



Red Hat Reference Architecture Series

Deploying Red Hat EAP 6 Microservices on High Availability Red Hat Enterprise Linux OpenStack Platform 7 *with RHEL-OSP director*

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Executive Summary

This reference architecture describes a realistic use case for deploying a microservices architecture application on a Red Hat Enterprise Linux OpenStack Platform 7 cluster. It begins with steps for deploying RHEL-OSP 7 on baremetal servers via RHEL-OSP director, Red Hat's new deployment toolchain. Next it describes Red Hat's approach to implementing highly available OpenStack. The reference architecture concludes with instructions for implementing a microservices architecture that provides shopping cart functionality via a multi-tier web application.

Architecture Overview

Red Hat Enterprise Linux OpenStack Platform (RHEL-OSP) delivers an integrated foundation to create, deploy, and scale an OpenStack cloud. RHEL-OSP 7, Red Hat's 5th iteration of OpenStack Platform, is based on the community Kilo OpenStack release. This version introduces RHEL-OSP director, Red Hat's new deployment toolchain. RHEL-OSP director combines functionality from the upstream **TripleO** and **Ironic** projects with components from Red Hat's previous installers.

Red Hat JBoss Enterprise Application Platform 6 (EAP) is a fully-certified Java EE platform to quickly deploy and develop enterprise applications. This reference architecture describes a realistic use case for deploying an EAP 6 Microservices Architecture (MSA) on a high availability RHEL-OSP 7 cluster. A microservices architecture is a modular enterprise application where individual instances or containers run single services and communicate via lightweight protocols and APIs. The EAP 6 MSA used in this reference architecture is a multi-tier shopping cart that processes customer transactions and logs them in a backend database.

The complete reference architecture use case provides a comprehensive, end-to-end example of deploying a RHEL-OSP 7 cloud on baremetal using OpenStack director then implementing the microservices architecture via **Heat** templates. This reference architecture complements existing RHEL-OSP documentation by providing a *comprehensive example* of deploying a complex enterprise web application on OpenStack, demonstrating RHEL-OSP 7's features and tools in a realistic context.

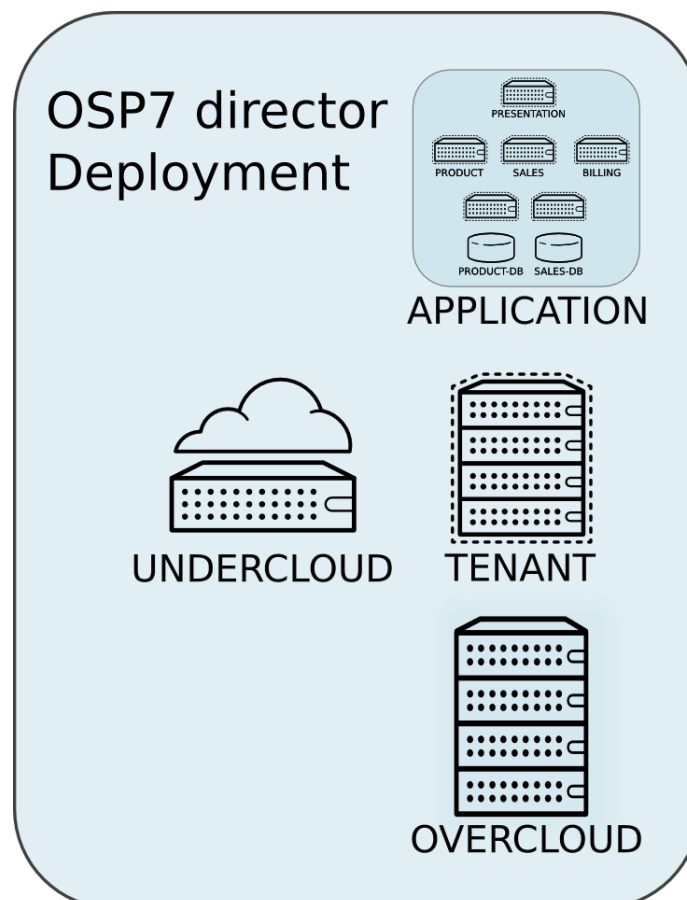


Figure 2.1: OpenStack Platform director

The first section of this reference architecture introduces the principal components: Red Hat Enterprise Linux OpenStack Platform 7, RHEL-OSP director, and a microservices architecture built with Red Hat JBoss Enterprise Application Platform 6. It also describes Red Hat's approach to making OpenStack high availability. Core OpenStack services are managed and monitored in a High Availability (HA) cluster. A load balancer provides access to the service endpoints. There are no direct connections from the clients to the the services. This approach allows administrators to manage, operate, and scale services together or independently.

The second section of the paper describes the lab environment, hardware, and software used to implement and test the reference architecture.

The third section documents the installation and configuration procedure. All of the steps listed in this document were performed by the Red Hat Systems Engineering team. The complete use case was deployed in the Systems Engineering lab on bare metal servers using RHEL-OSP director and generally available code.

OpenStack Platform 7 director

RHEL-OSP delivers an integrated foundation to create, deploy, and scale a secure and reliable public or private OpenStack cloud. RHEL-OSP starts with the proven foundation of Red Hat Enterprise Linux and integrates Red Hat's OpenStack Platform technology to provide a production-ready cloud platform backed by an ecosystem of more than 350 certified partners.

RHEL-OSP 7 is based on the community Kilo OpenStack release. This release is Red Hat's fifth iteration of RHEL-OSP which has been successfully deployed by Red Hat customers worldwide across diverse vertical industries including financial, telecommunications, and education.

RHEL-OSP 7 introduces RHEL-OSP director, a cloud installation and lifecycle management tool chain. Director is the first RHEL-OSP installer to deploy OpenStack on and with OpenStack. This section of paper introduces RHEL-OSP director's architecture and describes the following features:

- Simplified deployment through ready-state provisioning of bare metal resources.
- Flexible network definitions
- High availability via tight integration with the Red Hat Enterprise Linux Server High Availability Add-on
- Integrated setup and installation of Red Hat Ceph Storage 1.3
- Content management via the Red Hat Content Delivery Network or Red Hat Satellite Server.

Ready State Provisioning and Server Roles

RHEL-OSP director is a converged installer. It combines mature upstream OpenStack deployment projects ([Triple0](#) and [Ironic](#)) with components from Red Hat's past RHEL-OSP installers.

[Triple0](#) stands for *OpenStack on OpenStack*. [Triple0](#) is an upstream OpenStack project that uses an existing OpenStack environment to install a production OpenStack environment. The deployment environment is called the [undercloud](#). The production environment is called the [overcloud](#).

The [undercloud](#) is the [Triple0](#) control plane. It uses native OpenStack APIs and services to deploy, configure, and manage the production OpenStack deployment. The undercloud defines the overcloud with [Heat](#) templates then deploys it via the [Ironic](#) baremetal provisioning service. RHEL-OSP director includes [Heat](#) predefined templates for the basic server roles that comprise the overcloud. Customizable templates allow director to deploy, redeploy, and scale complex overclouds in a repeatable fashion.

[Ironic](#) is a community bare-metal provisioning project. Director uses [Ironic](#) to deploy the overcloud servers. [Ironic](#) gathers information about baremetal servers via a discovery mechanism known as introspection. [Ironic](#) pairs servers with a bootable disk image and then installs them via PXE and remote power management.

RHEL-OSP director deploys all servers with the same generic image by injecting **Puppet modules** into the generic disk image to tailor it for specific server roles. It then applies host-specific customizations via Puppet including network and storage configurations.

While the undercloud is primarily used to deploy OpenStack, the **overcloud** is a functional cloud available to run virtual machines and workloads. Servers in the following roles comprise the overcloud:

Control

This role provides the endpoint for REST-based API queries to the majority of the OpenStack services. These include Compute, Image, Identity, Block, Network, and Data processing. The controller can run as a standalone server or as a HA cluster.

Compute

This role provides the processing, memory, storage, and networking resources to run virtual machine instances. They run the KVM hypervisor by default. New instances are spawned across compute nodes in a round-robin fashion.

Block storage

This role provides external block storage for HA controller nodes via the OpenStack Block Storage service **Cinder**.

Ceph storage

Ceph is a distributed object store and file system. This role deploys Object Storage Daemon (OSD) nodes for Ceph clusters. It also installs the Ceph Monitor service on the controller.

Object storage

This role provides external Account, Container, and Object (ACO) storage for the OpenStack Object Storage service, **Swift**, by installing a **Swift** proxy server on the controller nodes.



The overcloud requires at least one controller and one compute node. It runs independently from the undercloud once it is installed. This reference architecture uses the Control, Compute, and Ceph storage roles.

RHEL-OSP director also includes **advanced hardware configuration** tools from the eNovance SpinalStack installer. These tools validate server hardware prior to installation. **Profile matching** lets administrators specify hardware requirements for each server role. RHEL-OSP director only matches servers that meet minimum hardware requirements for each role. Profile matching is performed after introspection but prior to deployment.

RHEL-OSP director also supports pre-installation **benchmark collection**. Servers boot to a customized RAMdisk and run a series of benchmarks. The benchmarks report performance outliers to identify under performing nodes prior to installation.



RHEL-OSP 7 requires Red Hat Enterprise Linux 7 Server on all servers. Supported guest operating systems can be found at <https://access.redhat.com/articles/973163>. Deployment limitations are listed at <https://access.redhat.com/articles/1436373>.

Network Isolation

OpenStack requires multiple network functions. While it is possible to collapse all network functions onto a single network interface, isolating communication streams in their own physical or virtual networks provides better performance and scalability.

RHEL-OSP director supports isolating network traffic by type. One or more network traffic types can be assigned to a physical, virtual, or bonded interface. Multiple traffic types can be combined across the same physical interfaces or switches. Each OpenStack service is bound to an IP on a particular network. A virtual IP is created on that network and shared among all of the HA controllers.

RHEL-OSP director supports network isolation for the following traffic types:

Provisioning

The control plane installs the overcloud via this network. All cluster nodes must have a physical interface attached to the provisioning network. This network carries DHCP/PXE and TFTP traffic so it must be provided on a dedicated interface or a native VLAN to the boot interface. The provisioning interface can act as a default gateway for the overcloud if there is no other gateway on the network. Disable PXE on the remaining interfaces to ensure the servers boot from this network.

External

This network provides overcloud nodes with external connectivity. Controller nodes connect the external network to an **Open vSwitch** bridge and forward traffic originating from hypervisor instances through it. The **Horizon** service and OpenStack public API endpoints can share this network or they can be broken out to an optional public API network.

Internal API

This network exposes internal OpenStack API endpoints for the overcloud nodes. It handles inter-service communication between both core OpenStack services and the supporting services. By default this network also hosts cluster management traffic used by HA services to share data and track cluster state for automated failover. It is common practice to break the cluster management traffic out to a separate network if it affects performance or scaling. Supporting service traffic from the state database, message bus, and hostname resolution is also delivered via this network.

Tenant

Virtual machines communicate over the tenant network. It supports three modes of operation: VXLAN, GRE, and VLAN. VXLAN and GRE tenant traffic is delivered via software tunnels on a single VLAN. Individual VLANs correspond to tenant networks in the case where VLAN tenant networks are used.

Storage

This network carries storage communication including **Ceph**, **Cinder**, and **Swift** traffic. The virtual machine instances communicate with the storage servers via this network. Data-intensive OpenStack deployments should isolate storage traffic on a dedicated high bandwidth interface, i.e. 10 GB interface. The **Glance** API, **Swift** proxy, and **Ceph Public interface** services are all delivered via this network.

Storage Management

Storage management communication can generate large amounts of network traffic. This network is shared between the front and back end storage nodes. Storage controllers use this network to access data storage nodes. This network is also used for storage clustering and replication traffic.

Network traffic types are assigned to network interfaces through **Heat** template customizations prior to deploying the overcloud. RHEL-OSP director supports several network interface types including physical interfaces, bonded interfaces, and either tagged or native 802.1Q VLANs.



Disable DHCP on unused interfaces to avoid unwanted routes and network loops.

Network Types by Server Role

The previous section discussed [server roles](#). Each server role requires access to specific types of network traffic. Figure 3.1 [Network Topology](#) depicts the network roles by server type in this reference architecture.

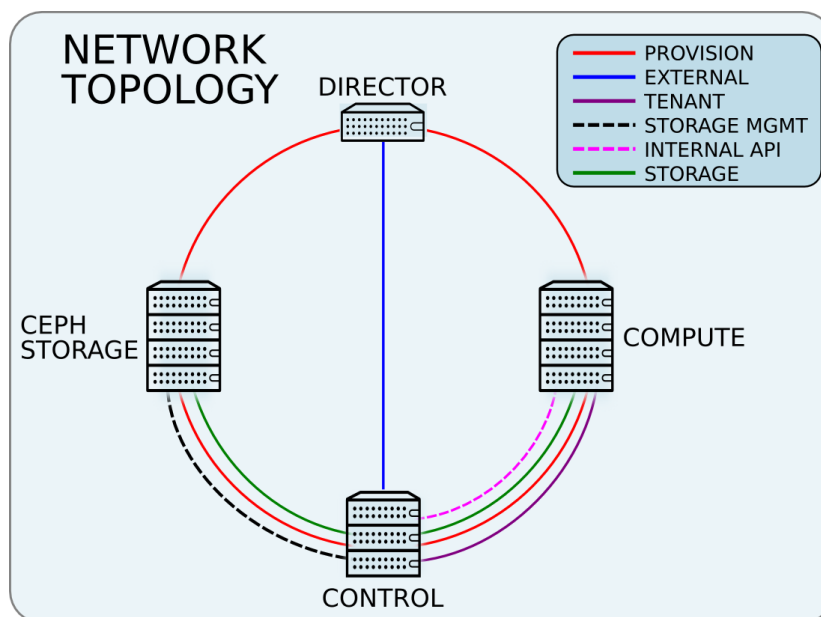


Figure 3.1 Network Topology

The network isolation feature allows RHEL-OSP director to segment network traffic by particular network types. When using network isolation, each server role must have access to its required network traffic types.

By default, RHEL-OSP director collapses all network traffic to the provisioning interface. This configuration is suitable for evaluation, proof of concept, and development environments. It is not recommended for production environments where scaling and performance are primary concerns.

Table 1 [Network type by server role](#) summarizes the required network types by server role.

Table 1. Network type by server role

Role	Network
Undercloud	External
	Provisioning
Control	External
	Provisioning
	Storage Mgmt
	Tenant
	Internal API
	Storage
Compute	Provisioning
	Tenant
	Internal API
	Storage
Ceph/Block/Object Storage	Provisioning
	Storage Mgmt
	Storage

Tenant Network Types

RHEL-OSP 7 supports tenant network communication through the OpenStack Networking (**Neutron**) service. OpenStack Networking supports overlapping IP address ranges across tenants via the Linux kernel's network namespace capability. It also supports three default networking types:

VLAN segmentation mode

Each tenant is assigned a network subnet mapped to a 802.1q VLAN on the physical network. This tenant networking type requires VLAN-assignment to the appropriate switch ports on the physical network.

GRE overlay mode

This mode isolates tenant traffic in virtual tunnels to provide Layer 2 network connectivity between

virtual machine instances on different hypervisors. GRE does not require changes to the network switches and supports more unique network IDs than VLAN segmentation. This is the default mode of operation for OpenStack Platform 7 director.

VXLAN

This overlay method similar to GRE. VXLAN combines the ease and scalability of GRE with superior performance.

Although Red Hat certifies third-party network plug-ins, RHEL-OSP director uses the **ML2** network plugin with the **Open vSwitch** driver by default.



RHEL-OSP director does not deploy legacy (**Nova**) networking.

High Availability

RHEL-OSP director's approach to high availability OpenStack leverages Red Hat's internal expertise with distributed cluster systems. Most of the technologies discussed in this section are available through the Red Hat Enterprise Linux Server High Availability Add On. These technologies are bundled with RHEL-OSP 7 to provide cluster services for production deployments.

Cluster Manager and Proxy Server

Two components drive HA for all core and non-core OpenStack services: the **cluster manager** and the **proxy server**.

The cluster manager is responsible for the startup and recovery of an inter-related services across a set of physical machines. It tracks the cluster's internal state across multiple machines. State changes trigger appropriate responses from the cluster manager to ensure service availability and data integrity.

Cluster manager benefits

1. Deterministic recovery of a complex, multi-machine application stack
2. State awareness of other cluster machines to co-ordinate service startup and failover.
3. Shared quorum calculation to determine majority set of surviving cluster nodes after a failure.
4. Data integrity through fencing. Machines running a non-responsive process are isolated to ensure they are not still responding to remote requests. Machines are typically fenced via a remotely accessible power switch or IPMI controller.
5. Automated recovery of failed instances to prevent additional load-induced failures.

In RHEL-OSP's HA model, clients do not directly connect to service endpoints. Connection requests are routed to service endpoints by a proxy server.

Proxy server benefits

1. Connections are load balanced across service endpoints
2. Service requests can be monitored in a central location
3. Cluster nodes can be added or removed without interrupting service

RHEL-OSP director uses **HAproxy** and **Pacemaker** to manage HA services and load balance connection requests. With the exception of **RabbitMQ** and **Galera**, **HAproxy** distributes connection requests to active nodes in a round-robin fashion. **Galera** and **RabbitMQ** use persistent options to ensure requests go only to active and/or synchronized nodes. **Pacemaker** checks service health at 1 second intervals. Timeout settings vary by service.

Benefits of combining Pacemaker and HAproxy

The combination of **Pacemaker** and **HAproxy**:

- Detects and recovers machine and application failures
- Starts and stops OpenStack services in the correct order
- Responds to cluster failures with appropriate actions including resource failover and machine restart and fencing
- Provides a thoroughly tested code base that has been used in production clusters across a variety of use cases

The following services deployed by RHEL-OSP director do not use the proxy server:

1. **RabbitMQ**
2. **memcached**
3. **mongodb**

Individual cluster services are discussed in the following section.



RHEL-OSP director uses **Pacemaker** and **HAproxy** for clustering. Red Hat also supports manually deployed RHEL-OSP 7 clustered with **keepalived** and **HAproxy**. Manual installation is beyond the scope of this document.

Cluster models: Segregated versus Collapsed

Cluster services can be deployed across cluster nodes in different combinations. The two primary approaches are *segregated* and *collapsed*.

Segregated clusters run each service on dedicated clusters of three or more nodes. Components are isolated and can be scaled individually. Each service has its own virtual IP address. Segregating services offers flexibility in service placement. Multiple services can be run on the same physical nodes, or, in an extreme case, each service can run on its own dedicated hardware.

Figure 3.2 [Segregated Cluster Services](#) depicts OpenStack service deployed in a segregated cluster model. Red Hat supports RHEL-OSP 7 services deployed in a segregated model but it is beyond the scope of this document.

Collapsed clusters run every service and component on the same set of three or more nodes. Cluster services share the same virtual IP address set. Collapsed services require fewer physical machines and are simpler to implement and manage.

Previous Red Hat Enterprise Linux OpenStack Platform installers deployed segregated clusters. RHEL-OSP director deploys overclouds as collapsed clusters. All controller nodes run the same services. Service endpoints are bound to the same set of virtual IP addresses. The undercloud is not clustered.

Figure 3.3 [Collapsed Cluter Services](#) depicts RHEL-OSP director’s default approach to deploying collapsed HA OpenStack services.



Segregated and collapsed are the dominant approaches to implementing HA clusters but hybrid approaches are also possible. Segregate one or more components expected to cause a bottleneck into individual clusters. Collapse the remainder. Deploying a mixed cluster is beyond the scope of this document.

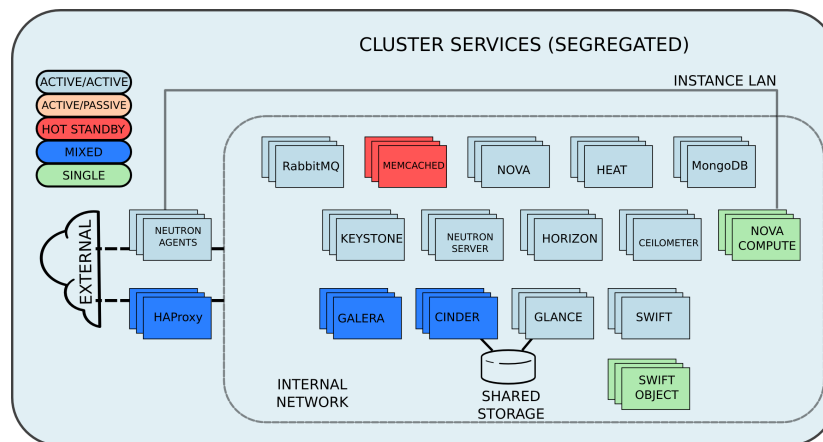


Figure 3.2: Segregated Cluster Services

Cluster Services and Quorum

Each clustered service operates in one of the following modes:

Active/active

Requests are load balanced between multiple cluster nodes running the same services. Traffic intended for failed nodes is sent to the remaining nodes.

Active/passive

A redundant copy of a running service is brought online when the primary node fails.

Hot Standby

Connections are only routed to one of several active service endpoints. New connections are routed

to a standby endpoint if the primary service endpoint fails.

Mixed

Mixed has one of two meanings: services within a group run in different modes, or the service runs active/active but is used as active/passive. Mixed services are explained individually.

Single

Each node runs an independent cluster manager that only monitors its local service.

A cluster **quorum** is the majority node set when a failure splits the cluster into two or more partitions. In this situation the majority fences the minority to ensure both sides are not running the same services — a so-called *split brain* situation. **Fencing** is the process of isolating a failed machine — typically via remote power control or networked switches — by powering it off. This is necessary to ensure data integrity.



Although **Pacemaker** supports up to 16 cluster nodes, Red Hat recommends an odd number of cluster members to help ensure quorum during cluster communication failure. RHEL-OSP director requires three active cluster members to achieve quorum.

Cluster Modes for Core Services

This section of the paper describes RHEL-OSP director’s default cluster mode for each OpenStack service.

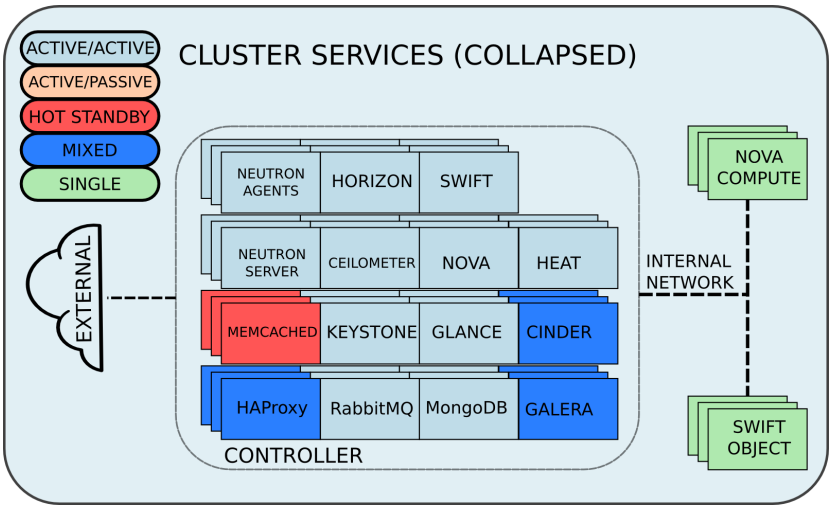


Figure 3.3: Collapsed Cluster Services

The following table lists service mode by service.

Table 2. Core Service Cluster Modes and Description

Service	Mode	Description
Ceilometer	Active/active	Measures usage of core OpenStack components. It is used within Heat to trigger application autoscaling.
Cinder	Mixed	Provides persistent block storage to virtual machines. All services are active/active except cinder-volume runs active/passive to prevent a potential race condition .
Glance	Active/active	Discovers, catalogs, and retrieves virtual machine images.
Horizon	Active/active	Web management interface runs via httpd in active/active mode.
Keystone	Active/active	Common OpenStack authentication system runs in httpd .
Neutron server	Active/active	Neutron allows users to define and join networks on demand.
Neutron agents	Active/active	Support Layer 2 and 3 communication plus numerous virtual networking technologies including ML2 and Open vSwitch .
Nova	Active/active	Provides compute capabilities to deploy and run virtual machine instances.
Swift proxy server	Active/active	Routes data requests to the appropriate Swift ACO server.

Cluster Modes for Supporting Services

The majority of the core OpenStack services run in active/active mode. The same is true for the supporting services, although several of them field connection requests directly from clients rather than **HProxy**.

The following table lists the cluster mode for the non-core OpenStack services.

Table 3. Supporting Service Cluster Modes and Description

Service	Mode	Description
Replicated state database	Active/active	Galera replicates databases to decrease client latency and prevent lost transactions. Galera runs in active/active mode but connections are only sent to one active node at a time to avoid lock contention.
Database cache	Hot standby	Memory caching system. HAproxy does not manage memcached connections because replicated access is still experimental.
Message bus	Active/active	AMQP message bus coordinates job execution and ensures reliable delivery. Not handled by HAproxy . Clients have a full list of RabbitMQ hosts.
NoSQL database	Active/active	NoSQL database mongodb supports Ceilometer and Heat . Not managed by HAproxy . Ceilometer servers have a full list of mongodb hosts.

Compute Node and Swift ACO Clustering

RHEL-OSP installs compute nodes and **Swift** storage servers as single-node clusters in order to monitor their health and that of the services running on them.

In the event that a compute node fails, **Pacemaker** restarts compute node services in the following order:

1. **neutron-ovs-agent**
2. **ceilometer-compute**
3. **nova-compute**

In the event that a **Swift** ACO node fails, **Pacemaker** restarts **Swift** services in the following order:

1. **swift-fs**
2. **swift-object**
3. **swift-container**
4. **swift-account**

If a service fails to start, the node where the service is running will be fenced in order to guarantee

data integrity.

Ceph Storage Integration

Red Hat Ceph Storage 1.3 is a distributed data object store designed for performance, reliability, and scalability. RHEL-OSP 7 director can deploy an integrated Ceph cluster in the overcloud. The integrated Ceph cluster acts as a storage virtualization layer for [Glance](#) images, [Cinder](#) volumes, and [Nova](#) ephemeral storage. Figure 3.4 [Ceph Integration](#) depicts RHEL-OSP 7 director Ceph cluster integration from a high level. The Ceph cluster consists of two types of daemons: Ceph OSD and Ceph Monitor. The **Ceph OSD Daemon** stores data in pools striped across one or more disks. Ceph OSDs also replicate, rebalance, and recover data, and report data usage.

The **Ceph Monitor** maintains a master copy of the Ceph storage map and the current state of the storage cluster. Ceph clients consult the Ceph monitor to receive the latest copy of the storage map then communicate directly with the primary data-owning OSD.

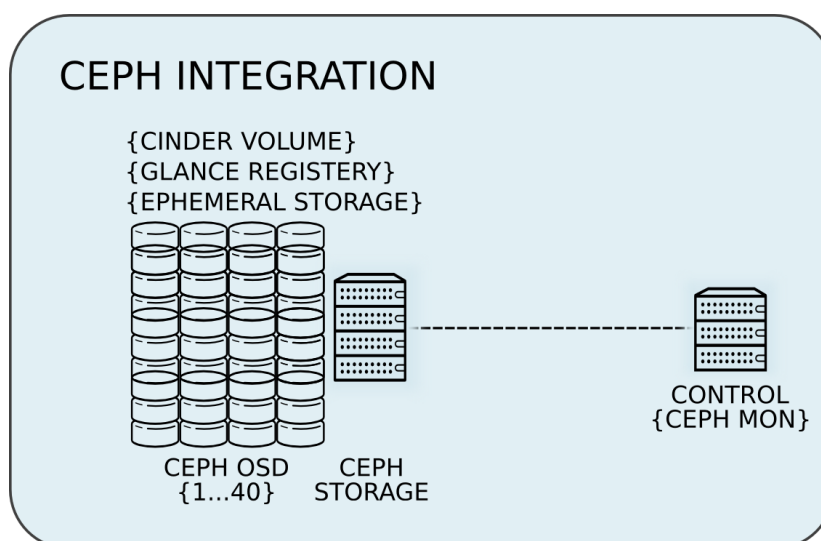


Figure 3.4: Ceph Integration

RHEL-OSP director can install a Ceph cluster with one or more OSD servers. By default the OSD server will use free space on its primary disk for the OSD storage device. Additional OSDs can be configured through Puppet customization prior to deploying the overcloud. Ceph performance scales with the number of OSD disks. The Ceph monitor is installed on the controller nodes whenever a Ceph storage role is deployed in the overcloud.

This reference architecture includes a 4-node Ceph cluster. Each node has 10 OSD disks (40 total). The OSDs in the reference architecture store [Glance](#) images, host [Cinder](#) volumes, and provide [Nova](#) instances with ephemeral storage.

Consult [Ceph documentation](#) for more information on Red Hat Ceph Storage 1.3. This [reference architecture](#) details how to install and run Ceph with standalone versions of Red Hat Enterprise Linux OpenStack Platform.

Reference Architecture Configuration Details

This section of the paper discusses the reference architecture use case. It includes an overview of the objective and workflow. This section also describes the test environment used to execute the use case in the Red Hat Systems Engineering lab.

Objective

This use case provides a comprehensive example for deploying an Red Hat JBoss Enterprise Application Platform 6 microservices architecture on a high availability Red Hat Enterprise Linux OpenStack Platform 7 cloud using RHEL-OSP director. The Red Hat Systems Engineering team validated all commands on bare metal servers using generally available software. The use case highlights many of RHEL-OSP director's features including:

- High Availability
- Network isolation
- Advanced Profile Matching
- Ceph integration
- Ceph customization
- Satellite subscription

The use case concludes with instructions for installing the EAP 6 microservices architecture via [Heat](#). The microservices architecture demonstrates OpenStack's ability to deploy and run a complex application typical to a production cloud. The microservices architecture in this example is a multi-tier shopping cart that includes a web presentation layer, product and customer databases, and sales, billing, and product microservices.

Workflow

Figure 4.1 [Reference Architecture Workflow](#) depicts a high-level overview of the use case workflow.

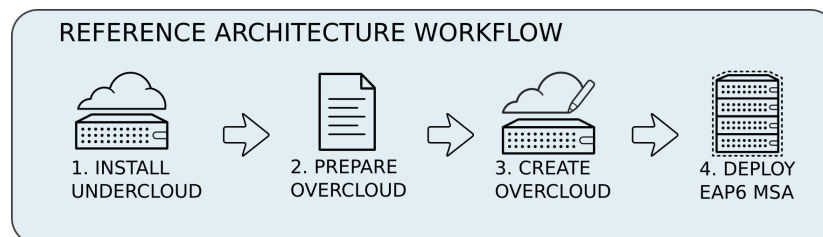


Figure 4.1 Reference Architecture Workflow

The use case is divided into the following steps:

1. **Install the undercloud:**

- a. Download the RHEL-OSP deployment package.
 - b. Deploy the undercloud baremetal server.
2. **Prepare the overcloud:**
- a. Import overcloud disk images.
 - b. Discover baremetal servers for overcloud deployment.
 - c. Match the servers to hardware profiles.
 - d. Customize the Ceph OSDs.
 - e. Define the network isolation configuration.
3. **Create the overcloud:**
- a. Deploy the overcloud via **Heat** templates.
 - b. Configure HA fencing devices.
 - c. Test the overcloud deployment.
4. **Deploy the EAP 6 MSA:**
- a. Configure the tenant
 - b. Deploy EAP 6 microservices application via **Heat** templates
 - c. Test the application

Conceptual Diagram of the Solution Stack

Figure 4.2 [Reference Architecture Diagram](#) depicts the deployed solution stack.

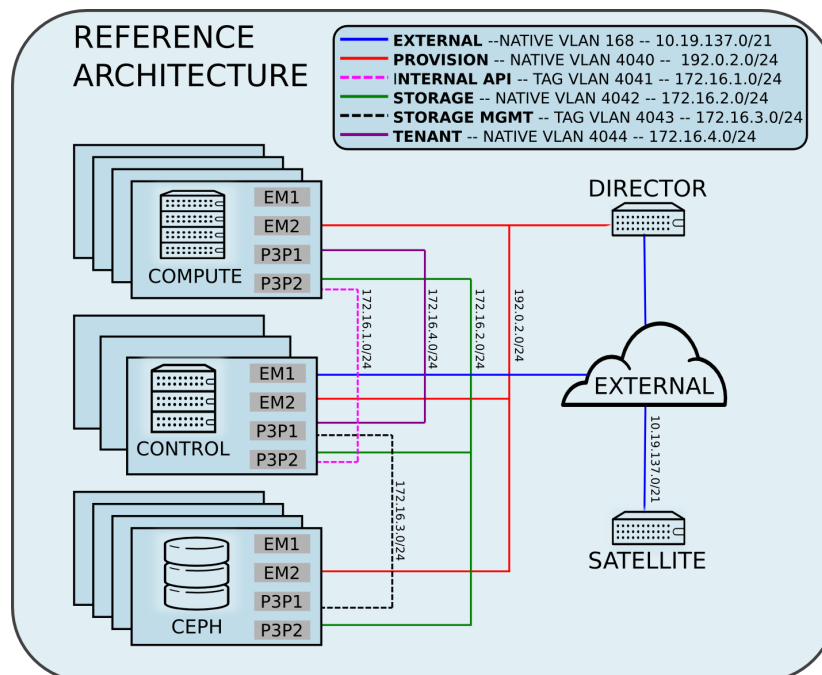


Figure 4.2: Reference Architecture Diagram

The [Network Topology](#) section of this paper describes the networking components in detail.

Server Roles

As depicted in Figure 4.2 [Reference Architecture Diagram](#), the use case requires 12 bare metal servers deployed with the following roles:

- 1 undercloud server
- 3 cloud controllers
- 4 compute nodes
- 4 Ceph storage servers

Servers are assigned to roles based on their hardware characteristics.

Table 4. Server hardware by role

Role	Count	Model
Undercloud	1	Dell PowerEdge R720xd
Cloud controller	3	Dell PowerEdge M520
Compute node	4	Dell PowerEdge M520
Ceph storage server	4	Dell PowerEdge R510

Appendix C [Hardware specifications](#) lists hardware specifics for each server model.

Network Topology

Figure 4.2 [Reference Architecture Diagram](#) details and describes the network topology of this reference architecture.

Each server has two Gigabit interfaces (nic1:2) and two 10-Gigabit interfaces (nic3:4) for network isolation to segment OpenStack communication by type.

The following network traffic types are isolated:

- Provisioning
- Internal API
- Storage
- Storage Management
- Tenant
- External

There are six isolated networks but only four physical interfaces. Two networks are isolated on each

physical 10 Gb interface using a combination of tagged and native VLANs.



The RHEL-OSP 7 network isolation feature supports bonded interfaces. Limitations in the Systems Engineering lab precluded the use of bonded interfaces in this reference architecture. Bonded interfaces are recommended for production deployments.

Table 5. Network isolation

Role	Interface	VLAN ID	Network	VLAN Type	CIDR
Undercloud	nic1	168	External	Native	10.19.137.0/21
	nic2	4040	Provisioning	Native	192.0.2.0/24
Control	nic1	168	External	Native	10.19.137.0/21
	nic2	4040	Provisioning	Native	192.0.2.0/24
	nic3	4043	Storage Mgmt	Tagged	172.16.3.0/24
	nic3	4044	Tenant	Native	172.16.4.0/24
	nic4	4041	Internal API	Tagged	172.16.1.0/24
	nic4	4042	Storage	Native	172.16.2.0/24
Compute	nic2	4040	Provisioning	Native	192.0.2.0/24
	nic3	4044	Tenant	Native	172.16.4.0/24
	nic4	4041	Internal API	Tagged	172.16.1.0/24
	nic4	4042	Storage	Native	172.16.2.0/24
Ceph storage	nic2	4040	Provisioning	Native	192.0.2.0/24
	nic3	4043	Storage Mgmt	Tagged	172.16.3.0/24
	nic4	4042	Storage	Native	172.16.2.0/24



All switch ports must be added to their respective VLANs prior to deploying the overcloud.

Deciding how to isolate networks is a crucial decision when designing for performance and scalability. There is no one-size-fits-all approach. Hardware constraints and workload characteristics must dictate this design decision. [This paper](#) shares an approach to using cloud benchmarks to guide RHEL-OSP design decisions for performance and scaling.



A complete archive of the configuration files and supporting scripts used in this reference architecture is available at <https://access.redhat.com/node/1610453/40/0>.

Install the undercloud

This section lists the steps to install and configure Red Hat Enterprise Linux OpenStack Platform 7 with RHEL-OSP director in the Red Hat Systems Engineering lab.

Prepare the undercloud server

The following steps are to be performed within the undercloud server as the `root` user unless otherwise specified.

1. Install the operating system.

```
# cat /etc/redhat-release
Red Hat Enterprise Linux Server release 7.1 (Maipo)
```

2. Set the hostname using the `hostnamectl` command.

```
# hostnamectl set-hostname rhos0.osplocal
# hostnamectl set-hostname --transient rhos0.osplocal
# export HOSTNAME=rhos0.osplocal
# hostname
rhos0.osplocal
```

3. Register the system with `subscription-manager`.

```
# subscription-manager register --org syseng --activationkey OSP7-undercloud
The system has been registered with ID:
84e0fb33-24b0-4a1d-968e-e80352daa4f6
Installed Product Current Status:
Product Name: Red Hat Enterprise Linux Server
Status:      Subscribed
```



In this example the system is registered to a satellite server via an organization activation key. The [product documentation](#) includes instructions for registering directly via `subscription-manager`. The [Red Hat Satellite 6.0 Provisioning Guide](#) includes instructions for creating an organization activation key.

4. List active repositories.

```
# yum repolist
Loaded plugins: langpacks, product-id, rhnplugin, subscription-manager
This system is receiving updates from RHN Classic or Red Hat
Satellite.
repo id                                repo name status
rhel-7-server-extras-rpms/x86_64      Red Hat Enterprise Linux 7 Server - Extras
(RPMs) 89
rhel-7-server-openstack-7.0-rpms/7Server/x86_64  Red Hat OpenStack 7.0 for RHEL 7 (RPMs)
497
rhel-7-server-optional-rpms/7Server/x86_64      Red Hat Enterprise Linux 7 Server -
Optional (RPMs) 5,674
rhel-7-server-rpms/7Server/x86_64              Red Hat Enterprise Linux 7 Server (RPMs)
7,392
rhel-x86_64-server-7                          Red Hat Enterprise Linux Server (v. 7 for
64-bit x86_64) 7,424
repolist: 21,076
```



Appendix D [Required channels](#) lists the required channels.

5. Create the `stack` user

```
# useradd stack
# echo stack:password | chpasswd
# echo "stack ALL=(root) NOPASSWD:ALL" | tee -a /etc/sudoers.d/stack
stack ALL=(root) NOPASSWD:ALL
# chmod 0440 /etc/sudoers.d/stack
# id stack
uid=1000(stack) gid=1000(stack) groups=1000(stack)
```

Deploy the Control Plane

1. Switch to the `stack` user account.

```
# su - stack
$ id
uid=1000(stack) gid=1000(stack) groups=1000(stack) context=unconfined_u:unconfined_r:unconfined_t:s0-
s0:c0.c1023
```

2. Install the RHEL-OSP director plugin.

```
$ sudo yum install -y -q python-rdomanager-oscplugin
$ sudo rpm -q python-rdomanager-oscplugin
python-rdomanager-oscplugin-0.0.8-44.el7ost.noarch
```

3. Create the *undercloud.conf*. This file contains configuration data for the undercloud installation.

```
[DEFAULT]

image_path = .
local_ip = 192.0.2.1/24
local_interface = eno4
masquerade_network = 192.0.2.0/24
dhcp_start = 192.0.2.5
dhcp_end = 192.0.2.24
network_cidr = 192.0.2.0/24
network_gateway = 192.0.2.1
discovery_interface = br-ctlplane
discovery_iprange = 192.0.2.100,192.0.2.120
discovery_runbench = false
undercloud_debug = true

[auth]

undercloud_db_password =
undercloud_admin_token =
undercloud_admin_password =
undercloud_glance_password =
undercloud_heat_encryption_key =
undercloud_heat_password =
undercloud_neutron_password =
undercloud_nova_password =
undercloud_ironic_password =
undercloud_tuskar_password =
undercloud_ceilometer_password =
undercloud_ceilometer_metering_secret =
undercloud_ceilometer_snmpd_user =
undercloud_ceilometer_snmpd_password =
undercloud_swift_password =
undercloud_rabbit_cookie =
undercloud_rabbit_password =
undercloud_rabbit_username =
undercloud_heat_stack_domain_admin_password =
undercloud_swift_hash_suffix =
```

eno4 is the provisioning network interface. Blank passwords are auto-generated by the installer. Accept *br-ctlplane* as the default discovery interface.

discovery_runbench is set to *false*. When enabled, the *Ironic* instances are booted to a RAMdisk image that runs a series of benchmark tests and reports outliers. This is beyond the scope of this reference architecture.



Installing with SSL support is beyond the scope of this reference architecture. For details on how to use SSL support for the undercloud see [the product documentation](#) or Appendix E [Deploying undercloud with SSL](#).

4. Install the undercloud.

```
$ openstack undercloud install | tee uc.out
```

```
... [Output Abbreviated] ...
```

```
#####
```

```
instack-install-undercloud complete.
```

```
The file containing this installation's passwords is at
/home/stack/undercloud-passwords.conf.
```

```
There is also a stackrc file at /home/stack/stackrc.
```

```
These files are needed to interact with the OpenStack services, and should be secured.
#####
```

5. Source *stackrc* to set environment variables for interacting with the undercloud.

```
$ source stackrc
```

```
$ env | grep OS_
```

```
OS_PASSWORD=7f1dbeead29fe7b1ca96fcf4bec20efb1717f6db
```

```
OS_AUTH_URL=http://192.0.2.1:5000/v2.0
```

```
OS_USERNAME=admin
```

```
OS_TENANT_NAME=admin
```

```
OS_NO_CACHE=True
```

6. Verify all services are active.



This command output was truncated for brevity. Verify all services are *active*. Appendix F [Undercloud Service List](#) lists the OpenStack services running on the undercloud.

```
$ openstack-service status
neutron-dhcp-agent (pid 16458) is active
neutron-openvswitch-agent (pid 17750) is active
neutron-server (pid 16517) is active
openstack-ceilometer-alarm-evaluator (pid 16101) is active
openstack-ceilometer-alarm-notifier (pid 16033) is active
openstack-ceilometer-api (pid 16068) is active
openstack-ceilometer-central (pid 15998) is active
openstack-ceilometer-collector (pid 15965) is active
openstack-ceilometer-notification (pid 15932) is active
...
```

7. Increase the maximum database connections. This is recommended for production cluster deployments in [Performance Tuning the Backend Database for Red Hat Enterprise Linux OpenStack Platform](#).

```
$ sudo sed -i s/max_connections =.*$/max_connections = 4096/ /etc/my.cnf.d/server.cnf
```

8. Verify the connections have been increased.

```
$ sudo grep max_connections /etc/my.cnf.d/server.cnf max_connections = 4096
```

9. Increase the connection limit for the running databases and verify.

```
$ sudo mysql -e "SET GLOBAL max_connections = 4096"
$ sudo mysql -e "SHOW GLOBAL VARIABLES LIKE max_connections"
-----+
| Variable_name | Value |
-----+
| max_connections | 4096 |
-----+
```

10. Increase or disable **Neutron** port quotas. In this example the port quota is disabled in order to accommodate all of the ports created for the overcloud servers and Pacemaker VIPs.



A [bug](#) tracking this issue has been filed to change the default **Neutron** port quota to accommodate network isolation.

```
$ neutron quota-update --port -1
```

-----+	
Field	Value
-----+	
network	10
port	-1
security_group	10
security_group_rule	100
subnet	10
-----+	

Deploy the overcloud

This section describes steps for deploying the overcloud.

Create the images

1. Download and extract the RHEL-OSP 7 discovery, deployment, and overcloud images.



Download the images from:

https://access.redhat.com/downloads/content/191/ver=7.0/rhel---7/7.0/x86_64/product-downloads

```
$ mkdir images
$ cd images
$ cp ../.tar .*
$ ls
overcloud-full-7.0.0-32.tar discovery-ramdisk-7.0.0-32.tar deploy-ramdisk-ironic-7.0.0-32.tar
```

2. Extract the images from the tar archives.

```
$ tar xf deploy-ramdisk-ironic-7.0.0-32.tar
$ tar xf discovery-ramdisk-7.0.0-32.tar
$ tar xf overcloud-full-7.0.0-32.tar
$ ls
deploy-ramdisk-ironic-7.0.0-32.tar  discovery-ramdisk-7.0.0-32.tar  overcloud-full-7.0.0-32.tar
overcloud-full.vmlinuz
deploy-ramdisk-ironic.initramfs    discovery-ramdisk.initramfs    overcloud-full.initrd
deploy-ramdisk-ironic.kernel      discovery-ramdisk.kernel      overcloud-full.qcow2
```

3. Upload the images

```
$ openstack overcloud image upload
```

4. List the images.

```
$ openstack image list
```

-----+-----		
ID		Name
-----+-----		
179a49cb-cda8-410f-b78d-0b8d31df59bf		bm-deploy-ramdisk
4266cce9-92f7-4c4f-85b0-908271b95241		bm-deploy-kernel
841ba92b-2183-45c7-8779-f0105471323c		overcloud-full
b17decc0-72f5-48ef-9ad1-85d371a3e0f8		overcloud-full-initrd
c55c1359-c9a7-40a7-983f-d4d7610954bb		overcloud-full-vmlinuz
-----+-----		

Register and introspect the nodes.

1. Create the host definition file. *openstack-ironic-discoverd* uses this file to discover nodes and populate the **Ironic** database.

```
{
  "nodes": [
    {
      "pm_password": "PASSWORD",
      "pm_type": "pxe_ipmitool",
      "mac": [
        "d4:ae:52:b2:20:d2"
      ],
      "cpu": "24",
      "memory": "49152",
      "disk": "500",
      "arch": "x86_64",
      "pm_user": "root",
      "pm_addr": "10.19.143.153"
    },
    ...
  ]
}
```

mac is the MAC address of the provisioning interface. The **pm_** entries refer to the hardware management interface.



The example below is truncated for brevity.

2. Import the node definitions to the **Ironic** database.


```
$ openstack baremetal import --json ~/instackenv.json
$ openstack baremetal list
```

UUID	Name	Instance UUID	Power State	Provision State	Maintenance
1adc6792-0bd6-4bd2-b8fc-4d9867d74597	None	None	power off	available	False
382ab2a5-b5c0-4017-b59f-82eee0fb9864	None	None	power off	available	False
84efb518-15e6-45c7-8f6a-56a5097c0b85	None	None	power off	available	False
15ca1ded-0914-469f-af63-3340f91bc56a	None	None	power off	available	False
8e6c96ad-c039-498d-8bd2-61a489bbae87	None	None	power off	available	False
84e34eb3-2352-49c8-8748-8bc6b6185587	None	None	power off	available	False
abb19869-b92f-42b3-9db1-f69f6ee00f2e	None	None	power off	available	False
db878d37-5b7a-4140-8809-1b50d4ddb4c4	None	None	power off	available	False
d472af62-5547-4f9a-8fbb-fc8556eb4110	None	None	power off	available	False
c8400dc0-4246-44ee-a406-9362381d7ce1	None	None	power off	available	False
0c7af223-1a7d-43cd-a0ff-19226872e09c	None	None	power off	available	False
5f52affb-cfe2-49dc-aa89-b57d99e5372a	None	None	power off	available	False

3. Assign a kernel and ramdisk to the nodes

```
$ openstack baremetal configure boot
```

4. Introspect the nodes to discover their hardware attributes.

```
$ openstack baremetal introspection bulk start
...
```



Bulk introspection time will vary based on node count and boot time. For this reference architecture bulk introspection lasted approximately 3 minutes per node.

5. Use **journalctl** to view introspection progress in a separate terminal.

```
$ sudo journalctl -l -u openstack-ironic-discoverd -u
openstack-ironic-discoverd-dnsmasq -u openstack-ironic-conductor |
grep -i finished
Aug 28 09:23:46 rhos0.osplocal ironic-discoverd[22863]:
INFO:ironic_discoverd.process:Introspection finished successfully for node 1adc6792-0bd6-4bd2-b8fc-
4d9867d74597
Aug 28 09:24:53 rhos0.osplocal ironic-discoverd[22863]:
INFO:ironic_discoverd.process:Introspection finished successfully for node 84efb518-15e6-45c7-8f6a-
56a5097c0b85
```

6. Verify nodes completed introspection without errors.

```
$ openstack baremetal introspection bulk status
```

Node UUID	Finished	Error
1adc6792-0bd6-4bd2-b8fc-4d9867d74597	True	None
382ab2a5-b5c0-4017-b59f-82eee0fb9864	True	None
84efb518-15e6-45c7-8f6a-56a5097c0b85	True	None
15ca1ded-0914-469f-af63-3340f91bc56a	True	None
8e6c96ad-c039-498d-8bd2-61a489bbae87	True	None
84e34eb3-2352-49c8-8748-8bc6b6185587	True	None
abb19869-b92f-42b3-9db1-f69f6ee00f2e	True	None
db878d37-5b7a-4140-8809-1b50d4ddbec4	True	None
d472af62-5547-4f9a-8fbb-fc8556eb4110	True	None
c8400dc0-4246-44ee-a406-9362381d7ce1	True	None
0c7af223-1a7d-43cd-a0ff-19226872e09c	True	None
5f52affb-cfe2-49dc-aa89-b57d99e5372a	True	None

Configure hardware profiles

1. Create the default flavor for baremetal deployments.

```
$ openstack flavor create --id auto --ram 4096 --disk 40 --vcpus 1 baremetal
```

Field	Value
OS-FLV-DISABLED:disabled	False
OS-FLV-EXT-DATA:ephemeral	0
disk	40
id	e3f8358d-983f-4383-8379-50cbbf5bf970
name	baremetal
os-flavor-access:is_public	True
ram	4096
rxtx_factor	1.0
swap	
vcpus	1

2. Set properties for the baremetal flavor.

```
$ openstack flavor set --property "cpu_arch"="x86_64" --property "capabilities:boot_option"="local" baremetal
```

Field	Value
OS-FLV-DISABLED:disabled	False
OS-FLV-EXT-DATA:ephemeral	0
disk	40
id	e3f8358d-983f-4383-8379-50cbbf5bf970
name	baremetal
os-flavor-access:is_public	True
properties	capabilities:boot_option=local, cpu_arch=x86_64
ram	4096
rxtx_factor	1.0
swap	
vcpus	1

3. Install *ahc-tools*.

```
$ sudo yum install -y -q ahc-tools
$ sudo rpm -qa | grep ahc-tools
ahc-tools-0.1.1-5.el7ost.noarch
```

4. Create the AHC configuration file.

```
$ sudo cp /etc/ironic-discoverd/discoverd.conf /etc/ahc-tools/ahc-tools.conf
$ sudo sed -i s/\[discoverd/\[ironic/ /etc/ahc-tools/ahc-tools.conf
$ sudo chmod 0600 /etc/ahc-tools/ahc-tools.conf
```

5. View `/etc/ahc-tools/ahc-tools.conf`.

```
$ sudo cat /etc/ahc-tools/ahc-tools.conf
[ironic]
debug = false
os_auth_url = http://192.0.2.1:5000/v2.0
identity_uri = http://192.0.2.1:35357
os_username = ironic
os_password = d5ba7515326d740725ea74bf0aec65fb079c0e19
os_tenant_name = service
dnsmasq_interface = br-ctlplane
database = /var/lib/ironic-discoverd/discoverd.sqlite
ramdisk_logs_dir = /var/log/ironic-discoverd/ramdisk/
processing_hooks =
ramdisk_error,root_device_hint,scheduler,validate_interfaces,edeploy
enable_setting_ipmi_credentials = true
keep_ports = added
ironic_retry_attempts = 6
ironic_retry_period = 10

[swift]
username = ironic
password = d5ba7515326d740725ea74bf0aec65fb079c0e19
tenant_name = service
os_auth_url = http://192.0.2.1:5000/v2.0
```

6. Create the AHC spec files.



Servers are matched to profiles by the order they are listed in this file.

```
$ for i in $(ls /etc/ahc-tools/edeploy/{*.specs,state}); do echo $i && cat $i; done
/etc/ahc-tools/edeploy/ceph.specs
[
  (disk, $disk, size, gt(400)),
]
/etc/ahc-tools/edeploy/compute.specs
[
  (cpu, $cpu, cores, 8),
  (memory, total, size, ge(64000000000)),
]
/etc/ahc-tools/edeploy/control.specs
[
  (cpu, $cpu, cores, 8),
  (disk, $disk, size, gt(100)),
  (memory, total, size, ge(64000000000)),
]
/etc/ahc-tools/edeploy/state
[(ceph, 4), (control, 3), (compute, *)]
```

This configuration defines:

- Minimum disk size of 400 GB for Ceph servers
- 8 cores per CPU and 64 GB RAM for compute nodes
- 8 cores per CPU, minimum 100 GB disk size and 64 GB RAM for controllers
- The state file specifies that AHC should match 3 controllers, 4 Ceph storage servers, and the remainder as compute nodes.



View [Appendix A](#) of the [eDeploy User's Guide](#) for an exhaustive list of the hardware components and settings that can be matched in a specification file.

7. This loop creates a hardware profile for each node type defined in the state file.

```
$ for i in ceph control compute; do openstack flavor create --id auto --ram 4096 --disk 40 --vcpus 1 $i;
openstack flavor set --property "cpu_arch"="x86_64" --property "capabilities:boot_option"="local"
--property "capabilities:profile"="$i" $i; done
...
```

```
$ openstack flavor list
```

ID	Name	RAM	Disk	Ephemeral	VCPUs	Is Public
3bd3c59f-16c4-4090-94b5-0d90e1f951fa	compute	4096	40	0	1	True
9a9c0a68-550a-4736-9b6d-f4aa1cc68a1f	ceph	4096	40	0	1	True
a3d47c7e-04dc-47e3-8fca-b19ea31d0ed2	control	4096	40	0	1	True
e3f8358d-983f-4383-8379-50cbbf5bf970	baremetal	4096	40	0	1	True

8. Assign **Ironic** nodes to profiles and view the results.

```
$ sudo ahc-match
```

9. View the profile assigned to each node.

```
$ for i in $(ironic node-list | awk ' /available/ { print $2 } );
do ironic node-show $i | grep capabilities; done
|          | u'cpus: u'24', u'capabilities':u'profile:ceph,boot_option:local'} |
|          | u'cpus': u'24', u'capabilities':u'profile:ceph,boot_option:local'} |
|          | u'cpus': u'24', u'capabilities':u'profile:ceph,boot_option:local'} |
|          | u'cpus': u'24', u'capabilities':u'profile:ceph,boot_option:local'} |
|          | u'cpus': u'32', u'capabilities':u'profile:control,boot_option:local'} |
|          | u'cpus': u'32', u'capabilities':u'profile:control,boot_option:local'} |
|          | u'cpus': u'32', u'capabilities':u'profile:control,boot_option:local'} |
|          | u'cpus': u'32', u'capabilities':u'profile:compute,boot_option:local'} |
|          | u'cpus': u'32', u'capabilities':u'profile:compute,boot_option:local'} |
|          | u'cpus': u'32', u'capabilities':u'profile:compute,boot_option:local'} |
|          | u'cpus': u'32', u'capabilities':u'profile:compute,boot_option:local'} |
|          | u'cpus': u'32', u'capabilities':u'profile:compute,boot_option:local'} |
```

In this example, the 4 R510 servers are assigned to Ceph, 3 M520 servers are assigned to control, and the remainder are assigned to compute.

Configure network isolation

This section describes how to configure network isolation for the reference architecture. Configure network isolation by defining networks in environment files. Pass the environment files to **Heat**.

The network isolation environment files used in this section produce the network described in [Reference Architecture Diagram](#).

1. Define isolated networks in *network-environment.yaml*.

```
resource_registry:
  OS::Triple0::BlockStorage::Net::SoftwareConfig:/home/stack/nic-configs/cinder-storage.yaml
  OS::Triple0::Compute::Net::SoftwareConfig:/home/stack/nic-configs/compute.yaml
  OS::Triple0::Controller::Net::SoftwareConfig:/home/stack/nic-configs/controller.yaml
  OS::Triple0::ObjectStorage::Net::SoftwareConfig:/home/stack/nic-configs/swift-storage.yaml
  OS::Triple0::CephStorage::Net::SoftwareConfig:/home/stack/nic-configs/ceph-storage.yaml

parameter_defaults:
  NeutronExternalNetworkBridge: "br-ex"
  InternalApiNetCidr: 172.16.1.0/24
  StorageNetCidr: 172.16.2.0/24
  StorageMgmtNetCidr: 172.16.3.0/24
  TenantNetCidr: 172.16.4.0/24
  ExternalNetCidr: 10.19.136.0/21
  InternalApiAllocationPools: [{'start': '172.16.1.10', 'end': '172.16.1.100'}]
  StorageAllocationPools: [{'start': '172.16.2.10', 'end': '172.16.2.200'}]
  StorageMgmtAllocationPools: [{'start': '172.16.3.10', 'end': '172.16.3.200'}]
  TenantAllocationPools: [{'start': '172.16.4.10', 'end': '172.16.4.200'}]
  ExternalAllocationPools: [{'start': '10.19.137.121', 'end': '10.19.137.151'}]
  InternalApiNetworkVlanID: 4041
  StorageNetworkVlanID: 4042
  StorageMgmtNetworkVlanID: 4043
  TenantNetworkVlanID: 4044
  ExternalNetworkVlanID: 168
  ExternalInterfaceDefaultRoute: "10.19.143.254"
  BondInterfaceOvsOptions:
    "bond_mode=balance-tcp lacp=active other-config:lacp-fallback-ab=true"
```

The *resource_registry* section defines role-specific configuration. These files are created in subsequent steps.

The *parameter_defaults* section defines default parameters used across the resource registry. These include CIDRs, VLAN IDs, and IP allocation pools for each network, as well as the external network bridge created by **Open vSwitch**.

The parameters defined in this file match the network configuration used in the reference architecture.



In most cases *NeutronExternalNetworkBridge* would be set to "" in order to support multiple floating IP VLANs or physical interfaces. In this case there was only one floating IP network on the native VLAN of bridge *br-ex*, so the bridge was specified directly for performance reasons.

2. Create the *nic-configs* files to define network configuration for each interface by server role.

```
$ mkdir ~/nic-configs
$ ls ~/nic-configs
ceph-storage.yaml  cinder-storage.yaml  compute.yaml  controller.yaml  swift-storage.yaml
```

Complete examples of each network configuration file are in Appendix I [NIC Configuration Files](#).



Swift and **Cinder** servers are not used in this reference architecture. Their files are included for completeness but not called by the installer.

3. Set the provisioning network nameserver. The overcloud servers use this nameserver for DNS resolution.

```
$ neutron subnet-update $(neutron subnet-list | awk ' /192.0.2/ { print $2 } ') --dns-nameserver
10.19.143.247
```

Customize Ceph Storage

Like network isolation, Ceph is customized by passing **Heat** additional environment files. The customization produce the Ceph cluster depicted in the [Ceph integration graphic](#).

In this reference architecture ten SAS disks in each R510 are configured as OSD drives. The journal for each OSD is created as a separate partition on the OSD drive. This is the recommended journal configuration for Ceph OSDs when SSD drives are not used.

1. Configure Ceph OSD disks as single-drive RAID 0 virtual disks for best performance. Ceph data is protected through replication across OSDs so RAID is not recommended.
2. Initialize the virtual disks to remove all partition and MBR data.
3. Create a *templates* directory for **Heat** template customization.

```
$ mkdir ~/templates
$ cp -rp /usr/share/openstack-tripleo-heat-templates/ ~/templates
```

4. Edit *~/templates/openstack-tripleo-heat-templates/puppet/hieradata/ceph.yaml* to include the Ceph customizations. This example includes the additional OSDs accepting the Puppet defaults for journaling.


```
ceph::profile::params::osd_journal_size: 1024
ceph::profile::params::osd_pool_default_pg_num: 128
ceph::profile::params::osd_pool_default_pgp_num: 128
ceph::profile::params::osd_pool_default_size: 3
ceph::profile::params::osd_pool_default_min_size: 1
ceph::profile::params::osds:
  '/dev/sdb':
    journal: {}
  '/dev/sdc':
    journal: {}
  '/dev/sdd':
    journal: {}
  '/dev/sde':
    journal: {}
  '/dev/sdf':
    journal: {}
  '/dev/sdg':
    journal: {}
  '/dev/sdh':
    journal: {}
  '/dev/sdi':
    journal: {}
  '/dev/sdj':
    journal: {}
  '/dev/sdk':
    journal: {}
ceph::profile::params::manage_repo: false
ceph::profile::params::authentication_type: cephx

ceph_pools:
- volumes
- vms
- images

ceph_osd_selinux_permissive: true
```



By default Ceph creates one OSD per storage server using the remaining free space on the operating system disk. The OSD journal is configured as a 5 GB file on the disk. This configuration is only suitable for evaluation and proof of concept.

Deploy and Test the overcloud

This section describes how to deploy and test the overcloud defined in the previous section.

Deploy the Overcloud servers

1. Use **ironic node-list** to verify all **Ironi**c nodes are powered off, available for provisioning, and not in maintenance mode.

```
$ ironic node-list
```

UUID	Name	Instance UUID	Power State	Provision State	Maintenance
1adc6792-0bd6-4bd2-b8fc-4d9867d74597	None	None	power off	available	False
382ab2a5-b5c0-4017-b59f-82eee0fb9864	None	None	power off	available	False
84efb518-15e6-45c7-8f6a-56a5097c0b85	None	None	power off	available	False
15ca1ded-0914-469f-af63-3340f91bc56a	None	None	power off	available	False
8e6c96ad-c039-498d-8bd2-61a489bbae87	None	None	power off	available	False
84e34eb3-2352-49c8-8748-8bc6b6185587	None	None	power off	available	False
abb19869-b92f-42b3-9db1-f69f6ee00f2e	None	None	power off	available	False
db878d37-5b7a-4140-8809-1b50d4ddbec4	None	None	power off	available	False
d472af62-5547-4f9a-8fbb-fc8556eb4110	None	None	power off	available	False
c8400dc0-4246-44ee-a406-9362381d7ce1	None	None	power off	available	False
0c7af223-1a7d-43cd-a0ff-19226872e09c	None	None	power off	available	False
5f52affb-cfe2-49dc-aa89-b57d99e5372a	None	None	power off	available	False

2. Deploy the overcloud.

```
$ openstack overcloud deploy -e
/usr/share/openstack-tripleo-heat-templates/environments/network-isolation.yaml \
-e /home/stack/network-environment.yaml --control-flavor control --compute-flavor compute \
--ceph-storage-flavor ceph --ntp-server 10.16.255.2 --control-scale 3 --compute-scale 4 \
--ceph-storage-scale 4 --block-storage-scale 0 --swift-storage-scale 0 \
-t 90 --templates /home/stack/templates/openstack-tripleo-heat-templates/ \
-e /usr/share/openstack-tripleo-heat-templates/environments/storage-environment.yaml \
--rhel-reg --reg-method satellite --reg-sat-url \
http://se-sat6.syseng.bos.redhat.com --reg-org syseng --reg-activation-key OSP-Overcloud
Deploying templates in the directory /home/stack/templates/openstack-tripleo-heat-templates
```

This lengthy command does the following:

- Specifies the location of *network-environment.yaml* to customize the network configurations.
- Specifies which flavors and how many control, compute, and ceph-storage nodes to instantiate.
- Specifies the location of the *storage-environment.yaml* for Ceph customization.
- Registers the overcloud servers with the lab satellite server using a predefined activation key.

3. Watch deployment progress in a separate console window.

```
$ heat resource-list overcloud | grep CREATE_COMPLETE
| BlockStorage          | 8565b42e-0b24-41ec-88d3-7d0d6bc18834 | OS::Heat::ResourceGroup |
CREATE_COMPLETE | 2015-08-28T16:25:53Z |
| ControlVirtualIP      | c4926ff9-2ea7-40f1-9677-d7f26e3517db | OS::Neutron::Port |
CREATE_COMPLETE | 2015-08-28T16:25:53Z |
| HeatAuthEncryptionKey | overcloud-HeatAuthEncryptionKey-paa5lxc3ubon |
OS::Heat::RandomString | CREATE_COMPLETE | 2015-08-28T16:25:53Z |
| HorizonSecret         | overcloud-HorizonSecret-mpgdt65yqsud |
OS::Heat::RandomString | CREATE_COMPLETE | 2015-08-28T16:25:53Z |
...
```

4. Run **nova-list** to view IP addresses for the overcloud servers.

```
$ nova list
...
| e50a67fa-ed75-4f39-a58f-47b51371f61d | overcloud-cephstorage-0 | ACTIVE | - | Running |
ctlplane=192.0.2.20 |
| e36b2f28-463c-4e01-91e0-8ed762a1c057 | overcloud-cephstorage-1 | ACTIVE | - | Running |
ctlplane=192.0.2.21 |
| 37c67128-8432-4330-afe7-ab3b01bdc6e | overcloud-cephstorage-2 | ACTIVE | - | Running |
ctlplane=192.0.2.19 |
| 3ee07cc2-9adf-457f-94e6-705657ac3767 | overcloud-cephstorage-3 | ACTIVE | - | Running |
ctlplane=192.0.2.22 |
| e1f2801b-cb6e-4c55-a82a-476d0090f1d6 | overcloud-compute-0 | ACTIVE | - | Running |
ctlplane=192.0.2.8 |
| 17be9669-247b-434f-9ad2-8ab59740c1e9 | overcloud-compute-1 | ACTIVE | - | Running |
ctlplane=192.0.2.23 |
| be30827b-e3b4-4504-8afb-fe5ea42fda54 | overcloud-compute-2 | ACTIVE | - | Running |
ctlplane=192.0.2.7 |
| 6a2ee7e1-31b8-48da-b56b-0834ac6bf3b4 | overcloud-compute-3 | ACTIVE | - | Running |
ctlplane=192.0.2.24 |
| 520c5af6-fc91-4b93-bb95-93f947a7cc71 | overcloud-controller-0 | ACTIVE | - | Running |
ctlplane=192.0.2.9 |
| 23a2de54-e3c9-4c1d-aaff-75ef5993b7af | overcloud-controller-1 | ACTIVE | - | Running |
ctlplane=192.0.2.6 |
| 2afb18d3-3494-41da-951a-b72d68b4bf88 | overcloud-controller-2 | ACTIVE | - | Running |
ctlplane=192.0.2.10 |
```

5. Source the *overcloudrc* file to set environment variables for the overcloud.

6. Verify all **Nova** services and enabled and up.

```
$ nova service-list
...
| 3 | nova-scheduler | overcloud-controller-0.localdomain | internal | enabled | up | 2015-08-28T21:56:01.000000 | -
| 6 | nova-scheduler | overcloud-controller-2.localdomain | internal | enabled | up | 2015-08-28T21:56:03.000000 | -
| 9 | nova-scheduler | overcloud-controller-1.localdomain | internal | enabled | up | 2015-08-28T21:56:04.000000 | -
| 12 | nova-consoleauth | overcloud-controller-1.localdomain | internal | enabled | up | 2015-08-28T21:56:03.000000 | -
| 15 | nova-consoleauth | overcloud-controller-2.localdomain | internal | enabled | up | 2015-08-28T21:56:03.000000 | -
| 18 | nova-consoleauth | overcloud-controller-0.localdomain | internal | enabled | up | 2015-08-28T21:56:04.000000 | -
| 21 | nova-conductor | overcloud-controller-2.localdomain | internal | enabled | up | 2015-08-28T21:55:57.000000 | -
| 57 | nova-conductor | overcloud-controller-0.localdomain | internal | enabled | up | 2015-08-28T21:55:57.000000 | -
| 105 | nova-conductor | overcloud-controller-1.localdomain | internal | enabled | up | 2015-08-28T21:55:58.000000 | -
| 123 | nova-compute | overcloud-compute-1.localdomain | nova | enabled | up | 2015-08-28T21:55:59.000000 | -
[ ... Output truncated ... ]
```

7. Verify all **Neutron** agents are alive and up.

```
$ neutron agent-list
...
| 2034c620-e2be-4fc3-8c7e-878125cccb46 | Open vSwitch agent | overcloud-compute-3.localdomain | :-)
| True | neutron-openvswitch-agent |
| 290a09bb-9878-4661-9c55-dee4c53f103c | Metadata agent | overcloud-controller-2.localdomain | :-)
| True | neutron-metadata-agent |
| 369ef1fd-992a-462a-8569-128c329cf7b1 | Open vSwitch agent | overcloud-compute-2.localdomain | :-)
| True | neutron-openvswitch-agent |
| 42b35c58-dda0-4e55-b53f-5f7466acdac5 | Open vSwitch agent | overcloud-compute-0.localdomain | :-)
| True | neutron-openvswitch-agent |
| 45b4e429-1ad7-4678-aa8b-bc8afa8761ea | DHCP agent | overcloud-controller-1.localdomain | :-)
| True | neutron-dhcp-agent |
| 91ff4990-6080-4fd2-98c2-b69cb5ea3d79 | L3 agent | overcloud-controller-0.localdomain | :-)
| True | neutron-l3-agent |
[ ... Output truncated ... ]
```

8. **ssh** to a controller node and switch to root user. Find the controller IP address by running **nova list** on the undercloud.

```
$ ssh -l heat-admin 192.0.2.9
The authenticity of host 192.0.2.9 (192.0.2.9) can't be established.
ECDSA key fingerprint is fe:a3:da:94:36:37:de:76:68:71:e0:70:cb:3a:00:aa.
Are you sure you want to continue connecting (yes/no)? yes
Warning: Permanently added 192.0.2.9 (ECDSA) to the list of known hosts.
$ sudo -i
```

9. Run **pcs status** to verify OpenStack services started correctly.



Run **pcs resource cleanup** if any of the services are not fully started.

```
# pcs status
Cluster name: tripleo_cluster
Last updated: Fri Aug 28 17:47:31 2015
Last change: Fri Aug 28 15:28:39 2015
Stack: corosync
Current DC: overcloud-controller-1 (2) - partition with quorum
Version: 1.1.12-a14efad
3 Nodes configured
112 Resources configured

Online: [ overcloud-controller-0 overcloud-controller-1 overcloud-controller-2 ]

Full list of resources:

Clone Set: haproxy-clone [haproxy]
  Started: [ overcloud-controller-0 overcloud-controller-1 overcloud-controller-2 ]
ip-172.16.1.11 (ocf::heartbeat:IPaddr2): Started overcloud-controller-0
ip-10.19.137.121 (ocf::heartbeat:IPaddr2): Started overcloud-controller-1
...
```



Appendix G [Overcloud Service List](#) shows complete **pcs status** Pacemaker output for a deployed overcloud.

Tune Ceph storage

This section includes steps for increasing the number of Placement Groups (PGs) per pool. [Ceph Placement Groups \(PGs\)](#) aggregate objects within pools. PGs within a pool are distributed across OSDs for data durability and performance. By default OSP director creates 4 pools with 64 PGs and 3 replicas per pool. There are 40 OSDs which leaves 19.2 PGs per OSD. Ceph recommends at least 30 PGs per OSD.

Each pool has two properties that dictate its number of placement groups: *pg_num* (number of placement groups) and *pgp_num* (number of PGs for placement on OSD.) At the time of writing, customizing *pg_num* in *ceph.yaml* prior to deployment was not working. See [BZ1252546](#) for details. Therefore, this reference architecture manually increases *pg_num* and *pgp_num* to Ceph recommendations.

Figure 6.1 [Ceph benchmark performance](#) shows the relative performance impact of Ceph tuning on an IO microbenchmark.

1. **ssh** to a Ceph OSD node and switch to root user.

```
$ ssh -l heat-admin 192.0.2.20
Last login: Fri Aug 28 17:58:30 2015 from 192.0.2.1
$ sudo -i
```

2. Run **ceph -s** to verify all OSDs are up and in, pool count, and total free space.

```
# ceph -s
cluster 7ced0d2a-4db6-11e5-86a4-90b11c56332a
health HEALTH_WARN too few PGs per OSD (19 < min 30)
monmap e2: 3 mons at {overcloud-controller-0=172.16.2.16:6789/0,overcloud-controller-1=172.16.2.15:6789/0,overcloud-controller-2=172.16.2.21:6789/0}

election epoch 6, quorum 0,1,2 overcloud-controller-1,overcloud-controller-0,overcloud-controller-2
osdmap e82: 40 osds: 40 up, 40 in
pgmap v120: 256 pgs, 4 pools, 0 bytes data, 0 objects
201 GB used, 37020 GB / 37221 GB avail
256 active+clean
```

3. List the pools and pool stats. There are four pools configured for object storage, images, block storage, and ephemeral storage. There are 256 PGs total, 64 per pool.

```
# ceph osd lspools
0 rbd,1 images,2 volumes,3 vms,
# ceph pg stat
v120: 256 pgs: 256 active+clean; 0 bytes data, 201 GB used, 37020 GB /
37221 GB avail
```

4. View overall Ceph health.

```
# ceph health
HEALTH_WARN too few PGs per OSD (19 < min 30)
```

5. Increase per-pool *pg_num* and *pgp_num* to 256.

```
# for i in rbd images volume vms; do
  ceph osd pool set $i pg_num 256;
  sleep 10
  ceph osd pool set $i pgp_num 256;
  sleep 10
done
set pool 0 pg_num to 256
set pool 0 pgp_num to 256
set pool 1 pg_num to 256
set pool 1 pgp_num to 256
set pool 2 pg_num to 256
set pool 2 pgp_num to 256
set pool 3 pg_num to 256
set pool 3 pgp_num to 256
```



The **sleep** statements are intended to ensure the cluster has time to complete the previous action before proceeding. If a large increase is needed increase *pg_num* in stages.

6. Re-run **ceph health** and **ceph pg stat**.

```
# ceph health
HEALTH_OK
# ceph pg stat
v180: 1024 pgs: 1024 active+clean; 0 bytes data, 201 GB used, 37020 GB
/ 37221 GB avail
```



Increase the PGs on only one Ceph node in the cluster.

Performance Impact of Ceph Tuning

This graphic illustrates the performance impact of increasing the OSD count from 4 to 40 and the PG count from 100 to 256. All performance numbers are relative to the default settings.

1. The *random read* performance improves slightly but does not benefit very much from increasing OSD or PG count. Random read performance is still limited by the average seek time on the disks.
2. Increasing the OSD count improves *sequential read* performance by more than 100% due to increased parallelism.
3. *sequential write* benefits from both OSD and PG increases and shows the largest relative improvement versus the default configuration.



These performance tests are for illustrative purposes only and do not reflect the achievable performance of the machines on a real application workload.

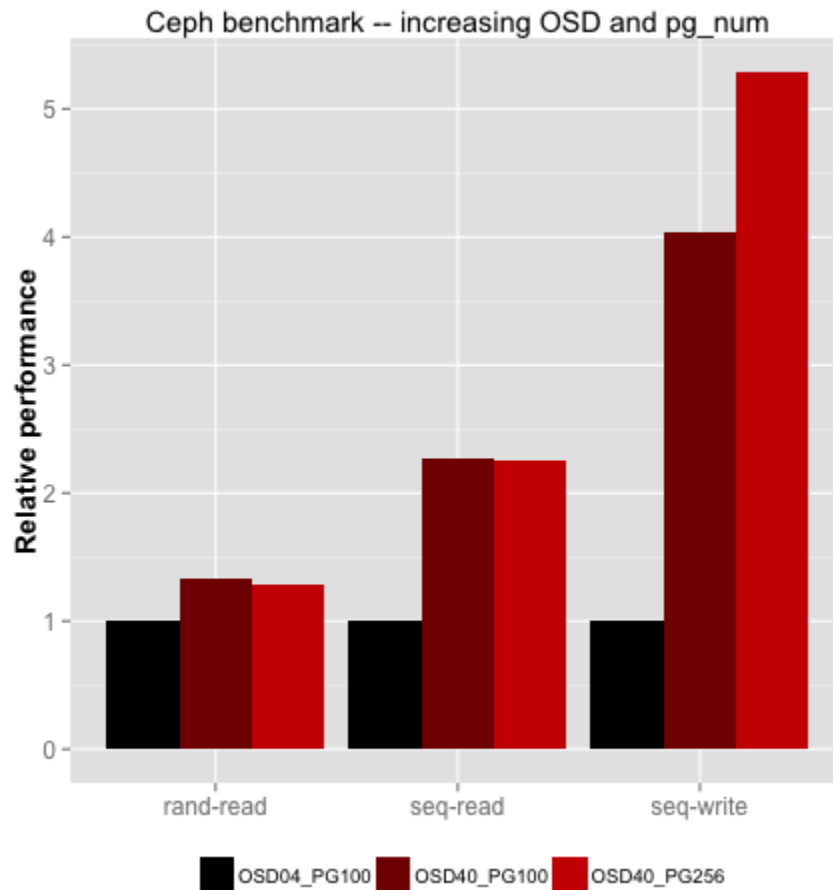


Figure 6.1: Ceph benchmark performance

Configure controller fencing

Fencing is an important concept for HA clusters. It is a method for bringing the cluster into a known state by removing members that are in an unknown state. In this reference architecture the controller IPMI interfaces act as fence devices. However, Red Hat Enterprise Linux OpenStack Platform director does not configure fencing. This section describes how the controller nodes were manually configured for fencing in this reference architecture.

Appendix H [Example fencing Script](#) shows an example script used to configure fencing in this reference architecture. This script configures each controller nodes IPMI as a fence device, constrains it so a controller cannot fence itself, and then enables all fence devices.

1. Run `configure_fence.sh`.

```
$ sh configure_fence.sh enable
Cluster Properties:
cluster-infrastructure: corosync
cluster-name: tripleo_cluster
dc-version: 1.1.12-a14efad
have-watchdog: false
redis_REPL_INFO: overcloud-controller-1
stonith-enabled: true
```

2. Verify fence devices are configured with **pcs status**.

```
$ ssh -l heat-admin 192.0.2.9 sudo pcs status | grep -i fence
overcloud-controller-0-ipmi (stonith:fence_ipmilan): Started overcloud-controller-1
overcloud-controller-1-ipmi (stonith:fence_ipmilan): Started overcloud-controller-2
overcloud-controller-2-ipmi (stonith:fence_ipmilan): Started overcloud-controller-0
```

Configure additional Pacemaker constraints

Pacemaker *resource constraints* enforce service co-location and start ordering requirements. In this section several additional resource constraints are manually added to the cluster to ensure proper recovery and startup.



The missing resource constraints are documented in [bug 1257414](#) and slated for addition in the next OSP director point release.

1. **ssh** to a controller node and run **sudo** to execute commands as the root user.

```
$ ssh -l heat-admin 192.0.2.17
$ sudo -i
```

2. Configure additional **pcs** restart location and startup constraints.

```
# pcs constraint order start rabbitmq-clone then openstack-keystone-clone
Adding rabbitmq-clone openstack-keystone-clone (kind: Mandatory) (Options: first-action=start then-
action=start)
# pcs constraint order promote galera-master then openstack-keystone-clone
Adding galera-master openstack-keystone-clone (kind: Mandatory) (Options: first-action=promote then-
action=start)
# pcs constraint order start haproxy-clone then openstack-keystone-clone
Adding haproxy-clone openstack-keystone-clone (kind: Mandatory) (Options: first-action=start then-
action=start)
# pcs constraint order start memcached-clone then openstack-keystone-clone
Adding memcached-clone openstack-keystone-clone (kind: Mandatory) (Options: first-action=start then-
action=start)
# pcs constraint order start openstack-nova-novncproxy-clone then openstack-nova-api-clone
Adding openstack-nova-novncproxy-clone openstack-nova-api-clone (kind: Mandatory) (Options: first-
action=start then-action=start)
# pcs constraint order promote redis-master then start openstack-ceilometer-central-clone require-
all=false
Adding redis-master openstack-ceilometer-central-clone (kind: Mandatory) (Options: require-all=false
first-action=promote then-action=start)
# pcs resource defaults resource-stickiness=INFINITY
```

3. List the resource constraints.

```
# pcs constraint list
Location Constraints:
Ordering Constraints:
  start ip-172.16.1.10 then start haproxy-clone (kind:Optional)
  start ip-192.0.2.6 then start haproxy-clone (kind:Optional)
  start ip-172.16.3.10 then start haproxy-clone (kind:Optional)
  start ip-10.19.137.121 then start haproxy-clone (kind:Optional)
  start ip-172.16.1.11 then start haproxy-clone (kind:Optional)
  start ip-172.16.2.10 then start haproxy-clone (kind:Optional)
  start mongod-clone then start openstack-ceilometer-central-clone (kind:Mandatory)
  start openstack-glance-registry-clone then start openstack-glance-api-clone (kind:Mandatory)
[ ... Output truncated ... ]
```

Install and Configure EAP 6

This section describes the steps to install and configure an example Red Hat JBoss Enterprise Application Platform 6 application on the deployed cloud. The example application is a multi-tier web application with a shopping cart.

Red Hat JBoss Enterprise Application Platform 6 (EAP) is a fully certified Java™ EE platform for developing and deploying enterprise applications. This reference architecture documents the steps to deploy an EAP 6 application demonstrating Microservices Architecture (MSA) on RHEL-OSP 7. MSA is software architectural style that increases modularity to decrease complexity. Applications are developed from suites of small services, each running as an independent process in its own container or virtual machine. Each service has a single responsibility. The services communicate with standard lightweight protocols and APIs, such as REST over HTTP.

More information about Red Hat JBoss Enterprise Application Platform 6 can be found at <http://red.ht/1NZrW0A>.

The MSA application used in this reference architecture is an example of *Business-Driven* microservices. The services in the application do not communicate directly with one another. A web application aggregates and coordinates communication between the services. It acts as a perimeter between the application and the clients. By employing this presentation layer, the microservices remain independent from each other. They can be developed, scaled, and maintained independently, without leading to the complex dependency graph inherent to other MSA approaches.

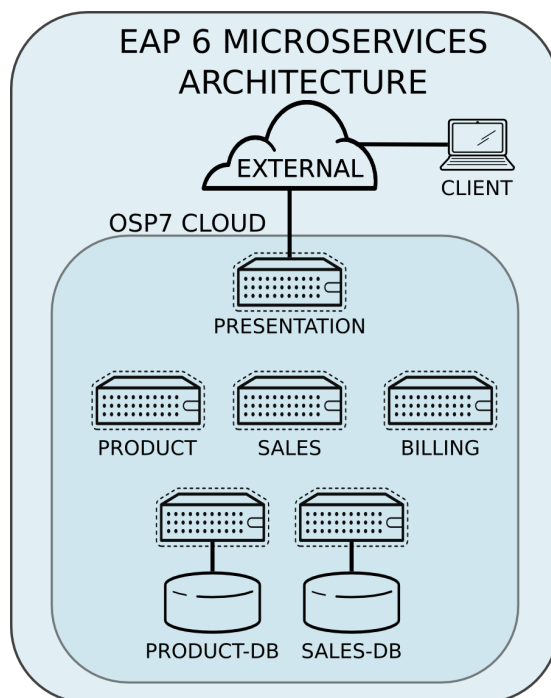


Figure 7.1: EAP6 Microservices Architecture

RHEL-OSP 7 provides a comprehensive platform for implementing, maintaining, and scaling an MSA application. Because microservices are independent, scalable services, they require a scalable platform

to reach their potential. OpenStack provides a robust underlying tool set for automating service implementation, deployment, discovery, and scaling. This reference architecture demonstrates how to deploy and orchestrate an EAP6 MSA application using nested [Heat](#) templates. Directions for future work might include auto-scaling to multiple MSA applications via [Heat](#) and [Ceilometer](#) and load balancing between them via LBaaS.

Figure 7.1 [EAP6 Microservices Architecture](#) depicts the MSA application deployed in this reference architecture.

More information on deploying a Red Hat JBoss Enterprise Application Platform 6.6 MSA application can be found at [Microservice Architecture: Building Microservices with JBOSS EAP 6](#).

Create the test environment

The MSA application does not exist in a vacuum. This section describes the steps for installing the supporting infrastructure around the application including a public [Neutron](#) network and subnet, a demo tenant and user, a Red Hat Enterprise Linux Server 7.1 [Glance](#) image, and a key pair for accessing the MSA application servers via **ssh**.

1. Source **overcloudrc**.

```
$ source overcloudrc
$ env | grep OS_
OS_PASSWORD=009fe566ba853020923a06c67c5c6a05fe7f9877
OS_AUTH_URL=http://10.19.137.121:5000/v2.0/
OS_USERNAME=admin
OS_TENANT_NAME=admin
OS_NO_CACHE=True
OS_CLOUDNAME=overcloud
```

2. Create an external network and subnet. This will be the public network for the MSA application. Export the external network ID.

```
$ neutron net-create ext-net -- --router:external=True --shared=True
```

Created a new network:

Field	Value
admin_state_up	True
id	b1f27b52-6229-41e7-a597-02a070320ab4
mtu	0
name	ext-net
provider:network_type	gre
provider:physical_network	
provider:segmentation_id	1
router:external	True
shared	True
status	ACTIVE
subnets	
tenant_id	346a061a7ef44605bd611efbe5d42b6e

3. Export *ext_net* network ID to pass it as a parameter to **heat stack-create**.

```
$ export ext_net_id=$(neutron net-show ext-net | awk ' / id/ { print $4 } ')
$ echo $ext_net_id
b1f27b52-6229-41e7-a597-02a070320ab4
```

4. Create a subnet on *ext-net*.

```
$ neutron subnet-create --name ext-net --allocation-pool=start=10.19.137.137,end=10.19.137.150
--gateway_ip=10.19.143.254 ext-net 10.19.136.0/21
```

Created a new subnet:

Field	Value
allocation_pools	{"start": "10.19.137.137", "end": "10.19.137.150"}
cidr	10.19.136.0/21
dns_nameservers	
enable_dhcp	True
gateway_ip	10.19.143.254
host_routes	
id	aebba97c-443d-42da-b8ad-ecb94d3ac607
ip_version	4
ipv6_address_mode	
ipv6_ra_mode	
name	ext-net
network_id	b1f27b52-6229-41e7-a597-02a070320ab4
subnetpool_id	
tenant_id	346a061a7ef44605bd611efbe5d42b6e

5. Create a demo user.

```
$ openstack user create --password redhat demo
```

Field	Value
email	None
enabled	True
id	3082d95300e546a3aa3525d81d695d72
name	demo
username	demo

6. Create a demo tenant.

```
$ openstack project create demo-tenant
```

Field	Value
description	None
enabled	True
id	a81f507d72c947739d911779f4403ae9
name	demo-tenant

7. Add the *member* role to the *demo-tenant* user.

```
$ openstack role add --user demo --project demo-tenant member
```

Field	Value
id	9fe2ff9ee4384b1894a90878d3e92bab
name	member

8. Create and source a *keystonerc* file for the demo user.

```
$ cat > ~/demorc << EOF
export OS_USERNAME=demo
export OS_TENANT_NAME=demo-tenant
export OS_PASSWORD=redhat
export OS_CLOUDNAME=overcloud
export OS_AUTH_URL=${OS_AUTH_URL}
export PS1='[\u@\h \W(demo_member)]\$ '
EOF
$ source ~/demorc
```

9. Upload a Red Hat Enterprise Linux Server 7.1 image for the MSA application servers. The image can be obtained by installing the *rhel-guest-image-7* package via 'yum'.


```
$ openstack image create --disk-format qcow2 --container-format bare --file /pub/rhel-guest-image-7.1-20150224.0.x86_64.qcow2 rhel-server7.1
```

Field	Value
checksum	b068d0e9531699516174a436bf2c300c
container_format	bare
created_at	2015-08-30T03:20:25.000000
deleted	False
deleted_at	None
disk_format	qcow2
id	c5bfc6bd-2b3e-4a2b-ac29-985ec45c8092
is_public	False
min_disk	0
min_ram	0
name	rhel-server7.1
owner	a81f507d72c947739d911779f4403ae9
properties	{}
protected	False
size	425956864
status	active
updated_at	2015-08-30T03:20:38.000000
virtual_size	None

10. List the image.

```
$ openstack image list
```

ID	Name
c5bfc6bd-2b3e-4a2b-ac29-985ec45c8092	rhel-server7.1

11. Create a key pair for accessing the MSA application servers via **ssh**.

```
$ openstack keypair create demokp > ~/demokp.pem
```

```
$ chmod 600 ~/demokp.pem
```

```
$ openstack keypair list
```

Name	Fingerprint
demokp	94:55:b1:fa:cd:79:91:07:ad:b9:18:e4:1c:2b:00:22

Deploy the MSA Application via Heat

Heat Orchestration Template (HOT) is the template format natively supported by **Heat**. These templates define resources. They accept user input to promote re-use.

The MSA application used in this reference architecture is defined as a series of nested templates. Each of the four services and two databases are defined in templates called by the master template. The private **Neutron** network, subnet, and router are also defined in a nested template.



The **Heat** templates used in this example are provided via the associated script archive. They are too lengthy to document.

1. Create the *templates/lib* directory.

```
$ mkdir ~/templates/lib
```

2. Extract the nested example templates to *templates/lib*.

```
$ ls templates/
eapws5_nested.yaml lib openstack-tripleo-heat-templates
$ ls templates/lib/
billing-service.yaml      private_network.yaml  product-service.yaml  sales-service.yaml
presentation-service.yaml product-db.yaml        sales-db.yaml
```

3. Deploy the MSA application with **Heat**.

```
$ heat stack-create --template-file templates/eapws5_nested.yaml eap6
--parameters="public_net_id=$ext_net_id"

+-----+
| id                  | stack_name | stack_status      | creation_time          |
+-----+
| 91c16a0e-62a3-485a-a7ae-d999384fabf9 | eap6       | CREATE_IN_PROGRESS | 2015-08-30T03:59:15Z |
+-----+
```

4. Watch progress with **heat resource-list**.

```
$ heat resource-list eap6
...
| billing-service      | ca3dc55e-42a4-4501-a9ff-848856a4982d | file:///home/stack/templates/lib/billing-
service.yaml          | CREATE_IN_PROGRESS | 2015-08-30T03:59:16Z
| presentation-service | 5262f57a-846e-4ff5-8535-b66a049f0743 |
file:///home/stack/templates/lib/presentation-service.yaml | CREATE_IN_PROGRESS | 2015-08-30T03:59:16Z
| private_network     | aa0fda9e-dc55-4ec2-af62-1d184db5b409 |
file:///home/stack/templates/lib/private_network.yaml          | CREATE_COMPLETE     | 2015-08-30T03:59:16Z
| product-db          | 3b5ca63d-22f4-40cc-a691-79eec5a317b5 | file:///home/stack/templates/lib/product-
db.yaml               | CREATE_IN_PROGRESS | 2015-08-30T03:59:16Z
| product-service     | 605abef9-0001-4649-9a39-bfda3654f7a5 | file:///home/stack/templates/lib/product-
service.yaml          | CREATE_IN_PROGRESS | 2015-08-30T03:59:16Z
| sales-db            | cf49eed9-5e47-47db-95fb-e50baad04954 | file:///home/stack/templates/lib/sales-
db.yaml               | CREATE_IN_PROGRESS | 2015-08-30T03:59:16Z
| sales-service       | 14b0a0e0-8322-4548-9dd7-d52a29e7ebfa | file:///home/stack/templates/lib/sales-
service.yaml          | CREATE_IN_PROGRESS | 2015-08-30T03:59:16Z
| security_group      | f429d022-9608-4fd5-87b5-da7584f5b806 | OS::Neutron::SecurityGroup
| CREATE_COMPLETE     | 2015-08-30T03:59:16Z
```

5. View **nova list** after **Heat** creates the stack successfully.

```
$ nova list
...
| a003370e-f8b2-4d76-bdb6-7b6064e155b1 | billing-service      | ACTIVE | -          | Running | demo-
net=172.16.5.14, 10.19.137.145 |
| 839347fc-cce9-4025-8c28-8879eddb9bc6 | presentation-service | ACTIVE | -          | Running | demo-
net=172.16.5.12, 10.19.137.146 |
| e1d5c9a0-634f-4b00-9922-0e3a0bd5ba3e | product-db          | ACTIVE | -          | Running | demo-
net=172.16.5.11, 10.19.137.142 |
| 190388cc-28fb-4956-bcdf-65d5fb0388b4 | product-service     | ACTIVE | -          | Running | demo-
net=172.16.5.13, 10.19.137.144 |
| c95c0fbd-2a49-42c1-9346-6a955754f905 | sales-db            | ACTIVE | -          | Running | demo-
net=172.16.5.10, 10.19.137.143 |
| ab46dd07-3cec-43a8-a2fa-530729541475 | sales-service       | ACTIVE | -          | Running | demo-
net=172.16.5.15, 10.19.137.141 |
```

6. The *cloud-init* service customizes instances post-boot. The *user-data* section of the nested templates includes the commands performed by *cloud-init* for each microservice instance. **ssh** to *presentation-service* to view */var/log/cloud-init.log* to track progress.

```
$ ssh -l cloud-user -i ~/demokp.pem 10.19.137.146
$ sudo -i
# tail /var/log/cloud-init.log
Sep  2 23:55:21 localhost cloud-init: 03:55:21,588 INFO [org.jboss.as.server] (ServerService Thread Pool
-- 39) JBAS015859:
Deployed "presentation.war" (runtime-name : "presentation.war")
Sep  2 23:55:21 localhost cloud-init: 03:55:21,887 INFO [org.jboss.as] (Controller Boot Thread)
JBAS015961: Http management
interface listening on http://172.16.5.12:9990/management
Sep  2 23:55:21 localhost cloud-init: 03:55:21,931 INFO [org.jboss.as] (Controller Boot Thread)
JBAS015951: Admin console
listening on http://172.16.5.12:9990
Sep  2 23:55:21 localhost cloud-init: 03:55:21,936 INFO [org.jboss.as] (Controller Boot Thread)
JBAS015874: JBoss EAP 6.4.0.GA
(AS 7.5.0.Final-redhat-21) started in 201375ms - Started 207 of 245 services (60 services are lazy,
passive or on-demand)
```



At the conclusion of *cloud-init* the Java application **standalone.sh** should be running. The entire stack creation and post-creation configuration can take up to 30 minutes depending on network conditions.

Test EAP server

This section describes a test procedure for the application.

1. Connect to a server via **ssh** and use **curl** verify the services are running.

```
$ ssh -l cloud-user -i ~/demokp.pem 10.19.137.144
$ sudo -i
# curl http://172.16.5.13:8080/product/products/?featured=true
[{"sku":10001,"name":"ABC HD32CS5002 32-inch LED TV","description":"HD
LED Picture Quality<p/>ConnectShare Movie<p/>Wide Color Enhancement<p/>Clear Motion Rate
60","length":29,"width":3,"height":17,"weight":17,"featured":true,"availability":52,"price":249.99,"image
":"TV"}, {"sku":10002,"name":"ABC
HD42CS5002 42-inch LED TV","description":"HD LED Picture Quality<p/>ConnectShare Movie<p/>Wide Color
Enhancement<p/>Clear
Motion Rate
60","length":37,"width":2,"height":22,"weight":20,"featured":true,"availability":64,"price":424.95,"image
":"TV"}
...
```

2. Verify the databases are running and mounted on the persistent storage.

```
$ ssh -l cloud-user -i ~/demokp.pem 10.19.137.142
$ sudo -i
# mysql -e SHOW TABLES product
-----
| Tables_in_product |
-----
| Keyword            |
| PRODUCT_KEYWORD    |
| Product             |
-----
# mount -v | grep mysql
/dev/vdb on /var/lib/mysql type ext4
(rw,relatime,seclabel,data=ordered)
```

3. From a client browser, access *presentation* via the floating IP address to make a test purchase:
<http://10.19.137.142:8080/presentation>

Welcome back, jacob
[Order History](#)
[Log Out](#)

ABC HD32CS5002 32-inch LED TV

	HD LED Picture Quality	Product Dimensions: 29 x 3 x 17 Product Weight: 17	\$249.99 Availability: 51 <input type="button" value="Purchase"/>
	ConnectShare Movie		
	Wide Color Enhancement		
	Clear Motion Rate 60		

Figure 7.2: EAP6 Web Interface



Complete steps are described in Section 4.6 of this reference architecture: [2015 - Microservice Architecture: Building microservices with JBoss EAP 6](#)

Conclusion

Red Hat Enterprise Linux OpenStack Platform 7 is Red Hat's 5th iteration of RHEL-OSP based on the Kilo community OpenStack release. The reference architecture introduces RHEL-OSP director — Red Hat's integrated management tool set — and describes Red Hat's approach to OpenStack HA. It also describes the steps performed by the Red Hat Systems Engineering team to deploy a highly available RHEL-OSP 7 cluster running a modern Red Hat JBoss Enterprise Application Platform 6 microservices application installed and configured via nested **Heat** templates. Every step in the reference architecture was tested with customer-available code on bare metal servers. It complements existing documentation by providing a comprehensive example of using RHEL-OSP director in a realistic environment with its own hardware and network constraints.

The use case provides:

1. undercloud installation steps including post-installation configuration of the database and **Neutron** quotas.
2. overcloud installation steps including post-installation configuration of the **Pacemaker** resource constraints and fence devices.
3. A fully worked example of Ceph OSD and journal customization via **Puppet** hiera data accompanied by post-installation configuration steps for increasing placement group settings for improved performance.
4. A fully worked example of network isolation configuration that describes a sensible method for collapsing multiple networks onto four physical interfaces using both tagged and native VLANs.
5. A detailed description of Red Hat's approach to highly available OpenStack including service placement and protection as implemented by RHEL-OSP director.
6. A fully worked example of deploying a multi-tiered Red Hat JBoss Enterprise Application Platform 6 application using nested **Heat** templates.

EAP microservices applications can be delivered via Red Hat OpenShift Enterprise using containers or another PaaS model. However, the use case is still valid from a DevOps perspective for staging and developing the application, and also for customers who are reluctant to move to PaaS because they already have a substantial investment in existing IaaS infrastructure. Also, although it is not covered in this reference architecture, OpenStack can put additional muscle behind an EAP 6 microservices application when it is coupled with **Heat** and **Ceilometer** auto-scaling functionality. Auto-scaling the EAP 6 application behind a **Neutron** LBaaS has potential as an interesting direction for future work.

Appendix A: Contributors

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2. Babak Mozaffari - technical content review (JBoss EAP)
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4. Keith Schincke - technical content review (Ceph)
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6. Steven Reichard — content review, technical content review (RHEL-OSP)
7. Scott Lewis — content review, messaging
8. Vinny Valdez — content review, technical content review (RHEL-OSP)

Appendix B: References

Ceph References

1. [Ceph Placement Groups](#)
2. [Benchmark Ceph Cluster Performance](#)
3. [2015 - RHEL OSP 5: Cinder Volume Performance on Inktank Ceph Enterprise 1.2.2](#)
4. [Red Hat Ceph Architecture Guide](#)
5. [2015 - Deploying Highly Available Red Hat Enterprise Linux OpenStack Platform 6 with Ceph Storage](#)

eDeploy and AHC References

1. [eDeploy User's Guide](#)
2. [Automatic Health Check \(AHC\) - User Guide](#)

Heat References

1. [Heat Orchestration Template \(HOT\) specification](#)
2. [Debugging TripleO Heat templates](#)

JBoss EAP References

1. [How can I execute the JBoss EAP 6 using Systemctl?](#)
2. [2015 - Microservice Architecture: Building microservices with JBoss EAP 6](#)

Red Hat OpenStack Platform References

1. [2015 - Guidelines and Considerations for Performance and Scaling your Red Hat Openstack 6 Cloud](#)
2. [Performance Tuning for RabbitMQ in Red Hat Enterprise Linux OpenStack Platform](#)
3. [Performance tuning the backend database for Red Hat Enterprise Linux OpenStack Platform](#)
4. [Red Hat Enterprise Linux 6 Virtualization Tuning and Optimization Guide](#)
5. [OpenStack Performance Optimization](#)
6. [Red Hat Enterprise Linux OpenStack Platform 7 Director Installation and Usage](#)
7. [Certified Guest Operating Systems in Red Hat Enterprise Linux OpenStack Platform and Red Hat Enterprise Virtualization Deployment Limits for Red Hat OpenStack Platform](#)
8. [The Red Hat Satellite 6.0 Provisioning Guide](#)

Appendix C: Hardware specifications

Table 6. Hardware specifications

Count	Model	Description
8	Dell PowerEdge M520	2x Intel Xeon CPU E5-2450 0 @ 2.10GHz, Broadcom 5720 1Gb Dual Port LOMs, Broadcom 57810S-k Dual Port 10Gb NIC, 6x DDR3 8192 MB @1333 MHZ DIMMs, 2 x 146GB SAS internal disk drives
4	Dell PowerEdge R510	2x Intel® Xeon® CPU X5650 @ 2.67 GHz (6 core), 2 x Broadcom NetXtreme II BCM5709S Gb Ethernet, 2x Emulex Corporation OneConnect 10Gb NIC, 6 x DDR3 8192 MB @1333 MHZ DIMMs, 12x 146GB SAS internal disk drives
1	Dell PowerEdge R720xd	2x Intel® Xeon® CPU X5650 @ 2.67 GHz (6 core), 2 x Broadcom NetXtreme II BCM5709S Gb Ethernet, 2x Emulex Corporation OneConnect 10Gb NIC, 6 x DDR3 8192 MB @1333 MHZ DIMMs, 12x 146GB SAS internal disk drives

Appendix D: Required channels

Red Hat Enterprise Linux OpenStack Platform 7 is available via the Red Hat Content Delivery Network or Red Hat Satellite Server.

Table 7. Required channels

Name	Description
rhel-7-server-extras-rpms	Red Hat Enterprise Linux 7 Server - Extras
rhel-7-server-openstack-7.0-director-rpms	Red Hat OpenStack 7.0 director for RHEL 7 (RPMs)
rhel-7-server-openstack-7.0-rpms	Red Hat OpenStack 7.0 for RHEL 7 (RPMs)
rhel-7-server-optional-rpms	Red Hat Enterprise Linux 7 Server - Optional (RPMs)
rhel-7-server-rpms	Red Hat Enterprise Linux 7 Server (RPMs)



This reference architecture uses a local satellite server for deployments and updates.

Appendix E: Deploying undercloud with SSL

This appendix describes steps for deploying the undercloud with SSL support.



The [product documentation](#) includes additional information for installing the undercloud with SSL support.

1. Generate a private key file.

```
$ openssl genrsa -out privkey.pem 2048
Generating RSA private key, 2048 bit long modulus
.....+
.....+
e is 65537 (0x10001)
```

2. Create the distinguished identifier for the certificate.



Replace this example with appropriate environment-specific answers.

```
$ openssl req -new -x509 -key privkey.pem -out cacert.pem -days 365
You are about to be asked to enter information that will be
incorporated
into your certificate request.
What you are about to enter is what is called a Distinguished Name or
a DN.
There are quite a few fields but you can leave some blank
For some fields there will be a default value,
If you enter ., the field will be left blank.
\-----
Country Name (2 letter code) [XX]:*US*
State or Province Name (full name) []:*Texas*
Locality Name (eg, city) [Default City]:*Austin*
Organization Name (eg, company) [Default Company Ltd]:*Red Hat*
Organizational Unit Name (eg, section) []:*Systems Engineering*
Common Name (eg, your name or your server's hostname) []:*192.0.2.2*
Email Address []:*jliberma@redhat.com*
```

3. Write the certificate and key to *undercloud.pem*.

```
$ cat cacert.pem privkey.pem > undercloud.pem
```

4. Copy the combined SSL key to */etc/pki/instal-cert/*.

```
$ sudo mkdir /etc/pki/instack-certs
$ sudo cp ~/undercloud.pem /etc/pki/instack-certs/.
```

5. Set the SELinux context on the key certificate directory and files.

```
$ sudo semanage fcontext -a -t etc_t "/etc/pki/instack-certs(/.\*)?"
```

6. Run **restorecon** to enforce the new SELinux contexts.

```
$ sudo restorecon -R /etc/pki/instack-certs
```

7. Modify the `undercloud.conf` from the previous example to include:

- a. An undercloud public VIP
- b. An undercloud private VIP
- c. The location for the undercloud service certificate.

```
$ head undercloud.conf
[DEFAULT]

image_path = .
local_ip = 192.0.2.1/24
undercloud_public_vip = 192.0.2.2
undercloud_admin_vip = 192.0.2.3
undercloud_service_certificate = /etc/pki/instack-certs/undercloud.pem
local_interface = eno4
masquerade_network = 192.0.2.0/24
dhcp_start = 192.0.2.5
```

8. Install the undercloud with SSL support.

```
$ openstack undercloud install
```

```
...
```

```
#####
```

```
instack-install-undercloud complete.
```

The file containing this installation's passwords is at
/home/stack/undercloud-passwords.conf.

There is also a stackrc file at /home/stack/stackrc.

These files are needed to interact with the OpenStack services, and
should be
secured.

```
#####
```

9. Source *stackrc* and verify the OpenStack services have separate internal and public endpoint URLs.

```
$ source ~stackrc
```

```
$ openstack endpoint show glance
```

-----+	
Field	Value
-----+	
adminurl	http://192.0.2.1:9292/
enabled	True
id	6f715600451f433f98e38b72a5b70606
internalurl	http://192.0.2.1:9292/
publicurl	https://192.0.2.2:13292/
region	regionOne
service_id	8553ca00fa2c4aa98b1d60aa53df3f89
service_name	glance
service_type	image
-----+	

Appendix F: Undercloud Service List

neutron-dhcp-agent
neutron-openvswitch-agent
neutron-server
openstack-ceilometer-alarm-evaluator
openstack-ceilometer-alarm-notifier
openstack-ceilometer-api
openstack-ceilometer-central
openstack-ceilometer-collector
openstack-ceilometer-notification
openstack-glance-api
openstack-glance-registry
openstack-heat-api-cfn
openstack-heat-api-cloudwatch
openstack-heat-api
openstack-heat-engine
openstack-ironic-api
openstack-ironic-conductor
openstack-ironic-discoverd-dnsmasq
openstack-ironic-discoverd
openstack-keystone
openstack-nova-api
openstack-nova-compute
openstack-nova-conductor
openstack-nova-consoleauth
openstack-nova-scheduler
openstack-swift-account-auditor
openstack-swift-account-reaper
openstack-swift-account-replicator
openstack-swift-account
openstack-swift-container-auditor
openstack-swift-container-replicator
openstack-swift-container-updater
openstack-swift-container
openstack-swift-object-auditor
openstack-swift-object-replicator
openstack-swift-object-updater
openstack-swift-object
openstack-swift-proxy
openstack-tuskar-api

Appendix G: Overcloud Service List

Cluster name: tripleo_cluster

Last updated: Tue Sep 8 12:41:33 2015

Last change: Tue Sep 8 11:47:03 2015

Stack: corosync

Current DC: overcloud-controller-2 (3) - partition with quorum

Version: 1.1.12-a14efad

3 Nodes configured

112 Resources configured

Online: [overcloud-controller-0 overcloud-controller-1 overcloud-controller-2]

Full list of resources:

```
ip-192.0.2.6 (ocf::heartbeat:IPAddr2):      Started overcloud-controller-0
Clone Set: haproxy-clone [haproxy]
  Started: [ overcloud-controller-0 overcloud-controller-1 overcloud-controller-2 ]
ip-172.16.1.11 (ocf::heartbeat:IPAddr2):      Started overcloud-controller-1
ip-10.19.137.121 (ocf::heartbeat:IPAddr2):      Started overcloud-controller-2
ip-172.16.2.10 (ocf::heartbeat:IPAddr2):      Started overcloud-controller-0
ip-172.16.1.10 (ocf::heartbeat:IPAddr2):      Started overcloud-controller-1
Master/Slave Set: galera-master [galera]
  Masters: [ overcloud-controller-0 overcloud-controller-1 overcloud-controller-2 ]
ip-172.16.3.10 (ocf::heartbeat:IPAddr2):      Started overcloud-controller-2
Master/Slave Set: redis-master [redis]
  Masters: [ overcloud-controller-2 ]
  Slaves: [ overcloud-controller-0 overcloud-controller-1 ]
Clone Set: mongod-clone [mongod]
  Started: [ overcloud-controller-0 overcloud-controller-1 overcloud-controller-2 ]
Clone Set: rabbitmq-clone [rabbitmq]
  Started: [ overcloud-controller-0 overcloud-controller-1 overcloud-controller-2 ]
Clone Set: memcached-clone [memcached]
  Started: [ overcloud-controller-0 overcloud-controller-1 overcloud-controller-2 ]
Clone Set: openstack-nova-scheduler-clone [openstack-nova-scheduler]
  Started: [ overcloud-controller-0 overcloud-controller-1 overcloud-controller-2 ]
Clone Set: neutron-l3-agent-clone [neutron-l3-agent]
  Started: [ overcloud-controller-0 overcloud-controller-1 overcloud-controller-2 ]
Clone Set: openstack-ceilometer-alarm-notifier-clone [openstack-ceilometer-alarm-notifier]
  Started: [ overcloud-controller-0 overcloud-controller-1 overcloud-controller-2 ]
Clone Set: openstack-heat-engine-clone [openstack-heat-engine]
  Started: [ overcloud-controller-0 overcloud-controller-1 overcloud-controller-2 ]
Clone Set: openstack-ceilometer-api-clone [openstack-ceilometer-api]
  Started: [ overcloud-controller-0 overcloud-controller-1 overcloud-controller-2 ]
Clone Set: neutron-metadata-agent-clone [neutron-metadata-agent]
  Started: [ overcloud-controller-0 overcloud-controller-1 overcloud-controller-2 ]
Clone Set: neutron-ovs-cleanup-clone [neutron-ovs-cleanup]
  Started: [ overcloud-controller-0 overcloud-controller-1 overcloud-controller-2 ]
Clone Set: neutron-netns-cleanup-clone [neutron-netns-cleanup]
  Started: [ overcloud-controller-0 overcloud-controller-1 overcloud-controller-2 ]
Clone Set: openstack-heat-api-clone [openstack-heat-api]
```

```

Started: [ overcloud-controller-0 overcloud-controller-1 overcloud-controller-2 ]
Clone Set: openstack-cinder-scheduler-clone [openstack-cinder-scheduler]
Started: [ overcloud-controller-0 overcloud-controller-1 overcloud-controller-2 ]
Clone Set: openstack-nova-api-clone [openstack-nova-api]
Started: [ overcloud-controller-0 overcloud-controller-1 overcloud-controller-2 ]
Clone Set: openstack-heat-api-cloudwatch-clone [openstack-heat-api-cloudwatch]
Started: [ overcloud-controller-0 overcloud-controller-1 overcloud-controller-2 ]
Clone Set: openstack-ceilometer-collector-clone [openstack-ceilometer-collector]
Started: [ overcloud-controller-0 overcloud-controller-1 overcloud-controller-2 ]
Clone Set: openstack-keystone-clone [openstack-keystone]
Started: [ overcloud-controller-0 overcloud-controller-1 overcloud-controller-2 ]
Clone Set: openstack-nova-consoleauth-clone [openstack-nova-consoleauth]
Started: [ overcloud-controller-0 overcloud-controller-1 overcloud-controller-2 ]
Clone Set: openstack-glance-registry-clone [openstack-glance-registry]
Started: [ overcloud-controller-0 overcloud-controller-1 overcloud-controller-2 ]
Clone Set: openstack-ceilometer-notification-clone [openstack-ceilometer-notification]
Started: [ overcloud-controller-0 overcloud-controller-1 overcloud-controller-2 ]
Clone Set: openstack-cinder-api-clone [openstack-cinder-api]
Started: [ overcloud-controller-0 overcloud-controller-1 overcloud-controller-2 ]
Clone Set: neutron-dhcp-agent-clone [neutron-dhcp-agent]
Started: [ overcloud-controller-0 overcloud-controller-1 overcloud-controller-2 ]
Clone Set: openstack-glance-api-clone [openstack-glance-api]
Started: [ overcloud-controller-0 overcloud-controller-1 overcloud-controller-2 ]
Clone Set: neutron-openvswitch-agent-clone [neutron-openvswitch-agent]
Started: [ overcloud-controller-0 overcloud-controller-1 overcloud-controller-2 ]
Clone Set: openstack-nova-novncproxy-clone [openstack-nova-novncproxy]
Started: [ overcloud-controller-0 overcloud-controller-1 overcloud-controller-2 ]
Clone Set: delay-clone [delay]
Started: [ overcloud-controller-0 overcloud-controller-1 overcloud-controller-2 ]
Clone Set: neutron-server-clone [neutron-server]
Started: [ overcloud-controller-0 overcloud-controller-1 overcloud-controller-2 ]
Clone Set: httpd-clone [httpd]
Started: [ overcloud-controller-0 overcloud-controller-1 overcloud-controller-2 ]
Clone Set: openstack-ceilometer-central-clone [openstack-ceilometer-central]
Started: [ overcloud-controller-0 overcloud-controller-1 overcloud-controller-2 ]
Clone Set: openstack-ceilometer-alarm-evaluator-clone [openstack-ceilometer-alarm-evaluator]
Started: [ overcloud-controller-0 overcloud-controller-1 overcloud-controller-2 ]
Clone Set: openstack-heat-api-cfn-clone [openstack-heat-api-cfn]
Started: [ overcloud-controller-0 overcloud-controller-1 overcloud-controller-2 ]
openstack-cinder-volume      (systemd:openstack-cinder-volume):      Started overcloud-controller-2
Clone Set: openstack-nova-conductor-clone [openstack-nova-conductor]
Started: [ overcloud-controller-0 overcloud-controller-1 overcloud-controller-2 ]

```

PCSD Status:

```

overcloud-controller-0: Online
overcloud-controller-1: Online
overcloud-controller-2: Online

```

Daemon Status:

```

corosync: active/enabled
pacemaker: active/enabled
pcsdd: active/enabled

```


Appendix H: Example fencing Script

This script was used by the Red Hat Systems Engineering team to configure and test **Pacemaker** fencing. The script is not tested nor suitable for production use. It is included as a reference for manually configuring fencing or as an example for scripted configuration.

```
#!/bin/bash

source ~/stackrc
env | grep OS_
SSH_CMD="ssh -l heat-admin"

function usage {
    echo "USAGE: $0 [enable|test]"
    exit 1
}

function enable_stonith {
    # for all controller nodes
    for i in $(nova list | awk ' /controller/ { print $12 } ' | cut -f2 -d=)
    do
        echo $i
        # create the fence device
        $SSH_CMD $i 'sudo pcs stonith create $(hostname -s)-ipmi fence_ipmilan
pcmk_host_list=$(hostname -s) ipaddr=$(sudo ipmitool lan print 1 | awk " /IP Address / { print \$4 } ")
login=root passwd=PASSWORD lanplus=1 cipher=1 op monitor interval=60sr'
        # avoid fencing yourself
        $SSH_CMD $i 'sudo pcs constraint location $(hostname -s)-ipmi avoids $(hostname -s)'
    done

    # enable STONITH devices from any controller
    $SSH_CMD $i 'sudo pcs property set stonith-enabled=true'
    $SSH_CMD $i 'sudo pcs property show'
}

function test_fence {

    for i in $(nova list | awk ' /controller/ { print $12 } ' | cut -f2 -d= | head -n 1)
    do
        # get REDIS_IP
        REDIS_IP=$(($SSH_CMD $i 'sudo grep -ri redis_vip /etc/puppet/hieradata/' | awk
'/vip_data.yaml/ { print $2 } '))
        done
        # for all controller nodes
        for i in $(nova list | awk ' /controller/ { print $12 } ' | cut -f2 -d=)
        do
            if $SSH_CMD $i "sudo ip a" | grep -q $REDIS_IP
            then
                FENCE_DEVICE=$(($SSH_CMD $i 'sudo pcs stonith show $(hostname -s)-ipmi' | awk '
/Attributes/ { print $2 } ' | cut -f2 -d=)
                IUUID=$(nova list | awk " /$i/ { print \$2 } ")
                UUID=$(ironic node-list | awk " /$IUUID/ { print \$2 } ")
            else
```

```

        FENCER=$i
    fi
done 2>/dev/null

echo "REDIS_IP $REDIS_IP"
echo "FENCER $FENCER"
echo "FENCE_DEVICE $FENCE_DEVICE"
echo "UUID $UUID"
echo "IUUUID $IUUUID"

# stonith REDIS_IP owner
$SSH_CMD $FENCER sudo pcs stonith fence $FENCE_DEVICE

sleep 30

# fence REDIS_IP owner to keep ironic from powering it on
sudo ironic node-set-power-state $UUID off

sleep 60

# check REDIS_IP failover
$SSH_CMD $FENCER sudo pcs status | grep $REDIS_IP
}

if [ "$1" == "test" ]
then
    test_fence
elif [ "$1" == "enable" ]
then
    enable_stonith
else
    usage
fi

```

Appendix I: NIC Configuration Files

This appendix includes the full text of the network isolation environment files used in this use case.



The *swift-storage.yaml* and *cinder-storage.yaml* are not shown because they were not used.

network-environment.yaml

```
resource_registry:
  OS::Triple0::BlockStorage::Net::SoftwareConfig: /home/stack/nic-configs/cinder-storage.yaml
  OS::Triple0::Compute::Net::SoftwareConfig: /home/stack/nic-configs/compute.yaml
  OS::Triple0::Controller::Net::SoftwareConfig: /home/stack/nic-configs/controller.yaml
  OS::Triple0::ObjectStorage::Net::SoftwareConfig: /home/stack/nic-configs/swift-storage.yaml
  OS::Triple0::CephStorage::Net::SoftwareConfig: /home/stack/nic-configs/ceph-storage.yaml

parameter_defaults:
  NeutronExternalNetworkBridge: "br-ex"
  InternalApiNetCidr: 172.16.1.0/24
  StorageNetCidr: 172.16.2.0/24
  StorageMgmtNetCidr: 172.16.3.0/24
  TenantNetCidr: 172.16.4.0/24
  ExternalNetCidr: 10.19.136.0/21
  InternalApiAllocationPools: [{'start': '172.16.1.10', 'end': '172.16.1.100'}]
  StorageAllocationPools: [{'start': '172.16.2.10', 'end': '172.16.2.200'}]
  StorageMgmtAllocationPools: [{'start': '172.16.3.10', 'end': '172.16.3.200'}]
  TenantAllocationPools: [{'start': '172.16.4.10', 'end': '172.16.4.200'}]
  ExternalAllocationPools: [{'start': '10.19.137.121', 'end': '10.19.137.151'}]
  InternalApiNetworkVlanID: 4041
  StorageNetworkVlanID: 4042
  StorageMgmtNetworkVlanID: 4043
  TenantNetworkVlanID: 4044
  ExternalNetworkVlanID: 168
  ExternalInterfaceDefaultRoute: "10.19.143.254"
  BondInterfaceOvsOptions:
    "bond_mode=balance-tcp lacp=active other-config:lacp-fallback-ab=true"
```

controller.yaml

```
heat_template_version: 2015-04-30

description: >
  Software Config to drive os-net-config to configure VLANs for the
  controller role.
```

```
parameters:
  ExternalIpSubnet:
    default: ''
    description: IP address/subnet on the external network
    type: string
  InternalApiIpSubnet:
    default: ''
    description: IP address/subnet on the internal API network
    type: string
  StorageIpSubnet:
    default: ''
    description: IP address/subnet on the storage network
    type: string
  StorageMgmtIpSubnet:
    default: ''
    description: IP address/subnet on the storage mgmt network
    type: string
  TenantIpSubnet:
    default: ''
    description: IP address/subnet on the tenant network
    type: string
  ExternalNetworkVlanID:
    default: 168
    description: Vlan ID for the external network traffic.
    type: number
  InternalApiNetworkVlanID:
    default: 4041
    description: Vlan ID for the internal_api network traffic.
    type: number
  StorageNetworkVlanID:
    default: 4042
    description: Vlan ID for the storage network traffic.
    type: number
  StorageMgmtNetworkVlanID:
    default: 4043
    description: Vlan ID for the storage mgmt network traffic.
    type: number
  TenantNetworkVlanID:
    default: 4044
    description: Vlan ID for the tenant network traffic.
    type: number
  ExternalInterfaceDefaultRoute:
    default: '10.19.143.254'
    description: Default route for the external network.
    type: string
```

```
resources:
```

```

OsNetConfigImpl:
  type: OS::Heat::StructuredConfig
  properties:
    group: os-apply-config
    config:
      os_net_config:
        network_config:
          -
            type: ovs_bridge
            name: br-ex
            use_dhcp: false
            addresses:
              -
                ip_netmask: {get_param: ExternalIpSubnet}
            routes:
              -
                ip_netmask: 0.0.0.0/0
                next_hop: {get_param: ExternalInterfaceDefaultRoute}
            members:
              -
                type: interface
                name: nic1
                primary: true
          -
            type: ovs_bridge
            name: br-nic3
            use_dhcp: false
            addresses:
              -
                ip_netmask: {get_param: TenantIpSubnet}
            members:
              -
                type: interface
                name: nic3
                primary: true
              -
                type: vlan
                vlan_id: {get_param: StorageMgmtNetworkVlanID}
                addresses:
                  -
                    ip_netmask: {get_param: StorageMgmtIpSubnet}
          -
            type: ovs_bridge
            name: br-nic4
            use_dhcp: false
            addresses:
              -
                ip_netmask: {get_param: StorageIpSubnet}

```

```

members:
  -
    type: interface
    name: nic4
    primary: true
  -
    type: vlan
    vlan_id: {get_param: InternalApiNetworkVlanID}
    addresses:
      -
        ip_netmask: {get_param: InternalApiIpSubnet}

```

```

outputs:
  OS::stack_id:
    description: The OsNetConfigImpl resource.
    value: {get_resource: OsNetConfigImpl}

```

compute.yaml

```
heat_template_version: 2015-04-30
```

```

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

```

```

parameters:
  ExternalIpSubnet:
    default: ''
    description: IP address/subnet on the external network
    type: string
  InternalApiIpSubnet:
    default: ''
    description: IP address/subnet on the internal API network
    type: string
  StorageIpSubnet:
    default: ''
    description: IP address/subnet on the storage network
    type: string
  StorageMgmtIpSubnet:
    default: ''
    description: IP address/subnet on the storage mgmt network
    type: string
  TenantIpSubnet:
    default: ''
    description: IP address/subnet on the tenant network
    type: string

```

```
InternalApiNetworkVlanID:
  default: 4041
  description: Vlan ID for the internal_api network traffic.
  type: number
StorageNetworkVlanID:
  default: 4042
  description: Vlan ID for the storage network traffic.
  type: number
TenantNetworkVlanID:
  default: 4044
  description: Vlan ID for the tenant network traffic.
  type: number
```

```
resources:
```

```
OsNetConfigImpl:
  type: OS::Heat::StructuredConfig
  properties:
    group: os-apply-config
    config:
      os_net_config:
        network_config:
          -
            type: interface
            name: nic1
            use_dhcp: false
          -
            type: ovs_bridge
            name: br-nic3
            use_dhcp: false
            addresses:
              -
                ip_netmask: {get_param: TenantIpSubnet}
            members:
              -
                type: interface
                name: nic3
                primary: true
          -
            type: ovs_bridge
            name: br-nic4
            use_dhcp: false
            addresses:
              -
                ip_netmask: {get_param: StorageIpSubnet}
            members:
              -
                type: interface
                name: nic4
```

```

        primary: true
    -
      type: vlan
      vlan_id: {get_param: InternalApiNetworkVlanID}
      addresses:
    -
      ip_netmask: {get_param: InternalApiIpSubnet}

```

outputs:

```

OS::stack_id:
  description: The OsNetConfigImpl resource.
  value: {get_resource: OsNetConfigImpl}

```

ceph.-storage.yaml

heat_template_version: 2015-04-30

description: >

Software Config to drive os-net-config with 2 bonded nics on a bridge with a VLANs attached for the compute role.

parameters:

```

ExternalIpSubnet:
  default: ''
  description: IP address/subnet on the external network
  type: string
InternalApiIpSubnet:
  default: ''
  description: IP address/subnet on the internal API network
  type: string
StorageIpSubnet:
  default: ''
  description: IP address/subnet on the storage network
  type: string
StorageMgmtIpSubnet:
  default: ''
  description: IP address/subnet on the storage mgmt network
  type: string
TenantIpSubnet:
  default: ''
  description: IP address/subnet on the tenant network
  type: string
StorageNetworkVlanID:
  default: 4042
  description: Vlan ID for the storage network traffic.
  type: number

```



```
StorageMgmtNetworkVlanID:
  default: 4043
  description: Vlan ID for the storage network traffic.
  type: number

resources:
  OsNetConfigImpl:
    type: OS::Heat::StructuredConfig
    properties:
      group: os-apply-config
      config:
        os_net_config:
          network_config:
            -
              type: interface
              name: nic1
              use_dhcp: false
            -
              type: ovs_bridge
              name: br-nic3
              use_dhcp: false
              addresses:
                -
                  ip_netmask: {get_param: StorageMgmtIpSubnet}
            members:
              -
                type: interface
                name: nic3
                primary: true
            -
              type: ovs_bridge
              name: br-nic4
              use_dhcp: false
              addresses:
                -
                  ip_netmask: {get_param: StorageIpSubnet}
            members:
              -
                type: interface
                name: nic4
                primary: true

outputs:
  OS::stack_id:
    description: The OsNetConfigImpl resource.
    value: {get_resource: OsNetConfigImpl}
```