

# **Dell EMC Red Hat OpenStack NFV Solution**

**Architecture Guide  
Version 6.0**



**Dell EMC Validated Solutions**

# Contents

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List of Figures.....	4
List of Tables.....	5
Trademarks.....	6
Glossary.....	7
Notes, Cautions, and Warnings.....	10
 Chapter 1: Overview.....	 11
OpenStack Maturity.....	12
Hardware Options.....	12
Networking and Network Services.....	12
Taxonomy.....	13
Red Hat OpenStack Platform 9.....	15
Key Benefits.....	15
 Chapter 2: OpenStack Architecture.....	 16
OpenStack Components.....	17
 Chapter 3: Server Options.....	 19
PowerEdge R630 Server.....	20
PowerEdge R730xd Servers.....	20
Base Hardware Configurations.....	20
Configuration Notes.....	22
Optional Servers.....	22
PowerEdge R430.....	22
PowerEdge R730.....	23
 Chapter 4: Storage Options.....	 24
Storage Options Overview.....	25
Local Storage.....	25
Red Hat Ceph Storage.....	26
Optional Dell Storage.....	26
Dell Storage Arrays.....	26
 Chapter 5: Network Architecture.....	 28
Network Architecture Overview.....	29
Infrastructure Layouts.....	29
Network Components.....	29
Server Nodes.....	29
Access Switch or Top of Rack (ToR).....	30

Aggregation Switches.....	30
Core.....	31
Layer-2 and Layer-3 Switching.....	31
VLANs.....	31
Out of Band Management Network.....	31
Dell EMC OpenSwitch Solution.....	32
 Chapter 6: Operational Notes.....	 33
Backup/Recovery.....	34
Service Layout.....	34
Deployment.....	35
 Chapter 7: Solution Bundle.....	 37
Solution Bundle Overview.....	38
Solution Bundle Rack Layout.....	38
Solution Bundle Network Configuration.....	40
Solution Admin Host (SAH) Networking.....	42
Virtual Infrastructure Manager (VIM) Node Networking.....	43
Optional Solution Configurations.....	44
 Appendix A: Update History.....	 46
Initial Release.....	47
Version 1.....	47
Version 2.....	47
Version 3.....	47
Version 4.....	48
Version 5.....	48
 Appendix B: References.....	 49
To Learn More.....	50

## List of Figures

---

Figure 1: Dell EMC Red Hat OpenStack NFV Solution Base Taxonomy.....	14
Figure 2: PowerEdge R730xd Servers - 2.5" and 3.5" Chassis Options.....	20
Figure 3: Solution Bundle and Red Hat Ceph Storage Cluster.....	39
Figure 4: Cluster Network Logical Architecture with Optional Dell Storage PS Series....	40
Figure 5: Solution Admin Host Internal Network Fabric.....	43
Figure 6: Virtual Infrastructure Manager (VIM) Node Internal Network Fabric.....	44

## List of Tables

---

Table 1: Deployed Core Services.....	13
Table 2: Deployed Non-Core Services.....	13
Table 3: Optional Services.....	13
Table 4: OpenStack Core Components.....	17
Table 5: Non-Core Deployed Components.....	18
Table 6: Controller Node Hardware Configurations – PowerEdge R630.....	20
Table 7: Compute Node Hardware Configurations – PowerEdge R630.....	21
Table 8: Solution Admin Host Hardware Configurations – PowerEdge R630.....	21
Table 9: Storage Node Hardware Configurations – PowerEdge R730xd.....	21
Table 10: ToR Switches.....	29
Table 11: Channel Bonding Modes Supported.....	30
Table 12: Overcloud: Node Type to Services.....	34
Table 13: OpenStack Node Type to Network 802.1q Tagging.....	41
Table 14: Storage Node Type to Network 8.2.1q Tagging.....	41

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# Glossary

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## BMC/IDRAC Enterprise

Baseboard management controller. An on-board microcontroller that monitors the system for critical events by communicating with various sensors on the system board and sends alerts and log events when certain parameters exceed their preset thresholds.

## Bundle

A customer-orderable solution that consists of:

- All server, network, and storage hardware needed to install and operate the solution as outlined
- All necessary solution software licenses needed to install and operate the solution as outlined

## Cloud Computing

See <http://nvlpubs.nist.gov/nistpubs/Legacy/SP/nistspecialpublication800-145.pdf>

Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.

## Cluster

A set of servers dedicated to OpenStack that can be attached to multiple distribution switches.

## Compute Node

The hardware configuration that best supports the hypervisor server or Nova compute roles.

## DevOps

Development Operations (DevOps) is an operational model for managing data centers using improved automated deployments, shortened lead times between fixes, and faster mean time to recovery. See <https://en.wikipedia.org/wiki/DevOps>.

## Hypervisor

Software that runs virtual machines (VMs).

## IaaS

Infrastructure as a Service.

## ISV

Independent Software Vendor.

## LAG

Link Aggregation Group.

## LAN

Local Area Network.

## LOM

LAN on motherboard.

## Node

One of the servers in the cluster.

## OSP

OpenStack Platform

## OSPD

OpenStack Platform Director

## Overcloud

The functional cloud that is available to run guest VMs and workloads.

## Pod

An installation comprised of three racks, consists of servers, storage, and networking.

## SAH

The Solution Admin Host (SAH) is a physical server that supports VMs for the Undercloud machines needed for the cluster to be deployed and operated.

## SDS

Software-defined storage (SDS) is an approach to computer data storage in which software is used to manage policy-based provisioning and management of data storage, independent of the underlying hardware.

## Storage Node

The hardware configuration that best supports SDS functions such as Red Hat Ceph Storage.

## ToR

Top-of-rack switch/router.

## Undercloud

The Undercloud is the system used to control, deploy, and monitor the Overcloud. The Undercloud is *not* HA configured.

## VLT

A Virtual Link Trunk (VLT) is the combined port channel between an attached device (ToR switch) and the VLT peer switches.

## VLTi




A Virtual Link Trunk Interconnect (VLTi) is an interconnect used to synchronize states between the VLT peer switches. Both endpoints must be on 10G or 40G interfaces; 1G interfaces are not supported.

## VIM

Virtual Infrastructure Manager. A stand-alone machine that manages and monitors the health of both physical and virtual infrastructures by communicating with out-of-band management controllers and various agents on the nodes in the cloud.

## Notes, Cautions, and Warnings

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-  A **Note** indicates important information that helps you make better use of your system.
-  A **Caution** indicates potential damage to hardware or loss of data if instructions are not followed.
-  A **Warning** indicates a potential for property damage, personal injury, or death.

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# Chapter 1

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## Overview

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### Topics:

- [\*OpenStack Maturity\*](#)
- [\*Hardware Options\*](#)
- [\*Networking and Network Services\*](#)
- [\*Taxonomy\*](#)
- [\*Red Hat OpenStack Platform 9\*](#)

This Reference Architecture focuses on helping organizations to design an OpenStack® NFV Solution.

This jointly-engineered and validated architecture details the Dell Red Hat® OpenStack NFV Solution and encompasses software, hardware, and integration of the solution components. The architecture provides prescriptive guidance and recommendations for:

- Compute, Infrastructure, and Storage nodes
- Networking design
- Software layout
- Various system configurations

## OpenStack Maturity

The code base for Red Hat OpenStack Platform is evolving at a very rapid pace. Please see <https://access.redhat.com/site/support/policy/updates/OpenStack/platform> for more information.

This Reference Architecture is based on OpenStack release codename *Mitaka*. It builds upon the previous 11 releases with a focus on the Core Services with optional capabilities. Mitaka is developed by over 1933 individuals employed by more than 285 organizations. Please see <http://www.OpenStack.org/software/liberty>.

Dell EMC and Red Hat designed this Reference Architecture to make it easy for Dell EMC Red Hat OpenStack NFV Solution customers to build their own operational readiness cluster and design their initial offerings, using the current releases. Dell EMC and Red Hat provide the support and services customers need to stand up production-ready OpenStack clusters.

## Hardware Options

To reduce time spent on hardware specification for an initial system this Reference Architecture offers specific choices for servers, storage, and networking.

To reduce time spent on specifying hardware for an initial system, this Reference Architecture offers a full solution using validated Dell PowerEdge™ server hardware designed to allow a wide range of configuration options, including optimized configurations for:

- Compute roles
- Infrastructure roles
- Storage roles

As noted throughout this Reference Architecture, Dell EMC constantly adds capabilities to expand this offering.

Each of the Dell EMC PowerEdge™ server configurations in this Reference Architecture is designed as a getting-started setup for OpenStack Compute, Infrastructure, and Storage. Dell EMC recommends starting with OpenStack software using components from this Reference Architecture because the hardware and operations processes are a flexible foundation to expand upon. By design, you can expand the Reference Architecture configuration as your cloud deployment grows, so your investment is protected.

## Networking and Network Services

Network configuration is based upon using the Neutron-based options supported by the OSP code base, and does not rely upon third-party drivers. This reference configuration is based upon the Neutron networking services using the ML2 drivers for OpenVswitch with the `vlan` option.

Networking includes:

- Core and layered networking capabilities
- 10GbE networking
- NIC teaming
- Redundant trunking top-of-rack (ToR) switches into core routers

This enables the Dell EMC Red Hat OpenStack NFV Solution to operate in a full production environment.

See [Network Architecture](#) on page 28 for guidelines. Detailed designs are available through Dell consulting services.

## Taxonomy


The Dell EMC Red Hat OpenStack NFV Solution is built using the following core OpenStack components, as delivered in the Red Hat OpenStack Platform. See [Table 1: Deployed Core Services](#) on page 13 and [Table 2: Deployed Non-Core Services](#) on page 13.

**Table 1: Deployed Core Services**

Component	Code Name
Block Storage	Cinder with Red Hat Ceph Storage and Dell Storage PS Series or SC Series
Compute	Nova
Identity	Keystone
Image Service	Glance
Networking	Neutron

**Table 2: Deployed Non-Core Services**

Component	Code Name
Bare Metal Provisioning	Ironic and TripleO
Dashboard	Horizon
Orchestration	Heat
Telemetry	Ceilometer
Validation Testing	Tempest

 **Caution:** Before using Tempest, review the Tempest documentation at <http://docs.openstack.org/developer/tempest/>.

There are several optional<sup>1</sup> OpenStack components that are available but not part of the base solution. See [Table 3: Optional Services](#) on page 13.

**Table 3: Optional Services**

Database	Trove
Data Processing	Sahara
Database	Trove
DNS as a Service	Designate
File Share Service	Manila
Key Management	Barbican

The taxonomy presented in [Figure 1: Dell EMC Red Hat OpenStack NFV Solution Base Taxonomy](#) on page 14 reflects infrastructure components, and OpenStack-specific components, that are under active

<sup>1</sup> Available through a custom Services engagement.

development by the community, Dell EMC, and Red Hat. The taxonomy reflects that there are two sides for cloud users:

- Site-specific infrastructure
- Standards-based API (shown in pink) interactions

The standards-based APIs are the same between all OpenStack deployments, and let customers and vendor ecosystems operate across multiple clouds. The site-specific infrastructure combines open and proprietary software, Dell EMC hardware, and operational processes to deliver cloud resources as a service.

The implementation choices for each cloud infrastructure are highly specific to the requirements of each site. Many of these choices can be standardized and automated using the tools in this Reference Architecture. Conforming to best practices helps reduce operational risk by leveraging the accumulated experience of Dell EMC, Red Hat and the broader OpenStack community.

Red Hat OpenStack Director is used to deploy the solution (Overcloud) from the Undercloud. The Undercloud is a single server that runs a subset of OpenStack services used to deploy, manage and update the Overcloud servers. In the Dell EMC Red Hat OpenStack NFV Solution the OpenStack Controllers, Computes and Red Hat Ceph Storage servers comprise the Overcloud servers.

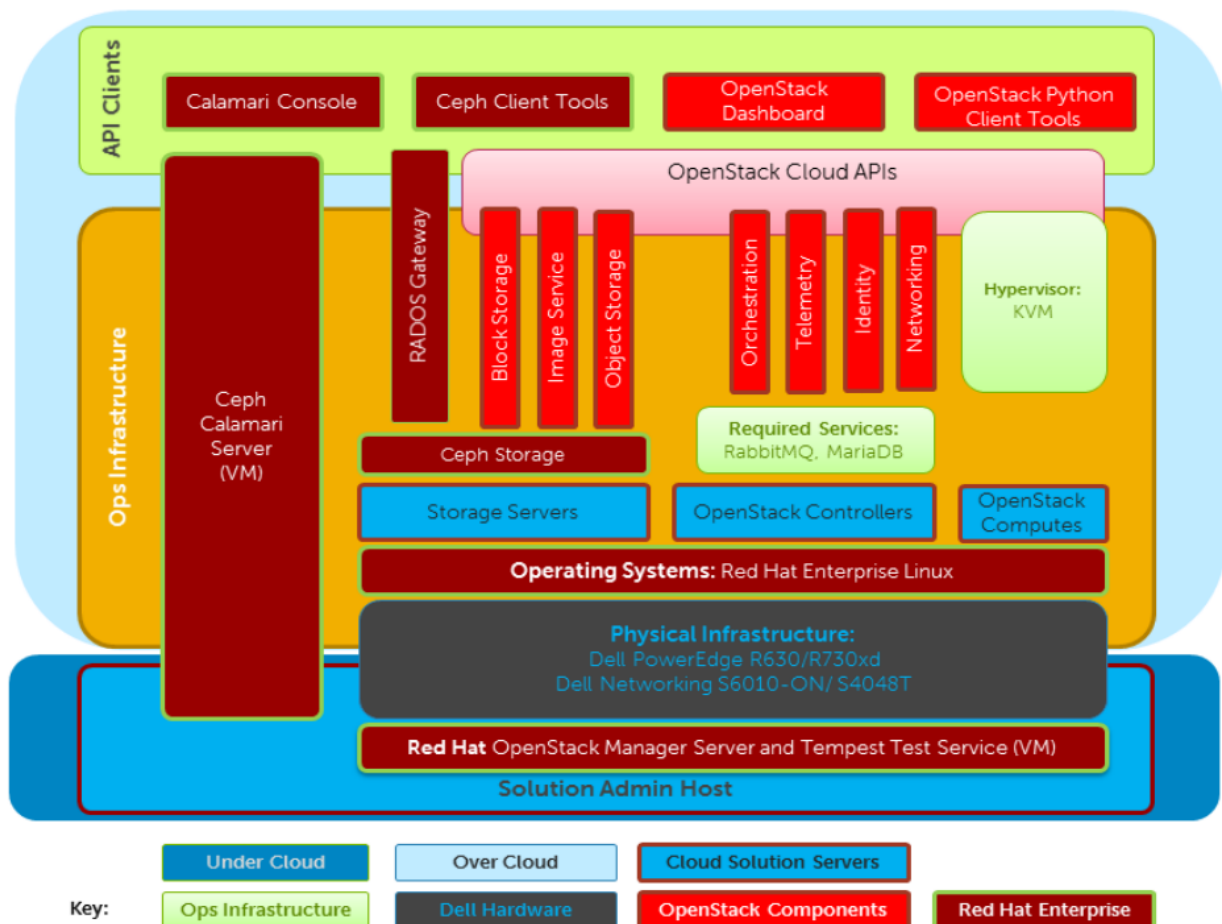


Figure 1: Dell EMC Red Hat OpenStack NFV Solution Base Taxonomy

## Red Hat OpenStack Platform 9

Red Hat OpenStack Platform provides the foundation to build a private or public Infrastructure-as-a-Service (IaaS) cloud on Red Hat Enterprise Linux. It offers a massively scalable, fault-tolerant platform for the development of cloud-enabled workloads.

The Red Hat OpenStack Platform IaaS cloud is implemented by a collection of interacting services that control its computing, storage, and networking resources. The cloud is managed using a web-based interface that allows administrators to control, provision, and automate OpenStack resources. Additionally, the OpenStack infrastructure is facilitated through an extensive API, which is also available to cloud end users.

Red Hat OpenStack Platform is purposely designed recognizing the unique dependencies that OpenStack has upon its underlying Linux® installation. Red Hat uniquely co-engineers and integrates Red Hat OpenStack technology with Red Hat Enterprise Linux Server 7, ensuring a stable, production-ready cloud platform. Version 9 boasts all of the core features and functions of the community Mitaka release and adds some additional innovations by Red Hat, resulting in a hardened, stable cloud platform.

### Key Benefits

- **Co-engineered and Integrated:** OpenStack depends upon Linux for performance, security, hardware enablement, networking, storage, and other primary services. The Red Hat OpenStack Platform delivers an OpenStack distribution with the proven performance, stability, and scalability of Red Hat Enterprise Linux; enabling you to focus on delivering the services your customers want, instead of focusing on the underlying operating platform.
- **Deploy with confidence,** as the Red Hat OpenStack Platform provides hardened and stable branch releases of OpenStack and Linux. The Red Hat OpenStack Platform is supported by Red Hat for a three (3) year “production phase” lifecycle, well beyond the six-month release cycle of unsupported, community OpenStack.
- **Take advantage of broad application support.** Red Hat Enterprise Linux, running as guest virtual machines, provides a stable application development platform with a broad set of ISV certifications. You can therefore rapidly build and deploy your cloud applications.
- **Avoid vendor lock-in** by moving to open technologies, while maintaining your existing infrastructure investments.
- **Benefit from the world’s largest partner ecosystem:** Red Hat has assembled the world’s largest ecosystem of certified partners for OpenStack compute, storage, networking, ISV software, and services for Red Hat OpenStack Platform deployments. This ensures the same level of broad support and compatibility that customers enjoy today in the Red Hat Enterprise Linux ecosystem.
- **Upgrade of RHEL OSP Director-based installations.**
- **Bring security to the cloud.** Rely upon the SELinux military-grade security and container technologies of Red Hat Enterprise Linux to prevent intrusions and protect your data, when running in public or private clouds.

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# Chapter

# 2

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## OpenStack Architecture

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### Topics:

- [OpenStack Components](#)

While OpenStack has many configurations and capabilities, the primary components for the Red Hat OpenStack Platform 9 (Mitaka), as defined in [Taxonomy](#) on page 13.



**Note:** For a complete overview of OpenStack software, visit [Red Hat OpenStack Enterprise Platform](#) and the [OpenStack Project](#).

## OpenStack Components

The following component descriptions are from the OpenStack Foundation website. Extensive documentation for the OpenStack components is available at <http://docs.openstack.org/>.

**Table 4: OpenStack Core Components**

Function	Code Name	Description
Bare Metal Provisioning	Ironi	<a href="#">Openstack Bare Metal Provisioning</a> aims to provision bare metal machines instead of virtual machines.
Block Storage	Cinder	<a href="#">OpenStack Block Storage</a> provides persistent block level storage devices for use with OpenStack compute instances. The block storage system manages the creation, attaching, and detaching of the block devices to servers. Block storage volumes are fully integrated into OpenStack Compute and the Dashboard enabling cloud users to manage their own storage needs.
Compute	Nova	<a href="#">OpenStack cloud operating system</a> enables enterprises and service providers to offer on-demand computing resources, by provisioning and managing large networks of virtual machines. Compute resources are accessible via APIs for developers or users and web interfaces for administrators and users.
Identity	Keystone	<a href="#">Identity Service</a> provides a central directory of users mapped to the OpenStack services they can access. It acts as a common authentication system across the cloud operating system and can integrate with existing backend directory services.
Image Service	Glance	<a href="#">OpenStack Image Service</a> provides discovery, registration, and delivery services for virtual disk images. The Image Service API server provides a standard REST interface for querying information about virtual disk images stored in a variety of back-end stores.
Networking	Neutron	<a href="#">OpenStack Networking</a> is a pluggable, scalable and API-driven system for managing networks and IP addresses. Like other aspects of the cloud operating system, it can be used by administrators and users to increase the value of existing datacenter assets.
Orchestration	Heat	<a href="#">OpenStack Orchestration</a> is a template-driven engine that enables application developers to describe and automate the deployment of infrastructure. The flexible template language can specify compute, storage and networking configurations as well as detailed post-deployment activity to automate the full provisioning of infrastructure as well as services and applications.
Orchestration	TripleO	<a href="#">OpenStack TripleO</a> is an OpenStack program that utilizes OpenStack's own cloud facilities to install and operate OpenStack clouds. This builds on Nova, Neutron, and Heat to automate small clouds to datacenter roll-outs.

**Table 5: Non-Core Deployed Components**

Function	Code Name	Description
Dashboard/ Portal	Horizon	<a href="#">OpenStack Dashboard</a> provides administrators and users a graphical interface to access, provision and automate cloud-based resources. The extensible design makes it easy to plug in and expose third party products and services.
Telemetry	Ceilometer	<a href="#">OpenStack Telemetry</a> aggregates usage and performance data across the services deployed in an OpenStack cloud. This powerful capability provides visibility and insight into the usage of the cloud across dozens of data points and allows cloud operators to view metrics globally or by individual deployed resources.
Validation Testing	Tempest	<a href="#">Tempest</a> is a set of integration tests to be run against a live OpenStack cluster. Tempest includes batteries of tests for OpenStack API validation, various scenarios, and other specific tests useful in validating an OpenStack deployment.

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# Chapter

# 3

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## Server Options

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### Topics:

- [PowerEdge R630 Server](#)
- [PowerEdge R730xd Servers](#)
- [Base Hardware Configurations](#)
- [Configuration Notes](#)
- [Optional Servers](#)

The base validated Solution supports the PowerEdge R630 and R730xd Server lines. See [Optional Servers](#) on page 22 for other options.



**Note:** Detailed part lists and rack layouts are included in the [Dell EMC Red Hat OpenStack NFV Solution Build of Materials Guide](#).

## PowerEdge R630 Server

The PowerEdge R630 server is a hyper-dense, two-socket, 1U rack server.

With computing capability previously only seen in 2U servers, the ultra-dense PowerEdge R630 two-socket 1U rack server delivers an impressive solution for cloud solutions, virtualization environments, large business applications, or transactional databases.

The PowerEdge R630 server is versatile and highly configurable for a variety of solutions, supporting the latest Intel® Xeon® processor E5-2600 v4 product family, 24 DIMMs of high-performance DDR4 memory and a broad range of local storage options.

## PowerEdge R730xd Servers

The PowerEdge R730xd is an exceptionally flexible and scalable two-socket 2U rack server, that delivers high performance processing and a broad range of workload-optimized local storage possibilities, including hybrid tiering.

Designed with an incredible range of configurability, the PowerEdge R730xd meets the needs of many different storage workloads with the latest Intel® Xeon® processor E5-2600 v4 product family, 24 DIMMs of high-performance DDR4 memory, and a broad range of local storage options.



Figure 2: PowerEdge R730xd Servers - 2.5" and 3.5" Chassis Options

## Base Hardware Configurations

Table 6: Controller Node Hardware Configurations – PowerEdge R630

Machine Function	Solution Bundle Controller Nodes
Platform	PowerEdge R630
CPU	2 x E5-2650v4 (12-core)
RAM (Minimum)	128 GB
LOM	2 x 1Gb, 2 x Intel X520 10Gb SFP+

Machine Function	Solution Bundle Controller Nodes
Add-in Network	1 x Intel X520 DP 10Gb DA/SFP+
Disk	8 x 600GB 10K SAS 12Gbps
Storage Controller	PERC H730
RAID	RAID 10

**Table 7: Compute Node Hardware Configurations – PowerEdge R630**

Machine Function	Solution Bundle Compute Nodes
Platform	PowerEdge R630
CPU	2 x E5-2650v4 (12-core)
RAM (Minimum)	128 GB
LOM	2 x 1Gb, 2 x Intel X520 10Gb SFP+
Add-in Network	1 x Intel X520 DP 10Gb DA/SFP+
Disk	8 x 600GB 10k SAS 12 Gbps
Storage Controller	PERC H730
RAID	RAID 10

**Table 8: Solution Admin Host Hardware Configurations – PowerEdge R630**

Machine Function	Solution Bundle Infrastructure Nodes
Platform	PowerEdge R630
CPU	2 x E5-2650v4 (12-core)
RAM (Minimum)	64 GB
LOM	2 x 1Gb, 2 x Intel X520 10Gb SFP+
Add-in Network	1 x Intel X520 DP 10Gb DA/SFP+
Disk	8 x 600GB 10k SAS 12 Gbps
Storage Controller	PERC H730
RAID	RAID 10

**Table 9: Storage Node Hardware Configurations – PowerEdge R730xd**

Machine Function	Solution Bundle Storage Nodes
Platforms	PowerEdge R730xd
CPU	2 x E5-2650v4 (12-core)
RAM (Minimum)	64 GB
LOM	1 x 1Gb, 2 x Intel X520 10Gb
Add-in Network	2 x Intel X520 DP 10Gb DA/SFP+

Machine Function	Solution Bundle Storage Nodes
Disk	Flex Bay: 2 X 300GB 15K 2.5-inch (OS) Front Drives: 3 X 400GB SSD 12 x 2TB or 4TB NL SAS 7.2K 3.5-inch
Storage Controller	PERC H730
RAID	RAID 1 (operating system) Pass through SSD Pass through each data disk



**Note:** Be sure to consult your Dell EMC account representative before changing the recommended hardware configurations.

## Configuration Notes

The [Dell EMC Red Hat OpenStack NFV Solution Bill of Materials Guide](#) contains the full bill of materials (BOM) listing for the PowerEdge R630 and R730Xd server configurations.

The R630 and R730xd configurations are used with 10GbE networking. To ensure that the network is HA ready, an additional network card is required in each node. Refer to the [Dell EMC Red Hat OpenStack NFV Solution Bill of Materials Guide](#), which outlines the supported cards and includes them as part of the solution.



**Caution:** You must ensure that the firmware on all servers is up to date. Otherwise, unexpected results may occur. See *Tested BIOS and Firmware* in the [Dell EMC Red Hat OpenStack NFV Solution Hardware Deployment Guide](#).

## Optional Servers

Two additional servers have been validated for specific roles in the solution:

- [PowerEdge R430](#) on page 22
- [PowerEdge R730](#) on page 23

### PowerEdge R430

The PowerEdge R430 is an option for the OpenStack Computes. It is a powerful, compact computing system that can support up to:

- 384 GB RAM
- 10 x 2.5 hot-plug drives
- 2PCIe 3.0 slots

This server is used in environments where power and cooling constraints need to be met. The smaller form factor (24" depth), and low power usage, ensure that the server can be utilized in your infrastructure with minimal impact.

Please contact your Dell EMC sales representative for options and configurations.

## PowerEdge R730

The PowerEdge R730 is an option for the OpenStack Compute nodes. With a 2U form factor, the R730 can support:

- Up to 7 PCIe cards
- HDD options include:
  - Up to 9TB in 2.5" hard drives, or
  - Up to 48TB in 3.5" hard drives

This server can be used where a large ephemeral storage pool is desired, or if there is a need for additional PCIe cards.

Please contact your Dell EMC sales representative for options and configurations.

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# Chapter

# 4

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## Storage Options

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### Topics:

- [Storage Options Overview](#)
- [Local Storage](#)
- [Red Hat Ceph Storage](#)
- [Optional Dell Storage](#)

OpenStack has several storage services, including:

- Cinder
- Glance
- Swift<sup>2</sup>

Together these services provide virtual machines (VMs) with block, image, and object storage. In turn, the services employ block and object storage subsystems. Since the service design has a mechanism to replace some or all of the implementation of these services, this solution can provide alternate implementations of these services that better serve your needs.

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<sup>2</sup> Available through a custom Services engagement.

## Storage Options Overview

Cinder virtualizes storage enabling VMs to use persistent block storage through Nova. OpenStack consumers should write data that must exist beyond the lifecycle of the guest to Cinder volumes. The volume can be accessed afterwards by a different guest.

Glance provides images to VMs. Generally, the images are block devices containing DVDs or virtual machines. VMs can be booted from these images or have the images attached to them.

Swift provides an object storage interface to VMs and other OpenStack consumers. Unlike block storage where the guest is provided a block device of a given format and is accessible within the cluster, object storage is not provided through the guest. Object storage is generally implemented as a HTTP/HTTPS-based service through a web server. Client implementations within the guest or external OpenStack clients would interact with Swift without any configuration required of the guest other than providing the requisite network access. For example, a VM within OpenStack can put data into Swift, and later external clients could pull that data for additional processing.



**Note:** "Swift" in this document refers to the Swift interfaces, not the Swift implementation, of the protocol.

As with other OpenStack services, there are client and server components for each storage service. The server component can be modified to use a particular type of storage rather than the default. For example, Cinder uses local disks as the storage back-end by default. The Dell EMC Red Hat OpenStack Cloud Solution modifies the default configuration for these services.

All virtual machines will need a virtual drive that is used for the OS. Two options are available:

- Ephemeral disks
- Boot from volume or snapshot, hosted on Red Hat Ceph Storage, or Dell Networking PS Series or SC Series arrays.

Ephemeral disks are virtual drives that are created when a VM is created, and destroyed when the VM is removed. The virtual drives can be stored on the local drives of the Nova host or on a shared file system, such as *rdp*. During the planning process, decisions can be made to place ephemeral on local or share, it is recommended that a shared backend is used that will allow live migration.

Boot from volume/snapshot will use one of the Cinder backends.

The Dell EMC Red Hat OpenStack Cloud Solution include alternate implementations of Cinder that enable the cluster to fit many needs. Cinder has been validated using each of the backends independently, and multi-backend utilizing multiple Storage backends consisting of two or all of:

- [Local Storage](#) on page 25
- [Red Hat Ceph Storage](#) on page 26
- [Optional Dell Storage](#) on page 26

In addition, the Dell EMC Red Hat OpenStack Cloud Solution provides Red Hat Ceph Storage as an alternate implementation for Glance, Block, and Object stores.

## Local Storage

When using local storage, each Compute node will host the ephemeral volumes associated with each virtual machine. Cinder will utilize LVMs that are shared by NFS for independent volumes, utilizing the local storage subsystem. With the hardware configuration for the Compute nodes (see [Table 7: Compute Node Hardware Configurations – PowerEdge R630](#) on page 21) using the eight (8) 600 GB disks in a RAID 10, there will be approximately 2 TB of storage available.

## Red Hat Ceph Storage

The Dell EMC Red Hat OpenStack NFV Solution bundle includes Red Hat Ceph Storage, which is a scale-out, distributed, software-defined storage system. Red Hat Ceph Storage is used as backend storage for Nova, Cinder and Glance. Storage nodes run the Red Hat Ceph Storage software, and Compute and Controller nodes run the Red Hat Ceph Storage block client.

Red Hat Ceph Storage also provides object storage for OpenStack VMs and other clients external to OpenStack. The object storage interface is an implementation of:

- The OpenStack Swift RESTful API (basic data access model)
- The Amazon S3 RESTful API

The object storage interface is provided by Red Hat Ceph Storage RADOS Gateway software running on the Controller nodes. Client access to the object storage is distributed across all Controller nodes in order to provide HA and IO load balancing.

Red Hat Ceph Storage stores data by running multiple Object Storage Daemons (OSD) on each Storage node. Each OSD has an associated physical drive where the data is stored, and a journal where write operations are staged prior to being committed.

- When a client reads data from the Red Hat Ceph Storage cluster the OSDs fetch the data directly from the drives.
- When a client writes data to the storage cluster the OSDs write the data to their journals prior to committing the data.

OSD journals can be located in a separate partition on the same physical drive where the data is stored, or they can be located on a separate high-performance drive, such as an SSD optimized for write-intensive workloads. For the reference architecture, a ratio of one (1) SSD to four (4) hard disks is used to achieve optimal performance. It should be noted that as of this writing using a greater ratio will result in server performance degradation.

In a cost-optimized solution, the greatest storage density is achieved by forgoing separate SSD journal drives, and populating every available physical drive bay with a high-capacity HDD.

In a throughput-optimized solution, a few drive bays can be populated with high performance SSDs that will host the journals for the OSD HDDs. For example, in an R730xd system with 16 drive bays available for Red Hat Ceph Storage, 3 bays could be used for SSD journal drives and 12 bays for HDD data drives, leaving 1 bay open for a spare drive. This is based upon the current industry guideline of a 4:1 HDD to SSD journal ratio.

## Optional Dell Storage

Two supported Dell Storage options have been validated for the solution:

- Dell Storage PS Series
- Dell Storage SC Series

### Dell Storage Arrays

Dell Storage PS Series and SC Series storage arrays are designed to provide simplified deployment and administration of consolidated storage environments. Dell Storage PS Series and SC Series storage systems are self-optimized, utilizing embedded load-balancing technologies that react to workload demands.

The core capabilities of Dell Storage PS Series and SC Series storage products include comprehensive software components and host integration, which simplify administrative tasks and assist with storage management. Application-layer integration with OpenStack enables Cinder to:

- Provision and manage volumes on Dell Storage PS Series and SC Series storage
- Utilize SAN-based snapshots for protection capability

Additionally, the Dell Storage SC Series:

- Provides automatic data tiering, based upon usage.
- Requires an additional server to be added to the cluster to support the Dell Storage Enterprise Manager. These solutions may require a service motion in order to implement them.



**Note:** iSCSI connections are only supported with the Dell Storage PS Series or SC Series. Fibre Channel connections are not supported in this Reference Architecture.

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# Chapter

# 5

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## Network Architecture

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### Topics:

- [Network Architecture Overview](#)
- [Infrastructure Layouts](#)
- [Network Components](#)

This Reference Architecture supports consistency in rapid deployments through minimal network configuration differences. Please contact your Dell EMC sales representative to find out if other viable options are available.

## Network Architecture Overview

The Dell EMC Red Hat OpenStack NFV Solution with Red Hat OpenStack Platform uses either of the recommended Ethernet switches, presented in [Table 10: ToR Switches](#) on page 29, as the top-of-rack connectivity to all OpenStack-related nodes.



**Note:** If already in your environment, you can substitute the alternate switches for the recommended switches.

**Table 10: ToR Switches**

Recommended Switches	Alternate Switches
Dell Networking S6010-ON 10/40/100-Gigabit	Dell Networking S6000-ON 10/40-Gigabit
Dell Networking S4048T 10/40-Gigabit	Dell Networking S4820T 10/40-Gigabit

## Infrastructure Layouts

The network consists of the following major network infrastructure layouts:

- **Core Network Infrastructure** - The connectivity of aggregation switches to the core for external connectivity.
- **Data Network Infrastructure** - The server NICs, top-of-rack (ToR) switches, and the aggregation switches.
- **Management Network Infrastructure** - The BMC management network, consisting of iDRAC ports and the out-of-band management ports of the switches, is aggregated into a 1-rack unit (RU) S4048T switch in one of the three racks in the cluster. This 1-RU switch in turn can connect to one of the Aggregation or Core switches to create a separate network with a separate VLAN.

## Network Components

The data network is primarily composed of the ToR and the aggregation switches. Configurations for 1GbE and 10GbE are included in this Reference Architecture. The following component blocks make up this network:


- [Server Nodes](#) on page 29
- [Access Switch or Top of Rack \(ToR\)](#) on page 30
- [Aggregation Switches](#) on page 30
- [Core](#) on page 31
- [Layer-2 and Layer-3 Switching](#) on page 31
- [VLANs](#) on page 31
- [Out of Band Management Network](#) on page 31
- [Dell EMC OpenSwitch Solution](#) on page 32

## Server Nodes

In order to create a highly-available solution, the network must be resilient to loss of a single network switch, network interface card (NIC) or bad cable. To achieve this, the network configuration uses channel bonding across the servers and switches.

There are several types (or modes) of channel bonding, but only one is recommended for the Solution. The OpenStack Controller, Compute nodes, Red Hat Ceph Storage nodes, and Solution Admin Host can use:

- 802.3ad or LACP (mode = 4)

 **Note:** Other modes, such as `balance-rr (mode=0)`, `balance-xor (mode=2)`, `broadcast (mode=3)`, `balance-tlb (mode=5)`, and `balance-alb (mode=6)`, are not supported. Please check with your technician for current support status of `active-backup (mode = 1)`.

All nodes' endpoints are terminated to switch ports that have been configured for LACP bonding mode, across two Dell Networking S6010-ONs configured with a VLTi across them. The configuration settings are explained in greater detail in the [Dell EMC Red Hat OpenStack NFV Solution Deployment Guide](#).

**Table 11: Channel Bonding Modes Supported**

	Channel Bonding Type
Node Type	802.3ad (LACP mode 4)
Solution Admin Host	Yes (solution default)
OpenStack Controller Nodes	Yes (solution default)
OpenStack Compute Nodes	Yes (solution default)
Red Hat Ceph Storage Nodes	Yes (solution default)

A single port is an option when bonding is not required. However, it is neither used nor validated in the Dell EMC Red Hat OpenStack NFV Solution. The need to eliminate single points of failure is taken into consideration as part of the design, and this option has been eliminated wherever possible.

Please contact your Dell EMC sales representative for other viable options.

## Access Switch or Top of Rack (ToR)

The 10GbE configuration utilizes Dell Networking S4048T switch as the ToR switch.

Dell's recommended switches for Top of Rack are:

- **10/40 GbE Connectivity** - Dell Networking S4048T
- **10/40 GbE Connectivity** - Dell Networking S4820T

Please contact your Dell EMC sales representative for other viable options.

## Aggregation Switches

For a deployment of from one to three racks of 10G servers, Dell recommends the Dell Networking S6010-ON as the aggregation switch. This multi-rate switch is 10GbE and 40GbE capable.

The 40GbE interfaces on the S6010-ON can be converted into four 10GbE interfaces. ToR switches connect to aggregate switches via uplinks of 40GbE interfaces from the ToR Dell Networking S4048T to the Dell Networking S6010-ON.

Dell's recommended architecture uses Virtual Link Trunking (VLT) between the two Dell Networking S6010-ON switches in each rack, and then aggregation to a core switch. This enables a multi-chassis LAG from the ToR switches in each rack. The stacks in each rack can divide their links between this pair of switches to achieve powerful active-active forwarding, while using full bandwidth capability, with no requirement for spanning tree. Using 40GbE Ethernet switches, like the Dell Networking Z9100, in aggregation can achieve a scale of up to hundreds of 1G deployed nodes.

For the 10G server deployment, Dell's recommendation depends upon:

- The scale at which the rack layouts are planned
- Required future scaling

Please contact your Dell EMC sales representative to find out if other viable options are available.

## Core

The aggregation layer could itself be the network core in many cases, but otherwise it would connect to a larger core. Discussion of this topic is beyond the scope of this document.

## Layer-2 and Layer-3 Switching

The layer-2 and layer-3 boundaries are separated at the aggregation layer.

The Reference Architecture uses layer-2 as the reference up to the aggregation layer, which is why VLT is used on the aggregation switches. The Red Hat OpenStack Director requires a layer-2 domain in order to provision servers.

The three network links - Provisioning, Storage, and Management - can have uplinks to a gateway device. The Provisioning network can use the Red Hat OpenStack Director as a proxy for pulling packages from a subscription server, or a gateway can be added.

There are many tools for OOB management for the iDRAC, which you can use after first adding the gateway to the network, and then updating the iDRAC.

The OpenStack Controllers are connected to a gateway device, usually a router or firewall. This device will handle routing for all networks external to the cluster. The required networks are:

- The floating IP range used by virtual machines
- A network for all external Public API and Graphical User Interface access

## VLANs

This Reference Architecture implements at a minimum eight (8) separate Layer 2 VLANs:

- **Management/Out of Band (OOB) Network** - iDRAC connections can be routed to an external network. All OpenStack HA Controllers need direct access to this network for IPMI operations.
- **Internal Networks VLAN for Tenants** - Sets up the backend network for Nova and the VMs to use.
- **Public API Network VLAN** - Sets up the network connection to a router that is external to the cluster. The network is used by the front-end network for routable traffic to individual VMs, access to the OpenStack API, RADOS Gateway, and the Horizon GUI. Depending upon the network configuration these networks may be either shared or routed, as needed. The RHEL OSP Director Node requires access to the Public API Network.
- **External Network VLAN for Tenants** - Sets up a network that will support the floating IPs and default external gateway for tenants and virtual machines. This connection is through a router external to the cluster.
- **Provisioning Network VLAN** - Connects a NIC from all nodes into the fabric, used for setup and provisioning of the OpenStack servers.
- **Private API Network VLAN** - Used for communication between OpenStack Controllers, the RHEL OSP Director Node, and Compute nodes for Private API and cluster communications.
- **Storage Network VLAN** - Used by all nodes for the data plane reads/writes to communicate to OpenStack Storage; setup, and provisioning of the Red Hat Ceph Storage cluster; and when included, the Dell Storage PS Series or SC Series arrays.
- **Storage Clustering Network VLAN** - Used by all Storage nodes for replication and data checks (Red Hat Ceph Storage clustering).

## Out of Band Management Network

The management network for all the servers and switches is aggregated into a Dell Networking S4048T switch, located in each rack of up to 3 racks, or a pod.

The Out of Band (OOB) Management network is used for several functions:

- The highly available software uses it to reboot and partition servers.

- When an uplink to a router is added and the iDRACs configured to use it as a gateway, there are tools for monitoring the servers and gather metrics on them. Discussion of this topic is beyond the scope of this document.

## Dell EMC OpenSwitch Solution

In addition to the Dell EMC switch-based Reference Architecture, Dell EMC provides an open standard that enables you to choose other brands and configurations of switches for your OpenStack environment.

The following list of requirements will enable other brands of switches to properly operate with Dell EMC's required tools and configurations:



**Note:** You are expected to ensure that the switches conform to these requirements, and that they are configured according to this Reference Architecture's guidelines.

- Support for IEEE 802.1Q VLAN traffic and port tagging
- Support for using one untagged, and multiple tagged VLANs, on the same port
- Ability to provide a minimum of 170 Gigabit Ethernet ports in a non-blocking configuration within the Provisioning VLAN
  - Configuration can be a single switch or a combination of stacked switches to meet the additional requirements
- Ability to create LAGs with a minimum of two physical links in each LAG
- If multiple switches are stacked:
  - Ability to create a LAG across stacked switches
  - Full-bisection bandwidth
  - Support for VLANs to be available across all switches in the stack
- 250,000 packets-per-second capability per switch
- A managed switch that supports SSH and serial line configuration
- SNMP v3 support

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# Chapter

# 6

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## Operational Notes

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### Topics:

- *Backup/Recovery*
- *Service Layout*
- *Deployment*

This section provides a basic overview of several important system aspects.

## Backup/Recovery

Backup and recovery have not been addressed in this configuration. Since the Red Hat OpenStack Director Virtual Server is not needed for normal operations of the services, it is neither redundant nor backed up.

## Service Layout

During the deployment each service configured by the Dell EMC Red Hat OpenStack NFV Solution needs to reside upon a particular hardware type. For each server platform, two types of nodes have been designed:

- R630 for Computes, Controllers, Solution Admin Hosts, or Infrastructure hardware type
- R730xd for Storage nodes or Storage hardware type

Red Hat OpenStack Director is designed for flexibility, enabling you to try different configurations in order to find the optimal service placement for your workload. [Table 12: Overcloud: Node Type to Services](#) on page 34 presents the recommended layout of each service.

The Red Hat OpenStack Director and the Red Hat Ceph Storage Admin are deployed to the Solution Admin Host as individual VMs. This enables each tool to control its respective resources.

**Table 12: Overcloud: Node Type to Services**

Hardware Type	Service	Node to Deploy
Infrastructure	Ceilometer	OpenStack Controllers
Infrastructure	Cinder-scheduler	OpenStack Controllers
Infrastructure	Cinder-volume	OpenStack Controllers
Infrastructure	Database-server	OpenStack Controllers
Infrastructure	Glance-Image	OpenStack Controllers
Infrastructure	HA-Proxy (Load Balancer)	OpenStack Controllers
Infrastructure	Heat	OpenStack Controllers
Infrastructure	Keystone-server	OpenStack Controllers
Infrastructure	Neutron-server	OpenStack Controllers
Infrastructure	Nova-Controller	OpenStack Controllers
Infrastructure	Nova dashboard-server	OpenStack Controllers
Infrastructure	Nova-multi-compute	Three or more Compute Nodes
Infrastructure	Pacemaker	OpenStack Controllers
Infrastructure	RabbitMQ-server (Messaging)	OpenStack Controllers
Infrastructure	Red Hat Ceph Storage RADOS Gateway	OpenStack Controllers
Infrastructure	Red Hat OpenStack Director	Solution Admin Host (KVM)
Infrastructure	Red Hat Ceph Storage Admin (Calamari)	Solution Admin Host (KVM)
Infrastructure	Red Hat Ceph Storage Monitor	OpenStack Controllers

Hardware Type	Service	Node to Deploy
Storage	Red Hat Ceph Storage (Block) <sup>3</sup>	Three or more Storage Servers
<b>Optional Services</b>		
Storage	Dell Storage PS Series Array	Dell Storage PS Series Arrays
Storage	Dell Storage SC Series Array	Dell Storage SC Series Arrays
Storage	Dell Storage Enterprise Manager	Dell Storage Enterprise Manager Server

## Deployment

Deployment consists of three phases:

### 1. Hardware Setup:

- Rack and stack
- Cabling
- Server BIOS and RAID Configuration
- Switch configuration

### 2. Software Setup:

- Deploy Solution Admin Host for provisioning services:
  - Deploy Red Hat Ceph Storage Admin Node VM to the Solution Admin Host
  - Deploy Red Hat OpenStack Director Virtual Server VM to the Solution Admin Host
- Discover nodes
- Import discovered nodes into RHEL OSP Director
- Configure Overcloud files
- Provision Overcloud
- Validate all nodes' networking
- Post-deployment adjustments, including but not limited to:
  - Enabling fencing
  - Enabling local storage for ephemeral
  - Deploy Virtual Infrastructure Manager (VIM) node for monitoring services
  - Deploy OpenManage Network Manager (OMNM) on virtual Infrastructure Manager (VIM) node
  - Enable IPv6 support in tenant VMs (optional)
  - Enable huge page support on compute nodes (optional)
  - Enable NUMA awareness and CPU pinning support on compute nodes (optional)

### 3. Environment Tests

- Tempest can be used to validate the deployment. At minimum the following tests should be performed:
  - Project Creation
  - User Creation
  - Network Creation
  - Image upload and launch
  - Floating IP Assignment
  - Basic network testing
  - Volume creation and attachment to VM

<sup>3</sup> Available through a custom Services engagement.

- Object storage upload, retrieval and deletion
- Deletion of all

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# Chapter 7

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## Solution Bundle

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### Topics:

- [\*Solution Bundle Overview\*](#)
- [\*Solution Bundle Rack Layout\*](#)
- [\*Solution Bundle Network Configuration\*](#)
- [\*Solution Admin Host \(SAH\) Networking\*](#)
- [\*Virtual Infrastructure Manager \(VIM\) Node Networking\*](#)
- [\*Optional Solution Configurations\*](#)

This core architecture provides prescriptive guidance and recommendations, jointly engineered by Dell EMC and Red Hat, for deploying Dell EMC Red Hat OpenStack NFV Solution 9 with Dell EMC infrastructure.

## Solution Bundle Overview

Our goals are to:

- Provide practical system design guidance and recommended configurations
- Develop tools to use with OpenStack for day-to-day usage and management
- Develop networking configurations capable of supporting your production system

The development of this architecture builds upon the experience and engineering skills of Dell EMC and Red Hat, and encapsulates best practices developed in numerous real-world deployments. The designs and configurations in this architecture have been tested in Dell EMC and Red Hat labs to verify system functionality and operational robustness.

The Solution Bundle consists of the components described in [Figure 3: Solution Bundle and Red Hat Ceph Storage Cluster](#) on page 39, and represents the base upon which all optional components and expansion of the Dell EMC Red Hat OpenStack Cloud Solution are built.

Using the recommended R630 and R730xd servers, and given a virtual machine with two (2) cores; 4GB of memory; and a 40GB local ephemeral drive, you can expect to run around 90 virtual machines with a 1.5 oversubscription of CPU cores. At 120 virtual machines, you will have:

- 2-to-1 CPU core oversubscription
- Local ephemeral storage undersubscribed
- Memory just starting to be oversubscribed

Since the Solution Bundle is designed for a production environment, key OpenStack services are made highly available (HA) by clustering the OpenStack Controller nodes. The networking is based upon 10GbE bonds for data networks, and the network switches are configured for HA. The Out of Band Management network is not HA, and is 1GbE.



**Note:** The Solution Admin Host that hosts the RHEL OSP Director Node and the Red Hat Ceph Storage Admin Node is not made highly available, and must be appropriately managed for backup and recovery.

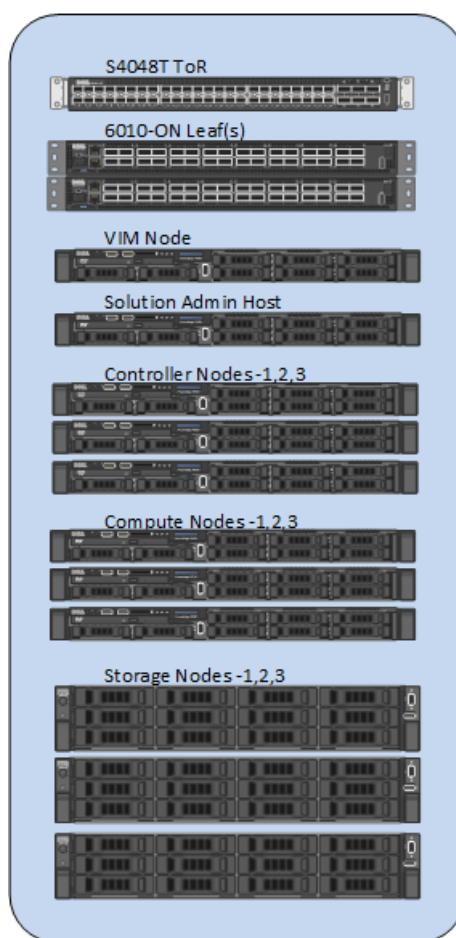
Please review and discuss the specifics with your Dell EMC sales representative.

## Solution Bundle Rack Layout

The Solution bundle includes three (3) storage nodes, configured in a Red Hat Ceph Storage cluster, which is tied into Cinder, Glance, and Nova.

See [Table 6: Controller Node Hardware Configurations – PowerEdge R630](#) on page 20 and [Table 9: Storage Node Hardware Configurations – PowerEdge R730xd](#) on page 21 for hardware configurations. The Solution Bundle includes:

- Node 1: R630 Solution Admin Host with the Red Hat OpenStack Director Installed
- Nodes 2 - 4: R630 OpenStack Controllers
- Nodes 5 - 7 R630 Nova Compute Nodes
- Nodes 8 - 10: R730xd Storage Nodes
- Network Switches: Two (2) Dell Networking S6010-ON, and one (1) Dell Networking S4048T



**Figure 3: Solution Bundle and Red Hat Ceph Storage Cluster**

The Red Hat Ceph Storage cluster provides data protection through replication, block device cloning, and snapshots. By default the data is striped across the entire cluster, with three replicas of each data entity. The number of Storage nodes in a single cluster can scale to hundreds of nodes and many petabytes in size.

Red Hat Ceph Storage considers the physical placement (position) of Storage nodes within defined fault domains (i.e., rack, row, and data center) when deciding how data is replicated. This reduces the probability that a given failure may result in the loss of more than one data replica.

The Red Hat Ceph Storage cluster services include:

- **RADOS Gateway** — Object storage gateway.
- **Object Storage Daemon (OSD)** — Running on Storage nodes, the OSD serves data to the Red Hat Ceph Storage clients from disks on the Storage nodes. Generally, there is one OSD process per disk drive.
- **Monitor (MON)** — Running on Controller nodes, the MON process is used by the Red Hat Ceph Storage clients and internal Red Hat Ceph Storage processes, to determine the composition of the cluster and where data is located. There should be a minimum of three MON processes for the Red Hat Ceph Storage cluster. The total number of MON processes should be odd.



**Note:** If MON processes on Controller nodes become a bottleneck, then additional MON processes can be added to the cluster by using dedicated machines, or by starting MON processes on Storage Nodes. A custom Services engagement can be arranged; please contact your Dell EMC sales representative for assistance.

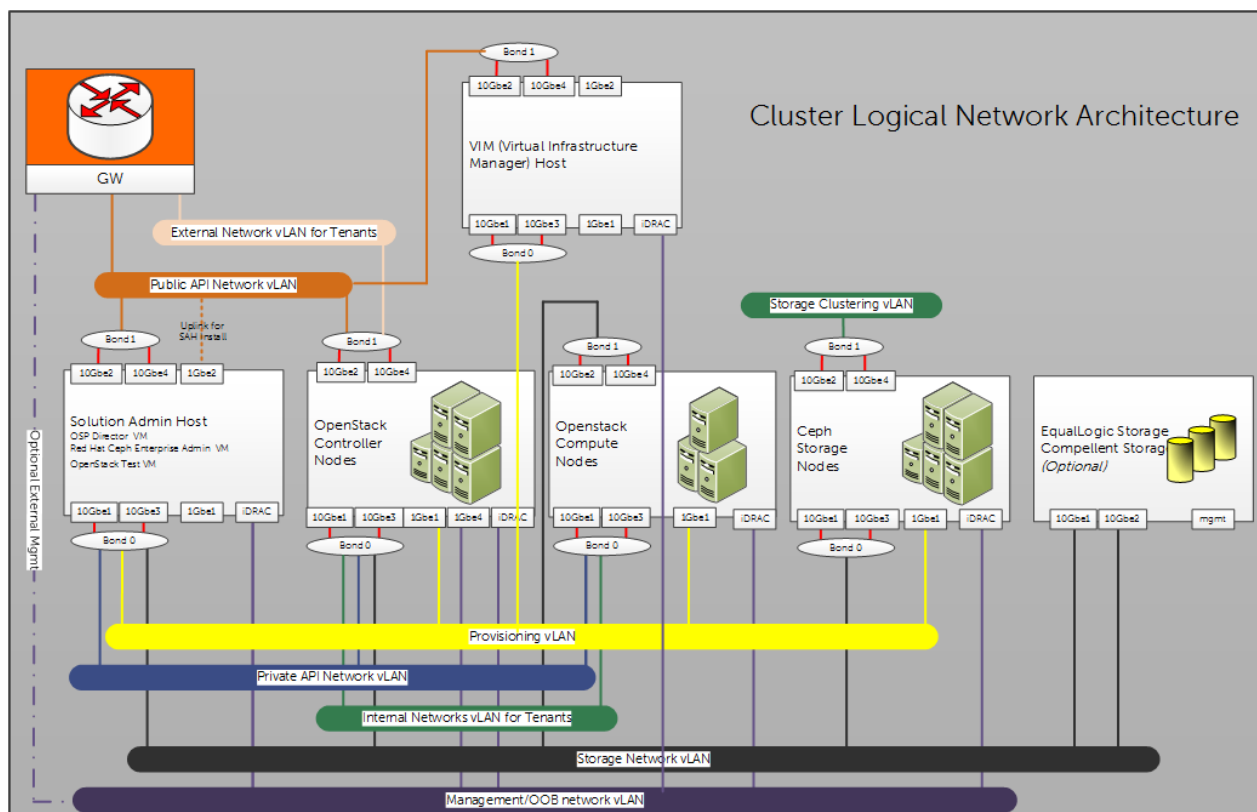
The Storage Network VLAN is described in the Red Hat Ceph Storage documentation as the public network. The Storage Cluster Network VLAN is described in the Red Hat Ceph Storage documentation as the cluster network.

A special distribution of Ceph is used in this solution: Red Hat Ceph Storage 1.3.2, which also includes the Red Hat Ceph Storage Admin Node (Calamari). The Red Hat Ceph Storage Admin Node also includes Red Hat Ceph Storage troubleshooting and servicing tools and utilities. Red Hat Ceph Storage is installed on a virtual machine that runs on the Solution Admin Host (SAH). Note that:

- The SAH must have access to the Controller and Storage nodes through the Private API Access VLAN in order to manage Red Hat Ceph Storage; and for the monitoring process on all Storage nodes to return status and performance telemetry.
- The Controller nodes must have access to the Storage nodes through the Storage Network VLAN in order for the MON processes on the Controller nodes to be able to query the Red Hat Ceph Storage MON processes, for the cluster state and configuration.
- The Compute nodes must have access to the Storage nodes through the Storage Network VLAN in order for the Red Hat Ceph Storage client on that node to interact with the storage nodes, OSDs, and the Red Hat Ceph Storage MON processes.
- The Storage nodes must have access to the Storage Network VLAN, as previously stated, and to the Storage Cluster Network VLAN.

## Solution Bundle Network Configuration

The network for the Dell EMC Red Hat OpenStack NFV Solution has been designed to support production-ready servers with a highly available network configuration. See [Figure 4: Cluster Network Logical Architecture with Optional Dell Storage PS Series](#) on page 40.



**Figure 4: Cluster Network Logical Architecture with Optional Dell Storage PS Series**

The node type will determine how the switches are configured for delivering the different networks. [Table 13: OpenStack Node Type to Network 802.1q Tagging](#) on page 41 and [Table 14: Storage Node Type to Network 8.2.1q Tagging](#) on page 41 outline the networks to the node types. The Management/OOB network is used by the Cluster Software to manage the OpenStack Controllers; therefore, they are the only ones that need direct connections. All iDRACs are plugged into this network without tagging.

**Table 13: OpenStack Node Type to Network 802.1q Tagging**

Network	Solution Admin Host	OpenStack Controller	OpenStack Compute	Red Hat Ceph Storage
Provisioning VLAN	Connected, Tagged	Connected, Untagged	Connected, Untagged	Connected, Untagged
Public API Network VLAN	Connected, Untagged <sup>5</sup>	Connected, Tagged	Not Connected	Not Connected
External Network VLAN for Tenants	Not Connected	Connected, tagged	Not Connected	Not Connected
Private API Network VLAN	Connected, Tagged	Connected, Tagged	Connected, Tagged	Not Connected
Internal Networks VLAN for Tenants	Not Connected	Connected, Tagged	Connected, Tagged	Not Connected
Storage Network VLAN	Connected, Tagged	Connected, Tagged	Connected, Untagged	Connected, Untagged
Storage Clustering VLAN	Not Connected	Not Connected	Not Connected	Connected, Untagged
Management/OOB Network VLAN	Connected, Tagged	Not Connected	Not Connected	Not Connected
iDRAC physical connection to the Management/OOB VLAN	Connected, Untagged	Connected, Untagged	Connected, Untagged	Connected, Untagged

**Table 14: Storage Node Type to Network 8.2.1q Tagging**

Network	PS Series Array	SC Series Enterprise Manager	SC Series Array
Provisioning VLAN	Not Connected	Not Connected	Not Connected
Public API Network VLAN	Not Connected	Connected, Untagged	Not Connected
External Network for Tenants VLAN	Not Connected	Not Connected	Not Connected
Private API Network VLAN	Not Connected	Not Connected	Not Connected
Internal Networks VLAN for Tenants	Not Connected	Not Connected	Not Connected
Storage Network VLAN	Connected, Untagged	Connected, Untagged	Connected, Untagged

<sup>4</sup> The 1Gbe port is used for provisioning the SAH during its installation only and can be disconnected afterwards.

Network	PS Series Array	SC Series Enterprise Manager	SC Series Array
Storage Clustering VLAN	Not Connected	Not Connected	Not Connected
Management/OOB Network VLAN	Not Connected	Not Connected	Not Connected
iDRAC physical connection to the Management/OOB VLAN	Not Connected	Not Connected	Not Connected

## Solution Admin Host (SAH) Networking

The Solution Admin Host has internal bridged networks for the Virtual Machines. It is physically connected to the following networks:

- **Management Network** — used by the RHEL OSP Director Node for iDRAC control of all Overcloud nodes.
- **Public API Network** — used for:
  - Inbound Access
    - HTTP/HTTPS access to the RHEL OSP Director Node
    - HTTP/HTTPS access to the Red Hat Ceph Storage Admin Node
    - Optional - SSH Access to the RHEL OSP Director Node and Red Hat Ceph Storage Admin Node
  - Outbound Access
    - HTTP/HTTPS access for Red Hat Ceph Storage, RHEL, and RHOSP updates
    - Used by the RHEL OSP Director Node to run Tempest tests using the OpenStack public API
- **Provisioning Network** — Used by the RHEL OSP Director Node to service DHCP to all hosts, provision each host, and act as a proxy for external network access
- **Private API Network** — Used by the RHEL OSP Director Node to run Tempest tests against the OpenStack private API
- **Storage Network** — Used by the Red Hat Ceph Storage Admin Node to monitor and manage the Red Hat Ceph Storage Cluster

*Figure 5: Solution Admin Host Internal Network Fabric* on page 43 displays how the networks are bridged inside the Solution Admin Host. Since the Provisioning, Private API, and Storage networks come in on one physical interface and the Public API and External Tenant networks on the other, 802.1q tagging is configured on the SAH and corresponding switch ports. This Reference Architecture does not cover any security aspects, so the appropriate Network and Security teams should be involved before connecting any machine to the externally-accessible networks.

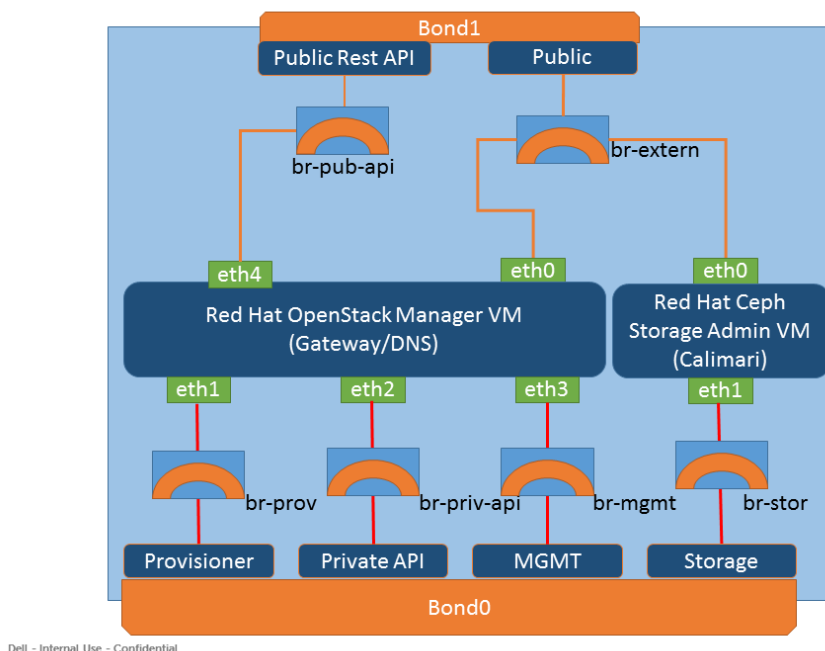


Figure 5: Solution Admin Host Internal Network Fabric

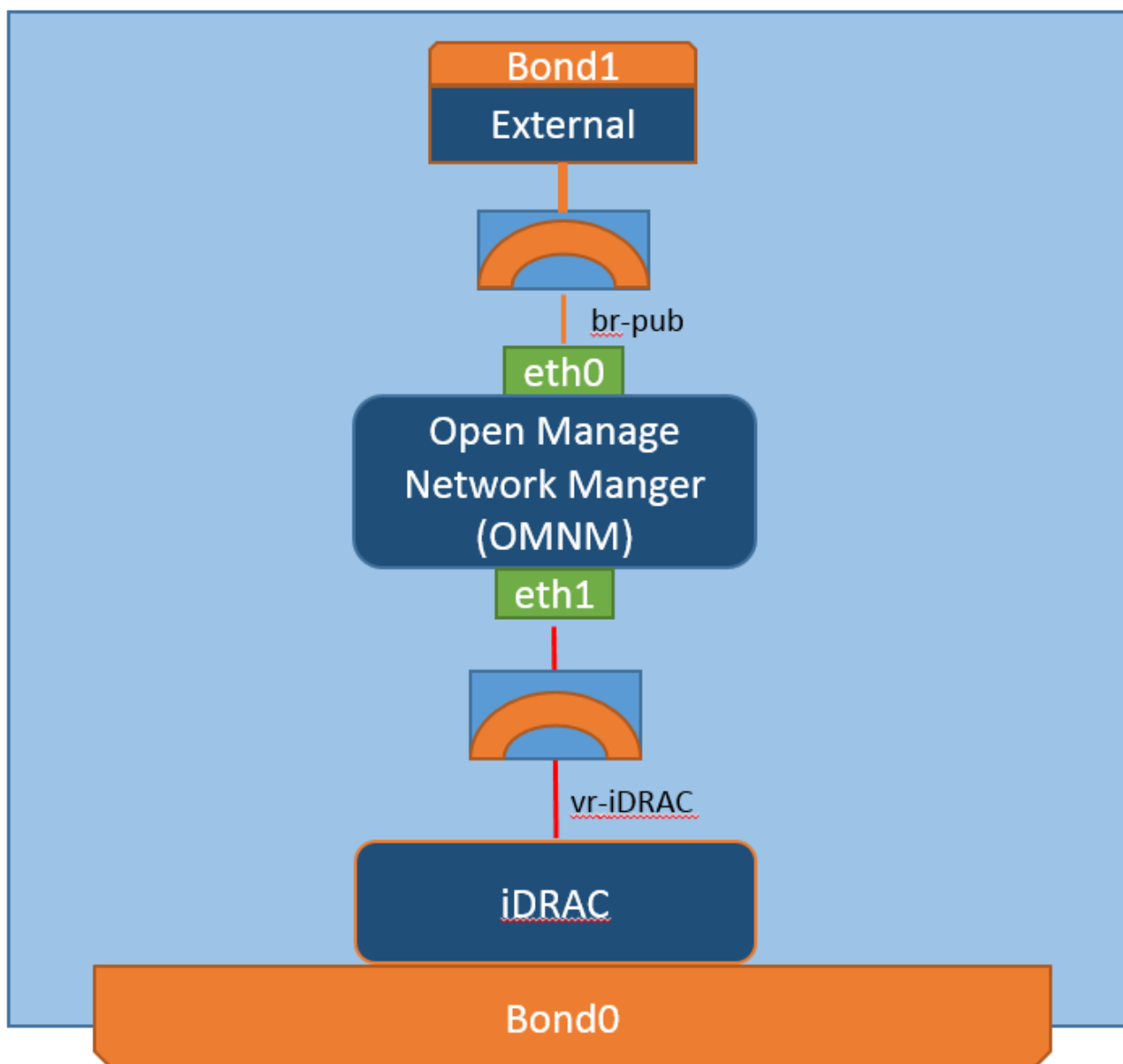
## Virtual Infrastructure Manager (VIM) Node Networking

The Virtual Infrastructure Manager (VIM) has internal bridged networks for the OpenManage Network Manager (OMNM) virtual machine.

The Virtual Infrastructure Manager (VIM) node is physically connected to the following networks:

1. **Public Network** - used for:
  - a. Inbound Access -
    - a. HTTP/HTTPS access to the OpenManage Network Manager (OMNM) Installer Node
  - b. Outbound Access
    - a. HTTP/HTTPS access for OpenManage Network Manager updates
2. **iDRAC** - Used by OpenManage Network Manager (OMNM) to communicate with all of the infrastructure components.

*Figure 6: Virtual Infrastructure Manager (VIM) Node Internal Network Fabric* on page 44 displays how the networks are bridged inside the Virtual Infrastructure Manager (VIM) node host. Since this document does not cover security aspects of a solution deployment, it is strongly urged that appropriate Network and Security teams should be involved before connecting any machine to externally accessible networks.



**Figure 6: Virtual Infrastructure Manager (VIM) Node Internal Network Fabric**

## Optional Solution Configurations

Optional component changes require that the base solution be modified. For example, you can use either the PowerEdge R430 or PowerEdge R730 as OpenStack Compute nodes instead of the PowerEdge R630 (see [Optional Servers](#) on page 22 for more information).

If you replace the PowerEdge R630 OpenStack Computes with either PowerEdge R430 or PowerEdge R730 servers there are no networking changes; just a change of the server hardware. When ordering the servers, the configuration must be similar to the PowerEdge R630. The servers will require:

- Enough disks to build a single RAID 10 set
- At least four (4) Intel® 10G network interface ports
- Two (2) 1Gb network interface ports
- An iDRAC Enterprise

The memory, RAID, and CPU configuration should be sized based upon expected workloads.

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# Appendix

# A

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## Update History

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**Topics:**

- [Initial Release](#)
- [Version 1](#)
- [Version 2](#)
- [Version 3](#)
- [Version 4](#)
- [Version 5](#)

This appendix lists changes to this document, per major release.

## Initial Release

First Reference Architecture for the Dell EMC Red Hat OpenStack Cloud Solution with Red Hat OpenStack Platform.

## Version 1

Update to support:

- Red Hat OpenStack Provisioning 5 Icehouse
- R620
- Red Hat Ceph Storage
- Cinder Multi-Backend and Multi-Instance
- Dell EMC EqualLogic (PS Series)
- HA

## Version 2

Updated as follows:

- New network diagrams
- Support for HA-only clusters
- Support for up to three (3) racks of equipment
- Renamed *Admin Node* to *Solution Admin Host*
- Added Virtual Servers to support Provisioning nodes
- Added optional Gateways for Provisioning/Storage/Management networks

## Version 3

Updated as follows:

- New network diagram
- Added support for PowerEdge R630 and R730xd
- Removed support for PowerEdge R620, R720, and R720xd
- Added support for OpenStack Neutron
- Removed support for Nova-Network
- Removed the POC from the Solution
- Updated to OpenStack Version: Grizzly
- Updated to RHOSP 7
- Standardized terminology for platforms and nodes

Update 1

- New Network Diagram
  - SAH changes
    - 1Gbe to external
    - Private API to bond
- Solution Admin Diagram

- Added Private API for Tempest Test Node
- Added Tempest Test Node
- Solution Admin Diagram Text
  - Added Private API for Tempest Test Node
  - Added Tempest Test Node to Public API Outbound
- Server Networking
  - Added discussion about the new bond modes and what is used by solution
  - Added table outline all modes and what can be used where.
    - Indicated the “solution default” on all modes

## Version 4

Updated as follows:

- Updated to OpenStack Version: Kilo
- Updated Taxonomy
- Added support for PowerEdge R430 and R730
- Added Ceph Object Store support with RADOS Gateway
- Standardized terminology for platforms and nodes
- Added Dell Storage Options

## Version 5

Updated as follows:

- Updated to OpenStack Version: Mitaka
- Red Hat OpenStack Platform version 9.
- Added PowerEdge R730xd 24-drive variants as optional Compute and Storage nodes.

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# Appendix

# B

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## References

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### Topics:

- [To Learn More](#)

Additional information can be obtained at <http://www.dell.com/nfv> or by e-mailing [nfv@dell.com](mailto:nfv@dell.com).

If you need additional services or implementation help, please contact your Dell EMC sales representative.

## To Learn More

For more information on the Dell EMC Red Hat OpenStack Cloud Solution visit <http://www.dell.com/learn/us/en/04/solutions/red-hat-openstack>.

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