roles by matching resource classes

You can designate overcloud nodes for specific roles by using custom resource classes. Resource classes match your nodes to deployment roles. By default all nodes are assigned the resource class of `baremetal`.

**Procedure**

1. Assign each bare metal node that you want to designate for a role with a custom resource class:

   ```bash
   (undercloud)$ openstack baremetal node set \
   --resource-class baremetal.<ROLE> <node>
   ```

   - Replace `<ROLE>` with a name that identifies the role.
   - Replace `<node>` with the ID of the bare metal node.

2. Add the role to your `overcloud-baremetal-deploy.yaml` file, if not already defined.

3. Define the resource class that you want to assign to the nodes for the role:
- name: <role>
  count: 1
  defaults:
    resource_class: baremetal.<ROLE>

- Replace <role> with the name of the role.
- Replace <ROLE> with a name that identifies the role.

4. Provision the overcloud nodes:

   (undercloud)$ openstack overcloud node provision \\
   --stack <stack> \\
   --output <deployment_file> \\
   /home/stack/templates/overcloud-baremetal-deploy.yaml

   - Replace <stack> with the name of stack for which the bare-metal nodes are provisioned. If not specified, the default is overcloud.
   - Replace <deployment_file> with the name of the heat environment file to generate for inclusion in the deployment command, for example /home/stack/templates/overcloud-baremetal-deployed.yaml.

5. Monitor the provisioning progress in a separate terminal. When provisioning is successful, the node state changes from available to active:

   (undercloud)$ watch openstack baremetal node list

11.2.6. Designating overcloud nodes for roles by matching profiles

You can designate overcloud nodes for specific roles by using the profile capability. Profiles match node capabilities to deployment roles.

TIP

You can also perform automatic profile assignment by using introspection rules. For more information, see Configuring automatic profile tagging.

Procedure

1. Check the existing capabilities of each registered node:

   $ openstack baremetal node show <node> \\
   -f json -c properties | jq -r .properties.capabilities

2. Assign the profile capability to each bare metal node that you want to match to a role profile, by adding profile:<profile> to the existing capabilities of the node:

   (undercloud)$ openstack baremetal node set <node> \\
   --property capabilities="profile:<profile>,<capability_1>,...,<capability_n>"

   - Replace <node> with the ID of the bare metal node.
   - Replace <profile> with the name of the profile that matches the role profile.
- Replace \texttt{<capability_1>}, and all capabilities up to \texttt{<capability_n>}, with each capability that you retrieved in step 1.

3. Add the role to your \texttt{overcloud-baremetal-deploy.yaml} file, if not already defined.

4. Define the profile that you want to assign to the nodes for the role:

```
- name: \texttt{<role>}
  count: 1
  defaults:
    profile: \texttt{<profile>}
```

- Replace \texttt{<role>} with the name of the role.
- Replace \texttt{<profile>} with the name of the profile that matches the node capability.

5. Provision the overcloud nodes:

```
(undercloud)$ openstack overcloud node provision \ 
--stack \texttt{<stack>} \ 
--output \texttt{<deployment_file>} \ 
/home/stack/templates/overcloud-baremetal-deploy.yaml
```

- Replace \texttt{<stack>} with the name of stack for which the bare-metal nodes are provisioned. If not specified, defaults to \texttt{overcloud}.
- Replace \texttt{<deployment_file>} with the name of the heat environment file to generate for inclusion in the deployment command, for example \texttt{/home/stack/templates/overcloud-baremetal-deployed.yaml}.

6. In a separate terminal, monitor your nodes to verify that they provision successfully. The provisioning process changes the node state from \texttt{available} to \texttt{active}:

```
(undercloud)$ watch openstack baremetal node list
```

### 11.2.7. Configuring whole disk partitions for the Object Storage service

The whole disk image, \texttt{overcloud-hardened-uefi-full}, is partitioned into separate volumes. By default, the \texttt{/var} partition of nodes deployed with the whole disk overcloud image is automatically increased until the disk is fully allocated. If you use the Object Storage service (swift), configure the size of the \texttt{/srv} partition based on the size of your disk and your storage requirements for \texttt{/var} and \texttt{/srv}.

**Prerequisites**

- You are performing the initial provisioning of your bare metal nodes for the overcloud.

**Procedure**

1. Configure the \texttt{/srv} and \texttt{/var} partitions by using \texttt{role_growvols_args} as an extra Ansible variable in the Ansible\_playbooks definition in your \texttt{overcloud-baremetal-deploy.yaml} node definition file. Set either \texttt{/srv} or \texttt{/var} to an absolute size in GB, and set the other to 100\% to consume the remaining disk space.
The following example configuration sets `/srv` to an absolute size for the Object Storage service deployed on the Controller node, and `/var` to 100% to consume the remaining disk space:

```yaml
ansible_playbooks:
  - playbook: /usr/share/ansible/tripleo-playbooks/cli-overcloud-node-growvols.yaml
extra_vars:
  role_growvols_args:
    default:
      /=8GB
      /tmp=1GB
      /var/log=10GB
      /var/log/audit=2GB
      /home=1GB
      /var=100%

Controller:
  /=8GB
  /tmp=1GB
  /var/log=10GB
  /var/log/audit=2GB
  /home=1GB
  /var=100%
  /srv=50GB
  /var=100%
```

The following example configuration sets `/var` to an absolute size, and `/srv` to 100% to consume the remaining disk space of the Object Storage node for the Object Storage service:

```yaml
ansible_playbooks:
  - playbook: /usr/share/ansible/tripleo-playbooks/cli-overcloud-node-growvols.yaml
extra_vars:
  role_growvols_args:
    default:
      /=8GB
      /tmp=1GB
      /var/log=10GB
      /var/log/audit=2GB
      /home=1GB
      /var=100%

ObjectStorage:
  /=8GB
  /tmp=1GB
  /var/log=10GB
  /var/log/audit=2GB
  /home=1GB
  /var=10GB
  /srv=100%
```

2. Return to Provisioning bare metal nodes for the overcloud to complete the provisioning process.

11.2.8. Enabling virtual media boot
IMPORTANT

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

You can use Redfish virtual media boot to supply a boot image to the Baseboard Management Controller (BMC) of a node so that the BMC can insert the image into one of the virtual drives. The node can then boot from the virtual drive into the operating system that exists in the image.

Redfish hardware types support booting deploy, rescue, and user images over virtual media. The Bare Metal service (ironic) uses kernel and ramdisk images associated with a node to build bootable ISO images for UEFI or BIOS boot modes at the moment of node deployment. The major advantage of virtual media boot is that you can eliminate the TFTP image transfer phase of PXE and use HTTP GET, or other methods, instead.

To boot a node with the `redfish` hardware type over virtual media, set the boot interface to `redfish-virtual-media` and, for UEFI nodes, define the EFI System Partition (ESP) image. Then configure an enrolled node to use Redfish virtual media boot.

**Prerequisites**

- Redfish driver enabled in the `enabled_hardware_types` parameter in the `undercloud.conf` file.
- A bare metal node registered and enrolled.
- IPA and instance images in the Image Service (glance).
- For UEFI nodes, you must also have an EFI system partition image (ESP) available in the Image Service (glance).
- A bare metal flavor.
- A network for cleaning and provisioning.
- Sushy library installed:
  
  ```sh
  $ sudo yum install sushy
  ```

**Procedure**

1. Set the Bare Metal service (ironic) boot interface to `redfish-virtual-media`:

   ```sh
   $ openstack baremetal node set --boot-interface redfish-virtual-media $NODE_NAME
   
   Replace `$NODE_NAME` with the name of the node.
   
2. For UEFI nodes, set the boot mode to `uefi`:

   ```sh
   NODE=<NODE NAME OR ID> ; openstack baremetal node set --property capabilities="boot_mode:uefi,$(openstack baremetal node show $NODE -f json -c properties | jq -r .properties.capabilities | sed "s/\"boot\:"/\"boot\":\"/g")" $NODE
   
   Replace `$NODE` with the name of the node.
3. For UEFI nodes, define the EFI System Partition (ESP) image:

```bash
$ openstack baremetal node set --driver-info bootloader=$ESP $NODE_NAME
```

Replace `$ESP` with the glance image UUID or URL for the ESP image, and replace `$NODE_NAME` with the name of the node.

NOTE
For BIOS nodes, do not complete this step.

4. Create a port on the bare metal node and associate the port with the MAC address of the NIC on the bare metal node:

```bash
$ openstack baremetal port create --pxe-enabled True --node $UUID $MAC_ADDRESS
```

Replace `$UUID` with the UUID of the bare metal node, and replace `$MAC_ADDRESS` with the MAC address of the NIC on the bare metal node.

11.2.9. Defining the root disk for multi-disk clusters

Most Ceph Storage nodes use multiple disks. When nodes use multiple disks, director must identify the root disk. By default, director writes the overcloud image to the root disk during the provisioning process.

Use this procedure to identify the root device by serial number. For more information about other properties you can use to identify the root disk, see Section 11.2.10, “Properties that identify the root disk”.

Procedure

1. Verify the disk information from the hardware introspection of each node. The following command to displays the disk information of a node:

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

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

```json
[
  {
    "size": 299439751168,
    "rotational": true,
    "vendor": "DELL",
    "name": "/dev/sda",
    "wwn_vendor_extension": "0x1ea4dcc412a9632b",
    "wwn_with_extension": "0x61866da04f3807001ea4dcc412a9632b",
    "model": "PERC H330 Mini",
    "wwn": "0x61866da04f380700",
```
2. On the undercloud, set the root disk for a node. Include the most appropriate hardware attribute value to define the root disk.

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

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

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

**NOTE**
Configure the BIOS of each node to boot from the root disk that you choose.
Configure the boot order to boot from the network first, then from the root disk.

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

### 11.2.10. Properties that identify the root disk

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

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

**IMPORTANT**

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

### 11.2.11. Using the overcloud-minimal image to avoid using a Red Hat subscription entitlement

The default image for a Red Hat OpenStack Platform (RHOSP) deployment is **overcloud-hardened-uefi-full**. The **overcloud-hardened-uefi-full** image uses a valid Red Hat OpenStack Platform (RHOSP) subscription. You can use the **overcloud-minimal** image when you do not want to consume your subscription entitlements, to avoid reaching the limit of your paid Red Hat subscriptions. This is useful, for example, when you want to provision nodes with only Ceph daemons, or when you want to provision a bare operating system (OS) where you do not want to run any other OpenStack services. For information about how to obtain the **overcloud-minimal** image, see [Obtaining images for overcloud nodes](#).

**NOTE**

The **overcloud-minimal** image supports only standard Linux bridges. The **overcloud-minimal** image does not support Open vSwitch (OVS) because OVS is an OpenStack service that requires a Red Hat OpenStack Platform subscription entitlement. OVS is not required to deploy Ceph Storage nodes. Use **linux_bond** instead of **ovs_bond** to define bonds. For more information about **linux_bond**, see [Linux bonding options](#).

**Procedure**

1. Open your **overcloud-baremetal-deploy.yaml** file.
2. Add or update the **image** property for the nodes that you want to use the **overcloud-minimal** image. You can set the image to **overcloud-minimal** on specific nodes, or for all nodes for a role:

   **Specific nodes**

   - name: Ceph
     count: 3
     instances:
     - hostname: overcloud-ceph-0
3. In the roles_data.yaml role definition file, set the rhsm_enforce parameter to False.

    rhsm_enforce: False

4. Run the provisioning command:

    (undercloud)$ openstack overcloud node provision \
    --stack stack \
    --output /home/stack/templates/overcloud-baremetal-deployed.yaml \
    /home/stack/templates/overcloud-baremetal-deploy.yaml

5. Pass the overcloud-baremetal-deployed.yaml environment file to the openstack overcloud deploy command.

11.3. CONFIGURING AND DEPLOYING THE OVERCLOUD

After you have provisioned the network resources and bare-metal nodes for your overcloud, you can configure your overcloud by using the unedited heat template files provided with your director installation, and any custom environment files you create. When you have completed the configuration of your overcloud, you can deploy the overcloud environment.

IMPORTANT

A basic overcloud uses local LVM storage for block storage, which is not a supported configuration. Red Hat recommends that you use an external storage solution, such as Red Hat Ceph Storage, for block storage.
11.3.1. Prerequisites

- You have provisioned the network resources and bare-metal nodes required for your overcloud.

11.3.2. Configuring your overcloud by using environment files

The undercloud includes a set of heat templates that form the plan for your overcloud creation. You can customize aspects of the overcloud with environment files, which are YAML-formatted files that override parameters and resources in the core heat template collection. You can include as many environment files as necessary. The environment file extension must be .yaml or .template.

Red Hat recommends that you organize your custom environment files in a separate directory, such as the templates directory.

You include environment files in your overcloud deployment by using the -e option. Any environment files that you add to the overcloud using the -e option become part of the stack definition of the overcloud. The order of the environment files is important because the parameters and resources that you define in subsequent environment files take precedence.

To modify the overcloud configuration after initial deployment, perform the following actions:

1. Modify parameters in the custom environment files and heat templates.
2. Run the openstack overcloud deploy command again with the same environment files.

Do not edit the overcloud configuration directly because director overrides any manual configuration when you update the overcloud stack.

**NOTE**

Open Virtual Networking (OVN) is the default networking mechanism driver in Red Hat OpenStack Platform 17.0-Beta. If you want to use OVN with distributed virtual routing (DVR), you must include the environments/services/neutron-ovn-dvr-ha.yaml file in the openstack overcloud deploy command. If you want to use OVN without DVR, you must include the environments/services/neutron-ovn-ha.yaml file in the openstack overcloud deploy command.

11.3.3. Creating an environment file for undercloud CA trust

If your undercloud uses TLS and the Certificate Authority (CA) is not publicly trusted, you can use the CA for SSL endpoint encryption that the undercloud operates. To ensure that the undercloud endpoints are accessible to the rest of your deployment, configure your overcloud nodes to trust the undercloud CA.

**NOTE**

For this approach to work, your overcloud nodes must have a network route to the public endpoint on the undercloud. It is likely that you must apply this configuration for deployments that rely on spine-leaf networking.

There are two types of custom certificates you can use in the undercloud:

- **User-provided certificates** - This definition applies when you have provided your own certificate. This can be from your own CA, or it can be self-signed. This is passed using the undercloud_service_certificate option. In this case, you must either trust the self-signed
certificate, or the CA (depending on your deployment).

- **Auto-generated certificates** - This definition applies when you use `certmonger` to generate the certificate using its own local CA. Enable auto-generated certificates with the `generate_service_certificate` option in the `undercloud.conf` file. In this case, director generates a CA certificate at `/etc/pki/ca-trust/source/anchors/cm-local-ca.pem` and the director configures the undercloud’s HAPROXY instance to use a server certificate. Add the CA certificate to the `infect-trust-anchor-hiera.yaml` file to present the certificate to OpenStack Platform.

This example uses a self-signed certificate located in `/home/stack/ca.crt.pem`. If you use auto-generated certificates, use `/etc/pki/ca-trust/source/anchors/cm-local-ca.pem` instead.

### Procedure

1. Open the certificate file and copy only the certificate portion. Do not include the key:

   ```
   $ vi /home/stack/ca.crt.pem
   
   The certificate portion you need looks similar to this shortened example:
   
   -----BEGIN CERTIFICATE-----
   MIIDlTCCAn2gAwIBAgIJAOnPtx2hHEhrMA0GCSqGSIb3DQEBCwUAMGExCzAJBgNV
   BAYTAiVTMQswCQYDVQQDAJoQzEQMA4GA1UEBwwHUmFsZWi6aDEQMA4GA1UECg
   UmVkIeDhDMELMKGA1UECwCUUxFDASBgNVBAMMCzE5Mi4xNjguMC4yMB4XDTEx
   -----END CERTIFICATE-----
   ```

2. Create a new YAML file called `/home/stack/inject-trust-anchor-hiera.yaml` with the following contents, and include the certificate you copied from the PEM file:

   ```yaml
   parameter_defaults:
     CAMap:
       undercloud-ca:
         content: |
           -----BEGIN CERTIFICATE-----
           MIIDlTCCAn2gAwIBAgIJAOnPtx2hHEhrMA0GCSqGSIb3DQEBCwUAMGExCzAJBgNV
           BAYTAiVTMQswCQYDVQQDAJoQzEQMA4GA1UEBwwHUmFsZWi6aDEQMA4GA1UECg
           UmVkIeDhDMELMKGA1UECwCUUxFDASBgNVBAMMCzE5Mi4xNjguMC4yMB4XDTEx
           -----END CERTIFICATE-----
   
   NOTE
   - The certificate string must follow the PEM format.
   - The CAMap parameter might contain other certificates relevant to SSL/TLS configuration.

3. Add the `/home/stack/inject-trust-anchor-hiera.yaml` file to your deployment command. Director copies the CA certificate to each overcloud node during the overcloud deployment. As a result, each node trusts the encryption presented by the undercloud’s SSL endpoints.
11.3.4. Disabling TSX on new deployments

From Red Hat Enterprise Linux 8.3 onwards, the kernel disables support for the Intel Transactional Synchronization Extensions (TSX) feature by default.

You must explicitly disable TSX for new overclouds unless you strictly require it for your workloads or third party vendors.

Set the **KernelArgs** heat parameter in an environment file.

```yaml
parameter_defaults:
  ComputeParameters:
    KernelArgs: "tsx=off"
```

Include the environment file when you run your `openstack overcloud deploy` command.

Additional resources

- "Guidance on Intel TSX impact on OpenStack guests (applies for RHEL 8.3 and above)"

11.3.5. Validating your overcloud configuration

Before deploying your overcloud, validate your heat templates and environment files.

**Prerequisites**

- You have an overcloud plan defined in a plan environment file. For information about creating an overcloud plan, see xxx.

**Procedure**

1. Source the **stackrc** file:

   ```bash
   $ source ~/stackrc
   ```

2. Update your overcloud plan with all the environment files your deployment requires:

   ```bash
   $ openstack overcloud deploy --templates \ 
   -e environment-file1.yaml \ 
   -e environment-file2.yaml \ 
   ... \ 
   --update-plan-only
   ```

3. Validate your overcloud plan:

   ```bash
   $ openstack tripleo validator run \ 
   --group pre-deployment \ 
   [--plan <custom_overcloud_plan> ]
   ```

   Use the **--plan** option if your overcloud name is different from the default **overcloud**. Replace `<custom_overcloud_plan>` with the name of your overcloud plan.

4. Review the results of the validation report:
$ openstack tripleo validator show run [--full] <UUID>

- Replace <UUID> with the UUID of the validation run.
- Optional: Use the --full option to view detailed output from the validation run.

**IMPORTANT**

A **FAILED** validation does not prevent you from deploying or running Red Hat OpenStack Platform. However, a **FAILED** validation can indicate a potential issue with a production environment.

### 11.3.6. Creating your overcloud

The final stage in creating your Red Hat OpenStack Platform (RHOSP) overcloud environment is to run the `openstack overcloud deploy` command to create the overcloud. For information about the options available to use with the `openstack overcloud deploy` command, see [Deployment command options](#).

**Procedure**

1. Collate the environment files and configuration files that you need for your overcloud environment, both the unedited heat template files provided with your director installation, and the custom environment files you created. This should include the following files:

   - `overcloud-baremetal-deployed.yaml` node definition file.
   - `overcloud-vip-deployed.yaml` network VIP definition file.
   - The location of the container images for containerized OpenStack services.
   - Any environment files for Red Hat CDN or Satellite registration.
   - Any other custom environment files.

2. Organize the environment files and configuration files by their order of precedence, listing unedited heat template files first, followed by your environment files that contain custom configuration, such as overrides to the default properties.

3. Construct your `openstack overcloud deploy` command, specifying the configuration files and templates in the required order, for example:

   ```
   (undercloud) $ openstack overcloud deploy --templates \ 
   [-n /home/stack/templates/network_data.yaml \ ] 
   -e /home/stack/templates/overcloud-baremetal-deployed.yaml\ 
   -e /home/stack/templates/overcloud-networks-deployed.yaml\ 
   -e /home/stack/templates/overcloud-vip-deployed.yaml \ 
   -e /home/stack/containers-prepare-parameter.yaml \ 
   -e /home/stack/inject-trust-anchor-hiera.yaml \ 
   [-r /home/stack/templates/roles_data.yaml ]
   
   -n /home/stack/templates/network_data.yaml
   The custom network configuration, if you use custom networks.
   
   -e /home/stack/containers-prepare-parameter.yaml
   ```
Adds the container image preparation environment file. You generated this file during the undercloud installation and can use the same file for your overcloud creation.

\[-e /home/stack/inject-trust-anchor-hiera.yaml\]

- Adds an environment file to install a custom certificate in the undercloud.

\[-r /home/stack/templates/roles_data.yaml\]

- The generated roles data, if you use custom roles or want to enable a multi-architecture cloud.

4. When the overcloud creation completes, director provides a recap of the Ansible plays that were executed to configure the overcloud:

```
PLAY RECAP *******************************************************
overcloud-compute-0     : ok=160  changed=67   unreachable=0    failed=0
overcloud-controller-0  : ok=210  changed=93   unreachable=0    failed=0
undercloud              : ok=10   changed=7    unreachable=0    failed=0
Tuesday 15 October 2018 18:30:57 +1000 (0:00:00.107) 1:06:37.514 *****
========================================================================
```

5. When the overcloud creation completes, director provides details to access your overcloud:

- Ansible passed.
- Overcloud configuration completed.
- Overcloud Endpoint: http://192.168.24.113:5000
- Overcloud Horizon Dashboard URL: http://192.168.24.113:80/dashboard
- Overcloud rc file: /home/stack/overcloudrc
- Overcloud Deployed

**TIP**

You can keep your deployment command in a file that you add to every time you update your configuration with a new env file.

### 11.3.7. Deployment command options

The following table lists the additional parameters for the `openstack overcloud deploy` command.

**IMPORTANT**

Some options are available in this release as a Technology Preview and therefore are not fully supported by Red Hat. They should only be used for testing and should not be used in a production environment. For more information about Technology Preview features, see Scope of Coverage Details.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
</table>

---

192
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>--templates [TEMPLATES]</strong></td>
<td>The directory that contains the heat templates that you want to deploy. If blank, the deployment command uses the default template location at <code>/usr/share/openstack-tripleo-heat-templates/</code></td>
</tr>
<tr>
<td><strong>--stack STACK</strong></td>
<td>The name of the stack that you want to create or update</td>
</tr>
<tr>
<td><strong>-t [TIMEOUT], --timeout [TIMEOUT]</strong></td>
<td>The deployment timeout duration in minutes</td>
</tr>
<tr>
<td><strong>--libvirt-type [LIBVIRT_TYPE]</strong></td>
<td>The virtualization type that you want to use for hypervisors</td>
</tr>
<tr>
<td><strong>--ntp-server [NTP_SERVER]</strong></td>
<td>The Network Time Protocol (NTP) server that you want to use to synchronize time. You can also specify multiple NTP servers in a comma-separated list, for example: <code>--ntp-server 0.centos.pool.org,1.centos.pool.org</code>. For a high availability cluster deployment, it is essential that your Controller nodes are consistently referring to the same time source. Note that a typical environment might already have a designated NTP time source with established practices.</td>
</tr>
<tr>
<td><strong>--no-proxy [NO_PROXY]</strong></td>
<td>Defines custom values for the environment variable <code>no_proxy</code>, which excludes certain host names from proxy communication.</td>
</tr>
<tr>
<td><strong>--overcloud-ssh-user OVERCLOUD_SSH_USER</strong></td>
<td>Defines the SSH user to access the overcloud nodes. Normally SSH access occurs through the <code>heat-admin</code> user.</td>
</tr>
<tr>
<td><strong>--overcloud-ssh-key OVERCLOUD_SSH_KEY</strong></td>
<td>Defines the key path for SSH access to overcloud nodes.</td>
</tr>
<tr>
<td><strong>--overcloud-ssh-network OVERCLOUD_SSH_NETWORK</strong></td>
<td>Defines the network name that you want to use for SSH access to overcloud nodes.</td>
</tr>
<tr>
<td><strong>-e [EXTRA HEAT TEMPLATE], --environment-file [ENVIRONMENT FILE]</strong></td>
<td>Extra environment files that you want to pass to the overcloud deployment. You can specify this option more than once. Note that the order of environment files that you pass to the <code>openstack overcloud deploy</code> command is important. For example, parameters from each sequential environment file override the same parameters from earlier environment files.</td>
</tr>
<tr>
<td>Parameter</td>
<td>Description</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>--environment-directory</td>
<td>A directory that contains environment files that you want to include in deployment. The deployment command processes these environment files in numerical order, then alphabetical order.</td>
</tr>
<tr>
<td>-r ROLES_FILE</td>
<td>Defines the roles file and overrides the default roles_data.yaml in the --templates directory. The file location can be an absolute path or the path relative to --templates.</td>
</tr>
<tr>
<td>-n NETWORKS_FILE</td>
<td>Defines the networks file and overrides the default network_data.yaml in the --templates directory. The file location can be an absolute path or the path relative to --templates.</td>
</tr>
<tr>
<td>-p PLAN_ENVIRONMENT_FILE</td>
<td>Defines the plan Environment file and overrides the default plan-environment.yaml in the --templates directory. The file location can be an absolute path or the path relative to --templates.</td>
</tr>
<tr>
<td>--no-cleanup</td>
<td>Use this option if you do not want to delete temporary files after deployment, and log their location.</td>
</tr>
<tr>
<td>--update-plan-only</td>
<td>Use this option if you want to update the plan without performing the actual deployment.</td>
</tr>
<tr>
<td>--validation-errors-nonfatal</td>
<td>The overcloud creation process performs a set of pre-deployment checks. This option exits if any non-fatal errors occur from the pre-deployment checks. It is advisable to use this option as any errors can cause your deployment to fail.</td>
</tr>
<tr>
<td>--validation-warnings-fatal</td>
<td>The overcloud creation process performs a set of pre-deployment checks. This option exits if any non-critical warnings occur from the pre-deployment checks. openstack-tripleo-validations</td>
</tr>
<tr>
<td>--dry-run</td>
<td>Use this option if you want to perform a validation check on the overcloud without creating the overcloud.</td>
</tr>
<tr>
<td>--run-validations</td>
<td>Use this option to run external validations from the openstack-tripleo-validations package.</td>
</tr>
<tr>
<td>--skip-postconfig</td>
<td>Use this option to skip the overcloud post-deployment configuration.</td>
</tr>
<tr>
<td>Parameter</td>
<td>Description</td>
</tr>
<tr>
<td>-----------</td>
<td>-------------</td>
</tr>
<tr>
<td>--force-postconfig</td>
<td>Use this option to force the overcloud post-deployment configuration.</td>
</tr>
<tr>
<td>--skip-deploy-identifier</td>
<td>Use this option if you do not want the deployment command to generate a unique identifier for the DeployIdentifier parameter. The software configuration deployment steps only trigger if there is an actual change to the configuration. Use this option with caution and only if you are confident that you do not need to run the software configuration, such as scaling out certain roles.</td>
</tr>
<tr>
<td>--answers-file ANSWERS_FILE</td>
<td>The path to a YAML file with arguments and parameters.</td>
</tr>
<tr>
<td>--disable-password-generation</td>
<td>Use this option if you want to disable password generation for the overcloud services.</td>
</tr>
<tr>
<td>--deployed-server</td>
<td>Use this option if you want to deploy pre-provisioned overcloud nodes. Used in conjunction with --disable-validations.</td>
</tr>
<tr>
<td>--no-config-download, --stack-only</td>
<td>Use this option if you want to disable the config-download workflow and create only the stack and associated OpenStack resources. This command applies no software configuration to the overcloud.</td>
</tr>
<tr>
<td>--config-download-only</td>
<td>Use this option if you want to disable the overcloud stack creation and only run the config-download workflow to apply the software configuration.</td>
</tr>
<tr>
<td>--output-dir OUTPUT_DIR</td>
<td>The directory that you want to use for saved config-download output. The directory must be writeable by the mistral user. When not specified, director uses the default, which is /var/lib/mistral/overcloud.</td>
</tr>
<tr>
<td>--override-ansible-cfg OVERRIDE_ANSIBLE_CFG</td>
<td>The path to an Ansible configuration file. The configuration in the file overrides any configuration that config-download generates by default.</td>
</tr>
<tr>
<td>--config-download-timeout CONFIG_DOWNLOAD_TIMEOUT</td>
<td>The timeout duration in minutes that you want to use for config-download steps. If unset, director sets the default to the amount of time remaining from the --timeout parameter after the stack deployment operation.</td>
</tr>
</tbody>
</table>
(Technology Preview) Use this option with a comma-separated list of nodes to limit the config-download playbook execution to a specific node or set of nodes. For example, the `--limit` option can be useful for scale-up operations, when you want to run config-download only on new nodes. This argument might cause live migration of instances between hosts to fail, see Running config-download with the ansible-playbook-command.sh script

(Technology Preview) Use this option with a comma-separated list of tags from the config-download playbook to run the deployment with a specific set of config-download tasks.

(Technology Preview) Use this option with a comma-separated list of tags that you want to skip from the config-download playbook.

Run the following command to view a full list of options:

```
(undercloud) $ openstack help overcloud deploy
```

Some command line parameters are outdated or deprecated in favor of using heat template parameters, which you include in the `parameter_defaults` section in an environment file. The following table maps deprecated parameters to their heat template equivalents.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Heat template parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>--control-scale</code></td>
<td>The number of Controller nodes to scale out</td>
<td><code>ControllerCount</code></td>
</tr>
<tr>
<td><code>--compute-scale</code></td>
<td>The number of Compute nodes to scale out</td>
<td><code>ComputeCount</code></td>
</tr>
<tr>
<td><code>--ceph-storage-scale</code></td>
<td>The number of Ceph Storage nodes to scale out</td>
<td><code>CephStorageCount</code></td>
</tr>
<tr>
<td><code>--block-storage-scale</code></td>
<td>The number of Block Storage (cinder) nodes to scale out</td>
<td><code>BlockStorageCount</code></td>
</tr>
<tr>
<td><code>--swift-storage-scale</code></td>
<td>The number of Object Storage (swift) nodes to scale out</td>
<td><code>ObjectStorageCount</code></td>
</tr>
<tr>
<td><code>--control-flavor</code></td>
<td>The flavor that you want to use for Controller nodes</td>
<td><code>OvercloudControllerFlavor</code></td>
</tr>
<tr>
<td>Parameter</td>
<td>Description</td>
<td>Heat template parameter</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td><code>--compute-flavor</code></td>
<td>The flavor that you want to use for Compute nodes</td>
<td><code>OvercloudComputeFlavor</code></td>
</tr>
<tr>
<td><code>--ceph-storage-flavor</code></td>
<td>The flavor that you want to use for Ceph Storage nodes</td>
<td><code>OvercloudCephStorageFlavor</code></td>
</tr>
<tr>
<td><code>--block-storage-flavor</code></td>
<td>The flavor that you want to use for Block Storage (cinder) nodes</td>
<td><code>OvercloudBlockStorageFlavor</code></td>
</tr>
<tr>
<td><code>--swift-storage-flavor</code></td>
<td>The flavor that you want to use for Object Storage (swift) nodes</td>
<td><code>OvercloudSwiftStorageFlavor</code></td>
</tr>
<tr>
<td><code>--validation-errors-fatal</code></td>
<td>The overcloud creation process performs a set of pre-deployment checks.</td>
<td>No parameter mapping</td>
</tr>
<tr>
<td></td>
<td>This option exits if any fatal errors occur from the pre-deployment checks.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>It is advisable to use this option because any errors can cause your</td>
<td></td>
</tr>
<tr>
<td></td>
<td>deployment to fail.</td>
<td></td>
</tr>
<tr>
<td><code>--disable-validations</code></td>
<td>Disable the pre-deployment validations entirely. These validations were</td>
<td>No parameter mapping</td>
</tr>
<tr>
<td></td>
<td>built-in pre-deployment validations, which have been replaced with</td>
<td></td>
</tr>
<tr>
<td></td>
<td>external validations from the <code>openstack-tripleo-validations</code> package.</td>
<td></td>
</tr>
<tr>
<td><code>--config-download</code></td>
<td>Run deployment using the <code>config-download</code> mechanism. This is now the</td>
<td>No parameter mapping</td>
</tr>
<tr>
<td></td>
<td>default and this CLI options may be removed in the future.</td>
<td></td>
</tr>
<tr>
<td><code>--rhel-reg</code></td>
<td>Use this option to register overcloud nodes to the Customer Portal or</td>
<td><code>RhsmVars</code></td>
</tr>
<tr>
<td></td>
<td>Satellite 6.</td>
<td></td>
</tr>
<tr>
<td><code>--reg-method</code></td>
<td>Use this option to define the registration method that you want to use for</td>
<td><code>RhsmVars</code></td>
</tr>
<tr>
<td></td>
<td>the overcloud nodes.</td>
<td></td>
</tr>
<tr>
<td></td>
<td><code>satellite</code> for Red Hat Satellite 6 or Red Hat Satellite 5, <code>portal</code> for</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Customer Portal.</td>
<td></td>
</tr>
<tr>
<td><code>--reg-org [REG_ORG]</code></td>
<td>The organization that you want to use for registration.</td>
<td><code>RhsmVars</code></td>
</tr>
<tr>
<td>Parameter</td>
<td>Description</td>
<td>Heat template parameter</td>
</tr>
<tr>
<td>----------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>--reg-force</td>
<td>Use this option to register the system even if it is already registered.</td>
<td>RhsmVars</td>
</tr>
<tr>
<td>--reg-sat-url [REG_SAT_URL]</td>
<td>The base URL of the Satellite server to register overcloud nodes. Use the Satellite HTTP URL and not the HTTPS URL for this parameter. For example, use <a href="http://satellite.example.com">http://satellite.example.com</a> and not <a href="https://satellite.example.com">https://satellite.example.com</a>. The overcloud creation process uses this URL to determine whether the server is a Red Hat Satellite 5 or Red Hat Satellite 6 server. If the server is a Red Hat Satellite 6 server, the overcloud obtains the <code>katello-ca-consumer-latest.noarch.rpm</code> file, registers with <code>subscription-manager</code>, and installs <code>katello-agent</code>. If the server is a Red Hat Satellite 5 server, the overcloud obtains the <code>RHN-ORG-TRUSTED-SSL-CERT</code> file and registers with <code>rhnreg_ks</code>.</td>
<td>RhsmVars</td>
</tr>
<tr>
<td>--reg-activation-key [REG_ACTIVATION_KEY]</td>
<td>Use this option to define the activation key that you want to use for registration.</td>
<td>RhsmVars</td>
</tr>
</tbody>
</table>

These parameters are scheduled for removal in a future version of Red Hat OpenStack Platform.

### 11.3.8. Validating your overcloud deployment

Validate your deployed overcloud.

**Prerequisites**

- You have deployed your overcloud.

**Procedure**

1. Source the `stackrc` file:
   ```bash
   $ source ~/stackrc
   ```
2. Validate your overcloud deployment:
$ openstack tripleo validator run \
--group post-deployment \
[--plan <custom_overcloud_plan> ]

Use the --plan option if your overcloud name is different from the default overcloud. Replace <custom_overcloud_plan> with the name of your overcloud plan.

3. Review the results of the validation report:

$ openstack tripleo validator show run [--full] <UUID>

- Replace <UUID> with the UUID of the validation run.
- Optional: Use the --full option to view detailed output from the validation run.

**IMPORTANT**

A FAILED validation does not prevent you from deploying or running Red Hat OpenStack Platform. However, a FAILED validation can indicate a potential issue with a production environment.

**Addtional resources**

- Using the validation framework

**11.3.9. Accessing the overcloud**

Director generates a credential file containing the credentials necessary to operate the overcloud from the undercloud. Director saves this file, overcloudrc, in the home directory of the stack user.

**Procedure**

1. Source the overcloudrc file:

   (undercloud)$ source ~/overcloudrc

   The command prompt changes to indicate that you are accessing the overcloud:

   (overcloud)$

2. To return to interacting with the undercloud, source the stackrc file:

   (overcloud)$ source ~/stackrc
   (undercloud)$

   The command prompt changes to indicate that you are accessing the undercloud:

   (undercloud)$

**11.4. DEPLOYING MULTIPLE OVERCLOUDS**
You can use a single undercloud node to deploy and manage multiple overclouds. Each overcloud is a unique heat stack that does not share stack resources. This can be useful for environments where a 1:1 ratio of underclouds to overclouds creates an unmanageable amount of overhead. For example, Edge, multi-site, and multi-product environments.

The overcloud environments in the multi-overcloud scenario are completely separate, and you can use the `source` command to switch between the environments. If you use Ironic for bare metal provisioning, all overclouds must be on the same provisioning network. If it is not possible to use the same provisioning network, you can use the deployed servers method to deploy multiple overclouds with routed networks. In this scenario, you must ensure that the value in the `HostnameMap` parameter matches the stack name for each overcloud.

### Additional resources

- Director installation and configuration
- Planning your overcloud
- Provisioning and deploying your overcloud

### 11.4.1. Deploying additional overclouds

In this example, `overcloud-one` is the existing overcloud. Complete the following steps to deploy a new overcloud `overcloud-two`.

#### Prerequisites

Before you begin to deploy additional overclouds, ensure that your environment contains the following configurations:

- Successful undercloud and overcloud deployments.
- Nodes available for your additional overcloud.
- Custom networks for additional overclouds so that each overcloud has a unique network in the resulting stack.

#### Procedure

1. Create a new directory for the additional overcloud that you want to deploy:

   ```bash
   $ mkdir ~/overcloud-two
   ```

2. In the new directory, create new environment files specific to the requirements of the additional overcloud, and copy any relevant environment files from the existing overcloud:

   ```bash
   $ cp network-data.yaml ~/overcloud-two/network-data.yaml
   $ cp network-environment.yaml ~/overcloud-two/network-environment.yaml
   ```
3. Modify the environment files according to the specification of the new overcloud. For example, the existing overcloud has the name `overcloud-one` and uses the VLANs that you define in the `network-data.yaml` environment file:

```yaml
- name: InternalApi
  name_lower: internal_api_cloud_1
  service_net_map_replace: internal_api
  vip: true
  vlan: 20
  ip_subnet: '172.17.0.0/24'
  allocation_pools: [{'start': '172.17.0.4', 'end': '172.17.0.250'}]
  ipv6_subnet: 'fd00:fd00:fd00:2000::/64'
  ipv6_allocation_pools: [{'start': 'fd00:fd00:fd00:2000::10', 'end': 'fd00:fd00:fd00:2000::ffff:ffff:ffff:fffe'}]
  mtu: 1500
- name: Storage
  ...
```

The new overcloud has the name `overcloud-two` and uses different VLANs. Edit the `~/overcloud-two/network-data.yaml` environment file and include the new VLAN IDs for each subnet. You must also define a unique `name_lower` value, and set the `service_net_map_replace` attribute to the name of the network that you want to replace:

```yaml
- name: InternalApi
  name_lower: internal_api_cloud_2
  service_net_map_replace: internal_api
  vip: true
  vlan: 21
  ip_subnet: '172.21.0.0/24'
  allocation_pools: [{'start': '172.21.0.4', 'end': '172.21.0.250'}]
  ipv6_subnet: 'fd00:fd00:fd00:2001::/64'
  ipv6_allocation_pools: [{'start': 'fd00:fd00:fd00:2001::10', 'end': 'fd00:fd00:fd00:2001::ffff:ffff:ffff:fffe'}]
  mtu: 1500
- name: Storage
  ...
```

4. Modify the following parameters in the `~/overcloud-two/network-environment.yaml` file:

- Enter a unique value in the `{provider:physical_network}` attribute of the `ExternalNetValueSpecs` parameter so that `overcloud-two` has a distinct external network, and define the network type with the `{provider:network_type}` attribute.

- Set the `ExternalInterfaceDefaultRoute` parameter to the IP address of the gateway for the external network so that the overcloud has external access.

- Set the `DnsServers` parameter to the IP address of your DNS server so that the overcloud can reach the DNS server.

```yaml
parameter_defaults:
  ...
  ExternalNetValueSpecs: {provider:physical_network: 'external_2',
  provider:network_type: 'flat'}
  ExternalInterfaceDefaultRoute: 10.0.10.1
```

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### DnsServers:
- 10.0.10.2
...

5. Run the `openstack overcloud deploy` command. Specify the core heat template collection with the `--templates` option, a new stack name with the `--stack` option, and any new environment files from the `~/overcloud-two` directory:

```bash
$ openstack overcloud deploy --templates
--stack overcloud-two 
... 
-n ~/overcloud-two/network-data.yaml 
-e ~/overcloud-two/network-environment.yaml 
-e /usr/share/openstack-tripleo-heat-templates/environments/network-isolation.yaml 
-e /usr/share/openstack-tripleo-heat-templates/environments/net-single-nic-with-vlans.yaml 
... 
```

Each overcloud has a unique credential file. In this example, the deployment process creates `overcloud-onerc` for `overcloud-one`, and `overcloud-twowrc` for `overcloud-two`. To interact with either overcloud, you must source the appropriate credential file. For example, to source the credential for the first overcloud, run the following command:

```
$ source overcloud-onerc
```

### 11.4.2. Managing multiple overclouds

Each overcloud that you deploy uses the same set of core heat templates `/usr/share/openstack-tripleo-heat-templates`. Red Hat recommends that you do not modify or duplicate these templates, because using a non-standard set of core templates can introduce issues with updates and upgrades.

Instead, for ease of management when you deploy or maintain multiple overclouds, create separate directories of environment files specific to each cloud. When you run the deploy command for each cloud, include the core heat templates together with the cloud-specific environment files that you create separately. For example, create the following directories for the undercloud and two overclouds:

~~stack/undercloud~~

Contains the environment files specific to the undercloud.

~~stack/overcloud-one~~

Contains the environment files specific to the first overcloud.

~~stack/overcloud-two~~

Contains the environment files specific to the second overcloud.

When you deploy or redeploy `overcloud-one` or `overcloud-two`, include the core heat templates in the deploy command with the `--templates` option, and then specify any additional environment files from the cloud-specific environment file directories.

Alternatively, create a repository in a version control system and use branches for each deployment. For more information, see the Using Customized Core Heat Templates section of the Advanced Overcloud Customization guide.

Use the following command to view a list of overcloud plans that are available:
$ openstack overcloud plan list

Use the following command to view a list of overclouds that are currently deployed:

$ openstack stack list

11.5. CONFIGURING A BASIC OVERCLOUD WITH PRE-PROVISIONED NODES

This chapter contains basic configuration procedures that you can use to configure a Red Hat OpenStack Platform (RHOSP) environment with pre-provisioned nodes. This scenario differs from the standard overcloud creation scenarios in several ways:

- You can provision nodes with an external tool and let the director control the overcloud configuration only.
- You can use nodes without relying on the director provisioning methods. This is useful if you want to create an overcloud without power management control, or use networks with DHCP/PXE boot restrictions.
- The director does not use OpenStack Compute (nova), OpenStack Bare Metal (ironic), or OpenStack Image (glance) to manage nodes.
- Pre-provisioned nodes can use a custom partitioning layout that does not rely on the QCOW2 overcloud-full image.

This scenario includes only basic configuration with no custom features. However, you can add advanced configuration options to this basic overcloud and customize it to your specifications with the instructions in the Advanced Overcloud Customization guide.

IMPORTANT

You cannot combine pre-provisioned nodes with director-provisioned nodes.

11.5.1. Pre-provisioned node requirements

Before you begin deploying an overcloud with pre-provisioned nodes, ensure that the following configuration is present in your environment:

- The director node that you created in Chapter 7, Installing director on the undercloud.
- A set of bare metal machines for your nodes. The number of nodes required depends on the type of overcloud you intend to create. These machines must comply with the requirements set for each node type. These nodes require Red Hat Enterprise Linux 9.0 installed as the host operating system. Red Hat recommends using the latest version available.
- One network connection for managing the pre-provisioned nodes. This scenario requires uninterrupted SSH access to the nodes for orchestration agent configuration.
- One network connection for the Control Plane network. There are two main scenarios for this network:
Using the Provisioning Network as the Control Plane, which is the default scenario. This network is usually a layer-3 (L3) routable network connection from the pre-provisioned nodes to director. The examples for this scenario use following IP address assignments:

### Table 11.10. Provisioning Network IP assignments

<table>
<thead>
<tr>
<th>Node name</th>
<th>IP address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Director</td>
<td>192.168.24.1</td>
</tr>
<tr>
<td>Controller 0</td>
<td>192.168.24.2</td>
</tr>
<tr>
<td>Compute 0</td>
<td>192.168.24.3</td>
</tr>
</tbody>
</table>

Using a separate network. In situations where the director’s Provisioning network is a private non-routable network, you can define IP addresses for nodes from any subnet and communicate with director over the Public API endpoint. For more information about the requirements for this scenario, see Section 11.5.6, “Using a separate network for pre-provisioned nodes”.

- All other network types in this example also use the Control Plane network for OpenStack services. However, you can create additional networks for other network traffic types.

- If any nodes use Pacemaker resources, the service user `hacluster` and the service group `haclient` must have a UID/GID of 189. This is due to [CVE-2018-16877](https://www.cvedetails.com/cve/CVE-2018-16877/). If you installed Pacemaker together with the operating system, the installation creates these IDs automatically. If the ID values are set incorrectly, follow the steps in the article [OpenStack minor update / fast-forward upgrade can fail on the controller nodes at pacemaker step with “Could not evaluate: backup_cib”](https://openstack.org/bugs/show_bug.cgi?id=156860) to change the ID values.

- To prevent some services from binding to an incorrect IP address and causing deployment failures, make sure that the `/etc/hosts` file does not include the `node-name=127.0.0.1` mapping.

### 11.5.2. Creating a user on pre-provisioned nodes

When you configure an overcloud with pre-provisioned nodes, director requires SSH access to the overcloud nodes. On the pre-provisioned nodes, you must create a user with SSH key authentication and configure passwordless sudo access for that user. After you create a user on pre-provisioned nodes, you can use the `--overcloud-ssh-user` and `--overcloud-ssh-key` options with the `openstack overcloud deploy` command to create an overcloud with pre-provisioned nodes.

By default, the values for the overcloud SSH user and overcloud SSH key are the `stack` user and `~/.ssh/id_rsa`. To create the `stack` user, complete the following steps.

**Procedure**

1. On each overcloud node, create the `stack` user and set a password. For example, run the following commands on the Controller node:

   ```
   [root@controller-0 ~]# useradd stack
   [root@controller-0 ~]# passwd stack  # specify a password
   ```

2. Disable password requirements for this user when using `sudo`:

   ```
   ```
3. After you create and configure the stack user on all pre-provisioned nodes, copy the stack user’s public SSH key from the director node to each overcloud node. For example, to copy the director’s public SSH key to the Controller node, run the following command:

```
(stack@director ~)$ ssh-copy-id stack@192.168.24.2
```

**IMPORTANT**

To copy your SSH keys, you might have to temporarily set `PasswordAuthentication Yes` in the SSH configuration of each overcloud node. After you copy the SSH keys, set `PasswordAuthentication No` and use the SSH keys to authenticate in the future.

### 11.5.3. Registering the operating system for pre-provisioned nodes

Each node requires access to a Red Hat subscription. Complete the following steps on each node to register your nodes with the Red Hat Content Delivery Network.

**IMPORTANT**

Enable only the repositories listed. Additional repositories can cause package and software conflicts. Do not enable any additional repositories.

**Procedure**

1. Run the registration command and enter your Customer Portal user name and password when prompted:

```
[root@controller-0 ~]# sudo subscription-manager register
```

2. Find the entitlement pool for Red Hat OpenStack Platform 17.0-beta:

```
[root@controller-0 ~]# sudo subscription-manager list --available --all --matches="Red Hat OpenStack"
```

3. Use the pool ID located in the previous step to attach the Red Hat OpenStack Platform 16 entitlements:

```
[root@controller-0 ~]# sudo subscription-manager attach --pool=pool_id
```

4. Disable all default repositories:

```
[root@controller-0 ~]# sudo subscription-manager repos --disable=*/
```

5. Enable the required Red Hat Enterprise Linux repositories.

   a. For x86_64 systems, run the following command:

```
[root@controller-0 ~]# sudo subscription-manager repos --enable=rhel-8-for-x86_64-
```
b. For POWER systems, run the following command:

```
[root@controller-0 ~]# sudo subscription-manager repos --enable=rhel-8-for-ppc64le-baseos-rpms --enable=rhel-8-for-ppc64le-appstream-rpms --enable=rhel-8-for-ppc64le-highavailability-rpms --enable=ansible-2.8-for-rhel-8-ppc64le-rpms --enable=openstack-16-for-rhel-8-ppc64le-rpms --enable=fast-datapath-for-rhel-8-ppc64le-rpms
```

6. Set the `container-tools` repository module to version **3.0**:

```
[root@controller-0 ~]# sudo dnf module disable -y container-tools:rhel8
[root@controller-0 ~]# sudo dnf module enable -y container-tools:3.0
```

7. If the overcloud uses Ceph Storage nodes, enable the relevant Ceph Storage repositories:

```
[root@cephstorage-0 ~]# sudo subscription-manager repos --enable=rhel-8-for-x86_64-baseos-rpms --enable=rhel-8-for-x86_64-appstream-rpms --enable=rhel-8-for-x86_64-highavailability-rpms --enable=ansible-2.8-for-rhel-8-x86_64-rpms --enable=openstack-beta-deployment-tools-for-rhel-8-x86_64-rpms
```

8. Update your system to ensure you have the latest base system packages:

```
[root@controller-0 ~]# sudo dnf update -y
[root@controller-0 ~]# sudo reboot
```

The node is now ready to use for your overcloud.

### 11.5.4. Configuring SSL/TLS access to director

If the director uses SSL/TLS, the pre-provisioned nodes require the certificate authority file used to sign the director’s SSL/TLS certificates. If you use your own certificate authority, perform the following actions on each overcloud node.

**Procedure**

1. Copy the certificate authority file to the `/etc/pki/ca-trust/source/anchors/` directory on each pre-provisioned node.

2. Run the following command on each overcloud node:

```
[root@controller-0 ~]# sudo update-ca-trust extract
```

These steps ensure that the overcloud nodes can access the director’s Public API over SSL/TLS.

### 11.5.5. Configuring networking for the control plane

The pre-provisioned overcloud nodes obtain metadata from director using standard HTTP requests. This means all overcloud nodes require L3 access to either:
- The director Control Plane network, which is the subnet that you define with the `network_cidr` parameter in your `undercloud.conf` file. The overcloud nodes require either direct access to this subnet or routable access to the subnet.

- The director Public API endpoint, that you specify with the `undercloud_public_host` parameter in your `undercloud.conf` file. This option is available if you do not have an L3 route to the Control Plane or if you want to use SSL/TLS communication. For more information about configuring your overcloud nodes to use the Public API endpoint, see Section 11.5.6, “Using a separate network for pre-provisioned nodes”.

Director uses the Control Plane network to manage and configure a standard overcloud. For an overcloud with pre-provisioned nodes, your network configuration might require some modification to accommodate communication between the director and the pre-provisioned nodes.

### Using network isolation

You can use network isolation to group services to use specific networks, including the Control Plane. There are multiple network isolation strategies in the the Advanced Overcloud Customization guide. You can also define specific IP addresses for nodes on the Control Plane. For more information about isolating networks and creating predictable node placement strategies, see the following sections in the Advanced Overcloud Customizations guide:

- "Basic network isolation"
- "Controlling Node Placement"

**NOTE**

If you use network isolation, ensure that your NIC templates do not include the NIC used for undercloud access. These templates can reconfigure the NIC, which introduces connectivity and configuration problems during deployment.

### Assigning IP addresses

If you do not use network isolation, you can use a single Control Plane network to manage all services. This requires manual configuration of the Control Plane NIC on each node to use an IP address within the Control Plane network range. If you are using the director Provisioning network as the Control Plane, ensure that the overcloud IP addresses that you choose are outside of the DHCP ranges for both provisioning (`dhcp_start` and `dhcp_end`) and introspection (`inspection_iprange`).

During standard overcloud creation, director creates OpenStack Networking (neutron) ports and automatically assigns IP addresses to the overcloud nodes on the Provisioning / Control Plane network. However, this can cause director to assign different IP addresses to the ones that you configure manually for each node. In this situation, use a predictable IP address strategy to force director to use the pre-provisioned IP assignments on the Control Plane.

For example, you can use an environment file `ctlplane-assignments.yaml` with the following IP assignments to implement a predictable IP strategy:

```yaml
resource_registry:
  OS::TripleO::DeployedServer::ControlPlanePort: /usr/share/openstack-tripleo-heat-templates/deployed-server/deployed-neutron-port.yaml

parameter_defaults:
  DeployedServerPortMap:
    controller-0-ctlplane:
```

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In this example, the `OS::TripleO::DeployedServer::ControlPlanePort` resource passes a set of parameters to director and defines the IP assignments of your pre-provisioned nodes. Use the `DeployedServerPortMap` parameter to define the IP addresses and subnet CIDRs that correspond to each overcloud node. The mapping defines the following attributes:

1. The name of the assignment, which follows the format `<node_hostname>-<network>` where the `<node_hostname>` value matches the short host name for the node, and `<network>` matches the lowercase name of the network. For example: `controller-0-ctlplane` for `controller-0.example.com` and `compute-0-ctlplane` for `compute-0.example.com`.

2. The IP assignments, which use the following parameter patterns:
   - `fixed_ips/ip_address` - Defines the fixed IP addresses for the control plane. Use multiple `ip_address` parameters in a list to define multiple IP addresses.
   - `subnets/cidr` - Defines the CIDR value for the subnet.

A later section in this chapter uses the resulting environment file (`ctlplane-assignments.yaml`) as part of the `openstack overcloud deploy` command.

### 11.5.6. Using a separate network for pre-provisioned nodes

By default, director uses the Provisioning network as the overcloud Control Plane. However, if this network is isolated and non-routable, nodes cannot communicate with the director Internal API during configuration. In this situation, you might need to define a separate network for the nodes and configure them to communicate with the director over the Public API.

There are several requirements for this scenario:

- The overcloud nodes must accommodate the basic network configuration from Section 11.5.5, “Configuring networking for the control plane”.


- You must define an accessible fully qualified domain name (FQDN) for director. This FQDN must resolve to a routable IP address for the director. Use the `undercloud_public_host` parameter in the `undercloud.conf` file to set this FQDN.
The examples in this section use IP address assignments that differ from the main scenario:

### Table 11.11. Provisioning network IP assignments

<table>
<thead>
<tr>
<th>Node Name</th>
<th>IP address or FQDN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Director (Internal API)</td>
<td>192.168.24.1 (Provisioning Network and Control Plane)</td>
</tr>
<tr>
<td>Director (Public API)</td>
<td>10.1.1.1 / director.example.com</td>
</tr>
<tr>
<td>Overcloud Virtual IP</td>
<td>192.168.100.1</td>
</tr>
<tr>
<td>Controller 0</td>
<td>192.168.100.2</td>
</tr>
<tr>
<td>Compute 0</td>
<td>192.168.100.3</td>
</tr>
</tbody>
</table>

The following sections provide additional configuration for situations that require a separate network for overcloud nodes.

### IP address assignments

The method for IP assignments is similar to Section 11.5.5, "Configuring networking for the control plane". However, since the Control Plane is not routable from the deployed servers, you must use the `DeployedServerPortMap` parameter to assign IP addresses from your chosen overcloud node subnet, including the virtual IP address to access the Control Plane. The following example is a modified version of the `ctlplane-assignments.yaml` environment file from Section 11.5.5, "Configuring networking for the control plane" that accommodates this network architecture:

```yaml
resource_registry:
  OS::TripleO::DeployedServer::ControlPlanePort: /usr/share/openstack-tripleo-heat-templates/deployed-server/deployed-neutron-port.yaml
  OS::TripleO::Network::Ports::ControlPlaneVipPort: /usr/share/openstack-tripleo-heat-templates/deployed-server/deployed-neutron-port.yaml
  OS::TripleO::Network::Ports::RedisVipPort: /usr/share/openstack-tripleo-heat-templates/network/ports/noop.yaml
  OS::TripleO::Network::Ports::OVNDBsVipPort: /usr/share/openstack-tripleo-heat-templates/network/ports/noop.yaml

parameter_defaults:
  NeutronPublicInterface: eth1
  DeployedServerPortMap:
    control_virtual_ip:
      fixed_ips:
        - ip_address: 192.168.100.1
        subnets:
          - cidr: 24
    controller-0-ctlplane:
      fixed_ips:
        - ip_address: 192.168.100.2
        subnets:
          - cidr: 24
    compute-0-ctlplane:
```

1
fixed_ips:
- ip_address: 192.168.100.3
subnets:
- cidr: 24

1 The RedisVipPort and OVNDBsVipPort resources are mapped to network/ports/noop.yaml. This mapping is necessary because the default Redis and OVNDBs VIP addresses come from the Control Plane. In this situation, use a noop to disable this Control Plane mapping.

11.5.7. Mapping pre-provisioned node hostnames

When you configure pre-provisioned nodes, you must map heat-based hostnames to their actual hostnames so that ansible-playbook can reach a resolvable host. Use the HostnameMap to map these values.

Procedure

1. Create an environment file, for example hostname-map.yaml, and include the HostnameMap parameter and the hostname mappings. Use the following syntax:

```yaml
parameter_defaults:
    HostnameMap:
        [HEAT HOSTNAME]: [ACTUAL HOSTNAME]
        [HEAT HOSTNAME]: [ACTUAL HOSTNAME]
```

The [HEAT HOSTNAME] usually conforms to the following convention: [STACK NAME]-[ROLE]-[INDEX]:

```yaml
parameter_defaults:
    HostnameMap:
        overcloud-controller-0: controller-00-rack01
        overcloud-controller-1: controller-01-rack02
        overcloud-controller-2: controller-02-rack03
        overcloud-novacompute-0: compute-00-rack01
        overcloud-novacompute-1: compute-01-rack01
        overcloud-novacompute-2: compute-02-rack01
```

2. Save the hostname-map.yaml file.

11.5.8. Configuring Ceph Storage for pre-provisioned nodes

Complete the following steps on the undercloud host to configure ceph-ansible for nodes that are already deployed.

Procedure

1. On the undercloud host, create an environment variable, OVERCLOUD_HOSTS, and set the variable to a space-separated list of IP addresses of the overcloud hosts that you want to use as Ceph clients:

```bash
export OVERCLOUD_HOSTS="192.168.1.8 192.168.1.42"
```
2. The default overcloud plan name is `overcloud`. If you use a different name, create an environment variable `OVERCLOUD_PLAN` to store your custom name:

```bash
export OVERCLOUD_PLAN="<custom-stack-name>"
```

Replace `<custom-stack-name>` with the name of your stack.

3. Run the `enable-ssh-admin.sh` script to configure a user on the overcloud nodes that Ansible can use to configure Ceph clients:

```bash
bash /usr/share/openstack-tripleo-heat-templates/deployed-server/scripts/enable-ssh-admin.sh
```

When you run the `openstack overcloud deploy` command, Ansible configures the hosts that you define in the `OVERCLOUD_HOSTS` variable as Ceph clients.

### 11.5.9. Creating the overcloud with pre-provisioned nodes

The overcloud deployment uses the standard CLI methods. For pre-provisioned nodes, the deployment command requires some additional options and environment files from the core heat template collection:

- `--disable-validations` - Use this option to disable basic CLI validations for services not used with pre-provisioned infrastructure. If you do not disable these validations, the deployment fails.

- `environments/deployed-server-environment.yaml` - Include this environment file to create and configure the pre-provisioned infrastructure. This environment file substitutes the `OS::Nova::Server` resources with `OS::Heat::DeployedServer` resources.

The following command is an example overcloud deployment command with the environment files specific to the pre-provisioned architecture:

```bash
$ source ~/stackrc
(undercloud) $ openstack overcloud deploy --disable-validations -e /usr/share/openstack-tripleo-heat-templates/environments/deployed-server-environment.yaml -e /home/stack/templates/hostname-map.yaml --overcloud-ssh-user stack --overcloud-ssh-key ~/.ssh/id_rsa <OTHER_OPTIONS>
```

The `--overcloud-ssh-user` and `--overcloud-ssh-key` options are used to SSH into each overcloud node during the configuration stage, create an initial `tripleo-admin` user, and inject an SSH key into `/home/tripleo-admin/.ssh/authorized_keys`. To inject the SSH key, specify the credentials for the initial SSH connection with `--overcloud-ssh-user` and `--overcloud-ssh-key` (defaults to `~/.ssh/id_rsa`). To limit exposure to the private key that you specify with the `--overcloud-ssh-key` option, director never passes this key to any API service, such as heat, and only the director `openstack overcloud deploy` command uses this key to enable access for the `tripleo-admin` user.

### 11.5.10. Accessing the overcloud

Director generates a credential file containing the credentials necessary to operate the overcloud from the undercloud. Director saves this file, `overcloudrc`, in the home directory of the `stack` user.
Procedure

1. Source the `overcloudrc` file:

   ```
   (undercloud)$ source ~/overcloudrc
   
   The command prompt changes to indicate that you are accessing the overcloud:
   ```

2. To return to interacting with the undercloud, source the `stackrc` file:

   ```
   (overcloud)$ source ~/stackrc
   (undercloud)$
   
   The command prompt changes to indicate that you are accessing the undercloud:
   ```

11.5.11. Scaling pre-provisioned nodes

The process for scaling pre-provisioned nodes is similar to the standard scaling procedures in Chapter 18, *Scaling overcloud nodes*. However, the process to add new pre-provisioned nodes differs because pre-provisioned nodes do not use the standard registration and management process from OpenStack Bare Metal (ironic) and OpenStack Compute (nova).

**Scaling up pre-provisioned nodes**

When scaling up the overcloud with pre-provisioned nodes, you must configure the orchestration agent on each node to correspond to the director node count.

Perform the following actions to scale up overcloud nodes:

1. Prepare the new pre-provisioned nodes according to Section 11.5.1, “Pre-provisioned node requirements”.

2. Scale up the nodes. For more information, see Chapter 18, *Scaling overcloud nodes*.

3. After you execute the deployment command, wait until the director creates the new node resources and launches the configuration.

**Scaling down pre-provisioned nodes**

When scaling down the overcloud with pre-provisioned nodes, follow the scale down instructions in Chapter 18, *Scaling overcloud nodes*.

In scale-down operations, you can use hostnames for both OSP provisioned or pre-provisioned nodes. You can also use the UUID for OSP provisioned nodes. However, there is no UUID for pre-provisioned nodes, so you always use hostnames. Pass the hostname or UUID value to the `openstack overcloud node delete` command.

Procedure

1. Identify the name of the node that you want to remove.
$ openstack stack resource list overcloud -n5 --filter type=OS::TripleO::ComputeDeployedServerServer

2. Pass the corresponding node name from the `stack_name` column to the `openstack overcloud node delete` command:

$ openstack overcloud node delete --stack <overcloud> <stack>

- Replace `<overcloud>` with the name or UUID of the overcloud stack.
- Replace `<stack_name>` with the name of the node that you want to remove. You can include multiple node names in the `openstack overcloud node delete` command.

3. Ensure that the `openstack overcloud node delete` command runs to completion:

$ openstack stack list

The status of the `overcloud` stack shows `UPDATE_COMPLETE` when the delete operation is complete.

After you remove overcloud nodes from the stack, power off these nodes. In a standard deployment, the bare metal services on the director control this function. However, with pre-provisioned nodes, you must either manually shut down these nodes or use the power management control for each physical system. If you do not power off the nodes after removing them from the stack, they might remain operational and reconnect as part of the overcloud environment.

After you power off the removed nodes, reprovision them to a base operating system configuration so that they do not unintentionally join the overcloud in the future

**NOTE**

Do not attempt to reuse nodes previously removed from the overcloud without first reprovisioning them with a fresh base operating system. The scale down process only removes the node from the overcloud stack and does not uninstall any packages.

**Removing a pre-provisioned overcloud**

To remove an entire overcloud that uses pre-provisioned nodes, see Section 14.6, “Removing the overcloud” for the standard overcloud remove procedure. After you remove the overcloud, power off all nodes and reprovision them to a base operating system configuration.

**NOTE**

Do not attempt to reuse nodes previously removed from the overcloud without first reprovisioning them with a fresh base operating system. The removal process only deletes the overcloud stack and does not uninstall any packages.
CHAPTER 12. ANSIBLE-BASED OVERCLOUD REGISTRATION

Director uses Ansible-based methods to register overcloud nodes to the Red Hat Customer Portal or to a Red Hat Satellite Server.

If you used the `rhel-registration` method from previous Red Hat OpenStack Platform versions, you must disable it and switch to the Ansible-based method. For more information, see [xref:ref_rhel-registration-to-rhsm-mappings_portal].

In addition to the director-based registration method, you can also manually register after deployment. For more information, see Section 12.9, “Running Ansible-based registration manually”

12.1. RED HAT SUBSCRIPTION MANAGER (RHSM) COMPOSABLE SERVICE

You can use the `rhsm` composable service to register overcloud nodes through Ansible. Each role in the default `roles_data` file contains a `OS::TripleO::Services::Rhsm` resource, which is disabled by default. To enable the service, register the resource to the `rhsm` composable service file:

```
resource_registry:
  OS::TripleO::Services::Rhsm: /usr/share/openstack-tripleo-heat-templates/deployment/rhsm/rhsm-baremetal-ansible.yaml
```

The `rhsm` composable service accepts a `RhsmVars` parameter, which you can use to define multiple sub-parameters relevant to your registration:

```
parameter_defaults:
  RhsmVars:
    rhsm_repos:
      - rhel-8-for-x86_64-baseos-eus-rpms
      - rhel-8-for-x86_64-appstream-eus-rpms
      - rhel-8-for-x86_64-highavailability-eus-rpms
    ...  
    rhsm_username: "myusername"
    rhsm_password: "p@55w0rd!"
    rhsm_org_id: "1234567"
    rhsm_release: 9.0
```

You can also use the `RhsmVars` parameter in combination with role-specific parameters, for example, `ControllerParameters`, to provide flexibility when enabling specific repositories for different nodes types.

12.2. RHSMVARS SUB-PARAMETERS

Use the following sub-parameters as part of the `RhsmVars` parameter when you configure the `rhsm` composable service. For more information about the Ansible parameters that are available, see the role documentation.

<table>
<thead>
<tr>
<th><code>rhsm</code></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>rhsm_method</code></td>
<td>Choose the registration method. Either portal, satellite, or disable.</td>
</tr>
<tr>
<td><strong>rhsm</strong></td>
<td>Description</td>
</tr>
<tr>
<td>-----------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>rhsm_org_id</strong></td>
<td>The organization that you want to use for registration. To locate this ID, run <code>sudo subscription-manager orgs</code> from the undercloud node. Enter your Red Hat credentials at the prompt, and use the resulting <strong>Key</strong> value. For more information on your organization ID, see Understanding the Red Hat Subscription Management Organization ID.</td>
</tr>
<tr>
<td><strong>rhsm_pool_ids</strong></td>
<td>The subscription pool ID that you want to use. Use this parameter if you do not want to auto-attach subscriptions. To locate this ID, run <code>sudo subscription-manager list --available --all --matches=&quot;*Red Hat OpenStack*&quot;</code> from the undercloud node, and use the resulting <strong>Pool ID</strong> value.</td>
</tr>
<tr>
<td><strong>rhsm_activation_key</strong></td>
<td>The activation key that you want to use for registration.</td>
</tr>
<tr>
<td><strong>rhsm_autosubscribe</strong></td>
<td>Use this parameter to attach compatible subscriptions to this system automatically. Set the value to <strong>true</strong> to enable this feature.</td>
</tr>
<tr>
<td><strong>rhsm_baseurl</strong></td>
<td>The base URL for obtaining content. The default URL is the Red Hat Content Delivery Network. If you use a Satellite server, change this value to the base URL of your Satellite server content repositories.</td>
</tr>
<tr>
<td><strong>rhsm_server_hostname</strong></td>
<td>The hostname of the subscription management service for registration. The default is the Red Hat Subscription Management hostname. If you use a Satellite server, change this value to your Satellite server hostname.</td>
</tr>
<tr>
<td><strong>rhsm_repos</strong></td>
<td>A list of repositories that you want to enable.</td>
</tr>
<tr>
<td><strong>rhsm_username</strong></td>
<td>The username for registration. If possible, use activation keys for registration.</td>
</tr>
<tr>
<td><strong>rhsm_password</strong></td>
<td>The password for registration. If possible, use activation keys for registration.</td>
</tr>
<tr>
<td><strong>rhsm_release</strong></td>
<td>Red Hat Enterprise Linux release for pinning the repositories. This is set to 9.0 for Red Hat OpenStack Platform</td>
</tr>
<tr>
<td><strong>rhsm_rhsm_proxy_hostname</strong></td>
<td>The hostname for the HTTP proxy. For example: <code>proxy.example.com</code>.</td>
</tr>
<tr>
<td><strong>rhsm_rhsm_proxy_port</strong></td>
<td>The port for HTTP proxy communication. For example: <code>8080</code>.</td>
</tr>
<tr>
<td><strong>rhsm_rhsm_proxy_user</strong></td>
<td>The username to access the HTTP proxy.</td>
</tr>
<tr>
<td><strong>rhsm_rhsm_proxy_password</strong></td>
<td>The password to access the HTTP proxy.</td>
</tr>
</tbody>
</table>
12.3. REGISTERING THE OVERCLOUD WITH THE RHSM COMPOSABLE SERVICE

Create an environment file that enables and configures the rhsm composable service. Director uses this environment file to register and subscribe your nodes.

Procedure

1. Create an environment file named templates/rhsm.yml to store the configuration.

2. Include your configuration in the environment file. For example:

   ```yaml
   resource_registry:
     OS::TripleO::Services::Rhsm: /usr/share/openstack-tripleo-heat-templates/deployment/rhsm/rhsm-baremetal-ansible.yaml
   parameter_defaults:
     RhsmVars:
       rhsm_repos:
         - rhel-8-for-x86_64-baseos-eus-rpms
         - rhel-8-for-x86_64-appstream-eus-rpms
         - rhel-8-for-x86_64-highavailability-eus-rpms
       rhsm_username: "myusername"
       rhsm_password: "p@55w0rd!"
       rhsm_org_id: "1234567"
       rhsm_pool_ids: "1a85f9223e3d5e43013e3d6e8ff506fd"
       rhsm_method: "portal"
       rhsm_release: 9.0
   ```

   - The `resource_registry` section associates the rhsm composable service with the `OS::TripleO::Services::Rhsm` resource, which is available on each role.
   - The `RhsmVars` variable passes parameters to Ansible for configuring your Red Hat registration.

3. Save the environment file.

12.4. APPLYING THE RHSM COMPOSABLE SERVICE TO DIFFERENT ROLES

You can apply the rhsm composable service on a per-role basis. For example, you can apply different sets of configurations to Controller nodes, Compute nodes, and Ceph Storage nodes.

Procedure

1. Create an environment file named templates/rhsm.yml to store the configuration.

2. Include your configuration in the environment file. For example:
resource_registry:
  OS::TripleO::Services::Rhsm: /usr/share/openstack-tripleo-heat-templates/deployment/rhsm/rhsm-baremetal-ansible.yaml

parameter_defaults:
  ControllerParameters:
    RhsmVars:
      rhsm_repos:
        - rhel-8-for-x86_64-baseos-eus-rpms
        - rhel-8-for-x86_64-appstream-eus-rpms
        - rhel-8-for-x86_64-highavailability-eus-rpms
        - ansible-2.9-for-rhel-8-x86_64-rpms
        - openstack-16.2-for-rhel-8-x86_64-rpms
        - fast datapath for rhel-8-x86_64-rpms
      rhsm_username: "myusername"
      rhsm_password: "p@55w0rd!"
      rhsm_org_id: "1234567"
      rhsm_pool_ids: "55d25f1f1490556f3e75aa37e89e10ce5"
      rhsm_method: "portal"
      rhsm_release: 9.0
  ComputeParameters:
    RhsmVars:
      rhsm_repos:
        - rhel-8-for-x86_64-baseos-eus-rpms
        - rhel-8-for-x86_64-appstream-eus-rpms
        - rhel-8-for-x86_64-highavailability-eus-rpms
        - ansible-2.9-for-rhel-8-x86_64-rpms
        - openstack-16.2-for-rhel-8-x86_64-rpms
        - fast datapath for rhel-8-x86_64-rpms
      rhsm_username: "myusername"
      rhsm_password: "p@55w0rd!"
      rhsm_org_id: "1234567"
      rhsm_pool_ids: "55d25f1f1490556f3e75aa37e89e10ce5"
      rhsm_method: "portal"
      rhsm_release: 9.0
  CephStorageParameters:
    RhsmVars:
      rhsm_repos:
        - rhel-8-for-x86_64-baseos-rpms
        - rhel-8-for-x86_64-appstream-rpms
        - rhel-8-for-x86_64-highavailability-rpms
        - ansible-2.9-for-rhel-8-x86_64-rpms
        - openstack-16.2-deployment-tools-for-rhel-8-x86_64-rpms
      rhsm_username: "myusername"
      rhsm_password: "p@55w0rd!"
      rhsm_org_id: "1234567"
      rhsm_pool_ids: "68790a7a2dc9dc50a9bc39fab55e0d"
      rhsm_method: "portal"
      rhsm_release: 9.0

The `resource_registry` associates the `rhsm` composable service with the `OS::TripleO::Services::Rhsm` resource, which is available on each role.

The `ControllerParameters`, `ComputeParameters`, and `CephStorageParameters` parameters each use a separate `RhsmVars` parameter to pass subscription details to their respective roles.
NOTE

Set the **RhsmVars** parameter within the **CephStorageParameters** parameter to use a Red Hat Ceph Storage subscription and repositories specific to Ceph Storage. Ensure the **rhsm_repos** parameter contains the standard Red Hat Enterprise Linux repositories instead of the Extended Update Support (EUS) repositories that Controller and Compute nodes require.

3. Save the environment file.

12.5. REGISTERING THE OVERCLOUD TO RED HAT SATELLITE SERVER

Create an environment file that enables and configures the **rhsm** composable service to register nodes to Red Hat Satellite instead of the Red Hat Customer Portal.

Procedure

1. Create an environment file named **templates/rhsm.yml** to store the configuration.

2. Include your configuration in the environment file. For example:

   ```yaml
   resource_registry:
   OS::TripleO::Services::Rhsm: /usr/share/openstack-tripleo-heat-templates/deployment/rhsm/rhsm-baremetal-ansible.yaml
   parameter_defaults:
   RhsmVars:
   rhsm_activation_key: "myactivationkey"
   rhsm_method: "satellite"
   rhsm_org_id: "ACME"
   rhsm_server_hostname: "satellite.example.com"
   rhsm_baseurl: "https://satellite.example.com/pulp/repos"
   rhsm_release: 9.0
   
   The **resource_registry** associates the **rhsm** composable service with the **OS::TripleO::Services::Rhsm** resource, which is available on each role.
   
   The **RhsmVars** variable passes parameters to Ansible for configuring your Red Hat registration.

3. Save the environment file.

12.6. SWITCHING TO THE RHSM COMPOSABLE SERVICE

The previous **rhel-registration** method runs a bash script to handle the overcloud registration. The scripts and environment files for this method are located in the core heat template collection at `/usr/share/openstack-tripleo-heat-templates/extraconfig/pre_deploy/rhel-registration/`.

Complete the following steps to switch from the **rhel-registration** method to the **rhsm** composable service.

Procedure

1. Exclude the **rhel-registration** environment files from future deployments operations. In most cases, exclude the following files:
If you use a custom `roles_data` file, ensure that each role in your `roles_data` file contains the `OS::TripleO::Services::Rhsm` composable service. For example:

```yaml
- name: Controller
description: |
  Controller role that has all the controller services loaded and handles
  Database, Messaging and Network functions.
CountDefault: 1
...
ServicesDefault:
...
- OS::TripleO::Services::Rhsm
  ...
```

3. Add the environment file for `rhsm` composable service parameters to future deployment operations.

This method replaces the `rhel-registration` parameters with the `rhsm` service parameters and changes the heat resource that enables the service from:

```yaml
resource_registry:
  OS::TripleO::NodeExtraConfig: rhel-registration.yaml
```

To:

```yaml
resource_registry:
  OS::TripleO::Services::Rhsm: /usr/share/openstack-tripleo-heat-templates/deployment/rhsm/rhsm-baremetal-ansible.yaml
```

You can also include the `/usr/share/openstack-tripleo-heat-templates/environments/rhsm.yaml` environment file with your deployment to enable the service.

### 12.7. RHEL-REGISTRATION TO RHSM MAPPINGS

To help transition your details from the `rhel-registration` method to the `rhsm` method, use the following table to map your parameters and values.
12.8. DEPLOYING THE OVERCLOUD WITH THE RHSM COMPOSABLE SERVICE

Deploy the overcloud with the `rhsm` composable service so that Ansible controls the registration process for your overcloud nodes.

**Procedure**

1. Include `rhsm.yml` environment file with the `openstack overcloud deploy` command:

   ```bash
   openstack overcloud deploy \n   <other cli args> \n   -e ~/templates/rhsm.yaml
   ```

   This enables the Ansible configuration of the overcloud and the Ansible-based registration.

2. Wait until the overcloud deployment completes.

3. Check the subscription details on your overcloud nodes. For example, log in to a Controller node and run the following commands:

   ```bash
   $ sudo subscription-manager status
   $ sudo subscription-manager list --consumed
   ```

12.9. RUNNING ANSIBLE-BASED REGISTRATION MANUALLY

You can perform manual Ansible-based registration on a deployed overcloud with the dynamic
inventory script on the director node. Use this script to define node roles as host groups and then run a playbook against them with `ansible-playbook`. Use the following example playbook to register Controller nodes manually.

**Procedure**

1. Create a playbook that uses the `redhat_subscription` modules to register your nodes. For example, the following playbook applies to Controller nodes:

   ```yaml
   ---
   - name: Register Controller nodes
     hosts: Controller
     become: yes
     vars:
       repos:
         - rhel-8-for-x86_64-baseos-eus-rpms
         - rhel-8-for-x86_64-appstream-eus-rpms
         - rhel-8-for-x86_64-highavailability-eus-rpms
         - ansible-2.9-for-rhel-8-x86_64-rpms
         - openstack-beta-for-rhel-8-x86_64-rpms
         - fast-datapath-for-rhel-8-x86_64-rpms
     tasks:
       - name: Register system
         redhat_subscription:
           username: myusername
           password: p@55w0rd!
           org_id: 1234567
           release: 9.0
           pool_ids: 1a85f9223e3d5e43013e3d6e8ff506fd
       - name: Disable all repos
         command: "subscription-manager repos --disable *"
       - name: Enable Controller node repos
         command: "subscription-manager repos --enable {{ item }}"
         with_items: {{ repos }}
   
   - This play contains three tasks:
     - Register the node.
     - Disable any auto-enabled repositories.
     - Enable only the repositories relevant to the Controller node. The repositories are listed with the `repos` variable.

2. After you deploy the overcloud, you can run the following command so that Ansible executes the playbook (`ansible-osp-registration.yml`) against your overcloud:

   ```bash
   $ ansible-playbook -i /usr/bin/tripleo-ansible-inventory ansible-osp-registration.yml
   ```

   This command performs the following actions:
   - Runs the dynamic inventory script to get a list of host and their groups.
   - Applies the playbook tasks to the nodes in the group defined in the `hosts` parameter of the playbook, which in this case is the Controller group.
CHAPTER 13. PERFORMING OVERCLOUD POST-INSTALLATION TASKS

This chapter contains information about tasks to perform immediately after you create your overcloud. These tasks ensure your overcloud is ready to use.

13.1. CHECKING OVERCLOUD DEPLOYMENT STATUS

To check the deployment status of the overcloud, use the `openstack overcloud status` command. This command returns the result of all deployment steps.

Procedure

1. Source the `stackrc` file:
   
   ```bash
   $ source ~/stackrc
   ```

2. Run the deployment status command:
   
   ```bash
   $ openstack overcloud status
   ```

   The output of this command displays the status of the overcloud:

   ```plaintext
   +-----------+---------------------+---------------------+-------------------+
   | Plan Name |       Created       |       Updated       | Deployment Status |
   +-----------+---------------------+---------------------+-------------------+
   +-----------+---------------------+---------------------+-------------------+
   ```

   If your overcloud uses a different name, use the `--plan` argument to select an overcloud with a different name:

   ```bash
   $ openstack overcloud status --plan my-deployment
   ```

13.2. CREATING BASIC OVERCLOUD FLAVORS

Validation steps in this guide assume that your installation contains flavors. If you have not already created at least one flavor, complete the following steps to create a basic set of default flavors that have a range of storage and processing capabilities:

Procedure

1. Source the `overcloudrc` file:
   
   ```bash
   $ source ~/overcloudrc
   ```

2. Run the `openstack flavor create` command to create a flavor. Use the following options to specify the hardware requirements for each flavor:

   ```bash
   --disk
   ```

   Defines the hard disk space for a virtual machine volume.
--ram
Defines the RAM required for a virtual machine.

--vcpus
Defines the quantity of virtual CPUs for a virtual machine.

3. The following example creates the default overcloud flavors:

```bash
$ openstack flavor create m1.tiny --ram 512 --disk 0 --vcpus 1
$ openstack flavor create m1.smaller --ram 1024 --disk 0 --vcpus 1
$ openstack flavor create m1.small --ram 2048 --disk 0 --vcpus 1
$ openstack flavor create m1.medium --ram 3072 --disk 0 --vcpus 2
$ openstack flavor create m1.large --ram 8192 --disk 0 --vcpus 4
$ openstack flavor create m1.xlarge --ram 8192 --disk 0 --vcpus 8
```

NOTE
Use `$ openstack flavor create --help` to learn more about the `openstack flavor create` command.

13.3. CREATING A DEFAULT TENANT NETWORK

The overcloud requires a default Tenant network so that virtual machines can communicate internally.

Procedure

1. Source the `overcloudrc` file:

   ```bash
   $ source ~/overcloudrc
   ```

2. Create the default Tenant network:

   ```bash
   (overcloud) $ openstack network create default
   ```

3. Create a subnet on the network:

   ```bash
   (overcloud) $ openstack subnet create default --network default --gateway 172.20.1.1 --subnet-range 172.20.0.0/16
   ```

4. Confirm the created network:

   ```bash
   (overcloud) $ openstack network list
   +-----------------------+-------------+--------------------------------------+
   | id                    | name        | subnets                              |
   +-----------------------+-------------+--------------------------------------+
   | 95fadaa1-5dda-4777... | default     | 7e060813-35c5-462c-a56a-1c6f8f4f332f |
   +-----------------------+-------------+--------------------------------------+
   ```

These commands create a basic Networking service (neutron) network named `default`. The overcloud automatically assigns IP addresses from this network to virtual machines using an internal DHCP mechanism.
13.4. CREATING A DEFAULT FLOATING IP NETWORK

To access your virtual machines from outside of the overcloud, you must configure an external network that provides floating IP addresses to your virtual machines.

This procedure contains two examples. Use the example that best suits your environment:

- Native VLAN (flat network)
- Non-Native VLAN (VLAN network)

Both of these examples involve creating a network with the name public. The overcloud requires this specific name for the default floating IP pool. This name is also important for the validation tests in Section 13.7, "Validating the overcloud".

By default, Openstack Networking (neutron) maps a physical network name called datacentre to the br-ex bridge on your host nodes. You connect the public overcloud network to the physical datacentre and this provides a gateway through the br-ex bridge.

Prerequisites

- A dedicated interface or native VLAN for the floating IP network.

Procedure

1. Source the overcloudrc file:
   
   ```bash
   $ source ~/overcloudrc
   ```

2. Create the public network:
   
   - Create a flat network for a native VLAN connection:
     
     ```bash
     (overcloud) $ openstack network create public --external --provider-network-type flat --provider-physical-network datacentre
     ```
   
   - Create a vlan network for non-native VLAN connections:
     
     ```bash
     (overcloud) $ openstack network create public --external --provider-network-type vlan --provider-physical-network datacentre --provider-segment 201
     ```

   Use the --provider-segment option to define the VLAN that you want to use. In this example, the VLAN is 201.

3. Create a subnet with an allocation pool for floating IP addresses. In this example, the IP range is 10.1.1.51 to 10.1.1.250:
   
   ```bash
   (overcloud) $ openstack subnet create public --network public --dhcp --allocation-pool start=10.1.1.51,end=10.1.1.250 --gateway 10.1.1.1 --subnet-range 10.1.1.0/24
   ```

   Ensure that this range does not conflict with other IP addresses in your external network.

13.5. CREATING A DEFAULT PROVIDER NETWORK
A provider network is another type of external network connection that routes traffic from private tenant networks to external infrastructure network. The provider network is similar to a floating IP network but the provider network uses a logical router to connect private networks to the provider network.

This procedure contains two examples. Use the example that best suits your environment:

- Native VLAN (flat network)
- Non-Native VLAN (VLAN network)

By default, Openstack Networking (neutron) maps a physical network name called datacentre to the br-ex bridge on your host nodes. You connect the public overcloud network to the physical datacentre and this provides a gateway through the br-ex bridge.

**Procedure**

1. Source the `overcloudrc` file:

   ```
   $ source ~/overcloudrc
   ```

2. Create the **provider** network:

   - Create a flat network for a native VLAN connection:
     ```
     (overcloud) $ openstack network create provider --external --provider-network-type flat --provider-physical-network datacentre --share
     ```
   
   - Create a vlan network for non-native VLAN connections:
     ```
     (overcloud) $ openstack network create provider --external --provider-network-type vlan --provider-physical-network datacentre --provider-segment 201 --share
     ```

   Use the `--provider-segment` option to define the VLAN that you want to use. In this example, the VLAN is 201.

   These example commands create a shared network. It is also possible to specify a tenant instead of specifying `--share` so that only the tenant has access to the new network.

   + If you mark a provider network as external, only the operator may create ports on that network.

3. Add a subnet to the **provider** network to provide DHCP services:

   ```
   (overcloud) $ openstack subnet create provider-subnet --network provider --dhcp --allocation-pool start=10.9.101.50,end=10.9.101.100 --gateway 10.9.101.254 --subnet-range 10.9.101.0/24
   ```

4. Create a router so that other networks can route traffic through the provider network:

   ```
   (overcloud) $ openstack router create external
   ```

5. Set the external gateway for the router to the **provider** network:

   ```
   (overcloud) $ openstack router set --external-gateway provider external
   ```
6. Attach other networks to this router. For example, run the following command to attach a subnet **subnet1** to the router:

   (overcloud) $ openstack router add subnet external subnet1

This command adds **subnet1** to the routing table and allows traffic from virtual machines using **subnet1** to route to the provider network.

### 13.6. CREATING ADDITIONAL BRIDGE MAPPINGS

Floating IP networks can use any bridge, not just **br-ex**, provided that you map the additional bridge during deployment.

**Procedure**

1. To map a new bridge called **br-floating** to the **floating** physical network, include the **NeutronBridgeMappings** parameter in an environment file:

   ```
   parameter_defaults:
     NeutronBridgeMappings: "datacentre:br-ex,floating:br-floating"
   ```

2. With this method, you can create separate external networks after creating the overcloud. For example, to create a floating IP network that maps to the **floating** physical network, run the following commands:

   ```
   $ source ~/overcloudrc
   (overcloud) $ openstack network create public --external --provider-physical-network floating --provider-network-type vlan --provider-segment 105
   (overcloud) $ openstack subnet create public --network public --dhcp --allocation-pool start=10.1.2.51,end=10.1.2.250 --gateway 10.1.2.1 --subnet-range 10.1.2.0/24
   ```

### 13.7. VALIDATING THE OVERCLOUD

The overcloud uses the OpenStack Integration Test Suite (tempest) tool set to conduct a series of integration tests. This section contains information about preparations for running the integration tests. For full instructions about how to use the OpenStack Integration Test Suite, see the [OpenStack Integration Test Suite Guide](https://docs.openstack.org/).  

The Integration Test Suite requires a few post-installation steps to ensure successful tests.

**Procedure**

1. If you run this test from the undercloud, ensure that the undercloud host has access to the Internal API network on the overcloud. For example, add a temporary VLAN on the undercloud host to access the Internal API network (ID: 201) using the 172.16.0.201/24 address:

   ```
   $ source ~/stackrc
   (undercloud) $ sudo ovs-vsctl add-port br-ctlplane vlan201 tag=201 -- set interface vlan201 type=internal
   (undercloud) $ sudo ip l set dev vlan201 up; sudo ip addr add 172.16.0.201/24 dev vlan201
   ```

2. Run the integration tests as described in the [OpenStack Integration Test Suite Guide](https://docs.openstack.org/).
3. After completing the validation, remove any temporary connections to the overcloud Internal
API. In this example, use the following commands to remove the previously created VLAN on
the undercloud:

```
$ source ~/stackrc
(undercloud) $ sudo ovs-vsctl del-port vlan201
```

### 13.8. PROTECTING THE OVERCLOUD FROM REMOVAL

Set a custom policy for heat to protect your overcloud from being deleted.

**Procedure**

1. Create an environment file called `prevent-stack-delete.yaml`.

2. Set the `HeatApiPolicies` parameter:

   ```yaml
   parameter_defaults:
   HeatApiPolicies:
     heat-deny-action:
       key: 'actions:action'
       value: 'rule:deny_everybody'
     heat-protect-overcloud:
       key: 'stacks:delete'
       value: 'rule:deny_everybody'
   ```

   **IMPORTANT**
   
   The `heat-deny-action` is a default policy that you must include in your undercloud
   installation.

3. Add the `prevent-stack-delete.yaml` environment file to the `custom_env_files` parameter in
   the `undercloud.conf` file:

   ```yaml
   custom_env_files = prevent-stack-delete.yaml
   ```

4. Run the undercloud installation command to refresh the configuration:

   ```bash
   $ openstack undercloud install
   ```

This environment file prevents you from deleting any stacks in the overcloud, which means you cannot
perform the following functions:

- Delete the overcloud
- Remove individual Compute nor Ceph Storage nodes
- Replace Controller nodes

To enable stack deletion, remove the `prevent-stack-delete.yaml` file from the `custom_env_files`
parameter and run the `openstack undercloud install` command.
CHAPTER 14. PERFORMING BASIC OVERCLOUD ADMINISTRATION TASKS

This chapter contains information about basic tasks you might need to perform during the lifecycle of your overcloud.

14.1. ACCESSING OVERCLOUD NODES THROUGH SSH

You can access each overcloud node through the SSH protocol.

- Each overcloud node contains a heat-admin user.
- The stack user on the undercloud has key-based SSH access to the heat-admin user on each overcloud node.
- All overcloud nodes have a short hostname that the undercloud resolves to an IP address on the control plane network. Each short hostname uses a .ctlplane suffix. For example, the short name for overcloud-controller-0 is overcloud-controller-0.ctlplane

Prerequisites

- A deployed overcloud with a working control plane network.

Procedure

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

   ```
   $ source ~/stackrc
   ```
3. Find the name of the node that you want to access:

   ```
   (undercloud) $ openstack server list
   ```
4. Connect to the node as the heat-admin user and use the short hostname of the node:

   ```
   (undercloud) $ ssh heat-admin@overcloud-controller-0.ctlplane
   ```

14.2. MANAGING CONTAINERIZED SERVICES

Red Hat OpenStack Platform (RHOSP) runs services in containers on the undercloud and overcloud nodes. In certain situations, you might need to control the individual services on a host. This section contains information about some common commands you can run on a node to manage containerized services.

Listing containers and images

To list running containers, run the following command:

```
$ sudo podman ps
```

To include stopped or failed containers in the command output, add the --all option to the command:
$ sudo podman ps --all

To list container images, run the following command:

$ sudo podman images

**Inspecting container properties**

To view the properties of a container or container images, use the `podman inspect` command. For example, to inspect the `keystone` container, run the following command:

$ sudo podman inspect keystone

**Managing containers with Systemd services**

Previous versions of OpenStack Platform managed containers with Docker and its daemon. In OpenStack Platform 16, the Systemd services interface manages the lifecycle of the containers. Each container is a service and you run Systemd commands to perform specific operations for each container.

**NOTE**

It is not recommended to use the Podman CLI to stop, start, and restart containers because Systemd applies a restart policy. Use Systemd service commands instead.

To check a container status, run the `systemctl status` command:

$ sudo systemctl status tripleo_keystone

- tripleo_keystone.service - keystone container
  Loaded: loaded (/etc/systemd/system/tripleo_keystone.service; enabled; vendor preset: disabled)
  Active: active (running) since Fri 2019-02-15 23:53:18 UTC; 2 days ago
  Main PID: 29012 (podman)
  CGroup: /system.slice/tripleo_keystone.service
       └─ 29012 /usr/bin/podman start -a keystone

To stop a container, run the `systemctl stop` command:

$ sudo systemctl stop tripleo_keystone

To start a container, run the `systemctl start` command:

$ sudo systemctl start tripleo_keystone

To restart a container, run the `systemctl restart` command:

$ sudo systemctl restart tripleo_keystone

Because no daemon monitors the containers status, Systemd automatically restarts most containers in these situations:

- Clean exit code or signal, such as running `podman stop` command.
- Unclean exit code, such as the podman container crashing after a start.
Unclean signals.

- Timeout if the container takes more than 1m 30s to start.

For more information about Systemd services, see the `systemd.service` documentation.

**NOTE**

Any changes to the service configuration files within the container revert after restarting the container. This is because the container regenerates the service configuration based on files on the local file system of the node in `/var/lib/config-data/puppet-generated/`. For example, if you edit `/etc/keystone/keystone.conf` within the `keystone` container and restart the container, the container regenerates the configuration using `/var/lib/config-data/puppet-generated/keystone/etc/keystone/keystone.conf` on the local file system of the node, which overwrites any the changes that were made within the container before the restart.

**Monitoring podman containers with Systemd timers**

The Systemd timers interface manages container health checks. Each container has a timer that runs a service unit that executes health check scripts.

To list all OpenStack Platform containers timers, run the `systemctl list-timers` command and limit the output to lines containing `tripleo`:

```
$ sudo systemctl list-timers | grep tripleo
Mon 2019-02-18 20:18:30 UTC  1s left       tripleo_nova_metadata_healthcheck.timer         tripleo_nova_metadata_healthcheck.service
Mon 2019-02-18 20:18:34 UTC  5s left       tripleo_keystone_healthcheck.timer           tripleo_keystone_healthcheck.service
Mon 2019-02-18 20:18:35 UTC  6s left       tripleo_memcached_healthcheck.timer          tripleo_memcached_healthcheck.service
(...)
```

To check the status of a specific container timer, run the `systemctl status` command for the healthcheck service:

```
$ sudo systemctl status tripleo_keystone_healthcheck.service
● tripleo_keystone_healthcheck.service - keystone healthcheck
  Loaded: loaded (/etc/systemd/system/tripleo_keystone_healthcheck.service; disabled; vendor preset: disabled)
  Active: inactive (dead) since Mon 2019-02-18 20:22:46 UTC; 22s ago
  Process: 115581 ExecStart=/usr/bin/podman exec keystone /openstack/healthcheck (code=exited, status=0/SUCCESS)
  Main PID: 115581 (code=exited, status=0/SUCCESS)

Feb 18 20:22:46 undercloud.localdomain systemd[1]: Starting keystone healthcheck...
Feb 18 20:22:46 undercloud.localdomain podman[115581]: {"versions": {"values": ["stable", "updated": "2019-01-22T00:00:00Z", "..."]}}
Feb 18 20:22:46 undercloud.localdomain podman[115581]: 300 192.168.24.1:35357 0.012 seconds
```

To stop, start, restart, and show the status of a container timer, run the relevant `systemctl` command against the `.timer` Systemd resource. For example, to check the status of the `tripleo_keystone_healthcheck.timer` resource, run the following command:
If the healthcheck service is disabled but the timer for that service is present and enabled, it means that the check is currently timed out, but will be run according to timer. You can also start the check manually.

NOTE
The podman ps command does not show the container health status.

Checking container logs
Red Hat OpenStack Platform 17.0-beta logs all standard output (stdout) from all containers, and standard errors (stderr) consolidated in one single file for each container in /var/log/containers/stdout.

The host also applies log rotation to this directory, which prevents huge files and disk space issues.

In case a container is replaced, the new container outputs to the same log file, because podman uses the container name instead of container ID.

You can also check the logs for a containerized service with the podman logs command. For example, to view the logs for the keystone container, run the following command:

$ sudo podman logs keystone

Accessing containers
To enter the shell for a containerized service, use the podman exec command to launch /bin/bash. For example, to enter the shell for the keystone container, run the following command:

$ sudo podman exec -it keystone /bin/bash

To enter the shell for the keystone container as the root user, run the following command:

$ sudo podman exec --user 0 -it <NAME OR ID> /bin/bash

To exit the container, run the following command:

# exit

14.3. MODIFYING THE OVERCLOUD ENVIRONMENT
You can modify the overcloud to add additional features or alter existing operations.

Procedure

1. To modify the overcloud, make modifications to your custom environment files and heat templates, then rerun the openstack overcloud deploy command from your initial overcloud creation. For example, if you created an overcloud using Section 11.3, “Configuring and deploying the overcloud”, rerun the following command:
$ source ~/stackrc
(undercloud) $ openstack overcloud deploy --templates \
-e ~/templates/node-info.yaml \
-e /usr/share/openstack-tripleo-heat-templates/environments/network-isolation.yaml \
-e ~/templates/network-environment.yaml \
-e ~/templates/storage-environment.yaml \
--ntp-server pool.ntp.org

Director checks the **overcloud** stack in heat, and then updates each item in the stack with the environment files and heat templates. Director does not recreate the overcloud, but rather changes the existing overcloud.

**IMPORTANT**

Removing parameters from custom environment files does not revert the parameter value to the default configuration. You must identify the default value from the core heat template collection in `/usr/share/openstack-tripleo-heat-templates` and set the value in your custom environment file manually.

2. If you want to include a new environment file, add it to the `openstack overcloud deploy` command with the `-e` option. For example:

```
$ source ~/stackrc
(undercloud) $ openstack overcloud deploy --templates \
-e ~/templates/new-environment.yaml \
-e /usr/share/openstack-tripleo-heat-templates/environments/network-isolation.yaml \
-e ~/templates/network-environment.yaml \
-e ~/templates/storage-environment.yaml \
-e ~/templates/node-info.yaml \
--ntp-server pool.ntp.org
```

This command includes the new parameters and resources from the environment file into the stack.

**IMPORTANT**

It is not advisable to make manual modifications to the overcloud configuration because director might overwrite these modifications later.

### 14.4. IMPORTING VIRTUAL MACHINES INTO THE OVERCLOUD

You can migrate virtual machines from an existing OpenStack environment to your Red Hat OpenStack Platform (RHOSP) environment.

**Procedure**

1. On the existing OpenStack environment, create a new image by taking a snapshot of a running server and download the image:

```
$ openstack server image create instance_name --name image_name
$ openstack image save image_name --file exported_vm.qcow2
```

2. Copy the exported image to the undercloud node:
$ scp exported_vm.qcow2 stack@192.168.0.2:~/.

3. Log in to the undercloud as the **stack** user.

4. Source the **overcloudrc** file:

   $ source ~/overcloudrc

5. Upload the exported image into the overcloud:

   (overcloud) $ openstack image create imported_image --file exported_vm.qcow2 --disk-format qcow2 --container-format bare

6. Launch a new instance:

   (overcloud) $ openstack server create imported_instance --key-name default --flavor m1.demo --image imported_image --nic net-id=net_id

**IMPORTANT**

These commands copy each virtual machine disk from the existing OpenStack environment to the new Red Hat OpenStack Platform. QCOW snapshots lose their original layering system.

This process migrates all instances from a Compute node. You can now perform maintenance on the node without any instance downtime. To return the Compute node to an enabled state, run the following command:

$ source ~/overcloudrc
(overcloud) $ openstack compute service set [hostname] nova-compute --enable

### 14.5. RUNNING THE DYNAMIC INVENTORY SCRIPT

Director can run Ansible-based automation in your Red Hat OpenStack Platform (RHOSP) environment. Director uses the **tripleo-ansible-inventory** command to generate a dynamic inventory of nodes in your environment.

**Procedure**

1. To view a dynamic inventory of nodes, run the **tripleo-ansible-inventory** command after sourcing **stackrc**:

   $ source ~/stackrc
   (undercloud) $ tripleo-ansible-inventory --list

   Use the **--list** option to return details about all hosts. This command outputs the dynamic inventory in a JSON format:

   ```json
   {"overcloud": {"children": ["controller", "compute"], "vars": {"ansible_ssh_user": "heat-admin"}},
   "controller": ["192.168.24.2"], "undercloud": ["hosts": ["localhost"], "vars":
   ```
To execute Ansible playbooks on your environment, run the `ansible` command and include the full path of the dynamic inventory tool using the `-i` option. For example:

```
(undercloud) $ ansible [HOSTS] -i /bin/tripleo-ansible-inventory [OTHER OPTIONS]
```

- Replace `[HOSTS]` with the type of hosts that you want to use to use:
  - `controller` for all Controller nodes
  - `compute` for all Compute nodes
  - `overcloud` for all overcloud child nodes. For example, `controller` and `compute` nodes
  - `undercloud` for the undercloud
  - `*` for all nodes

- Replace `[OTHER OPTIONS]` with additional Ansible options.
  - Use the `--ssh-extra-args='-o StrictHostKeyChecking=no'` option to bypass confirmation on host key checking.
  - Use the `-u [USER]` option to change the SSH user that executes the Ansible automation. The default SSH user for the overcloud is automatically defined using the `ansible_ssh_user` parameter in the dynamic inventory. The `-u` option overrides this parameter.
  - Use the `-m [MODULE]` option to use a specific Ansible module. The default is `command`, which executes Linux commands.
  - Use the `-a [MODULE_ARGS]` option to define arguments for the chosen module.

**IMPORTANT**

Custom Ansible automation on the overcloud is not part of the standard overcloud stack. Subsequent execution of the `openstack overcloud deploy` command might override Ansible-based configuration for OpenStack Platform services on overcloud nodes.

### 14.6. REMOVING THE OVERCLOUD

To remove the overcloud, run the `openstack overcloud delete` command.

**Procedure**

1. Delete an existing overcloud:
   ```
   $ source ~/stackrc
   (undercloud) $ openstack overcloud delete overcloud
   ```

2. Confirm that the overcloud is no longer present in the output of the `openstack stack list` command:
   ```
   (undercloud) $ openstack stack list
   ```
Deletion takes a few minutes.

3. When the deletion completes, follow the standard steps in the deployment scenarios to recreate your overcloud.
CHAPTER 15. CONFIGURING THE OVERCLOUD WITH ANSIBLE

Ansible is the main method to apply the overcloud configuration. This chapter provides information about how to interact with the overcloud Ansible configuration.

Although director generates the Ansible playbooks automatically, it is a good idea to familiarize yourself with Ansible syntax. For more information about using Ansible, see https://docs.ansible.com/.

NOTE

Ansible also uses the concept of roles, which are different to OpenStack Platform director roles. **Ansible roles** form reusable components of playbooks, whereas director roles contain mappings of OpenStack services to node types.

15.1. ANSIBLE-BASED OVERCLOUD CONFIGURATION (CONFIG-DOWNLOAD)

The **config-download** feature is the method that director uses to configure the overcloud. Director uses **config-download** in conjunction with OpenStack Orchestration (heat) to generate the software configuration and apply the configuration to each overcloud node. Although heat creates all deployment data from **SoftwareDeployment** resources to perform the overcloud installation and configuration, heat does not apply any of the configuration. Heat only provides the configuration data through the heat API.

As a result, when you run the **openstack overcloud deploy** command, the following process occurs:

- Director creates a new deployment plan based on **openstack-tripleo-heat-templates** and includes any environment files and parameters to customize the plan.
- Director uses heat to interpret the deployment plan and create the overcloud stack and all descendant resources. This includes provisioning nodes with the OpenStack Bare Metal service (ironic).
- Heat also creates the software configuration from the deployment plan. Director compiles the Ansible playbooks from this software configuration.
- Director generates a temporary user (**tripleo-admin**) on the overcloud nodes specifically for Ansible SSH access.
- Director downloads the heat software configuration and generates a set of Ansible playbooks using heat outputs.
- Director applies the Ansible playbooks to the overcloud nodes using **ansible-playbook**.

15.2. CONFIG-DOWNLOAD WORKING DIRECTORY

The **ansible-playbook** command creates an Ansible project directory, default name  ~/config-download/overcloud. This project directory stores downloaded software configuration from heat. It includes all Ansible-related files which you need to run **ansible-playbook** to configure the overcloud.

The contents of the directory include:

- **tripleo-ansible-inventory.yaml** - Ansible inventory file containing **hosts** and **vars** for all the overcloud nodes.
After the project directory is created, run the `ansible-playbook-command.sh` command to reproduce the deployment.

```sh
$ ./ansible-playbook-command.sh
```

You can run the script with additional arguments, such as check mode `--check`, limiting hosts `--limit`, and overriding variables `-e`.

```sh
$ ./ansible-playbook-command.sh --check
```

### 15.3. CHECKING CONFIG-DOWNLOAD LOG

During the `config-download` process, Ansible creates a log file, named `ansible.log`, in the `/home/stack` directory on the undercloud.

**Procedure**

1. View the log with the `less` command:

```sh
$ less ~/ansible.log
```

### 15.4. PERFORMING GIT OPERATIONS ON THE WORKING DIRECTORY

The `config-download` working directory is a local Git repository. Every time a deployment operation runs, director adds a Git commit to the working directory with the relevant changes. You can perform Git operations to view configuration for the deployment at different stages and compare the configuration with different deployments.

Be aware of the limitations of the working directory. For example, if you use Git to revert to a previous version of the `config-download` working directory, this action affects only the configuration in the working directory. It does not affect the following configurations:

- **The overcloud data schema:** Applying a previous version of the working directory software configuration does not undo data migration and schema changes.

- **The hardware layout of the overcloud:** Reverting to previous software configuration does not undo changes related to overcloud hardware, such as scaling up or down.

- **The heat stack:** Reverting to earlier revisions of the working directory has no effect on the configuration stored in the heat stack. The heat stack creates a new version of the software configuration that applies to the overcloud. To make permanent changes to the overcloud, modify the environment files applied to the overcloud stack before you rerun the `openstack overcloud deploy` command.
Complete the following steps to compare different commits of the config-download working directory.

Procedure

1. Change to the config-download working directory for your overcloud, usually named overcloud:

   $ cd ~/config-download/overcloud

2. Run the git log command to list the commits in your working directory. You can also format the log output to show the date:

   $ git log --format=format: "%h%x09%cd%x09"
   a7e9063 Mon Oct 8 21:17:52 2018 +1000
   dfb9d12 Fri Oct 5 20:23:44 2018 +1000
   d0a910b Wed Oct 3 19:30:16 2018 +1000
   ...

   By default, the most recent commit appears first.

3. Run the git diff command against two commit hashes to see all changes between the deployments:

   $ git diff a7e9063 dfb9d12

15.5. DEPLOYMENT METHODS THAT USE CONFIG-DOWNLOAD

There are four main methods that use config-download in the context of an overcloud deployment:

Standard deployment

Run the openstack overcloud deploy command to automatically run the configuration stage after the provisioning stage. This is the default method when you run the openstack overcloud deploy command.

Separate provisioning and configuration

Run the openstack overcloud deploy command with specific options to separate the provisioning and configuration stages.

Run the ansible-playbook-command.sh script after a deployment

Run the openstack overcloud deploy command with combined or separate provisioning and configuration stages, then run the ansible-playbook-command.sh script supplied in the config-download working directory to re-apply the configuration stage.

Provision nodes, manually create config-download, and run Ansible

Run the openstack overcloud deploy command with a specific option to provision nodes, then run the ansible-playbook command with the deploy_steps_playbook.yaml playbook.

15.6. RUNNING CONFIG-DOWNLOAD ON A STANDARD DEPLOYMENT

The default method for executing config-download is to run the openstack overcloud deploy command. This method suits most environments.

Prerequisites
A successful undercloud installation.

Overcloud nodes ready for deployment.

Heat environment files that are relevant to your specific overcloud customization.

Procedure

1. Log in to the undercloud host as the stack user.

2. Source the stackrc file:

   ```bash
   $ source ~/stackrc
   ```

3. Run the deployment command. Include any environment files that you require for your overcloud:

   ```bash
   $ openstack overcloud deploy \
   --templates \
   -e environment-file1.yaml \
   -e environment-file2.yaml \
   ...
   ```

4. Wait until the deployment process completes.

During the deployment process, director generates the config-download files in a ~/config-download/overcloud working directory. After the deployment process finishes, view the Ansible playbooks in the working directory to see the tasks director executed to configure the overcloud.

15.7. RUNNING CONFIG-DOWNLOAD WITH SEPARATE PROVISIONING AND CONFIGURATION

The openstack overcloud deploy command runs the heat-based provisioning process and then the config-download configuration process. You can also run the deployment command to execute each process individually. Use this method to provision your overcloud nodes as a distinct process so that you can perform any manual pre-configuration tasks on the nodes before you run the overcloud configuration process.

Prerequisites

- A successful undercloud installation.
- Overcloud nodes ready for deployment.
- Heat environment files that are relevant to your specific overcloud customization.

Procedure

1. Log in to the undercloud host as the stack user.

2. Source the stackrc file:

   ```bash
   $ source ~/stackrc
   ```
3. Run the deployment command with the `--stack-only` option. Include any environment files you require for your overcloud:

```bash
$ openstack overcloud deploy \
   --templates \
   -e environment-file1.yaml \
   -e environment-file2.yaml \
   ... \
   --stack-only
```

4. Wait until the provisioning process completes.

5. Enable SSH access from the undercloud to the overcloud for the `tripleo-admin` user. The `config-download` process uses the `tripleo-admin` user to perform the Ansible-based configuration:

```bash
$ openstack overcloud admin authorize
```

6. Perform any manual pre-configuration tasks on nodes. If you use Ansible for configuration, use the `tripleo-admin` user to access the nodes.

7. Run the deployment command with the `--config-download-only` option. Include any environment files required for your overcloud:

```bash
$ openstack overcloud deploy \
   --templates \
   -e environment-file1.yaml \
   -e environment-file2.yaml \
   ... \
   --config-download-only
```

8. Wait until the configuration process completes.

During the configuration stage, director generates the `config-download` files in a `~/config-download/overcloud` working directory. After the deployment process finishes, view the Ansible playbooks in the working directory to see the tasks director executed to configure the overcloud.

### 15.8. RUNNING CONFIG-DOWNLOAD WITH THE ANSIBLE-PLAYBOOK-COMMAND.SH SCRIPT

When you deploy the overcloud, either with the standard method or a separate provisioning and configuration process, director generates a working directory in `~/config-download/overcloud`. This directory contains the playbooks and scripts necessary to run the configuration process again.

**Prerequisites**

- An overcloud deployed with one of the following methods:
  - Standard method that combines provisioning and configuration process.
  - Separate provisioning and configuration processes.

**Procedure**
1. Log in to the undercloud host as the stack user.

2. Run the ansible-playbook-command.sh script.
   You can pass additional Ansible arguments to this script, which are then passed unchanged to the ansible-playbook command. This makes it possible to take advantage of Ansible features, such as check mode (--check), limiting hosts (--limit), or overriding variables (-e). For example:

   ```bash
   $ ./ansible-playbook-command.sh --limit Controller
   ```

   **WARNING**
   When --limit is used to deploy at scale, only hosts included in the execution are added to the SSH known_hosts file across the nodes. Therefore, some operations, such as live migration, may not work across nodes that are not in the known_hosts file.

3. Wait until the configuration process completes.

**Additional information**

- The working directory contains a playbook called deploy_steps_playbook.yaml, which manages the overcloud configuration tasks. To view this playbook, run the following command:

  ```bash
  $ less deploy_steps_playbook.yaml
  ```

  The playbook uses various task files contained in the working directory. Some task files are common to all OpenStack Platform roles and some are specific to certain OpenStack Platform roles and servers.

- The working directory also contains sub-directories that correspond to each role that you define in your overcloud roles_data file. For example:

  ```bash
  $ ls Controller/
  ```

  Each OpenStack Platform role directory also contains sub-directories for individual servers of that role type. The directories use the composable role hostname format:

  ```bash
  $ ls Controller/overcloud-controller-0
  ```

- The Ansible tasks in deploy_steps_playbook.yaml are tagged. To see the full list of tags, use the CLI option --list-tags with ansible-playbook:

  ```bash
  $ ansible-playbook -i tripleo-ansible-inventory.yaml --list-tags deploy_steps_playbook.yaml
  ```

  Then apply tagged configuration using the --tags, --skip-tags, or --start-at-task with the ansible-playbook-command.sh script:
4. When you run the `config-download` playbooks against the overcloud, you might receive a message regarding the SSH fingerprint for each host. To avoid these messages, include `--ssh-common-args="-o StrictHostKeyChecking=no"` when you run the `ansible-playbook-command.sh` script:

```
$ ./ansible-playbook-command.sh --tags overcloud --ssh-common-args="-o StrictHostKeyChecking=no"
```

15.9. RUNNING CONFIG-DOWNLOAD WITH MANUALLY CREATED PLAYBOOKS

You can create your own `config-download` files outside of the standard workflow. For example, you can run the `openstack overcloud deploy` command with the `--stack-only` option to provision the nodes, and then manually apply the Ansible configuration separately.

Prerequisites

- A successful undercloud installation.
- Overcloud nodes ready for deployment.
- Heat environment files that are relevant to your specific overcloud customization.

Procedure

1. Log in to the undercloud host as the `stack` user.

2. Source the `stackrc` file:

   ```
   $ source ~/stackrc
   ```

3. Run the deployment command with the `--stack-only` option. Include any environment files required for your overcloud:

   ```
   $ openstack overcloud deploy \
   --templates \
   -e environment-file1.yaml \
   -e environment-file2.yaml \
   ... \
   --stack-only
   ```

4. Wait until the provisioning process completes.

5. Enable SSH access from the undercloud to the overcloud for the `tripleo-admin` user. The `config-download` process uses the `tripleo-admin` user to perform the Ansible-based configuration:

   ```
   $ openstack overcloud admin authorize
   ```

6. Generate the `config-download` files:
7. Change to the directory that contains your `config-download` files:

    $ cd ~/config-download

8. Generate a static inventory file:

    $ tripleo-ansible-inventory
        --stack <overcloud>
        --ansible_ssh_user heat-admin
        --static-yaml-inventory inventory.yaml

    Replace `<overcloud>` with the name of your overcloud.

9. Use the `config-download` files and the static inventory file to perform a configuration. To execute the deployment playbook, run the `ansible-playbook` command:

    $ ansible-playbook
        -i inventory.yaml
        -e gather_facts=True
        -e @global_vars.yaml
        --private-key ~/.ssh/id_rsa
        --become
        ~/config-download/deploy_steps_playbook.yaml

10. Wait until the configuration process completes.

11. To generate an `overcloudrc` file manually from this configuration, run the following command:

    $ openstack action execution run
        --save-result
        --run-sync
        tripleo.deployment.overcloudrc
        '{"container":"overcloud"}'
        | jq -r ".["result"]['overcloudrc.v3']" > overcloudrc.v3

12. Manually set the deployment status to success:

    $ openstack workflow execution create
        tripleo.deployment.v1.set_deployment_status_success
        '{"plan": "<OVERCLOUD>"}'

    Replace `<OVERCLOUD>` with the name of your overcloud.

Additional information

- The `config-download` directory contains a playbook called `deploy_steps_playbook.yaml`, which runs the overcloud configuration. To view this playbook, run the following command:
The playbook uses various task files contained in the working directory. Some task files are common to all OpenStack Platform roles and some are specific to certain OpenStack Platform roles and servers.

- The `config-download` directory also contains sub-directories that correspond to each role that you define in your `overcloud roles_data` file. For example:

```
$ ls Controller/
```

Each OpenStack Platform role directory also contains sub-directories for individual servers of that role type. The directories use the composable role hostname format:

```
$ ls Controller/overcloud-controller-0
```

- The Ansible tasks in `deploy_steps_playbook.yaml` are tagged. To see the full list of tags, use the CLI option `--list-tags` with `ansible-playbook`:

```
$ ansible-playbook -i tripleo-ansible-inventory.yaml --list-tags deploy_steps_playbook.yaml
```

Then apply tagged configuration using the `--tags`, `--skip-tags`, or `--start-at-task` with the `ansible-playbook-command.sh` script:

```
$ ansible-playbook  
  -i inventory.yaml  
  -e gather_facts=true  
  -e @global_vars.yaml  
  --private-key ~/.ssh/id_rsa  
  --become  
  --tags overcloud  
  ~/config-download/deploy_steps_playbook.yaml
```

1. When you run the `config-download` playbooks against the overcloud, you might receive a message regarding the SSH fingerprint for each host. To avoid these messages, include `--ssh-common-args="-o StrictHostKeyChecking=no"` to your `ansible-playbook` command:

```
$ ansible-playbook  
  -i inventory.yaml  
  -e gather_facts=true  
  -e @global_vars.yaml  
  --private-key ~/.ssh/id_rsa  
  --ssh-common-args="-o StrictHostKeyChecking=no"  
  --become  
  --tags overcloud  
  ~/config-download/deploy_steps_playbook.yaml
```

## 15.10. LIMITATIONS OF CONFIG-DOWNLOAD

The `config-download` feature has some limitations:

- When you use `ansible-playbook` CLI arguments such as `--tags`, `--skip-tags`, or `--start-at-task`, do
not run or apply deployment configuration out of order. These CLI arguments are a convenient way to rerun previously failed tasks or to iterate over an initial deployment. However, to guarantee a consistent deployment, you must run all tasks from `deploy_steps_playbook.yaml` in order.

- You can not use the `--start-at-task` arguments for certain tasks that use a variable in the task name. For example, the `--start-at-task` arguments does not work for the following Ansible task:

  ```
  - name: Run puppet host configuration for step {{ step }}
  ```

- If your overcloud deployment includes a director-deployed Ceph Storage cluster, you cannot skip `step1` tasks when you use the `--check` option unless you also skip `external_deploy_steps` tasks.

- You can set the number of parallel Ansible tasks with the `--forks` option. However, the performance of `config-download` operations degrades after 25 parallel tasks. For this reason, do not exceed 25 with the `--forks` option.

## 15.11. CONFIG-DOWNLOAD TOP LEVEL FILES

The following file are important top level files within a `config-download` working directory.

### Ansible configuration and execution

The following files are specific to configuring and executing Ansible within the `config-download` working directory.

- **ansible.cfg**
  Configuration file used when running `ansible-playbook`.

- **ansible.log**
  Log file from the last run of `ansible-playbook`.

- **ansible-errors.json**
  JSON structured file that contains any deployment errors.

- **ansible-playbook-command.sh**
  Executable script to rerun the `ansible-playbook` command from the last deployment operation.

- **ssh_private_key**
  Private SSH key that Ansible uses to access the overcloud nodes.

- **tripleo-ansible-inventory.yaml**
  Ansible inventory file that contains hosts and variables for all the overcloud nodes.

- **overcloud-config.tar.gz**
  Archive of the working directory.

### Playbooks

The following files are playbooks within the `config-download` working directory.

- **deploy_steps_playbook.yaml**
  Main deployment steps. This playbook performs the main configuration operations for your overcloud.

- **pre_upgrade_rolling_steps_playbook.yaml**
  Pre upgrade steps for major upgrade
upgrade_steps_playbook.yaml
Major upgrade steps.

post_upgrade_steps_playbook.yaml
Post upgrade steps for major upgrade.

update_steps_playbook.yaml
Minor update steps.

fast_forward_upgrade_playbook.yaml
Fast forward upgrade tasks. Use this playbook only when you want to upgrade from one long-life version of Red Hat OpenStack Platform to the next.

15.12. CONFIG-DOWNLOAD TAGS

The playbooks use tagged tasks to control the tasks that they apply to the overcloud. Use tags with the ansible-playbook CLI arguments --tags or --skip-tags to control which tasks to execute. The following list contains information about the tags that are enabled by default:

facts
Fact gathering operations.

common_roles
Ansible roles common to all nodes.

overcloud
All plays for overcloud deployment.

pre_deploy_steps
Deployments that happen before the deploy_steps operations.

host_prep_steps
Host preparation steps.

deploy_steps
Deployment steps.

post_deploy_steps
Steps that happen after the deploy_steps operations.

external
All external deployment tasks.

external_deploy_steps
External deployment tasks that run on the undercloud only.

15.13. CONFIG-DOWNLOAD DEPLOYMENT STEPS

The deploy_steps_playbook.yaml playbook configures the overcloud. This playbook applies all software configuration that is necessary to deploy a full overcloud based on the overcloud deployment plan.

This section contains a summary of the different Ansible plays used within this playbook. The play names in this section are the same names that are used within the playbook and that are displayed in the ansible-playbook output. This section also contains information about the Ansible tags that are set on each play.

Gather facts from undercloud
Fact gathering for the undercloud node.
Tags: facts

Gather facts from overcloud
Fact gathering for the overcloud nodes.
Tags: facts

Load global variables
Loads all variables from global_vars.yaml.
Tags: always

Common roles for TripleO servers
Applies common Ansible roles to all overcloud nodes, including tripleo-bootstrap for installing bootstrap packages, and tripleo-ssh-known-hosts for configuring ssh known hosts.
Tags: common_roles

Overcloud deploy step tasks for step 0
Applies tasks from the deploy_steps_tasks template interface.
Tags: overcloud, deploy_steps

Server deployments
Applies server-specific heat deployments for configuration such as networking and hieradata. Includes NetworkDeployment, <Role>Deployment, <Role>AllNodesDeployment, etc.
Tags: overcloud, pre_deploy_steps

Host prep steps
Applies tasks from the host_prep_steps template interface.
Tags: overcloud, host_prep_steps

External deployment step [1,2,3,4,5]
Applies tasks from the external_deploy_steps_tasks template interface. Ansible runs these tasks only against the undercloud node.
Tags: external, external_deploy_steps

Overcloud deploy step tasks for [1,2,3,4,5]
Applies tasks from the deploy_steps_tasks template interface.
Tags: overcloud, deploy_steps

Overcloud common deploy step tasks [1,2,3,4,5]
Applies the common tasks performed at each step, including puppet host configuration, container-puppet.py, and tripleo-container-manage (container configuration and management).
Tags: overcloud, deploy_steps

Server Post Deployments
Applies server specific heat deployments for configuration performed after the 5-step deployment process.
Tags: overcloud, post_deploy_steps

External deployment Post Deploy tasks
Applies tasks from the external_post_deploy_steps_tasks template interface. Ansible runs these tasks only against the undercloud node.

**Tags:** external, external_deploy_steps
CHAPTER 16. MANAGING CONTAINERS WITH ANSIBLE

Red Hat OpenStack Platform 17.0-beta uses the `tripleo_container_manage` Ansible role to perform management operations on containers. You can also write custom playbooks to perform specific container management operations:

- Collect the container configuration data that heat generates. The `tripleo_container_manage` role uses this data to orchestrate container deployment.
- Start containers.
- Stop containers.
- Update containers.
- Delete containers.
- Run a container with a specific configuration.

Although director performs container management automatically, you might want to customize a container configuration, or apply a hotfix to a container without redeploying the overcloud.

**NOTE**

This role supports only Podman container management.

### 16.1. TRIPLEO-CONTAINER-MANAGE ROLE DEFAULTS AND VARIABLES

The following excerpt shows the defaults and variables for the `tripleo_container_manage` Ansible role.

```yaml
# All variables intended for modification should be placed in this file.
tripleo_container_manage_hide_sensitive_logs: '{{ hide_sensitive_logs | default(true) }}'
tripleo_container_manage_debug: '{{ ((ansible_verbosity | int) >= 2) | bool }}'
tripleo_container_manage_clean_orphans: true
# All variables within this role should have a prefix of "tripleo_container_manage"
tripleo_container_manage_check_puppet_config: false
tripleo_container_manage_cli: podman
tripleo_container_manage_concurrency: 1
tripleo_container_manage_config: /var/lib/tripleo-config/
tripleo_container_manage_config_id: tripleo
tripleo_container_manage_config_overrides: {}
tripleo_container_manage_config_patterns: '*.json'
# Some containers where Puppet is run, can take up to 10 minutes to finish
# in slow environments.
tripleo_container_manage_create_retries: 120
# Default delay is 5s so 120 retries makes a timeout of 10 minutes which is
# what we have observed a necessary value for nova and neutron db-sync execs.
tripleo_container_manage_exec_retries: 120
tripleo_container_manage_healthcheck_disabled: false
tripleo_container_manage_log_path: /var/log/containers/stdouts
tripleo_container_manage_systemd.teardown: true
```
16.2. TRIPLEO-CONTAINER-MANAGE MOLECULE SCENARIOS

**Molecule** is used to test the `tripleo_container_manage` role. The following shows a `molecule` default inventory:

```yaml
hosts:
  all:
    hosts:
      instance:
        ansible_host: localhost
        ansible_connection: local
        ansible_distribution: centos8
```

**Usage**

Red Hat OpenStack 17.0-beta supports only Podman in this role. Docker support is on the roadmap.

The **Molecule** Ansible role performs the following tasks:

- Collect container configuration data, generated by the TripleO Heat Templates. This data is used as a source of truth. If a container is already managed by **Molecule**, no matter its present state, the configuration data will reconfigure the container as needed.

- Manage **systemd** shutdown files. It creates the **TripleO Container systemd** service, required for service ordering when shutting down or starting a node. It also manages the **netns-placeholder** service.

- Delete containers that are no longer needed or that require reconfiguration. It uses a custom filter, named `needs_delete()` which has a set of rules to determine if the container needs to be deleted.
  
  - A container will not be deleted if, the container is not managed by **tripleo_ansible** or the container `config_id` does not match the input ID.

  - A container will be deleted, if the container has no `config_data` or the container has `config_data` which does not match data in input. Note that when a container is removed, the role also disables and removes the **systemd** services and healthchecks.

- Create containers in a specific order defined by `start_order` container config, where the default is 0.
  
  - If the container is an `exec`, a dedicated playbook for `execs` is run, using **async** so multiple `execs` can be run at the same time.

  - Otherwise, the `podman_container` is used, in **async**, to create the containers. If the container has a `restart policy`, **systemd** service is configured. If the container has a healthcheck script, **systemd healthcheck** service is configured.

**NOTE**

`tripleo_container_manage_concurrency` parameter is set to 1 by default, and putting a value higher than 2 can expose issues with Podman locks.

Example of a playbook:

- name: Manage step_1 containers using tripleo-ansible
block:
- name: "Manage containers for step 1 with tripleo-ansible"
  include_role:
    name: tripleo_container_manage
  vars:
    tripleo_container_manage_config: "/var/lib/tripleo-config/container-startup-config/step_1"
    tripleo_container_manage_config_id: "tripleo_step1"

16.3. TRIPLEO_CONTAINER_MANAGE ROLE VARIABLES

The `tripleo_container_manage` Ansible role contains the following variables:

Table 16.1. Role variables

<table>
<thead>
<tr>
<th>Name</th>
<th>Default value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>tripleo_container_manage_check_puppet_config</td>
<td>false</td>
<td>Use this variable if you want Ansible to check Puppet container configurations. Ansible can identify updated container configuration using the configuration hash. If a container has a new configuration from Puppet, set this variable to <code>true</code> so that Ansible can detect the new configuration and add the container to the list of containers that Ansible must restart.</td>
</tr>
<tr>
<td>tripleo_container_manage_cli</td>
<td>podman</td>
<td>Use this variable to set the command line interface that you want to use to manage containers. The <code>tripleo_container_manage</code> role supports only Podman.</td>
</tr>
<tr>
<td>tripleo_container_manage_concurrency</td>
<td>1</td>
<td>Use this variable to set the number of containers that you want to manage concurrently.</td>
</tr>
<tr>
<td>tripleo_container_manage_config</td>
<td>/var/lib/tripleo-config/</td>
<td>Use this variable to set the path to the container configuration directory.</td>
</tr>
<tr>
<td>tripleo_container_manage_config_id</td>
<td>tripleo</td>
<td>Use this variable to set the ID of a specific configuration step. For example, set this value to <code>tripleo_step2</code> to manage containers for step two of the deployment.</td>
</tr>
<tr>
<td>Name</td>
<td>Default value</td>
<td>Description</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>---------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>tripleo_container_manage_config_patterns</td>
<td>*.json</td>
<td>Use this variable to set the bash regular expression that identifies configuration files in the container configuration directory.</td>
</tr>
<tr>
<td>tripleo_container_manage_debug</td>
<td>false</td>
<td>Use this variable to enable or disable debug mode. Run the tripleo_container_manage role in debug mode if you want to run a container with a specific one-time configuration, to output the container commands that manage the lifecycle of containers, or to run no-op container management operations for testing and verification purposes.</td>
</tr>
<tr>
<td>tripleo_container_manage_health_check_disable</td>
<td>false</td>
<td>Use this variable to enable or disable healthchecks.</td>
</tr>
<tr>
<td>tripleo_container_manage_log_path</td>
<td>/var/log/containers/stdouts</td>
<td>Use this variable to set the stdout log path for containers.</td>
</tr>
<tr>
<td>tripleo_container_manage_systemd_order</td>
<td>false</td>
<td>Use this variable to enable or disable systemd shutdown ordering with Ansible.</td>
</tr>
<tr>
<td>tripleo_container_manage_systemd_teardown</td>
<td>true</td>
<td>Use this variable to trigger the cleanup of obsolete containers.</td>
</tr>
<tr>
<td>tripleo_container_manage_config_overrides</td>
<td>{}</td>
<td>Use this variable to override any container configuration. This variable takes a dictionary of values where each key is the container name and the parameters that you want to override, for example, the container image or user. This variable does not write custom overrides to the JSON container configuration files and any new container deployments, updates, or upgrades revert to the content of the JSON configuration file.</td>
</tr>
<tr>
<td>tripleo_container_manage_valid_exit_code</td>
<td>[]</td>
<td>Use this variable to check if a container returns an exit code. This value must be a list, for example, [0,3].</td>
</tr>
</tbody>
</table>
16.4. TRIPLEO-CONTAINER-MANAGE HEALTHCHECKS

Until Red Hat OpenStack 17.0-beta, container healthcheck was implemented by a systemd timer which would run podman exec to determine if a given container was healthy. Now, it uses the native healthcheck interface in Podman which is easier to integrate and consume.

To check if a container (for example, keystone) is healthy, run the following command:

```
$ sudo podman healthcheck run keystone
```

The return code should be 0 and “healthy”.

```
"Healthcheck": {
  "Status": "healthy",
  "FailingStreak": 0,
  "Log": [
    {
      "Start": "2020-04-14T18:48:57.272180578Z",
      "End": "2020-04-14T18:48:57.806659104Z",
      "ExitCode": 0,
      "Output": ""
    },
    (...)
  ]
}
```

16.5. TRIPLEO-CONTAINER-MANAGE DEBUG

The tripleo_container_manage Ansible role allows you to perform specific actions on a given container. This can be used to:

- Run a container with a specific one-off configuration.
- Output the container commands to manage containers lifecycle.
- Output the changes made on containers by Ansible.

**NOTE**

To manage a single container, you need to know two things:

- At which step during the overcloud deployment was the container deployed.
- The name of the generated JSON file containing the container configuration.

The following is an example of a playbook to manage HAproxy container at step 1 which overrides the image setting:

```
- hosts: localhost
  become: true
  tasks:
    - name: Manage step_1 containers using tripleo-ansible
      block:
        - name: "Manage HAproxy container at step 1 with tripleo-ansible"
```
If Ansible is run in **check mode**, no container is removed or created, however at the end of the playbook run a list of commands is displayed to show the possible outcome of the playbook. This is useful for debugging purposes.

```bash
$ ansible-playbook haproxy.yaml --check
```

Adding the **diff mode** will show the changes that would have been made on containers by Ansible.

```bash
$ ansible-playbook haproxy.yaml --check --diff
```

The **tripleo_containermanage_clean_orphans** parameter is optional. It can be set to false meaning orphaned containers, with a specific **config_id**, will not be removed. It can be used to manage a single container without impacting other running containers with same **config_id**.

The **tripleo_containermanage_config_overrides** parameter is optional and can be used to override a specific container attribute, for example the image or the container user. The parameter creates dictionary with container name and the parameters to override. These parameters have to exist and they define the container configuration in TripleO Heat Templates.

Note the dictionary does not update the overrides in the JSON file so if an update or upgrade is executed, the container will be re-configured with the configuration in the JSON file.
CHAPTER 17. USING THE VALIDATION FRAMEWORK

Red Hat OpenStack Platform includes a validation framework that you can use to verify the requirements and functionality of the undercloud and overcloud. The framework includes two types of validations:

- Manual Ansible-based validations, which you execute through the `openstack tripleo validator` command set.
- Automatic in-flight validations, which execute during the deployment process.

You must understand which validations you want to run, and skip validations that are not relevant to your environment. For example, the pre-deployment validation includes a test for TLS-everywhere. If you do not intend to configure your environment for TLS-everywhere, this test fails. Use the `--validation` option in the `openstack tripleo validator run` command to refine the validation according to your environment.

17.1. ANSIBLE-BASED VALIDATIONS

During the installation of Red Hat OpenStack Platform director, director also installs a set of playbooks from the `openstack-tripleo-validations` package. Each playbook contains tests for certain system requirements and a set of groups that define when to run the test:

**no-op**
- Validations that run a no-op (no operation) task to verify to workflow functions correctly. These validations run on both the undercloud and overcloud.

**prep**
- Validations that check the hardware configuration of the undercloud node. Run these validation before you run the `openstack undercloud install` command.

**openshift-on-openstack**
- Validations that check that the environment meets the requirements to be able to deploy OpenShift on OpenStack.

**pre-introspection**
- Validations to run before the nodes introspection using Ironic Inspector.

**pre-deployment**
- Validations to run before the `openstack overcloud deploy` command.

**post-deployment**
- Validations to run after the overcloud deployment has finished.

**pre-upgrade**
- Validations to validate your OpenStack deployment before an upgrade.

**post-upgrade**
- Validations to validate your OpenStack deployment after an upgrade.

17.2. LISTING VALIDATIONS

Run the `openstack tripleo validator list` command to list the different types of validations available.

Procedure
1. Source the stackrc file:

```
$ source ~/stackrc
```

2. Run the openstack tripleo validator list command:

- To list all validations, run the command without any options:

```
$ openstack tripleo validator list
```

- To list validations in a group, run the command with the \(--\text{group}\) option:

```
$ openstack tripleo validator list --group prep
```

**NOTE**

For a full list of options, run `openstack tripleo validator list --help`.

### 17.3. RUNNING VALIDATIONS

To run a validation or validation group, use the openstack tripleo validator run command. To see a full list of options, use the `openstack tripleo validator run --help` command.

**Procedure**

1. Source the stackrc file:

```
$ source ~/stackrc
```

2. Create and validate a static inventory file called `inventory.yaml`.

```
$ tripleo-ansible-inventory --static-yaml-inventory inventory.yaml
$ openstack tripleo validator run --group pre-introspection -i inventory.yaml
```

3. Enter the openstack tripleo validator run command:

- To run a single validation, enter the command with the \(--\text{validation}\) option and the name of the validation. For example, to check the memory requirements of each node, enter \(--\text{validation check-ram}\):

```
$ openstack tripleo validator run --validation check-ram
```

If the overcloud uses a plan name that is different to the default overcloud name, set the plan name with the \(--\text{plan}\) option:

```
$ openstack tripleo validator run --validation check-ram --plan myovercloud
```

To run multiple specific validations, use the \(--\text{validation}\) option with a comma-separated list of the validations that you want to run. For more information about viewing the list of available validations, see Listing validations.

- To run all validations in a group, enter the command with the \(--\text{group}\) option:
$ openstack tripleo validator run --group prep

To view detailed output from a specific validation, run the `openstack tripleo validator show run --full` command against the UUID of the specific validation from the report:

$ openstack tripleo validator show run --full <UUID>

17.4. VIEWING VALIDATION HISTORY

Director saves the results of each validation after you run a validation or group of validations. View past validation results with the `openstack tripleo validator show history` command.

**Prerequisites**
- You have run a validation or group of validations.

**Procedure**

1. Source the `stackrc` file:

   $ source ~/stackrc

2. View a list of all validations:

   $ openstack tripleo validator show history

   To view history for a specific validation type, run the same command with the `--validation` option:

   $ openstack tripleo validator show history --validation ntp

3. View the log for a specific validation UUID with the `openstack tripleo validator show run --full` command:

   $ openstack tripleo validator show run --full 7380fed4-2ea1-44a1-ab71-aab561b44395

**Additional resources**
- Using the validation framework

17.5. VALIDATION FRAMEWORK LOG FORMAT

After you run a validation or group of validations, director saves a JSON-formatted log from each validation in the `/var/logs/validations` directory. You can view the file manually or use the `openstack tripleo validator show run --full` command to display the log for a specific validation UUID.

Each validation log file follows a specific format:

- `<UUID>_<Name>_<Time>`

  **UUID**

  The Ansible UUID for the validation.
Name
The Ansible name for the validation.

Time
The start date and time for when you ran the validation.

Each validation log contains three main parts:

- plays
- stats
- validation_output

plays
The **plays** section contains information about the tasks that the director performed as part of the validation:

play
A play is a group of tasks. Each **play** section contains information about that particular group of tasks, including the start and end times, the duration, the host groups for the play, and the validation ID and path.

tasks
The individual Ansible tasks that director runs to perform the validation. Each **tasks** section contains a **hosts** section, which contains the action that occurred on each individual host and the results from the execution of the actions. The **tasks** section also contains a **task** section, which contains the duration of the task.

stats
The **stats** section contains a basic summary of the outcome of all tasks on each host, such as the tasks that succeeded and failed.

validation_output
If any tasks failed or caused a warning message during a validation, the **validation_output** contains the output of that failure or warning.

### 17.6. VALIDATION FRAMEWORK LOG OUTPUT FORMATS

The default behaviour of the validation framework is to save validation logs in JSON format. You can change the output of the logs with the **ANSIBLE_STDOUT_CALLBACK** environment variable.

To change the validation output log format, run a validation and include the **--extra-env-vars ANSIBLE_STDOUT_CALLBACK=<callback>** option:

```
$ openstack tripleo validator run --extra-env-vars ANSIBLE_STDOUT_CALLBACK=<callback> --
validation check-ram
```

Replace `<callback>` with an Ansible output callback. To view a list of the standard Ansible output callbacks, run the following command:

```
$ ansible-doc -t callback -l
```
The validation framework includes the following additional callbacks.

**validation_json**

The framework saves JSON-formatted validation results as a log file in /var/logs/validations. This is the default callback for the validation framework.

**validation_stdout**

The framework displays JSON-formatted validation results on screen.

**http_json**

The framework sends JSON-formatted validation results to an external logging server. You must also include additional environment variables for this callback:

HTTP_JSON_SERVER

The URL for the external server.

HTTP_JSON_PORT

The port for the API entry point of the external server. The default port is 8989.

Set these environment variables with additional --extra-env-vars options:

```bash
$ openstack tripleo validator run --extra-env-vars ANSIBLE_STDOUT_CALLBACK=http_json \  --extra-env-vars HTTP_JSON_SERVER=http://logserver.example.com \  --extra-env-vars HTTP_JSON_PORT=8989 \  --validation check-ram
```

**IMPORTANT**

Before you use the http_json callback, you must add http_json to the callback_whitelist parameter in your ansible.cfg file:

```
callback_whitelist = http_json
```

### 17.7. IN-FLIGHT VALIDATIONS

Red Hat OpenStack Platform includes in-flight validations in the templates of composable services. In-flight validations verify the operational status of services at key steps of the overcloud deployment process.

In-flight validations run automatically as part of the deployment process. Some in-flight validations also use the roles from the openstack-tripleo-validations package.
CHAPTER 18. SCALING OVERCLOUD NODES

If you want to add or remove nodes after the creation of the overcloud, you must update the overcloud.

WARNING

Do not use `openstack server delete` to remove nodes from the overcloud. Follow the procedures in this section to remove and replace nodes correctly.

NOTE

Ensure that your bare metal nodes are not in maintenance mode before you begin scaling out or removing an overcloud node.

Use the following table to determine support for scaling each node type:

Table 18.1. Scale support for each node type

<table>
<thead>
<tr>
<th>Node type</th>
<th>Scale up?</th>
<th>Scale down?</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controller</td>
<td>N</td>
<td>N</td>
<td>You can replace Controller nodes using the procedures in Chapter 19, Replacing Controller nodes.</td>
</tr>
<tr>
<td>Compute</td>
<td>Y</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>Ceph Storage nodes</td>
<td>Y</td>
<td>N</td>
<td>You must have at least 1 Ceph Storage node from the initial overcloud creation.</td>
</tr>
<tr>
<td>Object Storage nodes</td>
<td>Y</td>
<td>Y</td>
<td></td>
</tr>
</tbody>
</table>

IMPORTANT

Ensure that you have at least 10 GB free space before you scale the overcloud. This free space accommodates image conversion and caching during the node provisioning process.

18.1. ADDING NODES TO THE OVERCLOUD

Complete the following steps to add more nodes to the director node pool.
NOTE

A fresh installation of Red Hat OpenStack Platform does not include certain updates, such as security errata and bug fixes. As a result, if you are scaling up a connected environment that uses the Red Hat Customer Portal or Red Hat Satellite Server, RPM updates are not applied to new nodes. To apply the latest updates to the overcloud nodes, you must do one of the following:

- Complete an overcloud update of the nodes after the scale-out operation.
- Use the **virt-customize** tool to modify the packages to the base overcloud image before the scale-out operation. For more information, see the Red Hat Knowledgebase solution Modifying the Red Hat Linux OpenStack Platform Overcloud Image with virt-customize.

Procedure

1. Create a new JSON file called **newnodes.json** that contains details of the new node that you want to register:

   ```json
   {
     "nodes": [
       {
         "mac": [
           "dd:dd:dd:dd:dd:dd"
         ],
         "cpu": "4",
         "memory": "6144",
         "disk": "40",
         "arch": "x86_64",
         "pm_type": "ipmi",
         "pm_user": "admin",
         "pm_password": "p@55w0rd!",
         "pm_addr": "192.168.24.207"
       },
       {
         "mac": [
           "ee:ee:ee:ee:ee:ee"
         ],
         "cpu": "4",
         "memory": "6144",
         "disk": "40",
         "arch": "x86_64",
         "pm_type": "ipmi",
         "pm_user": "admin",
         "pm_password": "p@55w0rd!",
         "pm_addr": "192.168.24.208"
       }
     ]
   }
   ```

2. Register the new nodes:

   ```bash
   $ source ~/stackrc
   (undercloud) $ openstack overcloud node import newnodes.json
   ```
After you register the new nodes, launch the introspection process for each new node:

```
(undercloud) $ openstack overcloud node introspect [NODE UUID] --provide
```

This process detects and benchmarks the hardware properties of the nodes.

Configure the image properties for the node:

```
(undercloud) $ openstack overcloud node configure [NODE UUID]
```

### 18.2. INCREASING NODE COUNTS FOR ROLES

Complete the following steps to scale overcloud nodes for a specific role, such as a Compute node.

**Procedure**

1. Tag each new node with the role you want. For example, to tag a node with the Compute role, run the following command:

   ```
   (undercloud) $ openstack baremetal node set --property capabilities='profile:compute,boot_option:local' [NODE UUID]
   ```

2. To scale the overcloud, you must edit the environment file that contains your node counts and re-deploy the overcloud. For example, to scale your overcloud to 5 Compute nodes, edit the `ComputeCount` parameter:

   ```yaml
   parameter_defaults:
   ...
   ComputeCount: 5
   ...
   ```

3. Rerun the deployment command with the updated file, which in this example is called `node-info.yaml`:

   ```
   (undercloud) $ openstack overcloud deploy --templates -e /home/stack/templates/node-info.yaml [OTHER_OPTIONS]
   ```

   Ensure that you include all environment files and options from your initial overcloud creation. This includes the same scale parameters for non-Compute nodes.

4. Wait until the deployment operation completes.

### 18.3. SCALING UP BARE METAL NODES

To increase the count of bare metal nodes in an existing overcloud, increment the node count in the `~/.overcloud-baremetal-deploy.yaml` file and redeploy the overcloud.

**Prerequisites**

- A successful undercloud installation. For more information, see [Installing director](#).
- A successful overcloud deployment. For more information, see [Configuring a basic overcloud with pre-provisioned nodes](#).
Bare metal nodes introspected and available for provisioning and deployment. For more information, see Registering nodes for the overcloud and Creating an inventory of the bare-metal node hardware.

Procedure

1. Source the stackrc undercloud credential file:

   ```bash
   $ source ~/stackrc
   ```

2. Edit the `~/.overcloud-baremetal-deploy.yaml` file that you used to provision your bare metal nodes, and increment the `count` parameter for the roles that you want to scale up. For example, if your overcloud contains three Compute nodes, use the following snippet to increase the Compute node count to 10:

   ```yaml
   - name: Controller
     count: 3
   - name: Compute
     count: 10
   ```

   You can also add predictive node placement with the `instances` parameter. For more information about the parameters and attributes that are available, see Bare metal node provisioning attributes.

3. Provision the overcloud nodes, specifying the name of the heat environment file that the provisioning process generates for inclusion in the deployment command:

   ```bash
   (undercloud)$ openstack overcloud node provision \
   --stack stack \
   --output ~/overcloud-baremetal-deployed.yaml \
   ~/overcloud-baremetal-deploy.yaml
   ```

4. Monitor the provisioning progress in a separate terminal. When provisioning is successful, the node state changes from available to active:

   ```bash
   (undercloud)$ watch openstack baremetal node list
   ```

5. Add the `~/.overcloud-baremetal-deployed.yaml` file generated by the provisioning command to the stack with your other environment files, and deploy the overcloud:

   ```bash
   (undercloud)$ openstack overcloud deploy \
   ... \
   -e /usr/share/openstack-tripleo-heat-templates/environments/deployed-server-environment.yaml \
   -e ~/.overcloud-baremetal-deployed.yaml \
   -e [your environment files] \
   --deployed-server \
   --disable-validations \
   ...
   ```

18.4. SCALING DOWN BARE METAL NODES
Tag the nodes that you want to delete from the stack in the `~/overcloud-baremetal-deploy.yaml` file, redeploy the overcloud, and then include this file in the `openstack overcloud node delete` command with the `--baremetal-deployment` option.

**Prerequisites**

- A successful undercloud installation. For more information, see Section 7.8, “Installing director”.
- A successful overcloud deployment. For more information, see Section 11.5, “Configuring a basic overcloud with pre-provisioned nodes”.
- At least one bare metal node that you want to remove from the stack.

**Procedure**

1. Source the `stackrc` undercloud credential file:
   ```bash
   $ source ~/stackrc
   ```

2. Decrement the `count` parameter in the `~/overcloud-baremetal-deploy.yaml` file, for the roles that you want to scale down.

3. Define the `hostname` and `name` of each node that you want to remove from the stack, if they are not already defined in the `instances` attribute for the role.

4. Add the attribute `provisioned: false` to the node that you want to remove. For example, to remove the node `overcloud-controller-1` from the stack, include the following snippet in your `~/overcloud-baremetal-deploy.yaml` file:
   ```yaml
   - name: Controller
     count: 2
     instances:
     - hostname: overcloud-controller-0
       name: node00
     - hostname: overcloud-controller-1
       name: node01
       # Removed from cluster due to disk failure
       provisioned: false
     - hostname: overcloud-controller-2
       name: node02
   ```

5. Provision the overcloud nodes, specifying the name of the heat environment file that the provisioning process generates for inclusion in the deployment command:
   ```bash
   (undercloud)$ openstack overcloud node provision \
   --stack stack \
   --output ~/overcloud-baremetal-deployed.yaml \
   ~/overcloud-baremetal-deploy.yaml
   ```

6. Add the `~/overcloud-baremetal-deployed.yaml` file generated by the provisioning command to the stack with your other environment files, and deploy the overcloud:
   ```bash
   (undercloud)$ openstack overcloud deploy \
   ... \
   -e /usr/share/openstack-tripleo-heat-templates/environments/deployed-server-`
After you redeploy the overcloud, the nodes that you define with the `provisioned: false` attribute are no longer present in the stack. However, these nodes are still running in a provisioned state.

**NOTE**

If you want to remove a node from the stack temporarily, you can deploy the overcloud with the attribute `provisioned: false` and then redeploy the overcloud with the attribute `provisioned: true` to return the node to the stack.

7. Delete the node from the overcloud:

```bash
(undercloud)$ openstack overcloud node delete \
--stack stack \
--baremetal-deployment ~/overcloud-baremetal-deploy.yaml
```

**NOTE**

Do not include the nodes that you want to remove from the stack as command arguments in the `openstack overcloud node delete` command.

### 18.5. REMOVING OR REPLACING A COMPUTE NODE

In some situations you need to remove a Compute node from the overcloud. For example, you might need to replace a problematic Compute node. When you delete a Compute node the node’s index is added by default to the denylist to prevent the index being reused during scale out operations.

You can replace the removed Compute node after you have removed the node from your overcloud deployment.

**Prerequisites**

- The Compute service is disabled on the nodes that you want to remove to prevent the nodes from scheduling new instances. To confirm that the Compute service is disabled, use the following command:

  ```bash
  (overcloud)$ openstack compute service list
  ```

  If the Compute service is not disabled then disable it:

  ```bash
  (overcloud)$ openstack compute service set <hostname> nova-compute --disable --disable-reason
  ```

  **TIP**

  Use the `--disable-reason` option to add a short explanation on why the service is being disabled. This is useful if you intend to redeploy the Compute service.
The workloads on the Compute nodes have been migrated to other Compute nodes. For more information, see Migrating virtual machine instances between Compute nodes.

If Instance HA is enabled, choose one of the following options:

- If the Compute node is accessible, log in to the Compute node as the root user and perform a clean shutdown with the `shutdown -h now` command.

- If the Compute node is not accessible, log in to a Controller node as the root user, disable the STONITH device for the Compute node, and shut down the bare metal node:

```
[stack@undercloud ~]$ source stackrc
[stack@undercloud ~]$ openstack baremetal node power off <UUID>
```

Procedure

1. Source the undercloud configuration:

```
(overcloud)$ source ~/stackrc
```

2. Identify the UUID of the overcloud stack:

```
(undercloud)$ openstack stack list
```

3. Identify the UUIDs or hostnames of the Compute nodes that you want to delete:

```
(undercloud)$ openstack server list
```

4. Optional: Run the `overcloud deploy` command with the `--update-plan-only` option to update the plans with the most recent configurations from the templates. This ensures that the overcloud configuration is up-to-date before you delete any Compute nodes:

```
$ openstack overcloud deploy --update-plan-only --templates  
- /usr/share/openstack-tripleo-heat-templates/environments/network-isolation.yaml 
- /home/stack/templates/network-environment.yaml 
- /home/stack/templates/storage-environment.yaml 
- /home/stack/templates/rhel-registration/environment-rhel-registration.yaml 
[-e |...]
```

**NOTE**

This step is required if you updated the overcloud node denylist. For more information about adding overcloud nodes to the denylist, see Blacklisting nodes.

5. Delete the Compute nodes from the stack:

```
$ openstack overcloud node delete --stack <overcloud> 
<node_1> ... [node_n]
```

- Replace `<overcloud>` with the name or UUID of the overcloud stack.
6. Wait for the Compute nodes to delete.

7. Check the status of the overcloud stack when the node deletion is complete:

```
(undercloud)$ openstack stack list
```

### Table 18.2. Result

<table>
<thead>
<tr>
<th>Status</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>UPDATE COMPLETE</td>
<td>The delete operation completed successfully.</td>
</tr>
<tr>
<td>UPDATE FAILED</td>
<td>The delete operation failed.</td>
</tr>
<tr>
<td></td>
<td>A common reason for a failed delete operation is an unreachable IPMI interface on the node that you want to remove.</td>
</tr>
<tr>
<td></td>
<td>When the delete operation fails, you must manually remove the Compute node. For more information, see Removing a Compute node manually from the overcloud.</td>
</tr>
</tbody>
</table>

8. If Instance HA is enabled, perform the following actions:

   a. Clean up the Pacemaker resources for the node:

```
$ sudo pcs resource delete <scaled_down_node>
$ sudo cibadmin -o nodes --delete --xml-text '<node id="<scaled_down_node>"/>
$ sudo cibadmin -o fencing-topology --delete --xml-text '<fencing-level target="<scaled_down_node>"/>
$ sudo cibadmin -o status --delete --xml-text '<node_state id="<scaled_down_node>"/>
```

   b. Delete the STONITH device for the node:

```
$ sudo pcs stonith delete <device-name>
```
If you are not replacing the removed Compute nodes on the overcloud, then decrease the `ComputeCount` parameter in the environment file that contains your node counts. This file is usually named `node-info.yaml`. For example, decrease the node count from four nodes to three nodes if you removed one node:

```
parameter_defaults:
    ...  
    ComputeCount: 3
```

Decreasing the node count ensures that director does not provision any new nodes when you run `openstack overcloud deploy`.

If you are replacing the removed Compute node on your overcloud deployment, see Replacing a removed Compute node.

### 18.5.1. Removing a Compute node manually

If the `openstack overcloud node delete` command failed due to an unreachable node, then you must manually complete the removal of the Compute node from the overcloud.

**Prerequisites**

- Performing the Removing or replacing a Compute node procedure returned a status of `UPDATE_FAILED`.

**Procedure**

1. Identify the UUID of the overcloud stack:

   ```
   (undercloud)$ openstack stack list
   ```

2. Identify the UUID of the node that you want to manually delete:

   ```
   (undercloud)$ openstack baremetal node list
   ```

3. Move the node that you want to delete to maintenance mode:

   ```
   (undercloud)$ openstack baremetal node maintenance set <node_uuid>
   ```

4. Wait for the Compute service to synchronize its state with the Bare Metal service. This can take up to four minutes.

5. Source the overcloud configuration:

   ```
   (undercloud)$ source ~/overcloudrc
   ```

6. Delete the network agents for the node that you deleted:

   ```
   (overcloud)$ for AGENT in $(openstack network agent list --host <scaled_down_node> -c ID -f value) ; do openstack network agent delete $AGENT ; done
   ```

Replace `<scaled_down_node>` with the name of the node to remove.
7. Confirm that the Compute service is disabled on the deleted node on the overcloud, to prevent the node from scheduling new instances:

(overcloud)$ openstack compute service list

If the Compute service is not disabled then disable it:

(overcloud)$ openstack compute service set <hostname> nova-compute --disable

**TIP**

Use the `--disable-reason` option to add a short explanation on why the service is being disabled. This is useful if you intend to redeploy the Compute service.

8. Remove the deleted Compute service as a resource provider from the Placement service:

(overcloud)$ openstack resource provider list
(overcloud)$ openstack resource provider delete <uuid>

9. Source the undercloud configuration:

(overcloud)$ source ~/stackrc

10. Delete the Compute node from the stack:

(undercloud)$ openstack overcloud node delete --stack <overcloud> <node>

- Replace `<overcloud>` with the name or UUID of the overcloud stack.
- Replace `<node>` with the Compute service host name or UUID of the Compute node that you want to delete.

**NOTE**

If the node has already been powered off, this command returns a WARNING message:

Ansible failed, check log at `~/ansible.log`
WARNING: Scale-down configuration error. Manual cleanup of some actions may be necessary. Continuing with node removal.

You can ignore this message.

11. Wait for the overcloud node to delete.

12. Check the status of the overcloud stack when the node deletion is complete:

(undercloud)$ openstack stack list

Table 18.3. Result
### Status and Description

<table>
<thead>
<tr>
<th>Status</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>UPDATE_COMPLETE</td>
<td>The delete operation completed successfully.</td>
</tr>
<tr>
<td>UPDATE_FAILED</td>
<td>The delete operation failed.</td>
</tr>
<tr>
<td></td>
<td>If the overcloud node fails to delete while in maintenance mode, then the problem might be with the hardware.</td>
</tr>
</tbody>
</table>

13. If Instance HA is enabled, perform the following actions:

   a. Clean up the Pacemaker resources for the node:

      ```
      $ sudo pcs resource delete <scaled_down_node>
      $ sudo cibadmin -o nodes --delete --xml-text '<node id="<scaled_down_node>"/>
      $ sudo cibadmin -o fencing-topology --delete --xml-text '<fencing-level target="
      <scaled_down_node>"/>
      $ sudo cibadmin -o status --delete --xml-text '<node_state id="<scaled_down_node>"/>
      $ sudo cibadmin -o status --delete-all --xml-text '<node id="<scaled_down_node>"/>
      ```

   b. Delete the STONITH device for the node:

      ```
      $ sudo pcs stonith delete <device-name>
      ```

14. If you are not replacing the removed Compute node on the overcloud, then decrease the `ComputeCount` parameter in the environment file that contains your node counts. This file is usually named `node-info.yaml`. For example, decrease the node count from four nodes to three nodes if you removed one node:

   ```
   parameter_defaults:
   ...
   ComputeCount: 3
   ...
   ```

   Decreasing the node count ensures that director does not provision any new nodes when you run `openstack overcloud deploy`.

   If you are replacing the removed Compute node on your overcloud deployment, see [Replacing a removed Compute node](#).  

### 18.5.2. Replacing a removed Compute node

To replace a removed Compute node on your overcloud deployment, you can register and inspect a new Compute node or re-add the removed Compute node. You must also configure your overcloud to provision the node.

#### Procedure

1. Optional: To reuse the index of the removed Compute node, configure the `RemovalPoliciesMode` and the `RemovalPolicies` parameters for the role to replace the denylist when a Compute node is removed:
parameter_defaults:
- <RoleName>RemovalPoliciesMode: update
- <RoleName>RemovalPolicies: [{'resource_list': []}]

2. Replace the removed Compute node:
   - To add a new Compute node, register, inspect, and tag the new node to prepare it for provisioning. For more information, see Configuring and deploying the overcloud.
   - To re-add a Compute node that you removed manually, remove the node from maintenance mode:
     
     (undercloud)$ openstack baremetal node maintenance unset <node_uuid>

3. Rerun the openstack overcloud deploy command that you used to deploy the existing overcloud.

4. Wait until the deployment process completes.

5. Confirm that director has successfully registered the new Compute node:

    (undercloud)$ openstack baremetal node list

6. If you performed step 1 to set the RemovalPoliciesMode for the role to update, then you must reset the RemovalPoliciesMode for the role to the default value, append, to add the Compute node index to the current denylist when a Compute node is removed:

    parameter_defaults:
    - <RoleName>RemovalPoliciesMode: append

7. Rerun the openstack overcloud deploy command that you used to deploy the existing overcloud.

18.6. PRESERVING HOSTNAMES WHEN REPLACING NODES THAT USE PREDICTABLE IP ADDRESSES AND HOSTNAMEMAP

If you configured your overcloud to use predictable IP addresses, and HostNameMap to map heat-based hostnames to the hostnames of pre-provisioned nodes, then you must configure your overcloud to map the new replacement node index to an IP address and hostname.

Procedure

1. Log in to the undercloud as the stack user.

2. Source the stackrc file:

    $ source ~/stackrc

3. Retrieve the physical_resource_id and the removed_rsrc_list for the resource you want to replace:

    (undercloud)$ openstack stack resource show <stack> <role>
Replace `<stack>` with the name of the stack the resource belongs to, for example, `overcloud`.

Replace `<role>` with the name of the role that you want to replace the node for, for example, `Compute`.

Example output:

```
+------------------------+-----------------------------------------------------------+
| Field                  | Value                                                     |
+------------------------+-----------------------------------------------------------+
| attributes             | {u'attributes': None, u'refs': None, u'refs_map': None,   |
|                        | u'removed_rsrc_list': [u'2', u'3']}                      |
| creation_time          | 2017-09-05T09:10:42Z                                      |
| description            |                                                           |
| links                  | [{u'href': u'http://192.168.24.1:8004/v1/bd9e6da805594de9 |
|                        | 8d4a1d3a3ee874dd/stacks/overcloud/1c7810c4-8a1e-         |
|                        | 4d61-a5d8-9f964915d503/resources/Compute', u'ref':     |
|                        | 805594de8d4a1d3a3ee874dd/stacks/overcloud/1c7810c4-8a1e-|
|                        | 4d61-a5d8-9f964915d503', u'ref': u'self'},           |
|                        | {u'href': u'http://192.168.24.1:8004/v1/bd9e6da805594de|
|                        | 9d4a1d3a3ee874dd/stacks/overcloud-Compute-zkjccox63sv|
|                        | g/7632fb0b- | |
|                        | 80b1-42b3-9ea7-6114c89adc29', u'ref': u'nested'}}       |
| logical_resource_id    | Compute                                                   |
| physical_resource_id   | 7632fb0b-80b1-42b3-9ea7-6114c89adc29                      |
| required_by            | [u'AllNodesDeploySteps',                                 |
|                        | u'ComputeAllNodesValidationDeployment',                   |
|                        | u'AllNodesExtraConfig', u'ComputeIpListMap',             |
|                        | u'ComputeHostsDeployment', u'UpdateWorkflow',            |
|                        | u'ComputeSshKnownHostsDeployment', u'hostsConfig',       |
|                        | u'SshKnownHostsDeployment', u'ComputeAllNodesDeployment' |
| resource_name          | Compute                                                   |
| resource_status        | CREATE_COMPLETE                                           |
| resource_status_reason | state changed                                             |
| resource_type          | OS::Heat::ResourceGroup                                   |
| updated_time           | 2017-09-05T09:10:42Z                                      |
+------------------------+-----------------------------------------------------------+

The removed_rsrc_list lists the indexes of nodes that have already been removed for the resource.

4. Retrieve the `resource_name` to determine the maximum index that heat has applied to a node for this resource:

   (undercloud)$ openstack stack resource list <physical_resource_id>

Replace `<physical_resource_id>` with the ID you retrieved in step 2.

5. Use the `resource_name` and the `removed_rsrc_list` to determine the next index that heat will apply to a new node:

   - If `removed_rsrc_list` is empty, then the next index will be `(current_maximum_index) + 1`.
   - If `removed_rsrc_list` includes the value `(current_maximum_index) + 1`, then the next index will be the next available index.
6. Retrieve the ID of the replacement bare-metal node:

(undercloud)$ openstack baremetal node list

7. Update the capability of the replacement node with the new index:

openstack baremetal node set --property capabilities='node:<role>-<index>,boot_option:local' <node>

- Replace `<role>` with the name of the role that you want to replace the node for, for example, `compute`.
- Replace `<index>` with the index calculated in step 5.
- Replace `<node>` with the ID of the bare metal node.

The Compute scheduler uses the node capability to match the node on deployment.

8. Assign a hostname to the new node by adding the index to the `HostnameMap` configuration, for example:

```
parameter_defaults:
  ControllerSchedulerHints:
    'capabilities:node': 'controller-%index%'
  ComputeSchedulerHints:
    'capabilities:node': 'compute-%index%'
  HostnameMap:
    overcloud-controller-0: overcloud-controller-prod-123-0
    overcloud-controller-1: overcloud-controller-prod-456-0
    overcloud-controller-2: overcloud-controller-prod-789-0
    overcloud-controller-3: overcloud-controller-prod-456-0
    overcloud-compute-0: overcloud-compute-prod-abc-0
    overcloud-compute-3: overcloud-compute-prod-abc-3
    overcloud-compute-8: overcloud-compute-prod-abc-3
...
```

1. Node that you are removing and replacing with the new node.
2. New node.
3. Node that you are removing and replacing with the new node.
4. New node.

**NOTE**

Do not delete the mapping for the removed node from `HostnameMap`.

9. Add the IP address for the replacement node to the end of each network IP address list in your network IP address mapping file, `ips-from-pool-all.yaml`. In the following example, the IP address for the new index, `overcloud-controller-3`, is added to the end of the IP address list for each `ControllerIPs` network, and is assigned the same IP address as `overcloud-controller-1`
because it replaces overcloud-controller-1. The IP address for the new index, overcloud-compute-8, is also added to the end of the IP address list for each ComputeIPs network, and is assigned the same IP address as the index it replaces, overcloud-compute-3:

```
parameter_defaults:
ControllerIPs:
  ...
  internal_api:
    - 192.168.1.10 1
    - 192.168.1.11 2
    - 192.168.1.12 3
    - 192.168.1.11 4
  ...
  storage:
    - 192.168.2.10
    - 192.168.2.11
    - 192.168.2.12
    - 192.168.2.11
  ...
ComputeIPs:
  ...
  internal_api:
    - 172.17.0.10 5
    - 172.17.0.11 6
    - 172.17.0.11 7
  ...
  storage:
    - 172.17.0.10
    - 172.17.0.11
    - 172.17.0.11
  ...
```

1. IP address assigned to index 0, host name overcloud-controller-prod-123-0.
2. IP address assigned to index 1, host name overcloud-controller-prod-456-0. This node is replaced by index 3. Do not remove this entry.
3. IP address assigned to index 2, host name overcloud-controller-prod-789-0.
4. IP address assigned to index 3, host name overcloud-controller-prod-456-0. This is the new node that replaces index 1.
5. IP address assigned to index 0, host name overcloud-compute-0.
6. IP address assigned to index 1, host name overcloud-compute-3. This node is replaced by index 2. Do not remove this entry.
7. IP address assigned to index 2, host name overcloud-compute-8. This is the new node that replaces index 1.

18.7. REPLACING CEPH STORAGE NODES
You can use director to replace Ceph Storage nodes in a director-created cluster. For more information, see the Deploying an Overcloud with Containerized Red Hat Ceph guide.

18.8. REPLACING OBJECT STORAGE NODES

Follow the instructions in this section to understand how to replace Object Storage nodes without impact to the integrity of the cluster. This example involves a three-node Object Storage cluster in which you want to replace the node overcloud-objectstorage-1 node. The goal of the procedure is to add one more node and then remove the overcloud-objectstorage-1 node. The new node replaces the overcloud-objectstorage-1 node.

Procedure

1. Increase the Object Storage count using the ObjectStorageCount parameter. This parameter is usually located in node-info.yaml, which is the environment file that contains your node counts:

   ```yaml
   parameter_defaults:
     ObjectStorageCount: 4
   ```

   The ObjectStorageCount parameter defines the quantity of Object Storage nodes in your environment. In this example, scale the quantity of Object Storage nodes from 3 to 4.

2. Run the deployment command with the updated ObjectStorageCount parameter:

   ```bash
   $ source ~/stackrc
   (undercloud) $ openstack overcloud deploy --templates -e node-info.yaml
   ```

   After the deployment command completes, the overcloud contains an additional Object Storage node.

3. Replicate data to the new node. Before you remove a node, in this case, overcloud-objectstorage-1, wait for a replication pass to finish on the new node. Check the replication pass progress in the /var/log/swift/swift.log file. When the pass finishes, the Object Storage service should log entries similar to the following example:

   ```
   Mar 29 08:49:05 localhost object-server: Object replication complete.
   Mar 29 08:49:11 localhost container-server: Replication run OVER
   Mar 29 08:49:13 localhost account-server: Replication run OVER
   ```

4. To remove the old node from the ring, reduce the ObjectStorageCount parameter to omit the old node. In this example, reduce the ObjectStorageCount parameter to 3:

   ```yaml
   parameter_defaults:
     ObjectStorageCount: 3
   ```

5. Create a new environment file named remove-object-node.yaml. This file identifies and removes the specified Object Storage node. The following content specifies the removal of overcloud-objectstorage-1:

   ```yaml
   parameter_defaults:
     ObjectStorageRemovalPolicies: 
       [{'resource_list': ['1']}
   ```
6. Include both the `node-info.yaml` and `remove-object-node.yaml` files in the deployment command:

```bash
(undercloud) $ openstack overcloud deploy --templates -e node-info.yaml <environment_files> -e remove-object-node.yaml
```

Director deletes the Object Storage node from the overcloud and updates the rest of the nodes on the overcloud to accommodate the node removal.

**IMPORTANT**

Include all environment files and options from your initial overcloud creation. This includes the same scale parameters for non-Compute nodes.

### 18.9. USING SKIP DEPLOY IDENTIFIER

During a stack update operation puppet, by default, reapplies all manifests. This can result in a time consuming operation, which may not be required.

To override the default operation, use the `skip-deploy-identifier` option.

```bash
openstack overcloud deploy --skip-deploy-identifier
```

Use this option if you do not want the deployment command to generate a unique identifier for the `DeployIdentifier` parameter. The software configuration deployment steps only trigger if there is an actual change to the configuration. Use this option with caution and only if you are confident that you do not need to run the software configuration, such as scaling out certain roles.

**NOTE**

If there is a change to the puppet manifest or hierdata, puppet will reapply all manifests even when `--skip-deploy-identifier` is specified.

### 18.10. BLACKLISTING NODES

You can exclude overcloud nodes from receiving an updated deployment. This is useful in scenarios where you want to scale new nodes and exclude existing nodes from receiving an updated set of parameters and resources from the core heat template collection. This means that the blacklisted nodes are isolated from the effects of the stack operation.

Use the `DeploymentServerBlacklist` parameter in an environment file to create a blacklist.

#### Setting the blacklist

The `DeploymentServerBlacklist` parameter is a list of server names. Write a new environment file, or add the parameter value to an existing custom environment file and pass the file to the deployment command:

```yaml
parameter_defaults:
  DeploymentServerBlacklist:
    - overcloud-compute-0
    - overcloud-compute-1
    - overcloud-compute-2
```
NOTE

The server names in the parameter value are the names according to OpenStack Orchestration (heat), not the actual server hostnames.

Include this environment file with your openstack overcloud deploy command:

```bash
$ source ~/.stackrc
(undercloud) $ openstack overcloud deploy --templates -e server-blacklist.yaml 
[OTHER OPTIONS]
```

Heat blacklists any servers in the list from receiving updated heat deployments. After the stack operation completes, any blacklisted servers remain unchanged. You can also power off or stop the os-collect-config agents during the operation.

**WARNING**

- Exercise caution when you blacklist nodes. Only use a blacklist if you fully understand how to apply the requested change with a blacklist in effect. It is possible to create a hung stack or configure the overcloud incorrectly when you use the blacklist feature. For example, if cluster configuration changes apply to all members of a Pacemaker cluster, blacklisting a Pacemaker cluster member during this change can cause the cluster to fail.

- Do not use the blacklist during update or upgrade procedures. Those procedures have their own methods for isolating changes to particular servers.

- When you add servers to the blacklist, further changes to those nodes are not supported until you remove the server from the blacklist. This includes updates, upgrades, scale up, scale down, and node replacement. For example, when you blacklist existing Compute nodes while scaling out the overcloud with new Compute nodes, the blacklisted nodes miss the information added to /etc/hosts and /etc/ssh/ssh_known_hosts. This can cause live migration to fail, depending on the destination host. The Compute nodes are updated with the information added to /etc/hosts and /etc/ssh/ssh_known_hosts during the next overcloud deployment where they are no longer blacklisted. Do not modify the /etc/hosts and /etc/ssh/ssh_known_hosts files manually. To modify the /etc/hosts and /etc/ssh/ssh_known_hosts files, run the overcloud deploy command as described in the Clearing the Blacklist section.

Clearing the blacklist

To clear the blacklist for subsequent stack operations, edit the DeploymentServerBlacklist to use an empty array:

```yaml
parameter_defaults:
  DeploymentServerBlacklist: []
```
WARNING

Do not omit the `DeploymentServerBlacklist` parameter. If you omit the parameter, the overcloud deployment uses the previously saved value.
CHAPTER 19. REPLACING CONTROLLER NODES

In certain circumstances a Controller node in a high availability cluster might fail. In these situations, you must remove the node from the cluster and replace it with a new Controller node.

Complete the steps in this section to replace a Controller node. The Controller node replacement process involves running the `openstack overcloud deploy` command to update the overcloud with a request to replace a Controller node.

**IMPORTANT**

The following procedure applies only to high availability environments. Do not use this procedure if you are using only one Controller node.

19.1. PREPARING FOR CONTROLLER REPLACEMENT

Before you replace an overcloud Controller node, it is important to check the current state of your Red Hat OpenStack Platform environment. Checking the current state can help avoid complications during the Controller replacement process. Use the following list of preliminary checks to determine if it is safe to perform a Controller node replacement. Run all commands for these checks on the undercloud.

**Procedure**

1. Check the current status of the `overcloud` stack on the undercloud:

   ```bash
   $ source stackrc
   (undercloud)$ openstack stack list --nested
   
   The `overcloud` stack and its subsequent child stacks should have either a `CREATE_COMPLETE` or `UPDATE_COMPLETE`.
   
2. Install the database client tools:

   ```bash
   (undercloud)$ sudo dnf -y install mariadb
   
   3. Configure root user access to the database:

   ```bash
   (undercloud)$ sudo cp /var/lib/config-data/puppet-generated/mysql/root/.my.cnf /root/
   
   4. Perform a backup of the undercloud databases:

   ```bash
   (undercloud)$ mkdir /home/stack/backup
   (undercloud)$ sudo mysqldump --all-databases --quick --single-transaction | gzip > /home/stack/backup/dump_db_undercloud.sql.gz
   
   5. Check that your undercloud contains 10 GB free storage to accommodate for image caching and conversion when you provision the new node:

   ```bash
   (undercloud)$ df -h
   
   6. If you are reusing the IP address for the new controller node, ensure that you delete the port used by the old controller:
7. Check the status of Pacemaker on the running Controller nodes. For example, if 192.168.0.47 is the IP address of a running Controller node, use the following command to view the Pacemaker status:

(undercloud)$ ssh heat-admin@192.168.0.47 'sudo pcs status'

The output shows all services that are running on the existing nodes and that are stopped on the failed node.

8. Check the following parameters on each node of the overcloud MariaDB cluster:

   - wsrep_local_state_comment: Synced
   - wsrep_cluster_size: 2

   Use the following command to check these parameters on each running Controller node. In this example, the Controller node IP addresses are 192.168.0.47 and 192.168.0.46:

   (undercloud)$ for i in 192.168.24.6 192.168.24.7 ; do echo "*** $i ***" ; ssh heat-admin@$i "sudo podman exec \$(sudo podman ps --filter name=galera-bundle -q) mysql -e \"SHOW STATUS LIKE 'wsrep_local_state_comment'; SHOW STATUS LIKE 'wsrep_cluster_size';\""; done

9. Check the RabbitMQ status. For example, if 192.168.0.47 is the IP address of a running Controller node, use the following command to view the RabbitMQ status:

(undercloud)$ ssh heat-admin@192.168.0.47 "sudo podman exec \$(sudo podman ps -f name=rabbitmq-bundle -q) rabbitmqctl cluster_status"

The running_nodes key should show only the two available nodes and not the failed node.

10. If fencing is enabled, disable it. For example, if 192.168.0.47 is the IP address of a running Controller node, use the following command to check the status of fencing:

(undercloud)$ ssh heat-admin@192.168.0.47 "sudo pcs property show stonith-enabled"

   Run the following command to disable fencing:

(undercloud)$ ssh heat-admin@192.168.0.47 "sudo pcs property set stonith-enabled=false"

11. Check the Compute services are active on the director node:

(undercloud)$ openstack hypervisor list

   The output should show all non-maintenance mode nodes as up.

12. Ensure all undercloud containers are running:

(undercloud)$ sudo podman ps

13. Stop all the nova_* containers running on the failed Controller node:
14. Optional: If you are using the Bare Metal Service (ironic) as the virt driver, you must manually update the service entries in your cell database for any bare metal instances whose `instances.host` is set to the controller that you are removing. Contact Red Hat Support for assistance.

NOTE
This manual update of the cell database when using Bare Metal Service (ironic) as the virt driver is a temporary workaround to ensure the nodes are rebalanced, until BZ2017980 is complete.

19.2. REMOVING A CEPH MONITOR DAEMON

If your Controller node is running a Ceph monitor service, complete the following steps to remove the `ceph-mon` daemon.

NOTE
Adding a new Controller node to the cluster also adds a new Ceph monitor daemon automatically.

Procedure

1. Connect to the Controller node that you want to replace and become the root user:

   ```
   # ssh heat-admin@192.168.0.47
   # sudo su -
   ```

   NOTE
   If the Controller node is unreachable, skip steps 1 and 2 and continue the procedure at step 3 on any working Controller node.

2. Stop the monitor:

   ```
   # systemctl stop ceph-mon@<monitor_hostname>
   ```
   For example:

   ```
   # systemctl stop ceph-mon@overcloud-controller-1
   ```

3. Disconnect from the Controller node that you want to replace.

4. Connect to one of the existing Controller nodes.
5. Remove the monitor from the cluster:

```bash
# sudo podman exec -it ceph-mon-controller-0 ceph mon remove overcloud-controller-1
```

6. On all Controller nodes, remove the v1 and v2 monitor entries from `/etc/ceph/ceph.conf`. For example, if you remove controller-1, then remove the IPs and hostname for controller-1.

Before:

```
mon initial members = overcloud-controller-2, overcloud-controller-1, overcloud-controller-0
```

After:

```
mon initial members = overcloud-controller-2, overcloud-controller-0
```

**NOTE**

Director updates the `/etc/ceph/ceph.conf` file on the relevant overcloud nodes when you add the replacement Controller node. Normally, director manages this configuration file exclusively and you should not edit the file manually. However, you can edit the file manually if you want to ensure consistency in case the other nodes restart before you add the new node.

7. (Optional) Archive the monitor data and save the archive on another server:

```bash
# mv /var/lib/ceph/mon/<cluster>-<daemon_id> /var/lib/ceph/mon/removed-<cluster>-<daemon_id>
```

### 19.3. PREPARING THE CLUSTER FOR CONTROLLER NODE REPLACEMENT

Before you replace the old node, you must ensure that Pacemaker is not running on the node and then remove that node from the Pacemaker cluster.

**Procedure**

1. To view the list of IP addresses for the Controller nodes, run the following command:

```bash
(undercloud) $ openstack server list -c Name -c Networks
+------------------------+-----------------------+
<table>
<thead>
<tr>
<th>Name</th>
<th>Networks</th>
</tr>
</thead>
<tbody>
<tr>
<td>overcloud-compute-0</td>
<td>ctlplane=192.168.0.44</td>
</tr>
<tr>
<td>overcloud-controller-0</td>
<td>ctlplane=192.168.0.47</td>
</tr>
</tbody>
</table>
```
2. If the old node is still reachable, log in to one of the remaining nodes and stop pacemaker on the old node. For this example, stop pacemaker on overcloud-controller-1:

(undercloud) $ ssh heat-admin@192.168.0.47 "sudo pcs status | grep -w Online | grep -w overcloud-controller-1"
(undercloud) $ ssh heat-admin@192.168.0.47 "sudo pcs cluster stop overcloud-controller-1"

**NOTE**

In case the old node is physically unavailable or stopped, it is not necessary to perform the previous operation, as pacemaker is already stopped on that node.

3. After you stop Pacemaker on the old node, delete the old node from the pacemaker cluster. The following example command logs in to overcloud-controller-0 to remove overcloud-controller-1:

(undercloud) $ ssh heat-admin@192.168.0.47 "sudo pcs cluster node remove overcloud-controller-1"

If the node that you want to replace is unreachable (for example, due to a hardware failure), run the `pcs` command with additional `--skip-offline` and `--force` options to forcibly remove the node from the cluster:

(undercloud) $ ssh heat-admin@192.168.0.47 "sudo pcs cluster node remove overcloud-controller-1 --skip-offline --force"

4. After you remove the old node from the pacemaker cluster, remove the node from the list of known hosts in pacemaker:

(undercloud) $ ssh heat-admin@192.168.0.47 "sudo pcs host deauth overcloud-controller-1"

You can run this command whether the node is reachable or not.

5. To ensure that the new Controller node uses the correct STONITH fencing device after the replacement, delete the old devices from the node by entering the following command:

(undercloud) $ ssh heat-admin@192.168.0.47 "sudo pcs stonith delete <stonith_resource_name>"

Replace `<stonith_resource_name>` with the name of the STONITH resource that corresponds to the old node. The resource name uses the the format `<resource_agent>-<host_mac>`. You can find the resource agent and the host MAC address in the FencingConfig section of the `fencing.yaml` file.

6. The overcloud database must continue to run during the replacement procedure. To ensure that Pacemaker does not stop Galera during this procedure, select a running Controller node and run the following command on the undercloud with the IP address of the Controller node:

(undercloud) $ ssh heat-admin@192.168.0.47 "sudo pcs resource unmanage galera-bundle"
19.4. REPLACING A CONTROLLER NODE

To replace a Controller node, identify the index of the node that you want to replace.

- If the node is a virtual node, identify the node that contains the failed disk and restore the disk from a backup. Ensure that the MAC address of the NIC used for PXE boot on the failed server remains the same after disk replacement.

- If the node is a bare metal node, replace the disk, prepare the new disk with your overcloud configuration, and perform a node introspection on the new hardware.

- If the node is a part of a high availability cluster with fencing, you might need recover the Galera nodes separately. For more information, see the article How Galera works and how to rescue Galera clusters in the context of Red Hat OpenStack Platform.

Complete the following example steps to replace the `overcloud-controller-1` node with the `overcloud-controller-3` node. The `overcloud-controller-3` node has the ID `75b25e9a-948d-424a-9b3b-f0ef70a6eacf`.

**IMPORTANT**

To replace the node with an existing bare metal node, enable maintenance mode on the outgoing node so that the director does not automatically reprovision the node.

**Procedure**

1. Source the `stackrc` file:

   ```
   $ source ~/stackrc
   ```

2. Identify the index of the `overcloud-controller-1` node:

   ```
   $ INSTANCE=$(openstack server list --name overcloud-controller-1 -f value -c ID)
   ```

3. Identify the bare metal node associated with the instance:

   ```
   $ NODE=$(openstack baremetal node list -f csv --quote minimal | grep $INSTANCE | cut -f1 -d,)
   ```

4. Set the node to maintenance mode:

   ```
   $ openstack baremetal node maintenance set $NODE
   ```

5. If the Controller node is a virtual node, run the following command on the Controller host to replace the virtual disk from a backup:

   ```
   $ cp <VIRTUAL_DISK_BACKUP> /var/lib/libvirt/images/<VIRTUAL_DISK>
   ```

   Replace `<VIRTUAL_DISK_BACKUP>` with the path to the backup of the failed virtual disk, and replace `<VIRTUAL_DISK>` with the name of the virtual disk that you want to replace.

   If you do not have a backup of the outgoing node, you must use a new virtualized node.
If the Controller node is a bare metal node, complete the following steps to replace the disk with a new bare metal disk:

- Replace the physical hard drive or solid state drive.
- Prepare the node with the same configuration as the failed node.

6. List unassociated nodes and identify the ID of the new node:

```bash
$ openstack baremetal node list --unassociated
```

7. Tag the new node with the `control` profile:

```bash
(undercloud) $ openstack baremetal node set --property
capabilities='profile:control,boot_option:local' 75b25e9a-948d-424a-9b3b-f0ef70a6eacf
```

## 19.5. REPLACING A BOOTSTRAP CONTROLLER NODE

If you want to replace the Controller node that you use for bootstrap operations and keep the node name, complete the following steps to set the name of the bootstrap Controller node after the replacement process.

**Procedure**

1. Find the name of the bootstrap Controller node by running the following command:

```bash
ssh heat-admin@CONTROLLER_IP "sudo hiera -c /etc/puppet/hiera.yaml
pacemaker_short_bootstrap_node_name"
```

   Replace `CONTROLLER_IP` with the IP address of any active Controller node.

2. Check if your environment files include the `ExtraConfig` section. If the `ExtraConfig` parameter does not exist, create the following environment file `~/templates/bootstrap-controller.yaml` and add the following content:

```yaml
parameter_defaults:
  ExtraConfig:
    pacemaker_short_bootstrap_node_name: NODE_NAME
    mysql_short_bootstrap_node_name: NODE_NAME
```

   Replace `NODE_NAME` with the name of an existing Controller node that you want to use in bootstrap operations after the replacement process.

   If your environment files already include the `ExtraConfig` parameter, add only the lines that set the `pacemaker_short_bootstrap_node_name` and `mysql_short_bootstrap_node_name` parameters.

3. Follow the steps to trigger the Controller node replacement and include the environment files in the `overcloud deploy command`. For more information, see xref:proc_triggering-the-controller-node-replacement_replacing-controller-nodes\[.*\].

For information about troubleshooting the bootstrap Controller node replacement, see the article Replacement of the first Controller node fails at step 1 if the same hostname is used for a new node .
19.6. PRESERVING HOSTNAMES WHEN REPLACING NODES THAT USE PREDICTABLE IP ADDRESSES AND HOSTNAMEMAP

If you configured your overcloud to use predictable IP addresses, and `HostNameMap` to map heat-based hostnames to the hostnames of pre-provisioned nodes, then you must configure your overcloud to map the new replacement node index to an IP address and hostname.

**Procedure**

1. Log in to the undercloud as the `stack` user.

2. Source the `stackrc` file:

   ```bash
   $ source ~/stackrc
   ```

3. Retrieve the `physical_resource_id` and the `removed_rsrc_list` for the resource you want to replace:

   ```bash
   (undercloud)$ openstack stack resource show <stack> <role>
   ```

   - Replace `<stack>` with the name of the stack the resource belongs to, for example, `overcloud`.
   - Replace `<role>` with the name of the role that you want to replace the node for, for example, `Compute`.

   Example output:

   ```plaintext
   +------------------------+-----------------------------------------------------------+
   | Field                  | Value                                                      |
   +------------------------+-----------------------------------------------------------+
   | attributes             | {u'attributes': None, u'refs': None, u'refs_map': None,   |
   |                        | u'removed_rsrc_list': [u'2', u'3']} | 1 |
   | creation_time          | 2017-09-05T09:10:42Z                                      |
   | description            |                                                           |
   | links                  | [{u'href': u'http://192.168.24.1:8004/v1/bd9e6da805594de9 |
   |                        | 8d4a1d3a3ee874dd/stacks/overcloud/1c7810c4-8a1e-            |
   |                        | 4d61-a5d8-9f964915d503/resources/Compute', u'rel':        |
   |                        | u'self'}, {u'href': u'http://192.168.24.1:8004/v1/bd9e6da |
   |                        | 805594de98d4a1d3a3ee874dd/stacks/overcloud/1c7810c4-8a1e- |
   |                        | 4d61-a5d8-9f964915d503', u'rel': u'stack'}, {u'href': u'h |
   |                        | tt://192.168.24.1:8004/v1/bd9e6da805594de98d4a1d3a3ee874 |
   |                        | dd/stacks/overcloud-Compute-zkjccox63svg/7632fb0b-        |
   |                        | 80b1-42b3-9ea7-6114c89adc29', u'rel': u'nested'}}]         |
   | logical_resource_id    | Compute                                                   |
   | physical_resource_id   | 7632fb0b-80b1-42b3-9ea7-6114c89adc29                     |
   | required_by            | [u'AllNodesDeploySteps',                                 |
   |                        | u'ComputeAllNodesValidationDeployment',                  |
   |                        | u'AllNodesExtraConfig', u'ComputeIpListMap',             |
   |                        | u'ComputeHostsDeployment', u'UpdateWorkflow',            |
   |                        | u'ComputeSshKnownHostsDeployment', u'hostsConfig',       |
   |                        | u'SshKnownHostsConfig', u'ComputeAllNodesDeployment']     |
   | resource_name          | Compute                                                   |
   | resource_status        | CREATE_COMPLETE                                           |
   | resource_status_reason | state changed                                             |
   ```
4. Retrieve the **resource_name** to determine the maximum index that heat has applied to a node for this resource:

   ```
   (undercloud)$ openstack stack resource list <physical_resource_id>
   ```

   Replace `<physical_resource_id>` with the ID you retrieved in step 2.

5. Use the **resource_name** and the **removed_rsrc_list** to determine the next index that heat will apply to a new node:

   - If **removed_rsrc_list** is empty, then the next index will be (current_maximum_index) + 1.
   - If **removed_rsrc_list** includes the value (current_maximum_index) + 1, then the next index will be the next available index.

6. Retrieve the ID of the replacement bare-metal node:

   ```
   (undercloud)$ openstack baremetal node list
   ```

7. Update the capability of the replacement node with the new index:

   ```
   openstack baremetal node set --property capabilities='node:<role>-<index>,boot_option:local' <node>
   ```

   - Replace `<role>` with the name of the role that you want to replace the node for, for example, `compute`.
   - Replace `<index>` with the index calculated in step 5.
   - Replace `<node>` with the ID of the bare metal node.

   The Compute scheduler uses the node capability to match the node on deployment.

8. Assign a hostname to the new node by adding the index to the **HostnameMap** configuration, for example:

   ```
   parameter_defaults:
   ControllerSchedulerHints:
   'capabilities:node': 'controller-%index%'
   ComputeSchedulerHints:
   'capabilities:node': 'compute-%index%'
   HostnameMap:
   overcloud-controller-0: overcloud-controller-prod-123-0
   overcloud-controller-1: overcloud-controller-prod-456-0
   overcloud-controller-2: overcloud-controller-prod-789-0
   overcloud-controller-3: overcloud-controller-prod-456-0
   overcloud-compute-0: overcloud-compute-prod-abc-0
   ```
overcloud-compute-3: overcloud-compute-prod-abc-3
overcloud-compute-8: overcloud-compute-prod-abc-3
....

1. Node that you are removing and replacing with the new node.

2. New node.

3. Node that you are removing and replacing with the new node.

4. New node.

NOTE
Do not delete the mapping for the removed node from HostnameMap.

9. Add the IP address for the replacement node to the end of each network IP address list in your network IP address mapping file, ips-from-pool-all.yaml. In the following example, the IP address for the new index, overcloud-controller-3, is added to the end of the IP address list for each ControllerIPs network, and is assigned the same IP address as overcloud-controller-1 because it replaces overcloud-controller-1. The IP address for the new index, overcloud-compute-8, is also added to the end of the IP address list for each ComputeIPs network, and is assigned the same IP address as the index it replaces, overcloud-compute-3:

```
parameter_defaults:
  ControllerIPs:
    ...
    internal_api:
      - 192.168.1.10
      - 192.168.1.11
      - 192.168.1.12
      - 192.168.1.11
      ...
    storage:
      - 192.168.2.10
      - 192.168.2.11
      - 192.168.2.12
      - 192.168.2.11
      ...

  ComputeIPs:
    ...
    internal_api:
      - 172.17.0.10
      - 172.17.0.11
      - 172.17.0.11
      - 172.17.0.11
      ...
    storage:
      - 172.17.0.10
      - 172.17.0.11
      - 172.17.0.11
      ...
```
1. IP address assigned to index 0, host name `overcloud-controller-prod-123-0`.
2. IP address assigned to index 1, host name `overcloud-controller-prod-456-0`. This node is replaced by index 3. **Do not remove this entry.**
3. IP address assigned to index 2, host name `overcloud-controller-prod-789-0`.
4. IP address assigned to index 3, host name `overcloud-controller-prod-456-0`. This is the new node that replaces index 1.
5. IP address assigned to index 0, host name `overcloud-compute-0`.
6. IP address assigned to index 1, host name `overcloud-compute-3`. This node is replaced by index 2. **Do not remove this entry.**
7. IP address assigned to index 2, host name `overcloud-compute-8`. This is the new node that replaces index 1.

### 19.7. TRIGGERING THE CONTROLLER NODE REPLACEMENT

Complete the following steps to remove the old Controller node and replace it with a new Controller node.

**Procedure**

1. Determine the UUID of the Controller node that you want to remove and store it in the `<NODEID>` variable. Ensure that you replace `<node_name>` with the name of the node that you want to remove:

   ```bash
   (undercloud)[stack@director ~]$ NODEID=$(openstack server list -f value -c ID --name <node_name>)
   ```

2. To identify the Heat resource ID, enter the following command:

   ```bash
   $ openstack stack resource show overcloud ControllerServers -f json -c attributes | jq --arg NODEID "$NODEID" -c '.attributes.value | keys[] as $k | if .[$k] == $NODEID then "Node index \($k\) for \(.[$k]\)" else empty end'
   ```

3. Create the following environment file `~/templates/remove-controller.yaml` and include the node index of the Controller node that you want to remove:

   ```yaml
   parameters:
   ControllerRemovalPolicies:
   [{'resource_list': ['<node_index>']}]  
   ```

4. Enter the overcloud deployment command, and include the `remove-controller.yaml` environment file and any other environment files relevant to your environment:

   ```bash
   (undercloud) $ openstack overcloud deploy --templates \
   -e /home/stack/templates/remove-controller.yaml \n   [OTHER OPTIONS]
   ```
NOTE

- Include `-e ~/templates/remove-controller.yaml` only for this instance of the deployment command. Remove this environment file from subsequent deployment operations.

- Include `~/templates/bootstrap-controller.yaml` if you are replacing a bootstrap Controller node and want to keep the node name. For more information, see [proc_replacing-a-bootstrap-controller-node].

5. Director removes the old node, creates a new node, and updates the overcloud stack. You can check the status of the overcloud stack with the following command:

   (undercloud) $ openstack stack list --nested

6. When the deployment command completes, director shows that the old node is replaced with the new node:

   (undercloud) $ openstack server list -c Name -c Networks

   +------------------------+-----------------------+
   | Name                   | Networks              |
   +------------------------+-----------------------+
   | overcloud-compute-0    | ctlplane=192.168.0.44 |
   | overcloud-controller-0 | ctlplane=192.168.0.47 |
   | overcloud-controller-2 | ctlplane=192.168.0.46 |
   | overcloud-controller-3 | ctlplane=192.168.0.48 |
   +------------------------+-----------------------+

   The new node now hosts running control plane services.

19.8. CLEANING UP AFTER CONTROLLER NODE REPLACEMENT

After you complete the node replacement, complete the following steps to finalize the Controller cluster.

Procedure

1. Log into a Controller node.

2. Enable Pacemaker management of the Galera cluster and start Galera on the new node:

   [heat-admin@overcloud-controller-0 ~]$ sudo pcs resource refresh galera-bundle
   [heat-admin@overcloud-controller-0 ~]$ sudo pcs resource manage galera-bundle

3. Perform a final status check to ensure that the services are running correctly:

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

NOTE

If any services have failed, use the `pcs resource refresh` command to resolve and restart the failed services.
4. Exit to director:
   
   [heat-admin@overcloud-controller-0 ~]$ exit

5. Source the `overcloudrc` file so that you can interact with the overcloud:
   
   $ source ~/overcloudrc

6. Check the network agents in your overcloud environment:
   
   (overcloud) $ openstack network agent list

7. If any agents appear for the old node, remove them:
   
   (overcloud) $ for AGENT in $(openstack network agent list --host overcloud-controller-1.localdomain -c ID -f value) ; do openstack network agent delete $AGENT ; done

   **NOTE**

   In an ML2/OVN deployment, bugs prevent removal of the OVN controller and metadata agents. To track progress on these bugs, see BZ1828889 and BZ1738554.

8. If necessary, add your router to the L3 agent host on the new node. Use the following example command to add a router named `r1` to the L3 agent using the UUID `2d1c1dc1-d9d4-4fa9-b2c8-f29cd1a649d4`:

   (overcloud) $ openstack network agent add router --l3 2d1c1dc1-d9d4-4fa9-b2c8-f29cd1a649d4 r1

9. Clean the cinder services.

   a. List the cinder services:

      (overcloud) $ openstack volume service list

   b. Log in to a controller node, connect to the `cinder-api` container and use the `cinder-manage service remove` command to remove leftover services:

      [heat-admin@overcloud-controller-0 ~]$ sudo podman exec -it cinder_api cinder-manage service remove cinder-backup <host>
      [heat-admin@overcloud-controller-0 ~]$ sudo podman exec -it cinder_api cinder-manage service remove cinder-scheduler <host>

10. Clean the RabbitMQ cluster.

    a. Log into a Controller node.

    b. Use the `podman exec` command to launch bash, and verify the status of the RabbitMQ cluster:
c. Use the `rabbitmqctl` command to forget the replaced controller node:

```bash
[heat-admin@overcloud-controller-0 ~]$ rabbitmqctl forget_cluster_node <node_name>
```

11. If you replaced a bootstrap Controller node, you must remove the environment file `~/templates/bootstrap-controller.yaml` after the replacement process, or delete the `pacemaker_short_bootstrap_node_name` and `mysql_short_bootstrap_node_name` parameters from your existing environment file. This step prevents director from attempting to override the Controller node name in subsequent replacements. For more information, see xref:proc_replacing-a-bootstrap-controller-node_replacing-controller-nodes\[.*\].
CHAPTER 20. REBOOTING NODES

You might need to reboot the nodes in the undercloud and overcloud. Use the following procedures to understand how to reboot different node types.

- If you reboot all nodes in one role, it is advisable to reboot each node individually. If you reboot all nodes in a role simultaneously, service downtime can occur during the reboot operation.

- If you reboot all nodes in your OpenStack Platform environment, reboot the nodes in the following sequential order:

  **Recommended node reboot order**
  1. Reboot the undercloud node.
  2. Reboot Controller and other composable nodes.
  3. Reboot standalone Ceph MON nodes.
  4. Reboot Ceph Storage nodes.
  5. Reboot Object Storage service (swift) nodes.
  6. Reboot Compute nodes.

**20.1. REBOOTING THE UNDERCLOUD NODE**

Complete the following steps to reboot the undercloud node.

**Procedure**

1. Log in to the undercloud as the stack user.
2. Reboot the undercloud:
   
   ```bash
   $ sudo reboot
   ```
3. Wait until the node boots.

**20.2. REBOOTING CONTROLLER AND COMPOSABLE NODES**

Reboot Controller nodes and standalone nodes based on composable roles, and exclude Compute nodes and Ceph Storage nodes.

**Procedure**

1. Log in to the node that you want to reboot.
2. Optional: If the node uses Pacemaker resources, stop the cluster:
   
   ```bash
   [heat-admin@overcloud-controller-0 ~]$ sudo pcs cluster stop
   ```
3. Reboot the node:
4. Wait until the node boots.

**Verification**

1. Verify that the services are enabled.
   a. If the node uses Pacemaker services, check that the node has rejoined the cluster:
      ```
      [heat-admin@overcloud-controller-0 ~]$ sudo pcs status
      ```
   b. If the node uses Systemd services, check that all services are enabled:
      ```
      [heat-admin@overcloud-controller-0 ~]$ sudo systemctl status
      ```
   c. If the node uses containerized services, check that all containers on the node are active:
      ```
      [heat-admin@overcloud-controller-0 ~]$ sudo podman ps
      ```

### 20.3. REBOOTING STANDALONE CEPH MON NODES

Complete the following steps to reboot standalone Ceph MON nodes.

**Procedure**

1. Log in to a Ceph MON node.
2. Reboot the node:
   ```
   $ sudo reboot
   ```
3. Wait until the node boots and rejoins the MON cluster.

Repeat these steps for each MON node in the cluster.

### 20.4. REBOOTING A CEPH STORAGE (OSD) CLUSTER

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

**Procedure**

1. Log in to a Ceph MON or Controller node and disable Ceph Storage cluster rebalancing temporarily:
   ```
   $ sudo cephadm shell -- ceph osd set noout
   $ sudo cephadm shell -- ceph osd set nocontinue
   ```
2. Select the first Ceph Storage node that you want to reboot and log in to the node.

3. Reboot the node:

   ```bash
   $ sudo reboot
   ```

4. Wait until the node boots.

5. Log in to the node and check the cluster status:

   ```bash
   $ sudo cephadm --shell ceph status
   ```

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

6. Log out of the node, reboot the next node, and check its status. Repeat this process until you have rebooted all Ceph Storage nodes.

7. When complete, log in to a Ceph MON or Controller node and re-enable cluster rebalancing:

   ```bash
   $ sudo cephadm shell -- ceph osd unset noout
   $ sudo cephadm shell -- ceph osd unset norebalance
   ```

20.5. REBOOTING OBJECT STORAGE SERVICE (SWIFT) NODES

The following procedure reboots Object Storage service (swift) nodes. Complete the following steps for every Object Storage node in your cluster.

Procedure

1. Log in to an Object Storage node.

2. Reboot the node:

   ```bash
   $ sudo reboot
   ```
3. Wait until the node boots.
4. Repeat the reboot for each Object Storage node in the cluster.

### 20.6. REBOOTING COMPUTE NODES

To ensure minimal downtime of instances in your Red Hat OpenStack Platform environment, the Migrating instances workflow outlines the steps you must complete to migrate instances from the Compute node that you want to reboot.

**Migrating instances workflow**

1. Decide whether to migrate instances to another Compute node before rebooting the node.
2. Select and disable the Compute node that you want to reboot so that it does not provision new instances.
3. Migrate the instances to another Compute node.
4. Reboot the empty Compute node.
5. Enable the empty Compute node.

**Prerequisites**

- **Before you reboot the Compute node, you must decide whether to migrate instances to another Compute node while the node is rebooting.**
  Review the list of migration constraints that you might encounter when you migrate virtual machine instances between Compute nodes. For more information, see Migration constraints in Configuring the Compute Service for Instance Creation.

- If you cannot migrate the instances, you can set the following core template parameters to control the state of the instances after the Compute node reboots:

  **NovaResumeGuestsStateOnHostBoot**
  Determines whether to return instances to the same state on the Compute node after reboot. When set to False, the instances remain down and you must start them manually. The default value is False.

  **NovaResumeGuestsShutdownTimeout**
  Number of seconds to wait for an instance to shut down before rebooting. It is not recommended to set this value to 0. The default value is 300. For more information about overcloud parameters and their usage, see Overcloud Parameters.

**Procedure**

1. Log in to the undercloud as the stack user.
2. List all Compute nodes and their UUIDs:

   ```bash
   $ source ~/stackrc
   (undercloud) $ openstack server list --name compute
   ```
Identify the UUID of the Compute node that you want to reboot.

3. From the undercloud, select a Compute node and disable it:

   $ source ~/overcloudrc
   (overcloud) $ openstack compute service list
   (overcloud) $ openstack compute service set <hostname> nova-compute --disable

4. List all instances on the Compute node:

   (overcloud) $ openstack server list --host <hostname> --all-projects

5. Optional: If you decide to migrate the instances to another Compute node, complete the following steps:

   a. If you decide to migrate the instances to another Compute node, use one of the following commands:

      • To migrate the instance to a different host, run the following command:

        (overcloud) $ openstack server migrate <instance_id> --live <target_host> --wait

      • Let nova-scheduler automatically select the target host:

        (overcloud) $ nova live-migration <instance_id>

      • Live migrate all instances at once:

        $ nova host-evacuate-live <hostname>

   b. Wait until migration completes.

   c. Confirm that the migration was successful:

      (overcloud) $ openstack server list --host <hostname> --all-projects

   d. Continue to migrate instances until none remain on the Compute node.

6. Log in to the Compute node and reboot the node:

   [heat-admin@overcloud-compute-0 ~]$ sudo reboot

7. Wait until the node boots.

8. Re-enable the Compute node:

   $ source ~/overcloudrc
   (overcloud) $ openstack compute service set <hostname> nova-compute --enable
9. Check that the Compute node is enabled:

    (overcloud) $ openstack compute service list
CHAPTER 21. SHUTTING DOWN AND STARTING UP THE UNDERCLOUD AND OVERCLOUD

If you must perform maintenance on the undercloud and overcloud, you must shut down and start up the undercloud and overcloud nodes in a specific order to ensure minimal issues when you start your overcloud.

Prerequisites

- A running undercloud and overcloud

21.1. UNDERCLOUD AND OVERCLOUD SHUTDOWN ORDER

To shut down the Red Hat OpenStack Platform environment, you must shut down the overcloud and undercloud in the following order:

1. Shut down instances on overcloud Compute nodes
2. Shut down Compute nodes
3. Stop all high availability and OpenStack Platform services on Controller nodes
4. Shut down Ceph Storage nodes
5. Shut down Controller nodes
6. Shut down the undercloud

21.2. SHUTTING DOWN INSTANCES ON OVERCLOUD COMPUTE NODES

As a part of shutting down the Red Hat OpenStack Platform environment, shut down all instances on Compute nodes before shutting down the Compute nodes.

Prerequisites

- An overcloud with active Compute services

Procedure

1. Log in to the undercloud as the stack user.

2. Source the credentials file for your overcloud:

   ```bash
   $ source ~/overcloudrc
   ```

3. View running instances in the overcloud:

   ```bash
   $ openstack server list --all-projects
   ```

4. Stop each instance in the overcloud:

   ```bash
   $ openstack server stop <INSTANCE>
   ```
Repeat this step for each instance until you stop all instances in the overcloud.

21.3. SHUTTING DOWN COMPUTE NODES

As a part of shutting down the Red Hat OpenStack Platform environment, log in to and shut down each Compute node.

Prerequisites

- Shut down all instances on the Compute nodes

Procedure

1. Log in as the root user to a Compute node.
2. Shut down the node:
   
   ```bash
   # shutdown -h now
   ```
3. Perform these steps for each Compute node until you shut down all Compute nodes.

21.4. STOPPING SERVICES ON CONTROLLER NODES

As a part of shutting down the Red Hat OpenStack Platform environment, stop services on the Controller nodes before shutting down the nodes. This includes Pacemaker and systemd services.

Prerequisites

- An overcloud with active Pacemaker services

Procedure

1. Log in as the root user to a Controller node.
2. Stop the Pacemaker cluster.
   
   ```bash
   # pcs cluster stop --all
   ```
   
   This command stops the cluster on all nodes.
3. Wait until the Pacemaker services stop and check that the services stopped.
   a. Check the Pacemaker status:
      
      ```bash
      # pcs status
      ```
   b. Check that no Pacemaker services are running in Podman:
      
      ```bash
      # podman ps --filter "name=.*-bundle.*"
      ```
4. Stop the Red Hat OpenStack Platform services:
# systemctl stop 'tripleo_*'

5. Wait until the services stop and check that services are no longer running in Podman:

   # podman ps

21.5. SHUTTING DOWN CEPH STORAGE NODES

As a part of shutting down the Red Hat OpenStack Platform environment, disable Ceph Storage services then log in to and shut down each Ceph Storage node.

Prerequisites

- A healthy Ceph Storage cluster
- Ceph MON services are running on standalone Ceph MON nodes or on Controller nodes

Procedure

1. Log in as the root user to a node that runs Ceph MON services, such as a Controller node or a standalone Ceph MON node.

2. Check the health of the cluster. In the following example, the podman command runs a status check within a Ceph MON container on a Controller node:

   # sudo podman exec -it ceph-mon-controller-0 ceph status

   Ensure that the status is HEALTH_OK.

3. Set the noout, norecover, norebalance, nobackfill, nodown, and pause flags for the cluster. In the following example, the podman commands set these flags through a Ceph MON container on a Controller node:

   # sudo podman exec -it ceph-mon-controller-0 ceph osd set noout
   # sudo podman exec -it ceph-mon-controller-0 ceph osd set norecover
   # sudo podman exec -it ceph-mon-controller-0 ceph osd set norebalance
   # sudo podman exec -it ceph-mon-controller-0 ceph osd set nobackfill
   # sudo podman exec -it ceph-mon-controller-0 ceph osd set nodown
   # sudo podman exec -it ceph-mon-controller-0 ceph osd set pause

4. Shut down each Ceph Storage node:
   a. Log in as the root user to a Ceph Storage node.
   b. Shut down the node:

      # shutdown -h now
   c. Perform these steps for each Ceph Storage node until you shut down all Ceph Storage nodes.

5. Shut down any standalone Ceph MON nodes:
   a. Log in as the root user to a standalone Ceph MON node.
b. Shut down the node:

```
# shutdown -h now
```

c. Perform these steps for each standalone Ceph MON node until you shut down all standalone Ceph MON nodes.

### Additional resources

- "What is the procedure to shutdown and bring up the entire ceph cluster?"

### 21.6. SHUTTING DOWN CONTROLLER NODES

As a part of shutting down the Red Hat OpenStack Platform environment, log in to and shut down each Controller node.

**Prerequisites**

- Stop the Pacemaker cluster
- Stop all Red Hat OpenStack Platform services on the Controller nodes

**Procedure**

1. Log in as the **root** user to a Controller node.
2. Shut down the node:

```
# shutdown -h now
```
3. Perform these steps for each Controller node until you shut down all Controller nodes.

### 21.7. SHUTTING DOWN THE UNDERCLOUD

As a part of shutting down the Red Hat OpenStack Platform environment, log in to the undercloud node and shut down the undercloud.

**Prerequisites**

- A running undercloud

**Procedure**

1. Log in to the undercloud as the **stack** user.
2. Shut down the undercloud:

```
$ sudo shutdown -h now
```

### 21.8. PERFORMING SYSTEM MAINTENANCE
After you completely shut down the undercloud and overcloud, perform any maintenance to the systems in your environment and then start up the undercloud and overcloud.

## 21.9. UNDERCLOUD AND OVERCLOUD STARTUP ORDER

To start the Red Hat OpenStack Platform environment, you must start the undercloud and overcloud in the following order:

1. Start the undercloud
2. Start Controller nodes
3. Start Ceph Storage nodes
4. Start Compute nodes
5. Start instances on overcloud Compute nodes

## 21.10. STARTING THE UNDERCLOUD

As a part of starting the Red Hat OpenStack Platform environment, power on the undercloud node, log in to the undercloud, and check the undercloud services.

### Prerequisites

- A powered down undercloud

### Procedure

1. Power on the undercloud and wait until the undercloud boots.

### Verification

1. Log in to the undercloud as the `stack` user.
2. Check the services on the undercloud:
   ```bash
   $ systemctl list-units 'tripleo_*'
   ```
3. Source the credential file for your undercloud and run the validation command to check that all services and containers are active and healthy.
   ```bash
   $ source stackrc
   $ openstack tripleo validator run --validation service-status --limit undercloud
   ```

### Additional resources

- [Using the validation framework](#)

## 21.11. STARTING CONTROLLER NODES

As a part of starting the Red Hat OpenStack Platform environment, power on each Controller node and check the non-Pacemaker services on the node.
Prerequisites

- Powered down Controller nodes

Procedure

1. Power on each Controller node.

Verification

1. Log in to each Controller node as the root user.
2. Check the services on the Controller node:
   
   ```
   $ systemctl -t service
   ```
   
   Only non-Pacemaker based services are running.
3. Wait until the Pacemaker services start and check that the services started:
   
   ```
   $ pcs status
   ```

   **NOTE**

   If your environment uses Instance HA, the Pacemaker resources do not start until you start the Compute nodes or perform a manual unfence operation with the `pcs stonith confirm <compute_node>` command. You must run this command on each Compute node that uses Instance HA.

21.12. STARTING CEPH STORAGE NODES

As a part of starting the Red Hat OpenStack Platform environment, power on the Ceph MON and Ceph Storage nodes and enable Ceph Storage services.

Prerequisites

- A powered down Ceph Storage cluster
- Ceph MON services are enabled on powered down standalone Ceph MON nodes or on powered on Controller nodes

Procedure

1. If your environment has standalone Ceph MON nodes, power on each Ceph MON node.
2. Power on each Ceph Storage node.
3. Log in as the root user to a node that runs Ceph MON services, such as a Controller node or a standalone Ceph MON node.
4. Check the status of the cluster nodes. In the following example, the `podman` command runs a status check within a Ceph MON container on a Controller node:
   
   ```
   # sudo podman exec -it ceph-mon-controller-0 ceph status
   ```
Ensure that each node is powered on and connected.

5. Unset the `noout`, `norecover`, `norebalance`, `nobackfill`, `nodown` and `pause` flags for the cluster. In the following example, the `podman` commands unset these flags through a Ceph MON container on a Controller node:

```
# sudo podman exec -it ceph-mon-controller-0 ceph osd unset noout
# sudo podman exec -it ceph-mon-controller-0 ceph osd unset norecover
# sudo podman exec -it ceph-mon-controller-0 ceph osd unset norebalance
# sudo podman exec -it ceph-mon-controller-0 ceph osd unset nobackfill
# sudo podman exec -it ceph-mon-controller-0 ceph osd unset nodown
# sudo podman exec -it ceph-mon-controller-0 ceph osd unset pause
```

Verification

1. Check the health of the cluster. In the following example, the `podman` command runs a status check within a Ceph MON container on a Controller node:

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

Ensure the status is `HEALTH_OK`.

Additional resources

- "What is the procedure to shutdown and bring up the entire ceph cluster?"

### 21.13. STARTING COMPUTE NODES

As a part of starting the Red Hat OpenStack Platform environment, power on each Compute node and check the services on the node.

**Prerequisites**

- Powered down Compute nodes

**Procedure**

1. Power on each Compute node.

**Verification**

1. Log in to each Compute as the `root` user.

2. Check the services on the Compute node:

```
$ systemctl -t service
```

### 21.14. STARTING INSTANCES ON OVERCLOUD COMPUTE NODES

As a part of starting the Red Hat OpenStack Platform environment, start the instances on Compute nodes.
Prerequisites

- An active overcloud with active nodes

Procedure

1. Log in to the undercloud as the **stack** user.

2. Source the credentials file for your overcloud:

   ```
   $ source ~/overcloudrc
   ```

3. View running instances in the overcloud:

   ```
   $ openstack server list --all-projects
   ```

4. Start an instance in the overcloud:

   ```
   $ openstack server start <INSTANCE>
   ```
CHAPTER 22. ADDITIONAL INTROSPECTION OPERATIONS

In some situations, you might want to perform introspection outside of the standard overcloud deployment workflow. For example, you might want to introspect new nodes or refresh introspection data after replacing hardware on existing unused nodes.

22.1. PERFORMING INDIVIDUAL NODE INTROSPECTION

To perform a single introspection on an available node, set the node to management mode and perform the introspection.

Procedure

1. Set all nodes to a manageable state:

   (undercloud) $ openstack baremetal node manage [NODE UUID]

2. Perform the introspection:

   (undercloud) $ openstack overcloud node introspect [NODE UUID] --provide

After the introspection completes, the node changes to an available state.

22.2. PERFORMING NODE INTROSPECTION AFTER INITIAL INTROSPECTION

After an initial introspection, all nodes enter an available state due to the --provide option. To perform introspection on all nodes after the initial introspection, set the node to management mode and perform the introspection.

Procedure

1. Set all nodes to a manageable state

   (undercloud) $ for node in $(openstack baremetal node list --fields uuid -f value) ; do openstack baremetal node manage $node ; done

2. Run the bulk introspection command:

   (undercloud) $ openstack overcloud node introspect --all-manageable --provide

After the introspection completes, all nodes change to an available state.

22.3. PERFORMING NETWORK INTROSPECTION FOR INTERFACE INFORMATION

Network introspection retrieves link layer discovery protocol (LLDP) data from network switches. The following commands show a subset of LLDP information for all interfaces on a node, or full information for a particular node and interface. This can be useful for troubleshooting. Director enables LLDP data collection by default.
Procedure

1. To get a list of interfaces on a node, run the following command:

   (undercloud) $ openstack baremetal introspection interface list [NODE UUID]

   For example:

   (undercloud) $ openstack baremetal introspection interface list c89397b7-a326-41a0-907d-79f8b86c7cd9

     +-----------+-------------------+------------------------+-------------------+----------------+
     | Interface | MAC Address       | Switch Port VLAN IDs   | Switch Chassis ID | Switch Port ID |
     +-----------+-------------------+------------------------+-------------------+----------------+
     | p2p2      | 00:0a:f7:79:93:19 | [103, 102, 18, 20, 42] | 64:64:9b:31:12:00 | 510            |
     | p2p1      | 00:0a:f7:79:93:18 | [101]                  | 64:64:9b:31:12:00 | 507            |
     +-----------+-------------------+------------------------+-------------------+----------------+

2. To view interface data and switch port information, run the following command:

   (undercloud) $ openstack baremetal introspection interface show [NODE UUID] [INTERFACE]

   For example:

   (undercloud) $ openstack baremetal introspection interface show c89397b7-a326-41a0-907d-79f8b86c7cd9 p2p1

     +--------------------------------------+------------------------------------------------------------------------
     | Field                                | Value
     +--------------------------------------+------------------------------------------------------------------------
     | interface                            | p2p1
     | mac                                  | 00:0a:f7:79:93:18
     | node_ident                           | c89397b7-a326-41a0-907d-79f8b86c7cd9
     | switch_capabilities_enabled          | [u'Bridge', u'Router']
     | switch_capabilities_support          | [u'Bridge', u'Router']
     | switch_chassis_id                    | 64:64:9b:31:12:00
     | switch_port_autonegotiation_enabled  | True
     | switch_port_autonegotiation_support  | True
     | switch_port_description              | ge-0/0/2.0
     | switch_port_id                       | 507
     | switch_port_link_aggregation_enabled | False
22.4. RETRIEVING HARDWARE INTROSPECTION DETAILS

The Bare Metal service hardware-inspection-extras feature is enabled by default, and you can use it to retrieve hardware details for overcloud configuration. For more information about the `inspection_extras` parameter in the `undercloud.conf` file, see Configuring the Director.

For example, the `numa_topology` collector is part of the hardware-inspection extras and includes the following information for each NUMA node:

- RAM (in kilobytes)
- Physical CPU cores and their sibling threads
- NICs associated with the NUMA node

Procedure

- To retrieve the information listed above, substitute `<UUID>` with the UUID of the bare-metal node to complete the following command:

  ```bash
  # openstack baremetal introspection data save <UUID> | jq .numa_topology
  ```

  The following example shows the retrieved NUMA information for a bare-metal node:
{ "cpus": [
  { "cpu": 1,
    "thread_siblings": [1, 17],
    "numa_node": 0
  },
  { "cpu": 2,
    "thread_siblings": [10, 26],
    "numa_node": 1
  },
  { "cpu": 0,
    "thread_siblings": [0, 16],
    "numa_node": 0
  },
  { "cpu": 5,
    "thread_siblings": [13, 29],
    "numa_node": 1
  },
  { "cpu": 7,
    "thread_siblings": [15, 31],
    "numa_node": 1
  },
  { "cpu": 7,
    "thread_siblings": [7, 23],
    "numa_node": 0
  },
  { "cpu": 1,
    "thread_siblings": [9, 25]
  }
]
null
"numa_node": 1
},
{
  "cpu": 3,
  "thread_siblings": [3, 19],
  "numa_node": 0
},
{
  "cpu": 2,
  "thread_siblings": [2, 18],
  "numa_node": 0
}
],
"ram": [
{
  "size_kb": 66980172,
  "numa_node": 0
},
{
  "size_kb": 67108864,
  "numa_node": 1
}
],
"nics": [
{
  "name": "ens3f1",
  "numa_node": 1
},
{
  "name": "ens3f0",
  "numa_node": 1
},
{
  "name": "ens2f0",
  "numa_node": 0
},
{
  "name": "ens2f1",
  "numa_node": 0
},
{
  "name": "ens1f1",
  "numa_node": 0
},
{
  "name": "ens1f0",
  "numa_node": 0
},
{
  "name": "eno4",
  "numa_node": 0
}]}
"numa_node": 0
},
{
  "name": "eno1",
  "numa_node": 0
},
{
  "name": "eno3",
  "numa_node": 0
},
{
  "name": "eno2",
  "numa_node": 0
}
CHAPTER 23. AUTOMATICALLY DISCOVERING BARE METAL NODES

You can use auto-discovery to register overcloud nodes and generate their metadata, without the need to create an `instackenv.json` file. This improvement can help to reduce the time it takes to collect information about a node. For example, if you use auto-discovery, you do not to collate the IPMI IP addresses and subsequently create the `instackenv.json`.

23.1. ENABLING AUTO-DISCOVERY

Enable and configure Bare Metal auto-discovery to automatically discover and import nodes that join your provisioning network when booting with PXE.

Procedure

1. Enable Bare Metal auto-discovery in the `undercloud.conf` file:

   ```
   enable_node_discovery = True
   discovery_default_driver = ipmi
   
   • `enable_node_discovery` - When enabled, any node that boots the introspection ramdisk using PXE is enrolled in the Bare Metal service (ironic) automatically.
   
   • `discovery_default_driver` - Sets the driver to use for discovered nodes. For example, `ipmi`.
   
   2. Add your IPMI credentials to ironic:

      a. Add your IPMI credentials to a file named `ipmi-credentials.json`. Replace the `SampleUsername`, `RedactedSecurePassword`, and `bmc_address` values in this example to suit your environment:

         ```
         [ 
           
           
           "description": "Set default IPMI credentials",
           "conditions": [ 
             
             "op": "eq",
             "field": "data://auto_discovered",
             "value": true
           ],
           "actions": [ 
             
             
             
             "action": "set-attribute",
             "path": "driver_info/ipmi_username",
             "value": "SampleUsername"},
            
            "action": "set-attribute",
            "path": "driver_info/ipmi_password",
            "value": "RedactedSecurePassword"},
            
            "action": "set-attribute",
            "path": "driver_info/ipmi_address",
            "value": "data[inventory][bmc_address]"
           ]
         ]
         ```

      3. Import the IPMI credentials file into ironic:

         ```
         $ openstack baremetal introspection rule import ipmi-credentials.json
         ```

23.2. TESTING AUTO-DISCOVERY
PXE boot a node that is connected to your provisioning network to test the Bare Metal auto-discovery feature.

**Procedure**

1. Power on the required nodes.

2. Run the `openstack baremetal node list` command. You should see the new nodes listed in an **enrolled** state:

   ```
   $ openstack baremetal node list
   +--------------------------------------+------+---------------+-------------+--------------------+------------+
   | UUID                                 | Name | Instance UUID | Power State | Provisioning State | Maintenance|
   +--------------------------------------+------+---------------+-------------+--------------------+------------+
   | c6e63aec-e5ba-4d63-8d37-bd57628258e8 | None | None          | power off   | enroll             | False      |
   | 0362b7b2-5b9c-4113-92e1-0b34a2535d9b | None | None          | power off   | enroll             | False      |
   +--------------------------------------+------+---------------+-------------+--------------------+------------+
   ```

3. Set the resource class for each node:

   ```
   $ for NODE in `openstack baremetal node list -c UUID -f value` ; do openstack baremetal node set $NODE --resource-class baremetal ; done
   ```

4. Configure the kernel and ramdisk for each node:

   ```
   $ for NODE in `openstack baremetal node list -c UUID -f value` ; do openstack baremetal node manage $NODE ; done
   $ openstack overcloud node configure --all-manageable
   ```

5. Set all nodes to available:

   ```
   $ for NODE in `openstack baremetal node list -c UUID -f value` ; do openstack baremetal node provide $NODE ; done
   ```

### 23.3. USING RULES TO DISCOVER DIFFERENT VENDOR HARDWARE

If you have a heterogeneous hardware environment, you can use introspection rules to assign credentials and remote management credentials. For example, you might want a separate discovery rule to handle your Dell nodes that use DRAC.

**Procedure**

1. Create a file named `dell-drac-rules.json` with the following contents:

   ```json
   [
   {
   "description": "Set default IPMI credentials",
   ```
"conditions": [
    {
      "op": "eq",
      "field": "data://auto_discovered",
      "value": true
    },
    {
      "op": "ne",
      "field": "data://inventory.system_vendor.manufacturer",
      "value": "Dell Inc."
    }
  ],

  "actions": [
    {
      "action": "set-attribute",
      "path": "driver_info/ipmi_username",
      "value": "SampleUsername"
    },
    {
      "action": "set-attribute",
      "path": "driver_info/ipmi_password",
      "value": "RedactedSecurePassword"
    },
    {
      "action": "set-attribute",
      "path": "driver_info/ipmi_address",
      "value": "data[inventory][bmc_address]"
    }
  ],

  "description": "Set the vendor driver for Dell hardware",

  "conditions": [
    {
      "op": "eq",
      "field": "data://auto_discovered",
      "value": true
    },
    {
      "op": "eq",
      "field": "data://inventory.system_vendor.manufacturer",
      "value": "Dell Inc."
    }
  ],

  "actions": [
    {
      "action": "set-attribute",
      "path": "driver",
      "value": "idrac"
    },
    {
      "action": "set-attribute",
      "path": "driver_info/drac_username",
      "value": "SampleUsername"
    },
    {
      "action": "set-attribute",
      "path": "driver_info/drac_password",
      "value": "RedactedSecurePassword"
    },
    {
      "action": "set-attribute",
      "path": "driver_info/drac_address",
      "value": "data[inventory][bmc_address]"
    }
  ]
}
CHAPTER 24. CONFIGURING AUTOMATIC PROFILE TAGGING

The introspection process performs a series of benchmark tests. The director saves the data from these tests. You can create a set of policies that use this data in various ways:

- The policies can identify underperforming or unstable nodes and isolate these nodes from use in the overcloud.
- The policies can define whether to tag nodes into specific profiles automatically.

24.1. POLICY FILE SYNTAX

Policy files use a JSON format that contains a set of rules. Each rule defines a description, a condition, and an action. A **description** is a plain text description of the rule, a **condition** defines an evaluation using a key-value pattern, and an **action** is the performance of the condition.

**Description**

A description is a plain text description of the rule.

**Example:**

```
"description": "A new rule for my node tagging policy"
```

**Conditions**

A condition defines an evaluation using the following key-value pattern:

- **field**
  - Defines the field to evaluate:
    - **memory_mb** - The amount of memory for the node in MB.
    - **cpus** - The total number of threads for the node CPU.
    - **cpu_arch** - The architecture of the node CPU.
    - **local_gb** - The total storage space of the node root disk.

- **op**
  - Defines the operation to use for the evaluation. This includes the following attributes:
    - **eq** - Equal to
    - **ne** - Not equal to
    - **lt** - Less than
    - **gt** - Greater than
    - **le** - Less than or equal to
    - **ge** - Greater than or equal to
    - **in-net** - Checks that an IP address is in a given network
- **matches** - Requires a full match against a given regular expression
- **contains** - Requires a value to contain a given regular expression
- **is-empty** - Checks that field is empty

**invert**

Boolean value to define whether to invert the result of the evaluation.

**multiple**

Defines the evaluation to use if multiple results exist. This parameter includes the following attributes:

- **any** - Requires any result to match
- **all** - Requires all results to match
- **first** - Requires the first result to match

**value**

Defines the value in the evaluation. If the field and operation result in the value, the condition return a true result. Otherwise, the condition returns a false result.

Example:

```json
"conditions": [ 
  { 
    "field": "local_gb",
    "op": "ge",
    "value": 1024
  }
],
```

**Actions**

If a condition is **true**, the policy performs an action. The action uses the **action** key and additional keys depending on the value of **action**:

- **fail** - Fails the introspection. Requires a **message** parameter for the failure message.
- **set-attribute** - Sets an attribute on an ironic node. Requires a **path** field, which is the path to an ironic attribute (for example, `/driver_info/ipmi_address`), and a **value** to set.
- **set-capability** - Sets a capability on an ironic node. Requires **name** and **value** fields, which are the name and the value for a new capability. This replaces the existing value for this capability. For example, use this to define node profiles.
- **extend-attribute** - The same as **set-attribute** but treats the existing value as a list and appends value to it. If the optional **unique** parameter is set to True, nothing is added if the given value is already in a list.

Example:

```json
"actions": [ 
  { 
    "action": "set-capability",
```
24.2. POLICY FILE EXAMPLE

The following is an example JSON file *(rules.json)* that contains introspection rules:

```json
[
    {
        "description": "Fail introspection for unexpected nodes",
        "conditions": [
            {
                "op": "lt",
                "field": "memory_mb",
                "value": 4096
            }
        ],
        "actions": [
            {
                "action": "fail",
                "message": "Memory too low, expected at least 4 GiB"
            }
        ]
    },
    {
        "description": "Assign profile for object storage",
        "conditions": [
            {
                "op": "ge",
                "field": "local_gb",
                "value": 1024
            }
        ],
        "actions": [
            {
                "action": "set-capability",
                "name": "profile",
                "value": "swift-storage"
            }
        ]
    },
    {
        "description": "Assign possible profiles for compute and controller",
        "conditions": [
            {
                "op": "lt",
                "field": "local_gb",
                "value": 1024
            },
            {
                "op": "ge",
                "field": "local_gb",
                "value": 40
            }
        ]
    }
]
```
This example consists of three rules:

- Fail introspection if memory is lower than 4096 MiB. You can apply these types of rules if you want to exclude certain nodes from your cloud.

- Nodes with a hard drive size 1 TiB and bigger are assigned the swift-storage profile unconditionally.

- Nodes with a hard drive less than 1 TiB but more than 40 GiB can be either Compute or Controller nodes. You can assign two capabilities (compute_profile and control_profile) so that the openstack overcloud profiles match command can later make the final choice. For this process to succeed, you must remove the existing profile capability, otherwise the existing profile capability has priority.

The profile matching rules do not change any other nodes.

**NOTE**

Using introspection rules to assign the profile capability always overrides the existing value. However, [PROFILE]_profile capabilities are ignored for nodes that already have a profile capability.

### 24.3. IMPORTING POLICY FILES

To import policy files to director, complete the following steps.

**Procedure**

1. Import the policy file into director:

   ```bash
   $ openstack baremetal introspection rule import rules.json
   ```

2. Run the introspection process:
$ openstack overcloud node introspect --all-manageable

3. After introspection completes, check the nodes and their assigned profiles:

$ openstack overcloud profiles list

4. If you made a mistake in introspection rules, run the following command to delete all rules:

$ openstack baremetal introspection rule purge
CHAPTER 25. CREATING WHOLE-DISK IMAGES

The main overcloud image is a flat partition image that contains no partitioning information or bootloader. Director uses a separate kernel and ramdisk when it boots nodes and creates a basic partitioning layout when it writes the overcloud image to disk. However, you can create a whole-disk image, which includes a partitioning layout, bootloader, and hardened security.

**IMPORTANT**

The following process uses the director image building feature. Red Hat only supports images that use the guidelines contained in this section. Custom images built outside of these specifications are not supported.

25.1. SECURITY HARDENING MEASURES

The whole disk image includes extra security hardening measures necessary for Red Hat OpenStack Platform deployments where security is an important feature.

Security recommendations for image creation

- The `/tmp` directory is mounted on a separate volume or partition and has the `rw, nosuid, nodev, noexec, and relatime` flags.

- The `/var`, `/var/log` and the `/var/log/audit` directories are mounted on separate volumes or partitions, with the `rw` and `relatime` flags.

- The `/home` directory is mounted on a separate partition or volume and has the `rw, nodev, and relatime` flags.

- Include the following changes to the `GRUB_CMDLINE_LINUX` setting:
  - To enable auditing, add the `audit=1` kernel boot flag.
  - To disable the kernel support for USB using boot loader configuration, add `nousb`.
  - To remove the insecure boot flags, remove `crashkernel=auto`.

- Blacklist insecure modules (`usb-storage, cramfs, freevxfs, jffs2, hfs, hfsplus, squashfs, udf, vfat`) and prevent these modules from loading.

- Remove any insecure packages (`kdump` installed by `kexec-tools` and `telnet`) from the image because they are installed by default.

25.2. WHOLE DISK IMAGE WORKFLOW

To build a whole disk image, complete the following workflow:

1. Download a base Red Hat Enterprise Linux 9.0 image.

2. Set the environment variables specific to registration.

3. Customize the image by modifying the partition schema and the size.

4. Create the image.
5. Upload the image to director.

25.3. DOWNLOADING THE BASE CLOUD IMAGE

Before you build a whole disk image, you must download an existing cloud image of Red Hat Enterprise Linux to use as a basis.

Procedure

   
   ![NOTE]
   
   Enter your customer Customer Portal login details if a prompt appears.

2. Click **Download Now** next to **Red Hat Enterprise Linux 9.0 KVM Guest Image**

25.4. ENABLING CONSISTENT INTERFACE NAMING

Consistent network interface device naming is disabled in the KVM guest image by default. Use `virt-customize` to enable consistent naming.

Procedure

1. Move the KVM guest image to `/var/lib/libvirt/images`: 

   ```bash
   $ sudo mv <kvm_guest_image> /var/lib/libvirt/images/
   ```

2. Start **libvirtd**:

   ```bash
   $ sudo systemctl start libvirtd
   ```

3. Enable consistent interface naming in the KVM guest image:

   ```bash
   $ sudo virt-customize -a /var/lib/libvirt/images/<kvm_guest_image> --edit
   /etc/default/grub:s/net.ifnames=0/net.ifnames=1/
   ```

4. Stop **libvirtd**:

   ```bash
   $ sudo systemctl stop libvirtd
   ```

25.5. DISK IMAGE ENVIRONMENT VARIABLES

As a part of the disk image building process, the director requires a base image and registration details to obtain packages for the new overcloud image. Define these attributes with the following Linux environment variables.
NOTE
The image building process temporarily registers the image with a Red Hat subscription and unregisters the system when the image building process completes.

To build a disk image, set Linux environment variables that suit your environment and requirements:

**DIB_LOCAL_IMAGE**
Sets the local image that you want to use as the basis for your whole disk image.

**REG_ACTIVATION_KEY**
Use an activation key instead of login details as part of the registration process.

**REG_AUTO_ATTACH**
Defines whether to attach the most compatible subscription automatically.

**REG_BASE_URL**
The base URL of the content delivery server that contains packages for the image. The default Customer Portal Subscription Management process uses [https://cdn.redhat.com](https://cdn.redhat.com). If you use a Red Hat Satellite 6 server, set this parameter to the base URL of your Satellite server.

**REG_ENVIRONMENT**
Registers to an environment within an organization.

**REG_METHOD**
Sets the method of registration. Use portal to register a system to the Red Hat Customer Portal. Use satellite to register a system with Red Hat Satellite 6.

**REG_ORG**
The organization where you want to register the images.

**REG_POOL_ID**
The pool ID of the product subscription information.

**REG_PASSWORD**
Sets the password for the user account that registers the image.

**REG_RELEASE**
Sets the Red Hat Enterprise Linux minor release version. You must use it with the REG_AUTO_ATTACH or the REG_POOL_ID environment variable.

**REG_REPOS**
A comma-separated string of repository names. Each repository in this string is enabled through subscription-manager.
Use the following repositories for a security hardened whole disk image:

- `rhel-8-for-x86_64-baseos-eus-rpms`
- `rhel-8-for-x86_64-appstream-eus-rpms`
- `rhel-8-for-x86_64-highavailability-eus-rpms`
- `ansible-2.9-for-rhel-8-x86_64-rpms`
- `fast-datapath-for-rhel-8-x86_64-rpms`
- `openstack-beta-for-rhel-8-x86_64-rpms`
REG_SAT_URL
The base URL of the Satellite server to register overcloud nodes. Use the Satellite HTTP URL and not the HTTPS URL for this parameter. For example, use `http://satellite.example.com` and not `https://satellite.example.com`.

REG_SERVER_URL
Sets the host name of the subscription service to use. The default host name is for the Red Hat Customer Portal at `subscription.rhn.redhat.com`. If you use a Red Hat Satellite 6 server, set this parameter to the host name of your Satellite server.

REG_USER
Sets the user name for the account that registers the image.

Use the following set of example commands to export a set of environment variables and temporarily register a local QCOW2 image to the Red Hat Customer Portal:

```bash
$ export DIB_LOCAL_IMAGE=./rhel-9.0-x86_64-kvm.qcow2
$ export REG_METHOD=portal
$ export REG_USER=<your_name>
$ export REG_PASSWORD=<your_password>
$ export REG_RELEASE="8.4"
$ export REG_POOL_ID=<pool_id>
$ export REG_REPOS="rhel-8-for-x86_64-baseos-eus-rpms \ 
rhel-8-for-x86_64-appstream-eus-rpms \ 
rhel-8-for-x86_64-highavailability-eus-rpms \ 
ansible-2.9-for-rhel-8-x86_64-rpms \ 
fast-datapath-for-rhel-8-x86_64-rpms \ 
openstack-beta-for-rhel-8-x86_64-rpms"
```

25.6. CUSTOMIZING THE DISK LAYOUT
The default security hardened image size is 20G and uses predefined partitioning sizes. However, you must modify the partitioning layout to accommodate overcloud container images. Complete the steps in the following sections to increase the image size to 40G. You can modify the partitioning layout and disk size to further suit your needs.

To modify the partitioning layout and disk size, perform the following steps:

- Modify the partitioning schema using the `DIB_BLOCK_DEVICE_CONFIG` environment variable.
- Modify the global size of the image by updating the `DIB_IMAGE_SIZE` environment variable.

25.7. MODIFYING THE PARTITIONING SCHEMA
You can modify the partitioning schema to alter the partitioning size, create new partitions, or remove existing partitions. Use the following environment variable to define a new partitioning schema:

```bash
$ export DIB_BLOCK_DEVICE_CONFIG='<yaml_schema_with_partitions>'
```

BIOS example
The following YAML structure represents the modified logical volume partitioning layout to accommodate enough space to pull overcloud container images:

```
"
export DIB_BLOCK_DEVICE_CONFIG=""
- local_loop:
  name: image0
- partitioning:
  base: image0
  label: mbr
  partitions:
  - name: root
    flags: [ boot, primary ]
    size: 40G
- lvm:
  name: lvm
  base: [ root ]
  pvs:
  - name: pv
    base: root
    options: [ "--force" ]
  vgs:
  - name: vg
    base: [ "pv" ]
    options: [ "--force" ]
  lvs:
  - name: lv_root
    base: vg
    extents: 23%VG
  - name: lv_tmp
    base: vg
    extents: 4%VG
  - name: lv_var
    base: vg
    extents: 45%VG
  - name: lv_log
    base: vg
    extents: 23%VG
  - name: lv_audit
    base: vg
    extents: 4%VG
  - name: lv_home
    base: vg
    extents: 1%VG
- mkfs:
  name: fs_root
  base: lv_root
  type: xfs
  label: "img-rootfs"
  mount:
    mount_point: /
    fstab:
      options: "rw,relatime"
      fsck-passno: 1
- mkfs:
  name: fs_tmp
  base: lv_tmp
  type: xfs
  mount:
    mount_point: /tmp
Use this sample YAML content as a basis for the partition schema of your image. Modify the partition sizes and layout to suit your needs.

NOTE

You must define the correct partition sizes for the image because you cannot resize them after the deployment.

UEFI example

The following YAML structure represents the modified logical volume partitioning layout to accommodate enough space to pull overcloud container images:

```bash
export DIB_BLOCK_DEVICE_CONFIG=""
```
- local_loop:
  name: image0
- partitioning:
  base: image0
  label: gpt
  partitions:
  - name: ESP
    type: 'EF00'
    size: 200MiB
  - name: BSP
    type: 'EF02'
    size: 1MiB
  - name: ROOT
    type: '8300'
    size: 100%
- mkfs:
  name: fs_esp
  base: ESP
  type: vfat
  mount:
    mount_point: /boot/efi
  fstab:
    options: "defaults"
  fsck-passno: 1
- mkfs:
  name: fs_root
  base: ROOT
  label: "img-rootfs"
  type: xfs
  mount:
    mount_point: /
  fstab:
    options: "defaults"
  fsck-passno: 1

Use this sample YAML content as a basis for the partition schema of your image. Modify the partition sizes and layout to suit your environment.

**NOTE**

You must define the correct partition sizes for the image before deployment because you cannot resize them after the deployment.

### 25.8. MODIFYING THE IMAGE SIZE

The global sum of the modified partitioning schema might exceed the default disk size (20G). In this situation, you might need to modify the image size. To modify the image size, edit the configuration files that create the image.

**Procedure**

1. Create a copy of the `/usr/share/openstack-tripleo-common/image-yaml/overcloud-hardened-images-python3.yaml`
# cp /usr/share/openstack-tripleo-common/image-yaml/overcloud-hardened-images-python3.yaml \ 
/home/stack/overcloud-hardened-images-python3-custom.yaml

**NOTE**


2. Edit the **DIB_IMAGE_SIZE** in the configuration file and adjust the values as necessary:

```yaml
environment:
    DIB_PYTHON_VERSION: '3'
    DIB_MODPROBE_BLACKLIST: 'usb-storage cramfs freevxfs jffs2 hfs hfsplus squashfs udf vfat bluetooth'
    DIB_BOOTLOADER_DEFAULT_CMDLINE: 'nofb nomodeset vga=normal console=tty0 console=ttyS0,115200 audit=1 nousb'
    DIB_IMAGE_SIZE: '40'
    COMPRESS_IMAGE: '1'
```

1. Adjust this value to the new total disk size.

3. Optional. To configure a proxy, you must also include the `http_proxy` and `https_proxy` environment variables:

```yaml
environment:
    http_proxy: <proxy_server>
    https_proxy: <proxy_server>
```

* Replace `<proxy_server>` with the address of your proxy.

4. Save the file.

**IMPORTANT**

When you deploy the overcloud, the director creates a RAW version of the overcloud image. This means your undercloud must have enough free space to accommodate the RAW image. For example, if you set the security hardened image size to 40G, you must have 40G of space available on the undercloud hard disk.

**IMPORTANT**

When director writes the image to the physical disk, it creates a 64MB configuration drive primary partition at the end of the disk. When you create your whole disk image, ensure that the size of the physical disk accommodates this extra partition.

### 25.9. BUILDING THE WHOLE DISK IMAGE

After you set the environment variables and customize the image, create the image using the `openstack overcloud image build` command.
Procedure

1. Run the `openstack overcloud image build` command with all necessary configuration files.

```bash
# openstack overcloud image build \
--image-name overcloud-hardened-full \  ①
--config-file /home/stack/overcloud-hardened-images-python3-custom.yaml \  ②
--config-file /usr/share/openstack-tripleo-common/image-yaml/overcloud-hardened-images-rhel8.yaml
```

For UEFI whole disk images, use `overcloud-hardened-uefi-full`.

The `overcloud-hardened-images-python3-custom.yaml` file is the custom configuration file that contains the new disk size. If you are not using a different custom disk size, use the original `/usr/share/openstack-tripleo-common/image-yaml/overcloud-hardened-images-python3.yaml` file instead. For standard UEFI whole disk images, use `overcloud-hardened-images-uefi-python3.yaml`.

For UEFI whole disk images, use `overcloud-hardened-images-uefi-rhel8.yaml`.

This command creates an image called `overcloud-hardened-full.qcow2`, which contains all the necessary security features.

25.10. UPLOADING THE WHOLE DISK IMAGE

Upload the image to the OpenStack Image (glance) service and start using it from the Red Hat OpenStack Platform director. To upload a security hardened image, complete the following steps:

1. Rename the newly generated image and move the image to your `images` directory:

   ```bash
   # mv overcloud-hardened-full.qcow2 ~/images/overcloud-full.qcow2
   ```

2. Remove all the old overcloud images:

   ```bash
   # openstack image delete overcloud-full
   # openstack image delete overcloud-full-initrd
   # openstack image delete overcloud-full-vmlinuz
   ```

3. Upload the new overcloud image:

   ```bash
   # openstack overcloud image upload --image-path /home/stack/images --whole-disk
   ```

If you want to replace an existing image with the security hardened image, use the `--update-existing` flag. This flag overwrites the original `overcloud-full` image with a new security hardened image.
CHAPTER 26. CREATING VIRTUALIZED CONTROL PLANES

A virtualized control plane is a control plane located on virtual machines (VMs) rather than on bare metal. Use a virtualized control plane to reduce the number of bare metal machines that you require for the control plane.

This chapter explains how to virtualize your Red Hat OpenStack Platform (RHOSP) control plane for the overcloud using RHOSP and Red Hat Virtualization.

26.1. VIRTUALIZED CONTROL PLANE ARCHITECTURE

Use director to provision an overcloud using Controller nodes that are deployed in a Red Hat Virtualization cluster. You can then deploy these virtualized controllers as the virtualized control plane nodes.

**NOTE**

Virtualized Controller nodes are supported only on Red Hat Virtualization.

The following architecture diagram illustrates how to deploy a virtualized control plane. Distribute the overcloud with the Controller nodes running on VMs on Red Hat Virtualization and run the Compute and Storage nodes on bare metal.

**NOTE**

Run the OpenStack virtualized undercloud on Red Hat Virtualization.

### Virtualized control plane architecture

![Virtualized control plane architecture diagram](image)

The OpenStack Bare Metal Provisioning service (ironic) includes a driver for Red Hat Virtualization VMs, **staging-ovirt**. You can use this driver to manage virtual nodes within a Red Hat Virtualization environment. You can also use it to deploy overcloud controllers as virtual machines within a Red Hat Virtualization environment.

**Benefits and limitations of virtualizing your RHOSP overcloud control plane**

Although there are a number of benefits to virtualizing your RHOSP overcloud control plane, this is not an option in every configuration.
Benefits

Virtualizing the overcloud control plane has a number of benefits that prevent downtime and improve performance.

- You can allocate resources to the virtualized controllers dynamically, using hot add and hot remove to scale CPU and memory as required. This prevents downtime and facilitates increased capacity as the platform grows.
- You can deploy additional infrastructure VMs on the same Red Hat Virtualization cluster. This minimizes the server footprint in the data center and maximizes the efficiency of the physical nodes.
- You can use composable roles to define more complex RHOSP control planes and allocate resources to specific components of the control plane.
- You can maintain systems without service interruption with the VM live migration feature.
- You can integrate third-party or custom tools that Red Hat Virtualization supports.

Limitations

Virtualized control planes limit the types of configurations that you can use.

- Virtualized Ceph Storage nodes and Compute nodes are not supported.
- Block Storage (cinder) image-to-volume is not supported for back ends that use Fiber Channel. Red Hat Virtualization does not support N_Port ID Virtualization (NPIV). Therefore, Block Storage (cinder) drivers that need to map LUNs from a storage back end to the controllers, where cinder-volume runs by default, do not work. You must create a dedicated role for cinder-volume and use the role to create physical nodes instead of including it on the virtualized controllers. For more information, see Composable Services and Custom Roles.

26.2. PROVISIONING VIRTUALIZED CONTROLLERS USING THE RED HAT VIRTUALIZATION DRIVER

Complete the following steps to provision a virtualized RHOSP control plane for the overcloud using RHOSP and Red Hat Virtualization.

Prerequisites

- You must have a 64-bit x86 processor with support for the Intel 64 or AMD64 CPU extensions.
- You must have the following software already installed and configured:
  - Red Hat Virtualization. For more information, see Red Hat Virtualization Documentation Suite.
  - Red Hat OpenStack Platform (RHOSP). For more information, see Director Installation and Usage.
- You must have the virtualized Controller nodes prepared in advance. These requirements are the same as for bare metal Controller nodes. For more information, see Controller Node Requirements.
- You must have the bare metal nodes being used as overcloud Compute nodes, and the storage nodes, prepared in advance. For hardware specifications, see the Compute Node Requirements.
Ceph Storage Node Requirements. To deploy overcloud Compute nodes on POWER (ppc64le) hardware, see Red Hat OpenStack Platform for POWER.

- You must have the logical networks created, and your cluster of host networks ready to use network isolation with multiple networks. For more information, see Logical Networks.
- You must have the internal BIOS clock of each node set to UTC to prevent issues with future-dated file timestamps when hwclock synchronizes the BIOS clock before applying the timezone offset.

**TIP**

To avoid performance bottlenecks, use composable roles and keep the data plane services on the bare metal Controller nodes.

**Procedure**

1. To enable the staging-ovirt driver in director, add the driver to the enabled_hardware_types parameter in the undercloud.conf configuration file:

   ```
   enabled_hardware_types = ipmi,redfish,ilo,idrac,staging-ovirt
   ```

2. Verify that the undercloud contains the staging-ovirt driver:

   ```
   (undercloud) [stack@undercloud ~]$ openstack baremetal driver list
   ```

   If you have configured the undercloud correctly, this command returns the following result:

   ```
   +---------------------+-----------------------+
   | Supported driver(s) | Active host(s)        |
   +---------------------+-----------------------+
   | idrac               | localhost.localdomain |
   | ilo                 | localhost.localdomain |
   | ipmi                | localhost.localdomain |
   | pxe_drac            | localhost.localdomain |
   | pxe_ilo             | localhost.localdomain |
   | pxe_ipmitool        | localhost.localdomain |
   | redfish             | localhost.localdomain |
   | staging-ovirt       | localhost.localdomain |
   ```

3. Update the overcloud node definition template, for example, nodes.json, to register the VMs hosted on Red Hat Virtualization with director. For more information, see Registering Nodes for the Overcloud. Use the following key:value pairs to define aspects of the VMs that you want to deploy with your overcloud:

   **Table 26.1. Configuring the VMs for the overcloud**

<table>
<thead>
<tr>
<th>Key</th>
<th>Set to this value</th>
</tr>
</thead>
<tbody>
<tr>
<td>pm_type</td>
<td>OpenStack Bare Metal Provisioning (ironic) service driver for oVirt/RHV VMs, staging-ovirt.</td>
</tr>
<tr>
<td>Key</td>
<td>Set to this value</td>
</tr>
<tr>
<td>-----------------</td>
<td>-----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>pm_user</td>
<td>Red Hat Virtualization Manager username.</td>
</tr>
<tr>
<td>pm_password</td>
<td>Red Hat Virtualization Manager password.</td>
</tr>
<tr>
<td>pm_addr</td>
<td>Hostname or IP of the Red Hat Virtualization Manager server.</td>
</tr>
<tr>
<td>pm_vm_name</td>
<td>Name of the virtual machine in Red Hat Virtualization Manager where the controller is created.</td>
</tr>
</tbody>
</table>

For example:

```json
{
  "nodes": [
    {
      "name": "osp13-controller-0",
      "pm_type": "staging-ovirt",
      "mac": ["00:1a:4a:16:01:56"],
      "cpu": "2",
      "memory": "4096",
      "disk": "40",
      "arch": "x86_64",
      "pm_user": "admin@internal",
      "pm_password": "password",
      "pm_addr": "rhvm.example.com",
      "pm_vm_name": "{osp_curr_ver}-controller-0",
      "capabilities": "profile:control,boot_option:local"
    },
    ...
  ]
}
```

Configure one Controller on each Red Hat Virtualization Host

4. Configure an affinity group in Red Hat Virtualization with "soft negative affinity" to ensure high availability is implemented for your controller VMs. For more information, see Affinity Groups.

5. Open the Red Hat Virtualization Manager interface, and use it to map each VLAN to a separate logical vNIC in the controller VMs. For more information, see Logical Networks.

6. Set `no_filter` in the vNIC of the director and controller VMs, and restart the VMs, to disable the MAC spoofing filter on the networks attached to the controller VMs. For more information, see Virtual Network Interface Cards.

7. Deploy the overcloud to include the new virtualized controller nodes in your environment:

   ```sh
   (undercloud) [stack@undercloud ~]$ openstack overcloud deploy --templates
   ```
CHAPTER 27. PERFORMING ADVANCED CONTAINER IMAGE MANAGEMENT

The default container image configuration suits most environments. In some situations, your container image configuration might require some customization, such as version pinning.

27.1. PINNING CONTAINER IMAGES FOR THE UNDERCLOUD

In certain circumstances, you might require a set of specific container image versions for your undercloud. In this situation, you must pin the images to a specific version. To pin your images, you must generate and modify a container configuration file, and then combine the undercloud roles data with the container configuration file to generate an environment file that contains a mapping of services to container images. Then include this environment file in the custom_env_files parameter in the undercloud.conf file.

Procedure

1. Log in to the undercloud host as the stack user.

2. Run the openstack tripleo container image prepare default command with the --output-env-file option to generate a file that contains the default image configuration:

   $ sudo openstack tripleo container image prepare default \
   --output-env-file undercloud-container-image-prepare.yaml

3. Modify the undercloud-container-image-prepare.yaml file according to the requirements of your environment.

   a. Remove the tag: parameter so that director can use the tag_from_label: parameter. Director uses this parameter to identify the latest version of each container image, pull each image, and tag each image on the container registry in director.

   b. Remove the Ceph labels for the undercloud.

   c. Ensure that the neutron_driver: parameter is empty. Do not set this parameter to OVN because OVN is not supported on the undercloud.

   d. Include your container image registry credentials:

      ContainerImageRegistryCredentials:
      registry.redhat.io
      myser: 'p@55w0rd!'  

   NOTE

   You cannot push container images to the undercloud registry on new underclouds because the image-serve registry is not installed yet. You must set the push_destination value to false, or use a custom value, to pull images directly from source. For more information, see Container image preparation parameters.

4. Generate a new container image configuration file that uses the undercloud roles file combined with your custom undercloud-container-image-prepare.yaml file:
```bash
$ sudo openstack tripleo container image prepare \
   -r /usr/share/openstack-tripleo-heat-templates/roles_data_undercloud.yaml \
   -e undercloud-container-image-prepare.yaml \
   --output-env-file undercloud-container-images.yaml
```

The `undercloud-container-images.yaml` file is an environment file that contains a mapping of service parameters to container images. For example, OpenStack Identity (keystone) uses the `ContainerKeystoneImage` parameter to define its container image:

```
```

Note that the container image tag matches the `{version}-{release}` format.

5. Include the `undercloud-container-images.yaml` file in the `custom_env_files` parameter in the `undercloud.conf` file. When you run the undercloud installation, the undercloud services use the pinned container image mapping from this file.

### 27.2. PINNING CONTAINER IMAGES FOR THE OVERCLOUD

In certain circumstances, you might require a set of specific container image versions for your overcloud. In this situation, you must pin the images to a specific version. To pin your images, you must create the `containers-prepare-parameter.yaml` file, use this file to pull your container images to the undercloud registry, and generate an environment file that contains a pinned image list.

For example, your `containers-prepare-parameter.yaml` file might contain the following content:

```yaml
parameter_defaults:
  ContainerImagePrepare:
    - push_destination: true
      set:
        name_prefix: openstack-
        name_suffix: "
        namespace: registry.redhat.io/rhosp-beta
        neutron_driver: ovn
        tag_from_label: '{version}-{release}'

  ContainerImageRegistryCredentials:
    registry.redhat.io:
      myuser: 'p@55w0rd!'
```

The `ContainerImagePrepare` parameter contains a single rule set. This rule set must not include the `tag` parameter and must rely on the `tag_from_label` parameter to identify the latest version and release of each container image. Director uses this rule set to identify the latest version of each container image, pull each image, and tag each image on the container registry in director.

**Procedure**

1. Run the `openstack tripleo container image prepare` command, which pulls all images from the source defined in the `containers-prepare-parameter.yaml` file. Include the `--output-env-file` to specify the output file that will contain the list of pinned container images:

   ```bash
   $ sudo openstack tripleo container image prepare -e /home/stack/templates/containers-
   prepare-parameter.yaml --output-env-file overcloud-images.yaml
   ```
The `overcloud-images.yaml` file is an environment file that contains a mapping of service parameters to container images. For example, OpenStack Identity (keystone) uses the `ContainerKeystoneImage` parameter to define its container image:

```
```

Note that the container image tag matches the `{{version}}-{{release}}` format.

2. Include the `containers-prepare-parameter.yaml` and `overcloud-images.yaml` files in that specific order with your environment file collection when you run the `openstack overcloud deploy` command:

```
$ openstack overcloud deploy --templates \
  ... \
  -e /home/stack/containers-prepare-parameter.yaml \
  -e /home/stack/overcloud-images.yaml \
  ... \
```

The overcloud services use the pinned images listed in the `overcloud-images.yaml` file.
CHAPTER 28. TROUBLESHOOTING DIRECTOR ERRORS

Errors can occur at certain stages of the director processes. This section contains some information about diagnosing common problems.

28.1. TROUBLESHOOTING NODE REGISTRATION

Issues with node registration usually occur due to issues with incorrect node details. In these situations, validate the template file containing your node details and correct the imported node details.

Procedure

1. Source the `stackrc` file:

   ```
   $ source ~/stackrc
   ```

2. Run the node import command with the `--validate-only` option. This option validates your node template without performing an import:

   ```
   (undercloud) $ openstack overcloud node import --validate-only ~/nodes.json
   Waiting for messages on queue 'tripleo' with no timeout.
   Successfully validated environment file
   ```

3. To fix incorrect details with imported nodes, run the `openstack baremetal` commands to update node details. The following example shows how to change networking details:

   a. Identify the assigned port UUID for the imported node:

      ```
      $ source ~/stackrc
      (undercloud) $ openstack baremetal port list --node [NODE UUID]
      ```

   b. Update the MAC address:

      ```
      (undercloud) $ openstack baremetal port set --address=[NEW MAC] [PORT UUID]
      ```

   c. Configure a new IPMI address on the node:

      ```
      (undercloud) $ openstack baremetal node set --driver-info ipmi_address=[NEW IPMI ADDRESS] [NODE UUID]
      ```

28.2. TROUBLESHOOTING HARDWARE INTROSPECTION

You must run the introspection process to completion. However, `ironic-inspector` times out after a default one hour period if the inspection ramdisk does not respond. Sometimes this indicates a bug in the inspection ramdisk but usually this time-out occurs due to an environment misconfiguration, particularly BIOS boot settings.

To diagnose and resolve common environment misconfiguration issues, complete the following steps:

Procedure
1. Source the `stackrc` file:

```
$ source ~/stackrc
```

2. Director uses OpenStack Object Storage (swift) to save the hardware data that it obtains during the introspection process. If this service is not running, the introspection can fail. Check all services related to OpenStack Object Storage to ensure that the service is running:

```
(undercloud) $ sudo systemctl list-units tripleo_swift*
```

3. Ensure that your nodes are in a `manageable` state. The introspection does not inspect nodes in an `available` state, which is meant for deployment. If you want to inspect nodes that are in an `available` state, change the node status to `manageable` state before introspection:

```
(undercloud) $ openstack baremetal node manage [NODE UUID]
```

4. Configure temporary access to the introspection ramdisk. You can provide either a temporary password or an SSH key to access the node during introspection debugging. Complete the following procedure to configure ramdisk access:

   a. Run the `openssl passwd -1` command with a temporary password to generate an MD5 hash:

```
(undercloud) $ openssl passwd -1 mytestpassword
\$1$enjRSylw$/fYUpJwr6abFy/d.koRgQ/
```

   b. Edit the `/var/lib/ironic/httpboot/inspector.ipxe` file, find the line starting with `kernel`, and append the `rootpwd` parameter and the MD5 hash:

```
kernel http://192.2.0.1:8088/agent.kernel ipa-inspection-callback-url=http://192.168.0.1:5050/v1/continue ipa-inspection-collectors=default,extra-hardware,logs systemd.journald.forward_to_console=yes BOOTIF=${mac} ipa-debug=1 ipa-inspection-benchmarks=cpu,mem,disk rootpwd="$1$enjRSylw$/fYUpJwr6abFy/d.koRgQ/" selinux=0
```

   Alternatively, append your public SSH key to the `sshkey` parameter.

   **NOTE**

   Include quotation marks for both the `rootpwd` and `sshkey` parameters.

5. Run the introspection on the node:

```
(undercloud) $ openstack overcloud node introspect [NODE UUID] --provide
```

   Use the `--provide` option to change the node state to `available` after the introspection completes.

6. Identify the IP address of the node from the `dnsmasq` logs:

```
(undercloud) $ sudo tail -f /var/log/containers/ironic-inspector/dnsmasq.log
```

7. If an error occurs, access the node using the root user and temporary access details:
Access the node during introspection to run diagnostic commands and troubleshoot the introspection failure.

To stop the introspection process, run the following command:

```
(undercloud) $ openstack baremetal introspection abort [NODE UUID]
```

You can also wait until the process times out.

**NOTE**

Red Hat OpenStack Platform director retries introspection three times after the initial abort. Run the `openstack baremetal introspection abort` command at each attempt to abort the introspection completely.

### 28.3. TROUBLESHOOTING OVERCLOUD CREATION AND DEPLOYMENT

The initial creation of the overcloud occurs with the OpenStack Orchestration (heat) service. If an overcloud deployment fails, use the OpenStack clients and service log files to diagnose the failed deployment.

**Procedure**

1. Source the `stackrc` file:

   ```
   $ source ~/stackrc
   ``

2. Run the deployment failures command:

   ```
   $ openstack overcloud failures
   ``

3. Run the following command to display the details of the failure:

   ```
   (undercloud) $ openstack stack failures list <OVERCLOUD_NAME> --long
   ```

   Replace `<OVERCLOUD_NAME>` with the name of your overcloud.

4. Run the following command to identify the stacks that failed:

   ```
   (undercloud) $ openstack stack list --nested --property status=FAILED
   ``

### 28.4. TROUBLESHOOTING NODE PROVISIONING

The OpenStack Orchestration (heat) service controls the provisioning process. If node provisioning fails, use the OpenStack clients and service log files to diagnose the issues.

**Procedure**

1. Source the `stackrc` file:
2. Check the bare metal service to see all registered nodes and their current status:

(undercloud) $ openstack baremetal node list

<table>
<thead>
<tr>
<th>UUID</th>
<th>Name</th>
<th>Instance UUID</th>
<th>Power State</th>
<th>Provision State</th>
<th>Maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>f1e261...</td>
<td>None</td>
<td>None</td>
<td>power off</td>
<td>available</td>
<td>False</td>
</tr>
<tr>
<td>f0b8c1...</td>
<td>None</td>
<td>None</td>
<td>power off</td>
<td>available</td>
<td>False</td>
</tr>
</tbody>
</table>

All nodes available for provisioning should have the following states set:

- **Maintenance** set to **False**.
- **Provision State** set to **available** before provisioning.

The following table outlines some common provisioning failure scenarios.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Cause</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maintenance</strong> sets itself to <strong>True</strong> automatically.</td>
<td>The director cannot access the power management for the nodes.</td>
<td>Check the credentials for node power management.</td>
</tr>
<tr>
<td><strong>Provision State</strong> is set to <strong>available</strong> but nodes do not provision.</td>
<td>The problem occurred before bare metal deployment started.</td>
<td>Check the node details including the profile and flavor mapping. Check that the node hardware details are within the requirements for the flavor.</td>
</tr>
<tr>
<td><strong>Provision State</strong> is set to <strong>wait callback</strong> for a node.</td>
<td>The node provisioning process has not yet finished for this node.</td>
<td>Wait until this status changes. Otherwise, connect to the virtual console of the node and check the output.</td>
</tr>
<tr>
<td><strong>Provision State</strong> is <strong>active</strong> and <strong>Power State</strong> is <strong>power on</strong> but the nodes do not respond.</td>
<td>The node provisioning has finished successfully and there is a problem during the post-deployment configuration step.</td>
<td>Diagnose the node configuration process. Connect to the virtual console of the node and check the output.</td>
</tr>
<tr>
<td><strong>Provision State</strong> is <strong>error</strong> or <strong>deploy failed</strong>.</td>
<td>Node provisioning has failed.</td>
<td>View the bare metal node details with the openstack baremetal node show command and check the last_error field, which contains error description.</td>
</tr>
</tbody>
</table>

28.5. TROUBLESHOOTING IP ADDRESS CONFLICTS DURING PROVISIONING
Introspection and deployment tasks fail if the destination hosts are allocated an IP address that is already in use. To prevent these failures, you can perform a port scan of the Provisioning network to determine whether the discovery IP range and host IP range are free.

**Procedure**

1. Install `nmap`:
   
   ```
   $ sudo dnf install nmap
   ```

2. Use `nmap` to scan the IP address range for active addresses. This example scans the 192.168.24.0/24 range, replace this with the IP subnet of the Provisioning network (using CIDR bitmask notation):
   
   ```
   $ sudo nmap -sn 192.168.24.0/24
   ```

3. Review the output of the `nmap` scan. For example, you should see the IP address of the undercloud, and any other hosts that are present on the subnet:
   
   ```
   $ sudo nmap -sn 192.168.24.0/24
   Starting Nmap 6.40 (http://nmap.org) at 2015-10-02 15:14 EDT
   Nmap scan report for 192.168.24.1
   Host is up (0.00057s latency).
   Nmap scan report for 192.168.24.2
   Host is up (0.00048s latency).
   Nmap scan report for 192.168.24.3
   Host is up (0.00045s latency).
   Nmap scan report for 192.168.24.5
   Host is up (0.00040s latency).
   Nmap scan report for 192.168.24.9
   Host is up (0.00019s latency).
   Nmap done: 256 IP addresses (5 hosts up) scanned in 2.45 seconds
   ```

   If any of the active IP addresses conflict with the IP ranges in undercloud.conf, you must either change the IP address ranges or release the IP addresses before you introspect or deploy the overcloud nodes.

28.6. TROUBLESHOOTING "NO VALID HOST FOUND" ERRORS

Sometimes the `/var/log/nova/nova-conductor.log` contains the following error:

```
NoValidHost: No valid host was found. There are not enough hosts available.
```

This error occurs when the Compute Scheduler cannot find a bare metal node that is suitable for booting the new instance. This usually means that there is a mismatch between resources that the Compute service expects to find and resources that the Bare Metal service advertised to Compute. To check that there is a mismatch error, complete the following steps:

**Procedure**

1. Source the `stackrc` file:
   
   ```
   $ source ~/stackrc
   ```
2. Check that the introspection succeeded on the node. If the introspection fails, check that each
node contains the required ironic node properties:

(undercloud) $ openstack baremetal node show [NODE UUID]

Check that the properties JSON field has valid values for keys cpus, cpu_arch, memory_mb
and local_gb.

3. Ensure that the Compute flavor that is mapped to the node does not exceed the node
properties for the required number of nodes:

(undercloud) $ openstack flavor show [FLAVOR NAME]

4. Run the openstack baremetal node list command to ensure that there are sufficient nodes in
the available state. Nodes in manageable state usually signify a failed introspection.

5. Run the openstack baremetal node list command and ensure that the nodes are not in
maintenance mode. If a node changes to maintenance mode automatically, the likely cause is an
issue with incorrect power management credentials. Check the power management credentials
and then remove maintenance mode:

(undercloud) $ openstack baremetal node maintenance unset [NODE UUID]

6. If you are using automatic profile tagging, check that you have enough nodes that correspond
to each flavor and profile. Run the openstack baremetal node show command on a node and
check the capabilities key in the properties field. For example, a node tagged for the Compute
role contains the profile:compute value.

7. You must wait for node information to propagate from Bare Metal to Compute after
introspection. However, if you performed some steps manually, there might be a short period of
time when nodes are not available to the Compute service (nova). Use the following command
to check the total resources in your system:

(undercloud) $ openstack hypervisor stats show

28.7. TROUBLESHOOTING CONTAINER CONFIGURATION

Red Hat OpenStack Platform director uses podman to manage containers and puppet to create
container configuration. This procedure shows how to diagnose a container when errors occur.

Accessing the host

1. Source the stackrc file:

   $ source ~/.stackrc

2. Get the IP address of the node with the container failure.

   (undercloud) $ openstack server list

3. Log in to the node:
Identifying failed containers

1. View all containers:

   $ sudo podman ps --all

   Identify the failed container. The failed container usually exits with a non-zero status.

Checking container logs

1. Each container retains standard output from its main process. Use this output as a log to help determine what actually occurs during a container run. For example, to view the log for the keystone container, run the following command:

   $ sudo podman logs keystone

   In most cases, this log contains information about the cause of a container failure.

2. The host also retains the stdout log for the failed service. You can find the stdout logs in /var/log/containers/stdouts/. For example, to view the log for a failed keystone container, run the following command:

   $ cat /var/log/containers/stdouts/keystone.log

Inspecting containers

In some situations, you might need to verify information about a container. For example, use the following command to view keystone container data:

   $ sudo podman inspect keystone

This command returns a JSON object containing low-level configuration data. You can pipe the output to the jq command to parse specific data. For example, to view the container mounts for the keystone container, run the following command:

   $ sudo podman inspect keystone | jq .[0].Mounts

You can also use the --format option to parse data to a single line, which is useful for running commands against sets of container data. For example, to recreate the options used to run the keystone container, use the following inspect command with the --format option:

   $ sudo podman inspect --format="\n{{range .Config.Env}} -e \"{{.}}\" {{end}} {{range .Mounts}} -v {{.Source}}:{{.Destination}}:{{ join .Options "," }}{{end}} -ti {{.Config.Image}}\n" keystone

   NOTE

   The --format option uses Go syntax to create queries.

Use these options in conjunction with the podman run command to recreate the container for troubleshooting purposes:
Running commands in a container

In some cases, you might need to obtain information from within a container through a specific Bash command. In this situation, use the following podman command to execute commands within a running container. For example, run the podman exec command to run a command inside the keystone container:

```
$ sudo podman exec -ti keystone <COMMAND>
```

**NOTE**
The -ti options run the command through an interactive pseudoterminal.

Replace `<COMMAND>` with the command you want to run. For example, each container has a health check script to verify the service connection. You can run the health check script for keystone with the following command:

```
$ sudo podman exec -ti keystone /openstack/healthcheck
```

To access the container shell, run podman exec using /bin/bash as the command you want to run inside the container:

```
$ sudo podman exec -ti keystone /bin/bash
```

Viewing a container filesystem

1. To view the file system for the failed container, run the podman mount command. For example, to view the file system for a failed keystone container, run the following command:

```
$ sudo podman mount keystone
```

This provides a mounted location to view the filesystem contents:

```
/var/lib/containers/storage/overlay/78946a109085aeb8b3a350fc20bd8049a08918d74f573396d7358270e711c610/merged
```

This is useful for viewing the Puppet reports within the container. You can find these reports in the `var/lib/puppet/` directory within the container mount.

Exporting a container

When a container fails, you might need to investigate the full contents of the file. In this case, you can export the full file system of a container as a tar archive. For example, to export the keystone container file system, run the following command:

```
$ sudo podman export keystone -o keystone.tar
```
This command creates the `keystone.tar` archive, which you can extract and explore.

**28.8. TROUBLESHOOTING COMPUTE NODE FAILURES**

Compute nodes use the Compute service to perform hypervisor-based operations. This means the main diagnosis for Compute nodes revolves around this service.

**Procedure**

1. Source the `stackrc` file:
   
   ```
   $ source ~/stackrc
   ```

2. Get the IP address of the Compute node that contains the failure:

   ```
   (undercloud) $ openstack server list
   ```

3. Log in to the node:

   ```
   (undercloud) $ ssh heat-admin@192.168.24.60
   ```

4. Change to the root user:

   ```
   $ sudo -i
   ```

5. View the status of the container:

   ```
   $ sudo podman ps -f name=nova_compute
   ```

6. The primary log file for Compute nodes is `/var/log/containers/nova/nova-compute.log`. If issues occur with Compute node communication, use this file to begin the diagnosis.

7. If you perform maintenance on the Compute node, migrate the existing instances from the host to an operational Compute node, then disable the node.

**28.9. CREATING AN SOSREPORT**

If you need to contact Red Hat for support with Red Hat OpenStack Platform, you might need to generate an `sosreport`. For more information about creating an `sosreport`, see:

- "How to collect all required logs for Red Hat Support to investigate an OpenStack issue"

**28.10. LOG LOCATIONS**

Use the following logs to gather information about the undercloud and overcloud when you troubleshoot issues.

**Table 28.1. Logs on both the undercloud and overcloud nodes**
### Table 28.2. Additional logs on the undercloud node

<table>
<thead>
<tr>
<th>Information</th>
<th>Log location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Containerized service logs</td>
<td>/var/log/containers/</td>
</tr>
<tr>
<td>Standard output from containerized services</td>
<td>/var/log/containers/stdouts</td>
</tr>
<tr>
<td>Ansible configuration logs</td>
<td>~/ansible.log</td>
</tr>
</tbody>
</table>

### Table 28.3. Additional logs on the overcloud nodes

<table>
<thead>
<tr>
<th>Information</th>
<th>Log location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Command history for <strong>openstack overcloud deploy</strong></td>
<td>/home/stack/.tripleo/history</td>
</tr>
<tr>
<td>Undercloud installation log</td>
<td>/home/stack/install-undercloud.log</td>
</tr>
<tr>
<td>Cloud-Init Log</td>
<td>/var/log/cloud-init.log</td>
</tr>
<tr>
<td>High availability log</td>
<td>/var/log/pacemaker.log</td>
</tr>
</tbody>
</table>
CHAPTER 29. TIPS FOR UNDERCLOUD AND OVERCLOUD SERVICES

This section provides advice on tuning and managing specific OpenStack services on the undercloud.

29.1. TUNING DEPLOYMENT PERFORMANCE

Red Hat OpenStack Platform director uses OpenStack Orchestration (heat) to conduct the main deployment and provisioning functions. Heat uses a series of workers to execute deployment tasks. To calculate the default number of workers, the director heat configuration halves the total CPU thread count of the undercloud. In this instance, thread count refers to the number of CPU cores multiplied by the hyper-threading value. For example, if your undercloud has a CPU with 16 threads, heat spawns 8 workers by default. The director configuration also uses a minimum and maximum cap by default:

<table>
<thead>
<tr>
<th>Service</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>OpenStack Orchestration (heat)</td>
<td>4</td>
<td>24</td>
</tr>
</tbody>
</table>

However, you can set the number of workers manually with the `HeatWorkers` parameter in an environment file:

```
heat-workers.yaml

parameter_defaults:
  HeatWorkers: 16
```

```
undercloud.conf

custom_env_files: heat-workers.yaml
```

29.2. RUNNING SWIFT-RING-BUILDER IN A CONTAINER

To manage your Object Storage (swift) rings, use the `swift-ring-builder` commands inside the server containers:

- `swift_object_server`
- `swift_container_server`
- `swift_account_server`

For example, to view information about your swift object rings, run the following command:

```
$ sudo podman exec -ti -u swift swift_object_server swift-ring-builder /etc/swift/object.builder
```

You can run this command on both the undercloud and overcloud nodes.

29.3. CHANGING THE SSL/TLS CIPHER RULES FOR HAPROXY
If you enabled SSL/TLS in the undercloud (see Section 7.2, “Director configuration parameters”), you might want to harden the SSL/TLS ciphers and rules that are used with the HAProxy configuration. This hardening helps to avoid SSL/TLS vulnerabilities, such as the POODLE vulnerability.

Set the following hieradata using the `hieradata_override` undercloud configuration option:

```
tripleo::haproxy::ssl_cipher_suite
  The cipher suite to use in HAProxy.

tripleo::haproxy::ssl_options
  The SSL/TLS rules to use in HAProxy.
```

For example, you might want to use the following cipher and rules:

```

• Rules: no-sslv3 no-tls-tickets
```

Create a hieradata override file (`haproxy-hiera-overrides.yaml`) with the following content:

```yaml
tripleo::haproxy::ssl_options: no-sslv3 no-tls-tickets
```

**NOTE**

The cipher collection is one continuous line.

Set the `hieradata_override` parameter in the `undercloud.conf` file to use the hieradata override file you created before you ran `openstack undercloud install`:

```
[DEFAULT]
...
hieradata_override = haproxy-hiera-overrides.yaml
...
```
CHAPTER 30. POWER MANAGEMENT DRIVERS

Although IPMI is the main method that director uses for power management control, director also supports other power management types. This appendix contains a list of the power management features that director supports. Use these power management settings when you register nodes for the overcloud. For more information, see Registering nodes for the overcloud.

30.1. INTELLIGENT PLATFORM MANAGEMENT INTERFACE (IPMI)

The standard power management method when you use a baseboard management controller (BMC).

- **pm_type**
  - Set this option to `ipmi`.

- **pm_user; pm_password**
  - The IPMI username and password.

- **pm_addr**
  - The IP address of the IPMI controller.

- **pm_port (Optional)**
  - The port to connect to the IPMI controller.

30.2. REDFISH

A standard RESTful API for IT infrastructure developed by the Distributed Management Task Force (DMTF)

- **pm_type**
  - Set this option to `redfish`.

- **pm_user; pm_password**
  - The Redfish username and password.

- **pm_addr**
  - The IP address of the Redfish controller.

- **pm_system_id**
  - The canonical path to the system resource. This path must include the root service, version, and the path/unique ID for the system. For example: `/redfish/v1/Systems/CX34R87`.

- **redfish_verify_ca**
  - If the Redfish service in your baseboard management controller (BMC) is not configured to use a valid TLS certificate signed by a recognized certificate authority (CA), the Redfish client in ironic fails to connect to the BMC. Set the `redfish_verify_ca` option to `false` to mute the error. However, be aware that disabling BMC authentication compromises the access security of your BMC.

30.3. DELL REMOTE ACCESS CONTROLLER (DRAC)

DRAC is an interface that provides out-of-band remote management features including power management and server monitoring.

- **pm_type**
  - Set this option to `idrac`.

- **pm_user; pm_password**
The DRAC username and password.

**pm_addr**
The IP address of the DRAC host.

### 30.4. INTEGRATED LIGHTS-OUT (ILO)

iLO from Hewlett-Packard is an interface that provides out-of-band remote management features including power management and server monitoring.

**pm_type**
Set this option to `ilo`.

**pm_user; pm_password**
The iLO username and password.

**pm_addr**
The IP address of the iLO interface.

- To enable this driver, add `ilo` to the `enabled_hardware_types` option in your `undercloud.conf` and rerun `openstack undercloud install`.
- HP nodes must have a minimum ILO firmware version of 1.85 (May 13 2015) for successful introspection. Director has been successfully tested with nodes using this ILO firmware version.
- Using a shared iLO port is not supported.

### 30.5. FUJITSU INTEGRATED REMOTE MANAGEMENT CONTROLLER (iRMC)

Fujitsu iRMC is a Baseboard Management Controller (BMC) with integrated LAN connection and extended functionality. This driver focuses on the power management for bare metal systems connected to the iRMC.

**IMPORTANT**
iRMC S4 or higher is required.

**pm_type**
Set this option to `irmc`.

**pm_user; pm_password**
The username and password for the iRMC interface.

**pm_addr**
The IP address of the iRMC interface.

**pm_port (Optional)**
The port to use for iRMC operations. The default is 443.

**pm_auth_method (Optional)**
The authentication method for iRMC operations. Use either `basic` or `digest`. The default is `basic`.

**pm_client_timeout (Optional)**
Timeout (in seconds) for iRMC operations. The default is 60 seconds.

**pm_sensor_method (Optional)**

Sensor data retrieval method. Use either `ipmitool` or `scci`. The default is `ipmitool`.

- To enable this driver, add `irmc` to the `enabled_hardware_types` option in your `undercloud.conf` and rerun the `openstack undercloud install` command.

### 30.6. RED HAT VIRTUALIZATION

This driver provides control over virtual machines in Red Hat Virtualization (RHV) through its RESTful API.

**pm_type**

Set this option to `staging-ovirt`.

**pm_user; pm_password**

The username and password for your RHV environment. The username also includes the authentication provider. For example: `admin@internal`.

**pm_addr**

The IP address of the RHV REST API.

**pm_vm_name**

The name of the virtual machine to control.

**mac**

A list of MAC addresses for the network interfaces on the node. Use only the MAC address for the Provisioning NIC of each system.

- To enable this driver, add `staging-ovirt` to the `enabled_hardware_types` option in your `undercloud.conf` and rerun the `openstack undercloud install` command.

### 30.7. MANUAL-MANAGEMENT DRIVER

Use the `manual-management` driver to control bare metal devices that do not have power management. Director does not control the registered bare metal devices, and you must perform manual power operations at certain points in the introspection and deployment processes.

**IMPORTANT**

This option is available only for testing and evaluation purposes. It is not recommended for Red Hat OpenStack Platform enterprise environments.

**pm_type**

Set this option to `manual-management`.

- This driver does not use any authentication details because it does not control power management.

- To enable this driver, add `manual-management` to the `enabled_hardware_types` option in your `undercloud.conf` and rerun the `openstack undercloud install` command.
In your `instackenv.json` node inventory file, set the `pm_type` to `manual-management` for the nodes that you want to manage manually.

**Introspection**

- When performing introspection on nodes, manually start the nodes after running the `openstack overcloud node introspect` command. Ensure the nodes boot through PXE.
- If you have enabled node cleaning, manually reboot the nodes after the `Introspection completed` message appears and the node status is `clean wait` for each node when you run the `openstack baremetal node list` command. Ensure the nodes boot through PXE.
- After the introspection and cleaning process completes, shut down the nodes.

**Deployment**

- When performing overcloud deployment, check the node status with the `openstack baremetal node list` command. Wait until the node status changes from `deploying` to `wait call-back` and then manually start the nodes. Ensure the nodes boot through PXE.
- After the overcloud provisioning process completes, the nodes will shut down. You must boot the nodes from disk to start the configuration process. To check the completion of provisioning, check the node status with the `openstack baremetal node list` command, and wait until the node status changes to `active` for each node. When the node status is `active`, manually boot the provisioned overcloud nodes.