NetApp HCI with Red Hat Virtualization

NetApp HCI Solutions

NetApp
June 10, 2024

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NVA-1148: NetApp HCI with Red Hat Virtualization

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NetApp HCI with Red Hat Virtualization is a verified, best-practice architecture for the deployment of an on-premises virtual datacenter environment in a reliable and dependable manner.

This architecture reference document serves as both a design guide and a deployment validation of the Red Hat Virtualization solution on NetApp HCI. The architecture described in this document has been validated by subject matter experts at NetApp and Red Hat to provide a best-practice implementation for an enterprise virtual datacenter deployment using Red Hat Virtualization on NetApp HCI within your own enterprise datacenter environment.

Use Cases

The NetApp HCI for Red Hat OpenShift on Red Hat Virtualization solution is architected to deliver exceptional value for customers with the following use cases:

1. Infrastructure to scale on demand with NetApp HCI
2. Enterprise virtualized workloads in Red Hat Virtualization

Value Proposition and Differentiation of NetApp HCI with Red Hat Virtualization

NetApp HCI provides the following advantages with this virtual infrastructure solution:

- A disaggregated architecture that allows for independent scaling of compute and storage.
- The elimination of virtualization licensing costs and a performance tax on independent NetApp HCI storage nodes.
- NetApp Element storage provides quality of service (QoS) per storage volume and allows for guaranteed storage performance for workloads on NetApp HCI, preventing adjacent workloads from negatively affecting performance.
- The data fabric powered by NetApp allows data to be replicated from an on-premise to on- premise location or replicated to the cloud to move the data closer to where the application needs the data.
- Support through NetApp Support or Red Hat Support.

NetApp HCI Design

NetApp HCI, is the industry’s first and leading disaggregated hybrid cloud infrastructure, providing the widely recognized benefits of hyperconverged solutions. Benefits include lower TCO and ease of acquisition, deployment, and management for virtualized workloads, while also allowing enterprise customers to independently scale compute and storage resources as needed. NetApp HCI with Red Hat Virtualization provides an open source, enterprise virtualization environment based on Red Hat Enterprise Linux.

By providing an agile turnkey infrastructure platform, NetApp HCI enables you to run enterprise-class virtualized and containerized workloads in an accelerated manner. At its core, NetApp HCI is designed to provide predictable performance, linear scalability of both compute and storage resources, and a simple deployment and management experience.

Predictable

One of the biggest challenges in a multitenant environment is delivering consistent, predictable performance for all your workloads. Running multiple enterprise-grade workloads can result in resource contention, where one workload interferes with the performance of another. NetApp HCI alleviates this concern with storage quality-of-service (QoS) limits that are available natively with NetApp Element software. Element enables the granular control of every application and volume, helps to eliminate noisy neighbors, and satisfies enterprise performance SLAs. NetApp HCI multitenancy capabilities can help eliminate many traditional performance-related problems.

Flexible

Previous generations of hyperconverged infrastructure typically required fixed resource ratios, limiting deployments to four-node and eight-node configurations. NetApp HCI is a disaggregated hyper-converged infrastructure that can scale compute and storage resources independently. Independent scaling prevents costly and inefficient overprovisioning, eliminates the 10% to 30% HCI tax from controller virtual machine (VM) overhead, and simplifies capacity and performance planning. NetApp HCI is available in mix-and-match, small, medium, and large storage and compute configurations.

The architectural design choices offered enable you to confidently scale on your terms, making HCI viable for core Tier-1 data center applications and platforms. NetApp HCI is architected in building blocks at either the chassis or the node level. Each chassis can hold four nodes in a mixed configuration of storage or compute nodes.

Simple

A driving imperative within the IT community is to simplify deployment and automate routine tasks, eliminating the risk of user error while freeing up resources to focus on more interesting, higher-value projects. NetApp HCI can help your IT department become more agile and responsive by both simplifying deployment and ongoing management.

Business Value

Enterprises that perform virtualization in an open-source data center with Red Hat products can realize the value of this solution by following the recommended design, deployment, and best practices described in this document. The detailed setup of RHV on NetApp HCI provides several benefits when deployed as part of an enterprise virtualization solution:

- High availability at all layers of the stack
- Thoroughly documented deployment procedures
- Nondisruptive operations and upgrades to hypervisors and the manager VM
- API-driven, programmable infrastructure to facilitate management
- Multitenancy with performance guarantees
- The ability to run virtualized workloads based on KVM with enterprise-grade features and support
- The ability to scale infrastructure independently based on workload demands

NetApp HCI with Red Hat Virtualization acknowledges these challenges and helps address each concern by implementing a verified architecture for solution deployment.

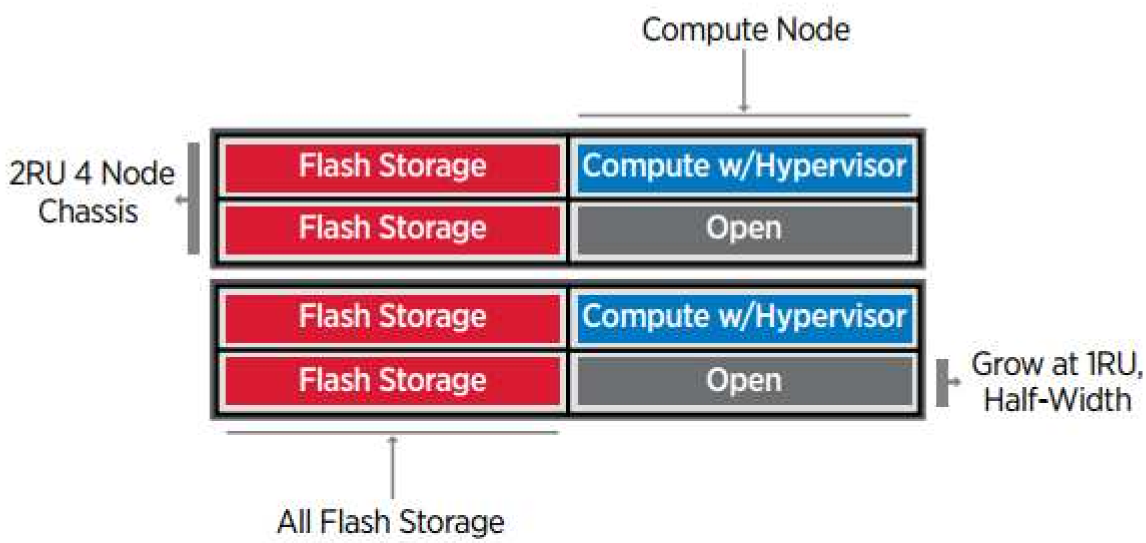
Technology Overview

With NetApp HCI for Red Hat Virtualization, you can deploy a fully integrated, production-grade virtual data center that allows you to take advantage of the following features:

- NetApp HCI compute and storage nodes
  - Enterprise-grade hyperconverged infrastructure designed for hybrid cloud workloads
  - NetApp Element storage software
  - Intel- based server compute nodes, including options for NVIDIA GPUs
- Red Hat Virtualization
  - Enterprise hypervisor solution for deployment and management of virtual infrastructures

NetApp HCI

NetApp HCI is an enterprise-scale disaggregated hybrid cloud infrastructure (HCI) solution that delivers compute and storage resources in an agile, scalable, and easy-to-manage two-rack unit (2RU) four-node building block. It can also be configured with 1RU compute and server nodes. The minimum deployment consists of four NetApp HCI storage nodes and two NetApp HCI compute nodes. The compute nodes are installed as RHV-H hypervisors in an HA cluster. This minimum deployment can be easily scaled to fit customer enterprise workload demands by adding additional NetApp HCI storage or compute nodes to expand available resources.



The design for NetApp HCI for Red Hat Virtualization consists of the following components in a minimum starting configuration:

- NetApp H-Series all-flash storage nodes running NetApp Element software
- NetApp H-Series compute nodes running the Red Hat Virtualization RHV-H hypervisor

For more information about compute and storage nodes in NetApp HCI, see the NetApp HCI Datasheet.

NetApp Element Software

NetApp Element software provides modular, scalable performance, with each storage node delivering guaranteed capacity and throughput to the environment. You can also specify per-volume storage QoS policies to support dedicated performance levels for even the most demanding workloads.

iSCSI Login Redirection and Self-Healing Capabilities

NetApp Element software uses the iSCSI storage protocol, a standard way to encapsulate SCSI commands on a traditional TCP/IP network. When SCSI standards change or when Ethernet network performance improves, the iSCSI storage protocol benefits without the need for any changes.

Although all storage nodes have a management IP and a storage IP, NetApp Element software advertises a single storage virtual IP address (SVIP address) for all storage traffic in the cluster. As a part of the iSCSI login process, storage can respond that the target volume has been moved to a different address, and therefore it cannot proceed with the negotiation process. The host then reissues the login request to the new address in a process that requires no host-side reconfiguration. This process is known as iSCSI login redirection.

iSCSI login redirection is a key part of the NetApp Element software cluster. When a host login request is received, the node decides which member of the cluster should handle the traffic based on IOPS and the capacity requirements for the volume. Volumes are distributed across the NetApp Element software cluster and are redistributed if a single node is handling too much traffic for its volumes or if a new node is added. Multiple copies of a given volume are allocated across the array. In this manner, if a node failure is followed by volume redistribution, there is no effect on host connectivity beyond a logout and login with redirection to the new location. With iSCSI login redirection, a NetApp Element software cluster is a self-healing, scale-out architecture that is capable of non- disruptive upgrades and operations.

NetApp Element Software Cluster QoS

A NetApp Element software cluster allows QoS to be dynamically configured on a per-volume basis. You can use per-volume QoS settings to control storage performance based on SLAs that you define. The following three configurable parameters define the QoS:

- **Minimum IOPS.** The minimum number of sustained IOPS that the NetApp Element software cluster provides to a volume. The minimum IOPS configured for a volume is the guaranteed level of performance for a volume. Per-volume performance does not drop below this level.
- **Maximum IOPS.** The maximum number of sustained IOPS that the NetApp Element software cluster provides to a specific volume.
- **Burst IOPS.** The maximum number of IOPS allowed in a short burst scenario. The burst duration setting is configurable, with a default of 1 minute. If a volume has been running below the maximum IOPS level, burst credits are accumulated. When performance levels become very high and are pushed, short bursts of IOPS beyond the maximum IOPS are allowed on the volume.

Multitenancy

Secure multitenancy is achieved with the following features:

- **Secure authentication.** The Challenge-Handshake Authentication Protocol (CHAP) is used for secure volume access. The Lightweight Directory Access Protocol (LDAP) is used for secure access to the cluster for management and reporting.
- **Volume access groups (VAGs).** Optionally, VAGs can be used in lieu of authentication, mapping any number of iSCSI initiator-specific iSCSI Qualified Names (IQNs) to one or more volumes. To access a volume in a VAG, the initiator’s IQN must be in the allowed IQN list for the group of volumes.
- **Tenant virtual LANs (VLANs).** At the network level, end-to-end network security between iSCSI initiators and the NetApp Element software cluster is facilitated by using VLANs. For any VLAN that is created to isolate a workload or a tenant, Element software creates a separate iSCSI target SVIP address that is

accessible only through the specific VLAN.

- **VPN routing/forwarding (VRF)-enabled VLANs.** To further support security and scalability in the data center, Element software allows you to enable any tenant VLAN for VRF-like functionality. This feature adds these two key capabilities:
    - **L3 routing to a tenant SVIP address.** This feature allows you to situate iSCSI initiators on a separate network or VLAN from that of the NetApp Element software cluster.
    - **Overlapping or duplicate IP subnets.** This feature enables you to add a template to tenant environments, allowing each respective tenant VLAN to be assigned IP addresses from the same IP subnet. This capability can be useful for service provider environments where scale and preservation of IP- space are important.

Enterprise Storage Efficiencies

The NetApp Element software cluster increases overall storage efficiency and performance. The following features are performed inline, are always on, and require no manual configuration by the user:

- **Deduplication.** The system only stores unique 4K blocks. Any duplicate 4K blocks are automatically associated with an already stored version of the data. Data is on block drives and is mirrored with Element Helix data protection. This system significantly reduces capacity consumption and write operations within the system.
- **Compression.** Compression is performed inline before data is written to NVRAM. Data is compressed, stored in 4K blocks, and remains compressed in the system. This compression significantly reduces capacity consumption, write operations, and bandwidth consumption across the cluster.
- **Thin provisioning.** This capability provides the right amount of storage at the time that you need it, eliminating capacity consumption that caused by overprovisioned volumes or underutilized volumes.
- **Helix.** The metadata for an individual volume is stored on a metadata drive and is replicated to a secondary metadata drive for redundancy.

> Element was designed for automation. All the storage features mentioned above can be managed with APIs. These APIs are the only method that the UI uses to control the system and can be incorporated into user workflows to ease the management of the solution.

Red Hat Virtualization

Red Hat Virtualization (RHV) is an enterprise virtual data center platform that runs on Red Hat Enterprise Linux using the KVM hypervisor.

For more information about Red Hat Virtualization, see the website located here.

RHV provides the following features:

- **Centralized management of VMs and hosts.** The RHV manager runs as a physical or VM in the deployment and provides a web-based GUI for the management of the solution from a central interface.
- **Self-Hosted Engine.** To minimize the hardware requirements, RHV allows RHV Manager to be deployed as a VM on the same hosts that run guest VMs.
- **High Availability.** To avoid disruption from host failures, RHV allows VMs to be configured for high availability. The highly available VMs are controlled at the cluster level using resiliency policies.
- **High Scalability.** A single RHV cluster can have up to 200 hypervisor hosts, enabling it to support the requirements of massive VMs to hold resource-greedy enterprise-class workloads.

- **Enhanced security.** Inherited from RHEL, Secure Virtualization (sVirt) and Security Enhanced Linux (SELinux) technologies are employed by RHV for the purposes of elevated security and hardening for the hosts and VMs. The key advantage from these features is logical isolation of a VM and its associated resources.

Red Hat Virtualization Manager

Red Hat Virtualization Manager (RHV-M) provides centralized enterprise-grade management for the physical and logical resources within the RHV virtualized environment. A web-based GUI with different role- based portals is provided to access RHV-M features.

RHV-M exposes configuration and management of RHV resources with open-source, community-driven RESTful APIs. It also supports full-fledged integration with Red Hat CloudForms and Red Hat Ansible for automation and orchestration.

Red Hat Virtualization Hosts

Hosts (also called hypervisors) are the physical servers that provide hardware resources for the VMs to run on. A kernel-based virtual machine (KVM) provides full virtualization support, and Virtual Desktop Server Manager (VDSM) is the host agent that is responsible for host communication with the RHV-M.

The two types of hosts supported in Red Hat Virtualization are Red Hat Virtualization Hosts (RHV-H) and Red Hat Enterprise Linux hosts (RHEL).

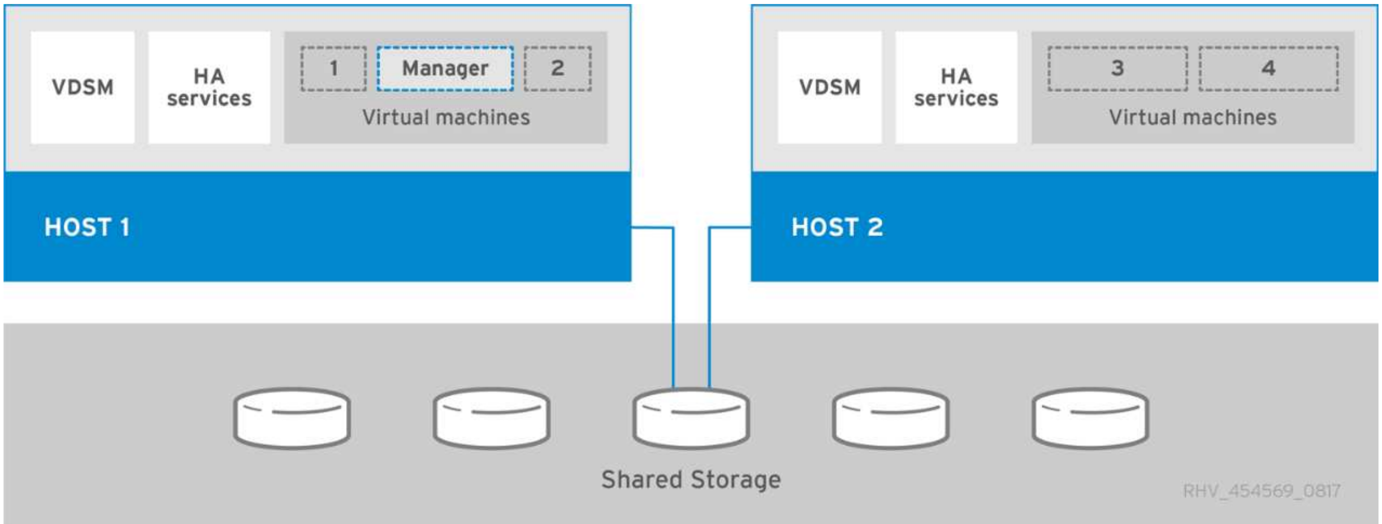
RHV-H is a minimal, light-weight operating system based on Red Hat Enterprise Linux that is optimized for the ease of setting up physical servers as RHV hypervisors.

RHEL hosts are servers that run the standard Red Hat Enterprise Linux operating system. They can then be configured with the required subscriptions to install the packages required to permit the physical servers to be used as RHV hosts.

Red Hat Virtualization Architecture

Red Hat Virtualization can be deployed in two different architectures, with the RHV-M as a physical server in the infrastructure or with the RHV-M configured as a self-hosted engine. NetApp recommends using the self-hosted engine deployment, in which the RHV-M is a VM hosted in the same environment as other VMs, as we do in this guide.

A minimum of two self-hosted nodes are required for high availability of guest VMs and RHV-M. To provide high availability for the manager VM, HA services are enabled and run on all the self-hosted engine nodes.



Architecture Overview: NetApp HCI with RHV

Hardware Requirements

The following table lists the minimum number of hardware components that are required to implement the solution. The hardware components that are used in specific implementations of the solution might vary based on customer requirements.

Hardware	Model	Quantity
NetApp HCI compute nodes	NetApp H410C	2
NetApp HCI storage nodes	NetApp H410S	4
Data switches	Mellanox SN2010	2
Management switches	Cisco Nexus 3048	2

Software Requirements

The following table lists the software components that are required to implement the solution. The software components that are used in any implementation of the solution might vary based on customer requirements.

Software	Purpose	Version
NetApp HCI	Infrastructure (compute/storage)	1.8
NetApp Element	Storage	12.0
Red Hat Virtualization	Virtualization	4.3.9

Design Considerations: NetApp HCI with RHV

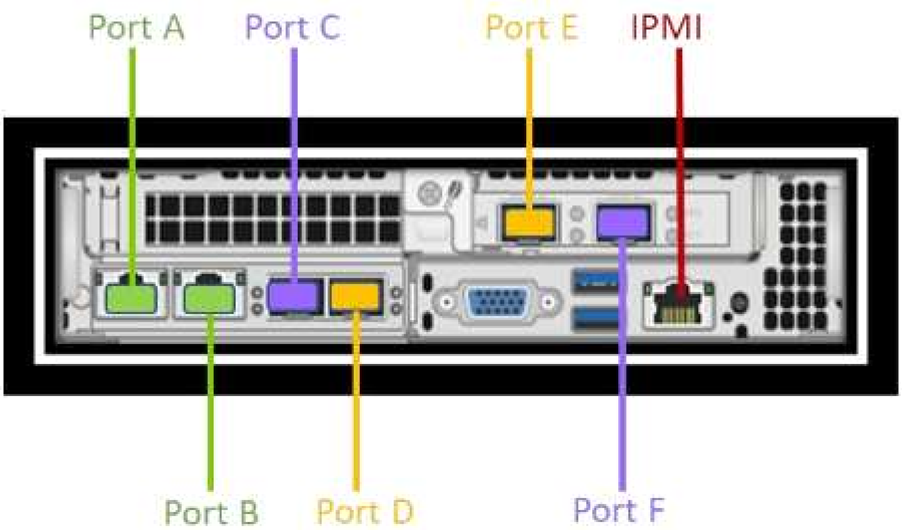
Review the following design considerations when developing your deployment strategy.

Networking Requirements

This section describes the networking requirements for the deployment of Red Hat Virtualization on NetApp HCI as a validated solution. It provides physical diagrams of the network ports on both the NetApp HCI compute nodes and the switches deployed in the solution. This section also describes the arrangement and purpose of each virtual network segment used in the solution.

Port Identification

NetApp HCI consists of NetApp H-Series nodes dedicated to either compute or storage. Both node configurations are available with two 1GbE ports (ports A and B) and two 10/25GbE ports (ports C and D) on board. The compute nodes have additional 10/25GbE ports (ports E and F) available in the first mezzanine slot. Each node also has an additional out-of-band management port that supports Intelligent Platform Management Interface (IPMI) functionality. Each of these ports on the rear of an H410C node can be seen in the following figure.



Network Design

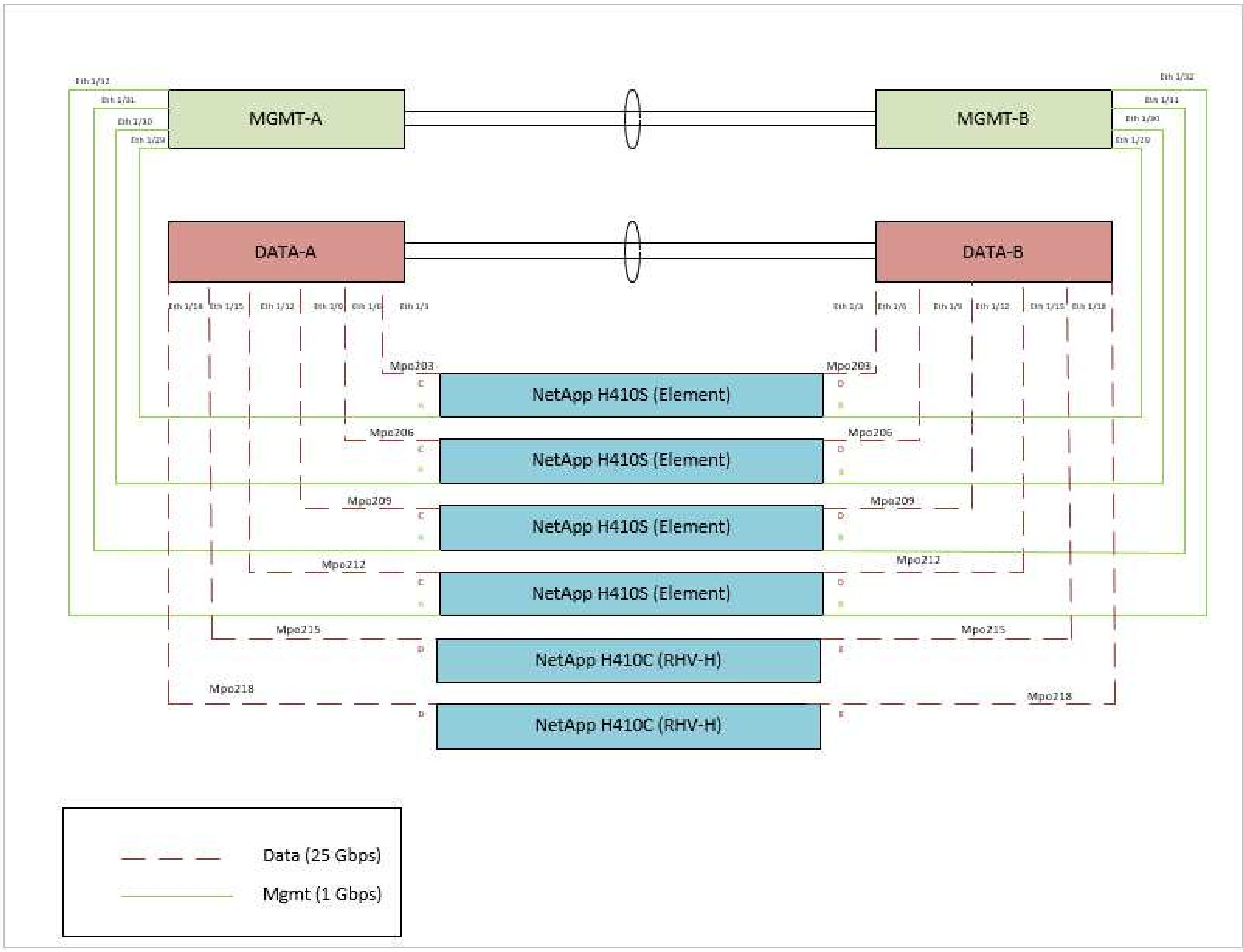
The NetApp HCI with Red Hat Virtualization solution uses two data switches to provide primary data connectivity at 25Gbps. It also uses two additional management switches that provide connectivity at 1Gbps for in-band management for the storage nodes and out-of-band management for IPMI functionality.

Cabling Storage Nodes

The management ports A and B must be active on each storage node to configure the NetApp HCI cluster, and provide management accessibility to Element after the solution is deployed. The two 25Gbps ports (C and D) should be connected, one to each data switch, to provide physical fault tolerance. The switch ports should be configured for multi-chassis link aggregation (MLAG) and the data ports on the node should be configured for LACP with jumbo-frames support enabled. The IPMI ports on each node can be used to remotely manage the node after it is installed in a data center. With IPMI, the node can be accessed with a web-browser-based console to run the initial installation, run diagnostics, and reboot or shut down the node if necessary.

Cabling Compute Nodes

The two 25Gbps ports (C and E) should be connected, one to each data switch, to provide physical fault tolerance. The switch ports should be configured for multi-chassis link aggregation (MLAG), and the data ports on the node should be configured for LACP with jumbo-frames support enabled. The IPMI ports can also be used to remotely manage the node after it is installed in a data center. With IPMI, the node can be accessed with a web-browser- based console to run the initial installation, run diagnostics, and reboot or shut down the node if necessary.



VLAN Requirements

The solution is designed to logically separate network traffic for different purposes by using Virtual Local Area Networks (VLANs). NetApp HCI requires a minimum of three network segments. However, this configuration can be scaled to meet customer demands or to provide further isolation for specific network services. The following table lists the VLANs that are required to implement the solution, as well as the specific VLAN IDs that are used later in the validated architecture deployment.

VLANs	Purpose	VLAN Used
Out-of-band management network	Management for HCI nodes / IPMI	16
In-band management network	Management for HCI nodes / ovirtmgmt	1172
Storage network	Storage network for NetApp Element.	3343
Migration network	Network for virtual guest migration.	3345

VLANs	Purpose	VLAN Used
VM network	Network for virtual guests.	3346

Network Infrastructure Support Resources

The following infrastructure should be in place prior to the deployment of the Red Hat Virtualization on NetApp HCI solution:

- At least one DNS server providing full host-name resolution that is accessible from the in-band management network and the VM network.
- At least one NTP server that is accessible from the in-band management network and the VM network.
- Outbound internet connectivity is recommended, but not required, for both the in-band management network and the VM network.

Deployment Procedures NetApp HCI with RHV

Deployment Summary: NetApp HCI with RHV

The detailed steps provided in this section provide a validation for the minimum hardware and software configuration required to deploy and validate the NetApp HCI with Red Hat Virtualization solution.

Deploying Red Hat Virtualization for NetApp HCI involves the following high-level tasks:

1. Configure Management Switches
2. Configure Data Switches
3. Deploy Element Storage System on HCI Storage Nodes
4. Install RHV-H to HCI Compute Nodes
5. Deploy RHV Manager as a Self-hosted Engine
6. Deploy Test VMs
7. Test HA Functionality

1. Configure Management Switches: NetApp HCI with RHV

Cisco Nexus 3048 switches are used in this deployment procedure to provide 1Gbps connectivity for in and out-of-band management of the compute and storage nodes. These steps begin after the switches have been racked, powered, and put through the initial setup process. To configure the switches to provide management connectivity to the infrastructure, complete the following steps:

Enable Advanced Features for Cisco Nexus

Run the following commands on each Cisco Nexus 3048 switch to configure advanced features:

1. Enter configuration mode.

```
Switch-01# configure terminal
```

2. Enable VLAN functionality.

```
Switch-01(config)# feature interface-vlan
```

3. Enable LACP.

```
Switch-01(config)# feature lacp
```

4. Enable virtual port channels (vPCs).

```
Switch-01(config)# feature vpc
```

5. Set the global port-channel load-balancing configuration.

```
Switch-01(config)# port-channel load-balance src-dst ip-l4port
```

6. Perform global spanning-tree configuration.

```
Switch-01(config)# spanning-tree port type network default
Switch-01(config)# spanning-tree port type edge bpduguard default
```

Configure Ports on the Switch for In-Band Management

1. Run the following commands to create VLANs for management purposes:

```
Switch-01(config)# vlan 2
Switch-01(config-vlan)# Name Native_VLAN
Switch-01(config-vlan)# vlan 16
Switch-01(config-vlan)# Name OOB_Network
Switch-01(config-vlan)# vlan 1172
Switch-01(config-vlan)# Name MGMT_Network
Switch-01(config-vlan)# exit
```

2. Configure the ports ETH1/29-32 as VLAN trunk ports that connect to management interfaces on each HCI storage node.

```
Switch-01(config)# int eth 1/29
Switch-01(config-if)# description HCI-STG-01 PortA
Switch-01(config-if)# switchport mode trunk
Switch-01(config-if)# switchport trunk native vlan 2
Switch-01(config-if)# switchport trunk allowed vlan 1172
Switch-01(config-if)# spanning tree port type edge trunk
Switch-01(config-if)# int eth 1/30
Switch-01(config-if)# description HCI-STG-02 PortA
Switch-01(config-if)# switchport mode trunk
Switch-01(config-if)# switchport trunk native vlan 2
Switch-01(config-if)# switchport trunk allowed vlan 1172
Switch-01(config-if)# spanning tree port type edge trunk
Switch-01(config-if)# int eth 1/31
Switch-01(config-if)# description HCI-STG-03 PortA
Switch-01(config-if)# switchport mode trunk
Switch-01(config-if)# switchport trunk native vlan 2
Switch-01(config-if)# switchport trunk allowed vlan 1172
Switch-01(config-if)# spanning tree port type edge trunk
Switch-01(config-if)# int eth 1/32
Switch-01(config-if)# description HCI-STG-04 PortA
Switch-01(config-if)# switchport mode trunk
Switch-01(config-if)# switchport trunk native vlan 2
Switch-01(config-if)# switchport trunk allowed vlan 1172
Switch-01(config-if)# spanning tree port type edge trunk
Switch-01(config-if)# exit
```

Configure Ports on the Switch for Out-of-Band Management

Run the following commands to configure the ports for cabling the IPMI interfaces on each HCI node.

```
Switch-01(config)# int eth 1/13
Switch-01(config-if)# description HCI-CMP-01 IPMI
Switch-01(config-if)# switchport mode access
Switch-01(config-if)# switchport access vlan 16
Switch-01(config-if)# spanning-tree port type edge
Switch-01(config-if)# int eth 1/14
Switch-01(config-if)# description HCI-STG-01 IPMI
Switch-01(config-if)# switchport mode access
Switch-01(config-if)# switchport access vlan 16
Switch-01(config-if)# spanning-tree port type edge
Switch-01(config-if)# int eth 1/15
Switch-01(config-if)# description HCI-STG-03 IPMI
Switch-01(config-if)# switchport mode access
Switch-01(config-if)# switchport access vlan 16
Switch-01(config-if)# spanning-tree port type edge
Switch-01(config-if)# exit
```

In the validated configuration, we cabled odd-node IPMI interfaces to Switch-01 and even-node IPMI interfaces to Switch-02.

Create a vPC Domain to Ensure Fault Tolerance

1. Activate the ports used for the vPC peer-link between the two switches.

   ```
   Switch-01(config)# int eth 1/1
   Switch-01(config-if)# description vPC peer-link Switch-02 1/1
   Switch-01(config-if)# int eth 1/2
   Switch-01(config-if)# description vPC peer-link Switch-02 1/2
   Switch-01(config-if)# exit
   ```

2. Perform the vPC global configuration.

```
Switch-01(config)# vpc domain 1
Switch-01(config-vpc-domain)# role priority 10
Switch-01(config-vpc-domain)# peer-keepalive destination <switch-
02_mgmt_address> source <switch-01_mgmt_address> vrf managment
Switch-01(config-vpc-domain)# peer-gateway
Switch-01(config-vpc-domain)# auto recovery
Switch-01(config-vpc-domain)# ip arp synchronize
Switch-01(config-vpc-domain)# int eth 1/1-2
Switch-01(config-vpc-domain)# channel-group 10 mode active
Switch-01(config-vpc-domain)# int Po10
Switch-01(config-if)# description vPC peer-link
Switch-01(config-if)# switchport mode trunk
Switch-01(config-if)# switchport trunk native vlan 2
Switch-01(config-if)# switchport trunk allowed vlan 16, 1172
Switch-01(config-if)# spanning-tree port type network
Switch-01(config-if)# vpc peer-link
Switch-01(config-if)# exit
```

2. Configure Data Switches: NetApp HCI with RHV

Mellanox SN2010 switches are used in this deployment procedure to provide 25Gbps connectivity for the data plane of the compute and storage nodes. These steps begin after the switches have been racked, cabled, and put through the initial setup process. To configure the switches to provide data connectivity to the infrastructure, complete the following steps:

Create MLAG Cluster to Provide Fault Tolerance

1. Run the following commands on each Mellanox SN210 switch for general configuration:
   a. Enter configuration mode.

   ```
   Switch-01 enable
   Switch-01 configure terminal
   ```

   b. Enable the LACP required for the Inter-Peer Link (IPL).

   ```
   Switch-01 (config) # lacp
   ```

   c. Enable the Link Layer Discovery Protocol (LLDP).

   ```
   Switch-01 (config) # lldp
   ```

d. Enable IP routing.

```
Switch-01 (config) # ip routing
```

e. Enable the MLAG protocol.

```
Switch-01 (config) # protocol mlag
```

f. Enable global QoS.

```
Switch-01 (config) # dcb priority-flow-control enable force
```

2. For MLAG to function, the switches must be made peers to each other through an IPL. This should consist of two or more physical links for redundancy. The MTU for the IPL is set for jumbo frames (9216), and all VLANs are enabled by default. Run the following commands on each switch in the domain:

a. Create port channel 10 for the IPL.

```
Switch-01 (config) # interface port-channel 10
Switch-01 (config interface port-channel 10) # description IPL
Switch-01 (config interface port-channel 10) # exit
```

b. Add interfaces ETH 1/20 and 1/22 to the port channel.

```
Switch-01 (config) # interface ethernet 1/20 channel-group 10 mode
active
Switch-01 (config) # interface ethernet 1/20 description ISL-SWB_01
Switch-01 (config) # interface ethernet 1/22 channel-group 10 mode
active
Switch-01 (config) # interface ethernet 1/22 description ISL-SWB_02
```

c. Create a VLAN outside of the standard range dedicated to IPL traffic.

```
Switch-01 (config) # vlan 4000
Switch-01 (config vlan 4000) # name IPL VLAN
Switch-01 (config vlan 4000) # exit
```

d. Define the port channel as the IPL.

```
Switch-01 (config) # interface port-channel 10 ipl 1
Switch-01 (config) # interface port-channel 10 dcb priority-flow-
control mode on force
```

e. Set an IP for each IPL member (non-routable; it is not advertised outside of the switch).

```
Switch-01 (config) # interface vlan 4000
Switch-01 (config vlan 4000) # ip address 10.0.0.1 255.255.255.0
Switch-01 (config vlan 4000) # ipl 1 peer-address 10.0.0.2
Switch-01 (config vlan 4000) # exit
```

3. Create a unique MLAG domain name for the two switches and assign a MLAG virtual IP (VIP). This IP is used for keep-alive heartbeat messages between the two switches. Run these commands on each switch in the domain:

   a. Create the MLAG domain and set the IP address and subnet.

```
Switch-01 (config) # mlag-vip MLAG-VIP-DOM ip a.b.c.d /24 force
```

   b. Create a virtual MAC address for the system MLAG.

```
Switch-01 (config) # mlag system-mac AA:BB:CC:DD:EE:FF
```

   c. Configure the MLAG domain so that it is active globally.

```
Switch-01 (config) # no mlag shutdown
```

The IP used for the MLAG VIP must be in the same subnet as the switch management network (mgmt0). Also, The MAC address used can be any unicast MAC address and must be set to the same value on both switches in the MLAG domain.

Configure Ports to Connect to Storage and Compute Hosts

1. Create each of the VLANs needed to support the services for NetApp HCI. Run these commands on each switch in the domain:

   a. Create the VLANs.

```
Switch-01 (config) # vlan 1172
Switch-01 (config vlan 1172) exit
Switch-01 (config) # vlan 3343
Switch-01 (config vlan 3343) exit
Switch-01 (config) # vlan 3344
Switch-01 (config vlan 3345) exit
Switch-01 (config) # vlan 3345
Switch-01 (config vlan 3346) exit
```

b. Create names for each VLAN for easier accounting.

```
Switch-01 (config) # vlan 1172 name “MGMT_Network”
Switch-01 (config) # vlan 3343 name “Storage_Network”
Switch-01 (config) # vlan 3345 name “Migration_Network”
Switch-01 (config) # vlan 3346 name “VM_Network”
```

2. Create MLAG interfaces and hybrid VLANs on ports identified so that you can distribute connectivity between the switches and tag the appropriate VLANs for the NetApp HCI compute nodes.
   a. Select the ports you want to work with.

```
Switch-01 (config) # interface ethernet 1/15
```

   b. Set the MTU for each port.

```
Switch-01 (config interface ethernet 1/15) # mtu 9216 force
```

   c. Modify spanning- tree settings for each port.

```
Switch-01 (config interface ethernet 1/15) # spanning-tree bpdufilter
enable
Switch-01 (config interface ethernet 1/15) # spanning-tree port type
edge
Switch-01 (config interface ethernet 1/15) # spanning-tree bpduguard
enable
```

   d. Set the switchport mode to hybrid.

```
Switch-01 (config interface ethernet 1/15) # switchport mode hybrid
Switch-01 (config interface ethernet 1/15) # exit
```

e. Create descriptions for each port being modified.

```
Switch-01 (config) # interface ethernet 1/15 description HCI-CMP-01
PortD
```

f. Create and configure the MLAG port channels.

```
Switch-01 (config) # interface mlag-port-channel 215
Switch-01 (config interface mlag-port-channel 215) # exit
Switch-01 (config) # interface mlag-port-channel 215 no shutdown
Switch-01 (config) # interface mlag-port-channel 215 mtu 9216 force
Switch-01 (config) # interface ethernet 1/15 lacp port-priority 10
Switch-01 (config) # interface ethernet 1/15 lacp rate fast
Switch-01 (config) # interface ethernet 1/15 mlag-channel-group 215
mode active
```

g. Tag the appropriate VLANs for the NetApp HCI environment.

```
Switch-01 (config) # interface mlag-port-channel 215 switchport
hybrid
Switch-01 (config) # interface mlag-port-channel 215 switchport
hybrid allowed-vlan add 1172
Switch-01 (config) # interface mlag-port-channel 215 switchport
hybrid allowed-vlan add 3343
Switch-01 (config) # interface mlag-port-channel 215 switchport
hybrid allowed-vlan add 3345
Switch-01 (config) # interface mlag-port-channel 215 switchport
hybrid allowed-vlan add 3346
```

3. Create MLAG interfaces and hybrid VLAN ports identified so that you can distribute connectivity between the switches and tag the appropriate VLANs for the NetApp HCI storage nodes.

a. Select the ports that you want to work with.

```
Switch-01 (config) # interface ethernet 1/3
```

b. Set the MTU for each port.

```
Switch-01 (config interface ethernet 1/3) # mtu 9216 force
```

c. Modify spanning tree settings for each port.

```
Switch-01 (config interface ethernet 1/3) # spanning-tree bpdufilter
enable
Switch-01 (config interface ethernet 1/3) # spanning-tree port type
edge
Switch-01 (config interface ethernet 1/3) # spanning-tree bpduguard
enable
```

d. Set the switchport mode to hybrid.

```
Switch-01 (config interface ethernet 1/3) # switchport mode hybrid
Switch-01 (config interface ethernet 1/3) # exit
```

e. Create descriptions for each port being modified.

```
Switch-01 (config) # interface ethernet 1/3 description HCI-STG-01
PortD
```

f. Create and configure the MLAG port channels.

```
Switch-01 (config) # interface mlag-port-channel 203
Switch-01 (config interface mlag-port-channel 203) # exit
Switch-01 (config) # interface mlag-port-channel 203 no shutdown
Switch-01 (config) # interface mlag-port-channel 203 mtu 9216 force
Switch-01 (config) # interface mlag-port-channel 203 lacp-individual
enable force
Switch-01 (config) # interface ethernet 203 lacp port-priority 10
Switch-01 (config) # interface ethernet 203 lacp rate fast
Switch-01 (config) # interface ethernet 1/3 mlag-channel-group 203
mode active
```

g. Tag the appropriate VLANs for the storage environment.

```
Switch-01 (config) # interface mlag-port-channel 203 switchport mode
hybrid
Switch-01 (config) # interface mlag-port-channel 203 switchport
hybrid allowed-vlan add 1172
Switch-01 (config) # interface mlag-port-channel 203 switchport
hybrid allowed-vlan add 3343
```

ⓘ The configurations in this section show the configuration for a single port as example. They must also be run for each additional port connected in the solution, as well as on the associated port of the second switch in the MLAG domain. NetApp recommends that the descriptions for each port are updated to reflect the device ports that are being cabled and configured on the other switch.

Create Uplink Ports for the Switches

1. Create an MLAG interface to provide uplinks to both Mellanox SN2010 switches from the core network.

```
Switch-01 (config) # interface mlag port-channel 201
Switch-01 (config interface mlag port-channel) # description Uplink
CORE-SWITCH port PORT
Switch-01 (config interface mlag port-channel) # exit
```

2. Configure the MLAG members.

```
Switch-01 (config) # interface ethernet 1/1 description Uplink to CORE-
SWITCH port PORT
Switch-01 (config) # interface ethernet 1/1 speed 10000 force
Switch-01 (config) # interface mlag-port-channel 201 mtu 9216 force
Switch-01 (config) # interface ethernet 1/1 mlag-channel-group 201 mode
active
```

3. Set the switchport mode to hybrid and allow all VLANs from the core uplink switches.

```
Switch-01 (config) # interface mlag-port-channel switchport mode hybrid
Switch-01 (config) # interface mlag-port-channel switchport hybrid
allowed-vlan all
```

4. Verify that the MLAG interface is up.

```
Switch-01 (config) # interface mlag-port-channel 201 no shutdown
Switch-01 (config) # exit
```

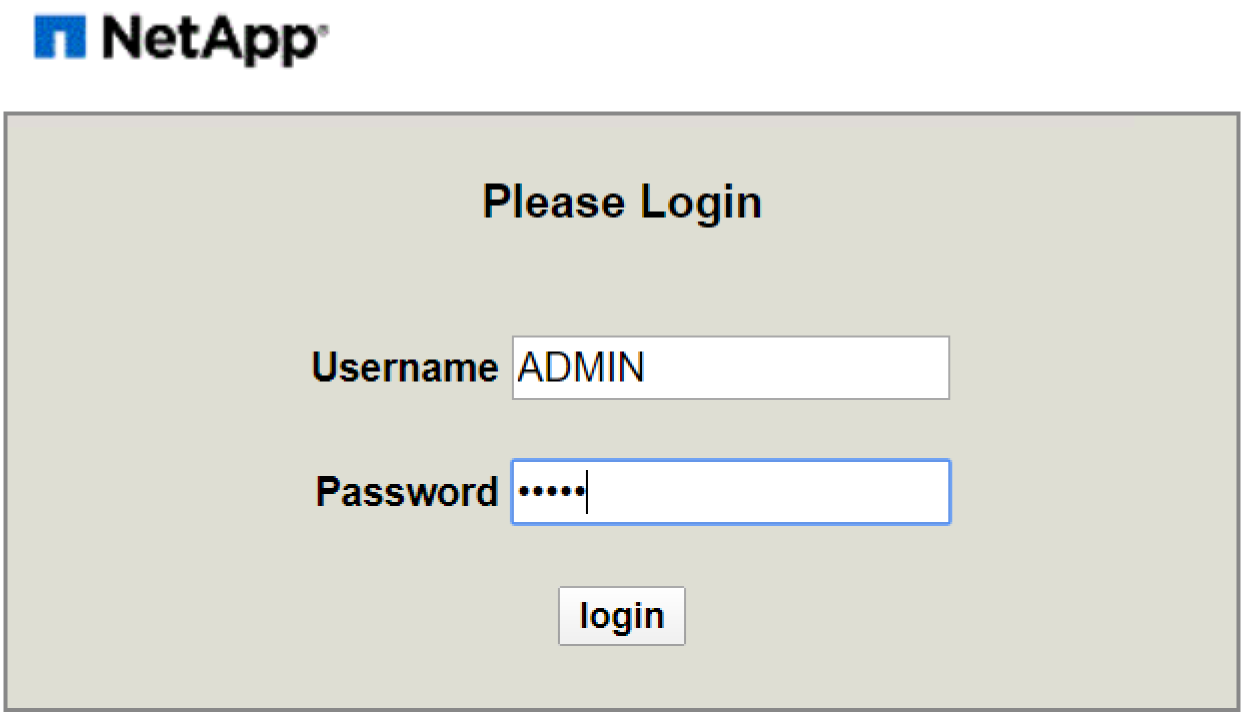
ⓘ The configurations in this section must also be run on the second switch in the MLAG domain. NetApp recommends that the descriptions for each port are updated to reflect the device ports that are being cabled and configured on the other switch.

3. Deploy the Element Storage System on the HCI Storage Nodes: NetApp HCI with RHV

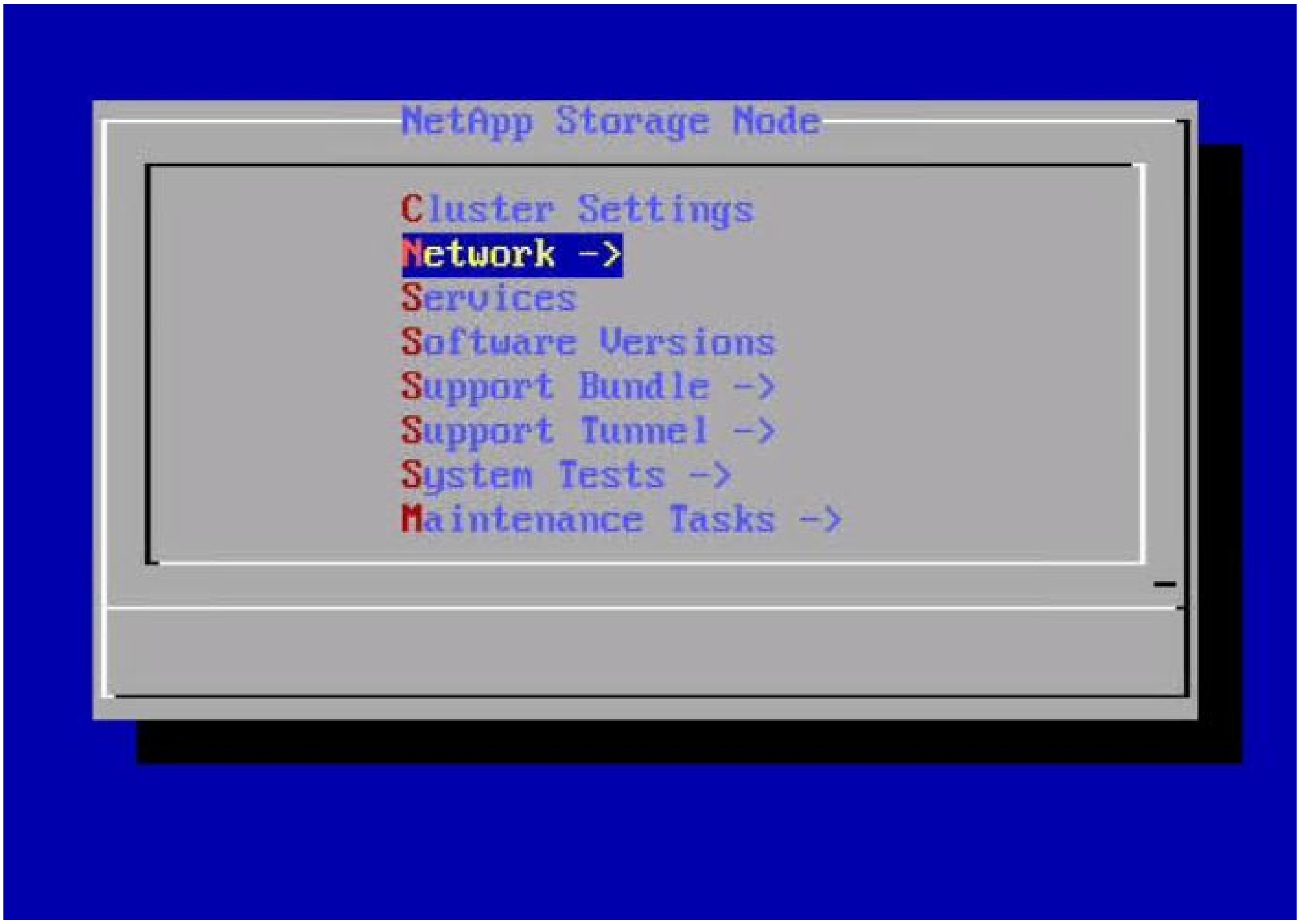
Basic NetApp Element Storage Setup

NetApp Element cluster setup is performed in a manner similar to a standalone NetApp SolidFire storage setup. These steps begin after the nodes have been racked, and cabled, and the IPMI port has been configured on each node using the console. To setup a storage cluster, complete the following steps:

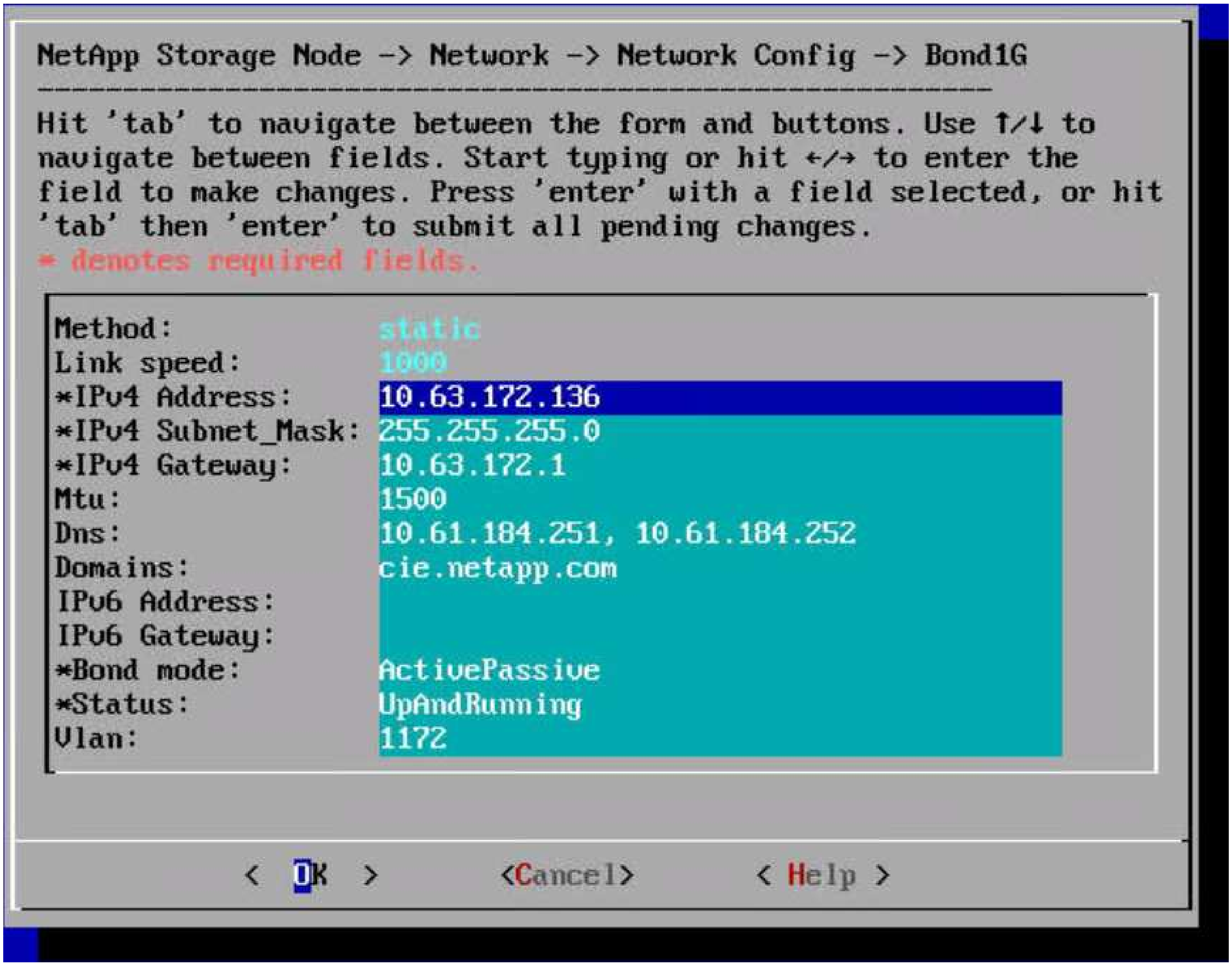
1. Access the out-of-band management console for the storage nodes in the cluster and log in with the default credentials ADMIN/ADMIN.



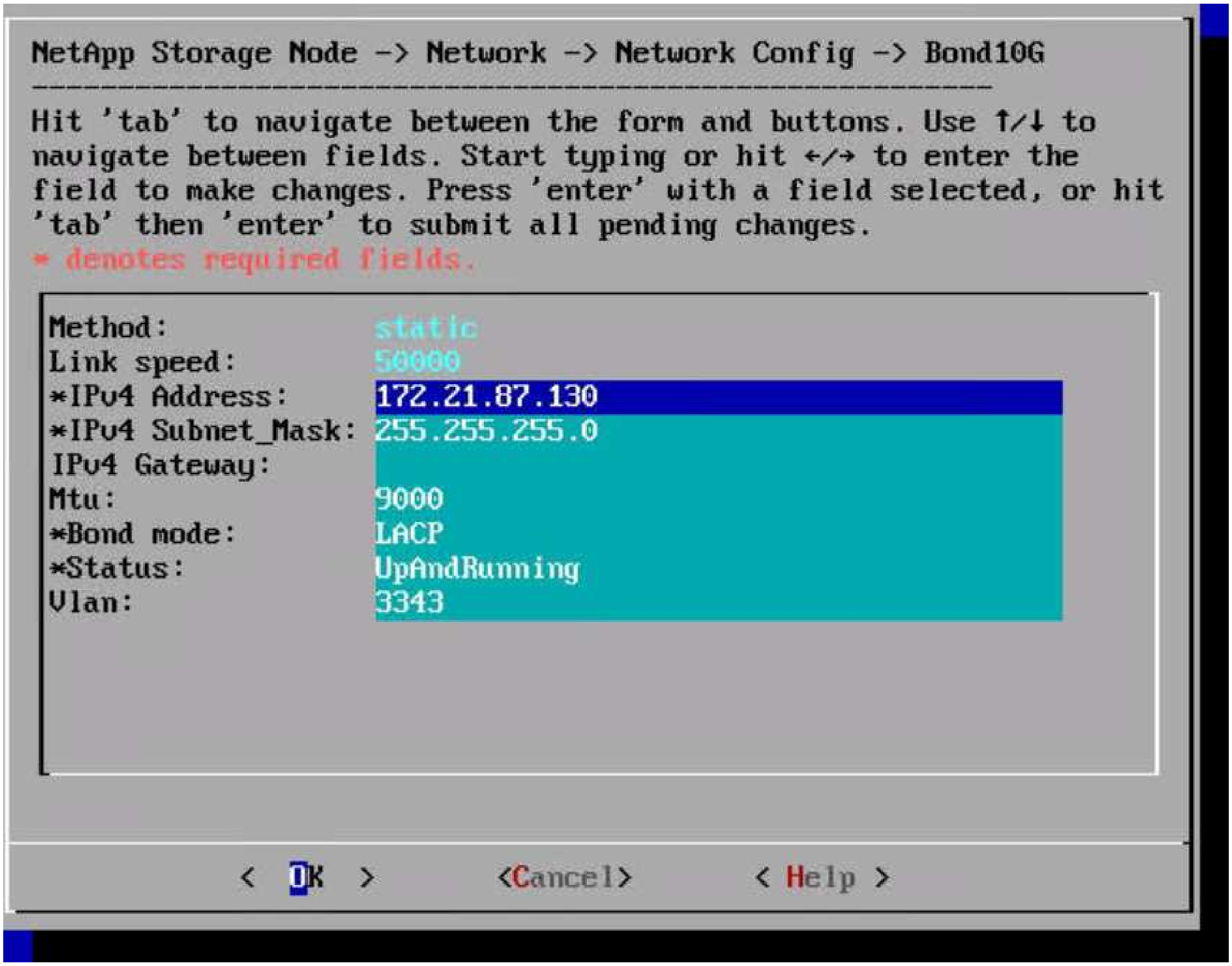
2. Click the Remote Console Preview image in the center of the screen to download a JNLP file launched by Java Web Start, which launches an interactive console to the system.



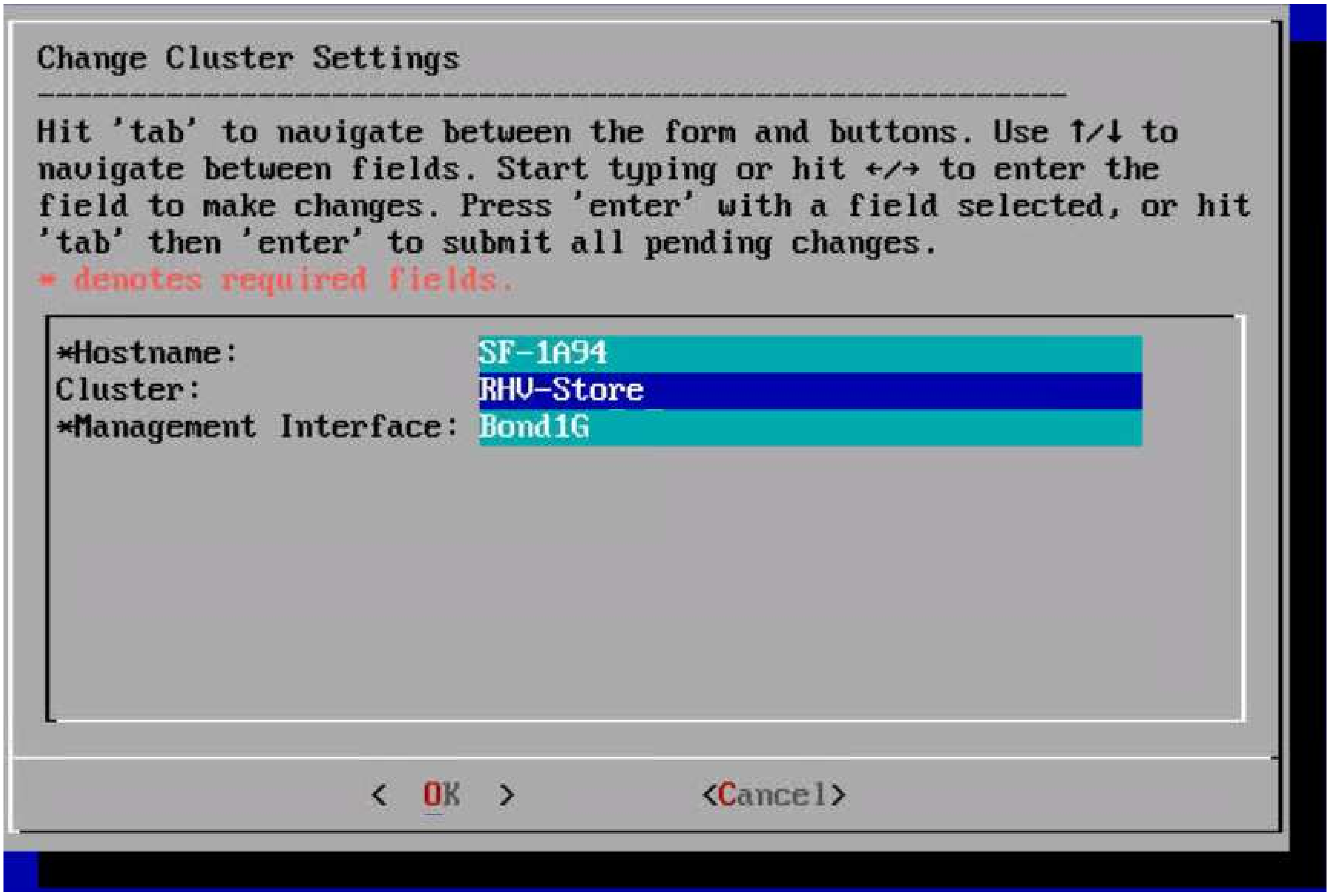
3. Navigate to Network > Network Config > Bond1G (Management) and configure the Bond1G interface. The Bond1G interface should be in ActivePassive bond mode and must have an IP, a netmask, and a gateway set statically. Its VLAN must correspond to IB Management network and DNS servers defined for the environment. Then click OK.



4. Select Bond10G (Storage) and configure the Bond10G interface. The Bond 10G interface must be in LACP bonding mode and have the MTU set to 9000 to enable jumbo frames. It must be assigned an IP address and netmask that are available on the defined storage VLAN. Click OK after entering the details.

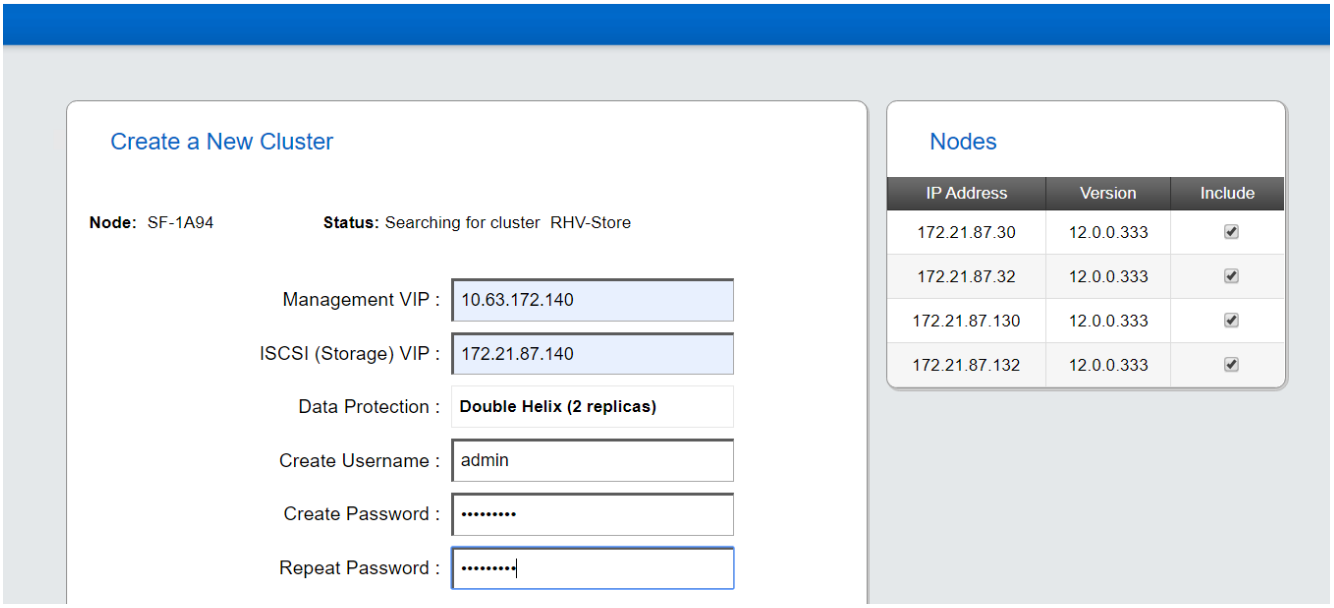


5. Go back to the initial screen, navigate to Cluster Settings, and click Change Settings. Enter the Cluster Name of your choice and click OK.

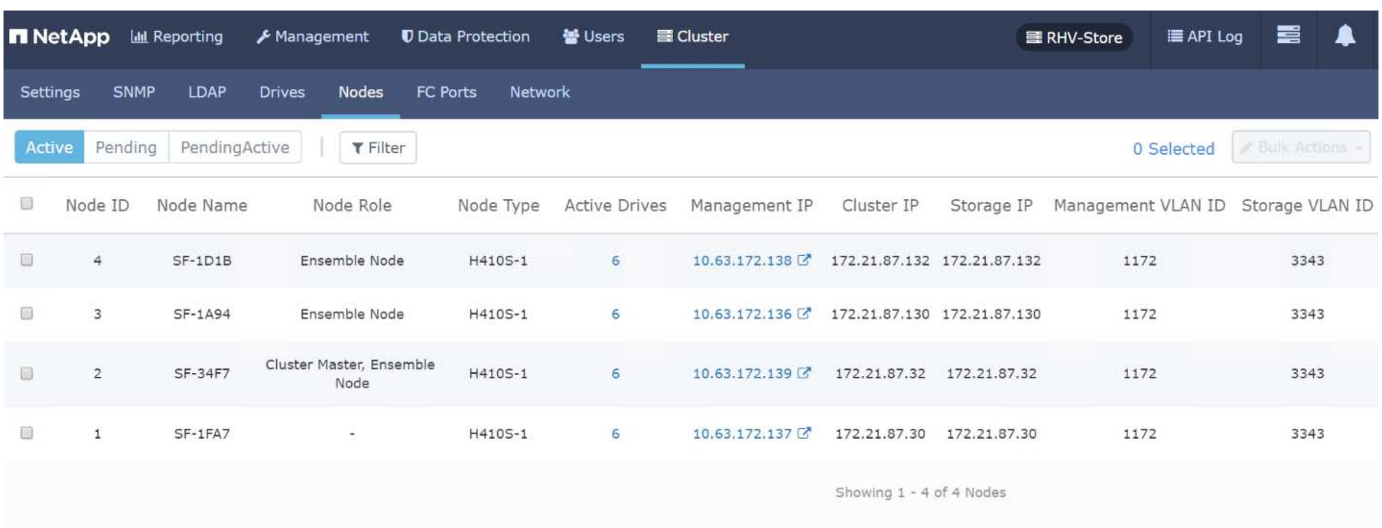


6. Repeat steps 1 to 5 for all HCI storage nodes.
7. After all the storage nodes are configured, use a web browser to log into the IB Management IP of one of the storage nodes. This presents the setup page with the Create a New Cluster dialog. Management VIP, storage VIP, and other details of the Element cluster are configured on this page. The storage nodes that were configured in the previous step are automatically detected. Make sure that any nodes that you do not want in the cluster are unchecked before proceeding. Accept the End User License Agreement and click Create New Cluster to begin the cluster creation process. It takes a few minutes to get the cluster up.

> In some cases, visiting the IB management address automatically connects on port 442 and launches the NDE setup wizard. If this happens, delete the port specification from the URL and reconnect to the page.



8. After the cluster is created, it redirects to the Element cluster management interface available at the assigned MVIP address. Log in with the credentials provided in the previous step.
9. After you log in, the cluster automatically detects the number of available drives and requests for confirmation to add all drives. Click Add Drives to add all drives at once.
10. The Element cluster is ready to use. Navigate to Cluster > Nodes, and all four nodes should be in a healthy state with active drives.



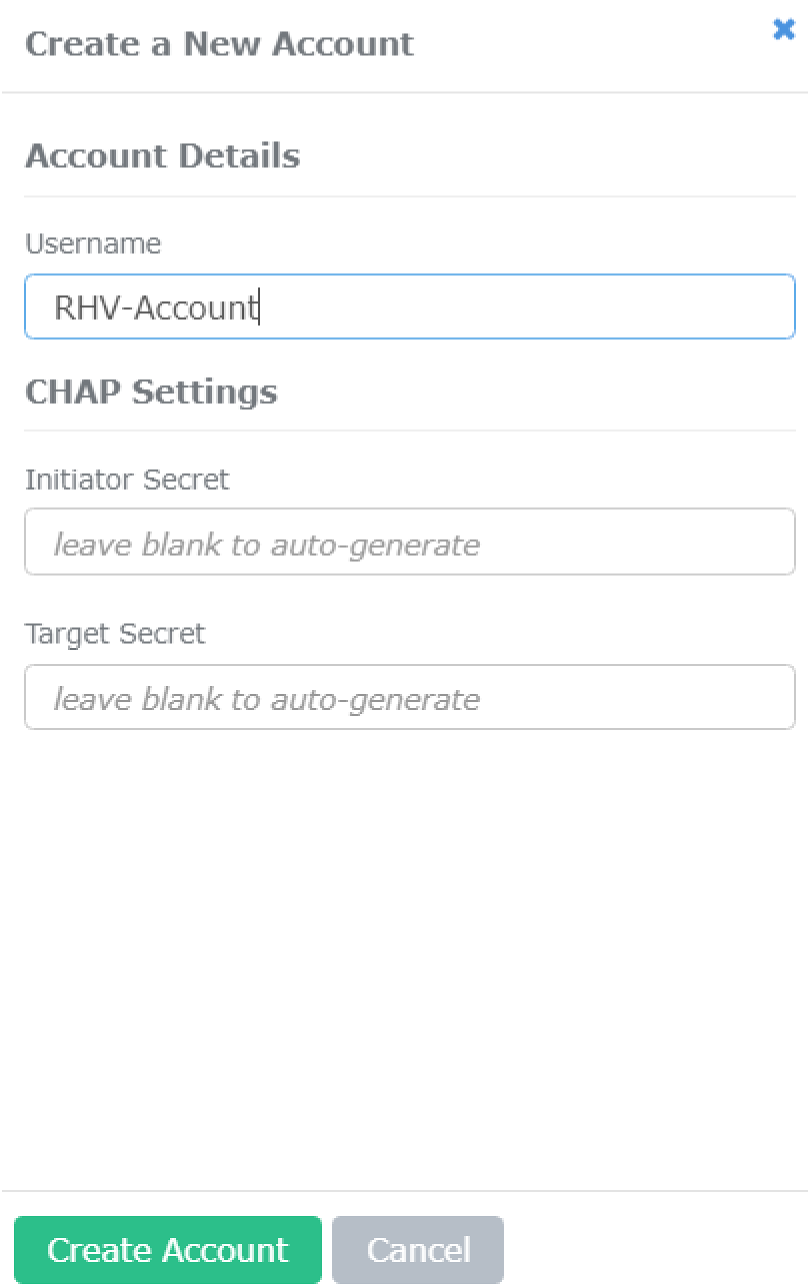
Element Storage Configuration to Support RHV Deployment

In our NetApp HCI for Red Hat Virtualization solution, we use a NetApp Element storage system to provide the backend storage support for RHV's requirement of shared storage domains. The self-hosted engine architecture of RHV deployment requires two storage domains at a minimum—one for the hosted engine storage domain and one for the guest VM data domain.

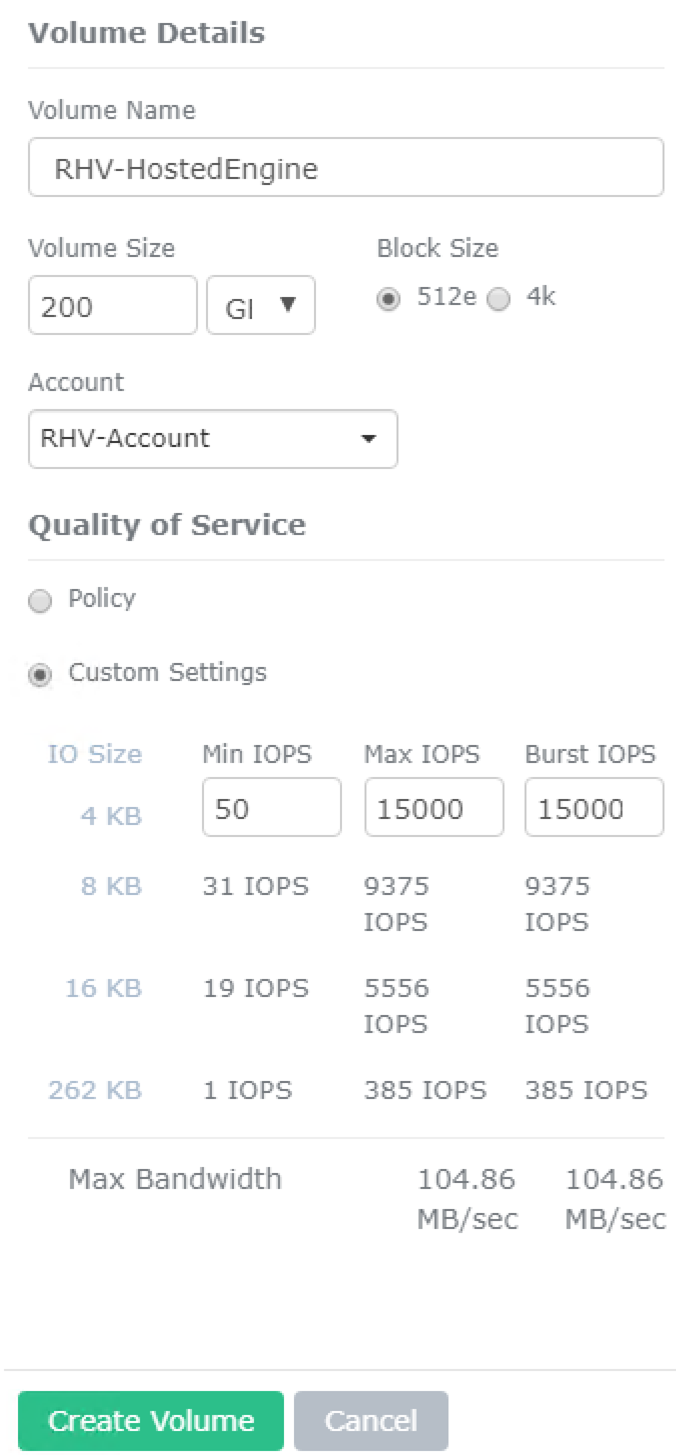
For this part of deployment, you must configure an account, two volumes of appropriate size, and the associated initiators. Then map these components to an access group that allows the RHV hosts to map the block volumes for use. Each of these actions can be performed through the web user interface or through the native API for the Element system. For this deployment guide, we go through the steps with the GUI.

Log in to the NetApp Element cluster GUI at its MVIP address using a web browser. Navigate to the Management tab and complete the following steps:

1. To create accounts, go to the Accounts sub-tab and click Create Account. Enter the name of your choice and click Create Account.

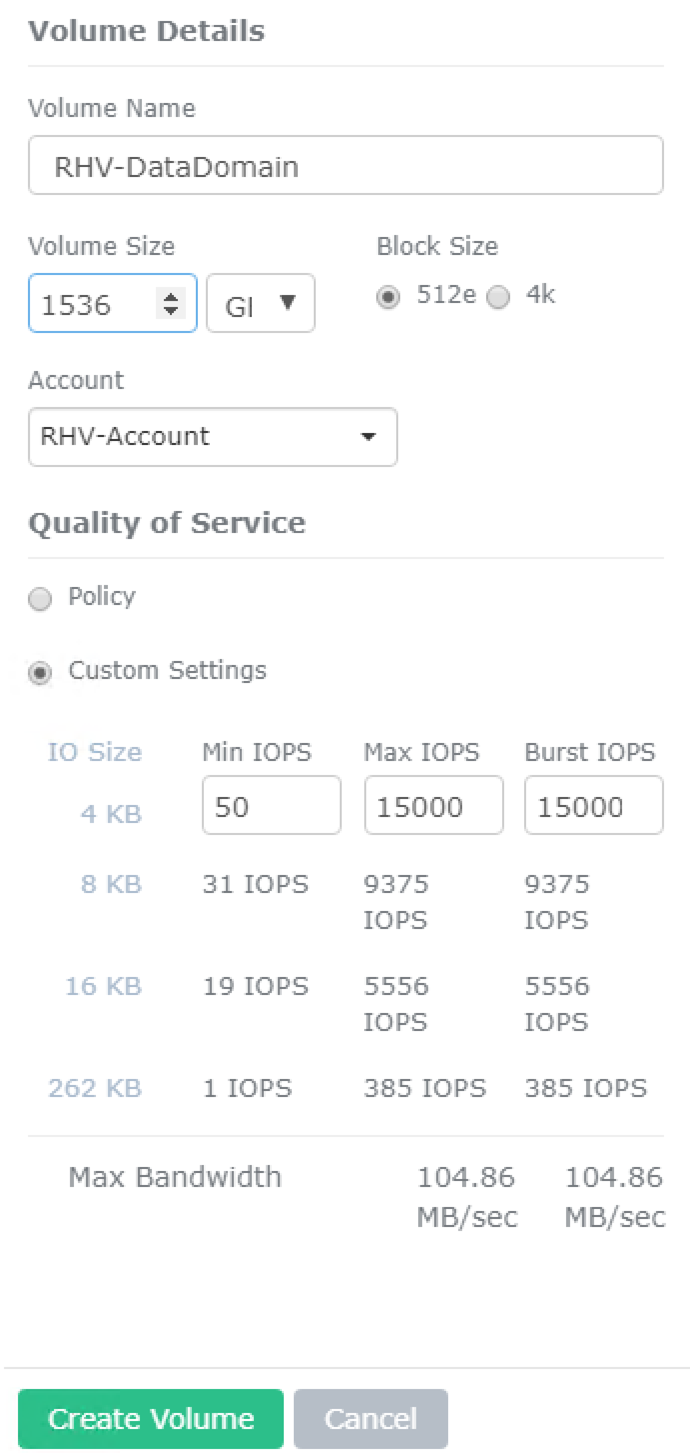


2. To create volumes, complete the following steps:
    a. Navigate to the Volumes sub-tab and click Create Volume.
    b. To create the volume for the self-hosted engine storage domain, enter the name of your choice, select the account you created in the last step, enter the size of the volume for the self-hosted engine storage domain, configure the QoS setting, and click Create Volume.



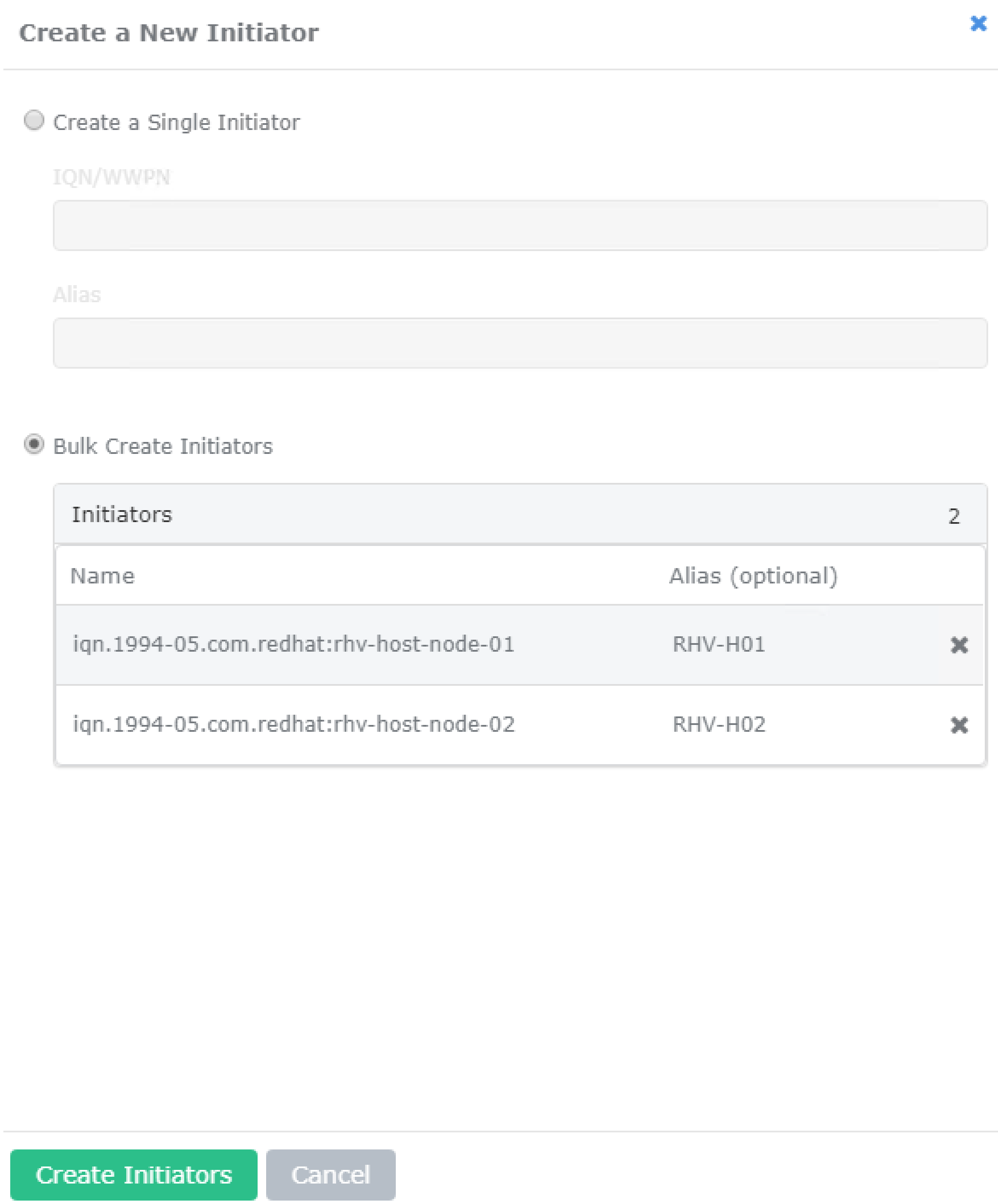
The minimum size for the hosted engine volume is 75GB. In our design, we added additional space to allow for future extents to be added to the RHV-M VM if necessary.

c. To create the volume for the guest VMs data storage domain, enter the name of your choice, select the account you created in the last step, enter the size of the volume for the data storage domain, configure the QoS setting and click Create Volume.

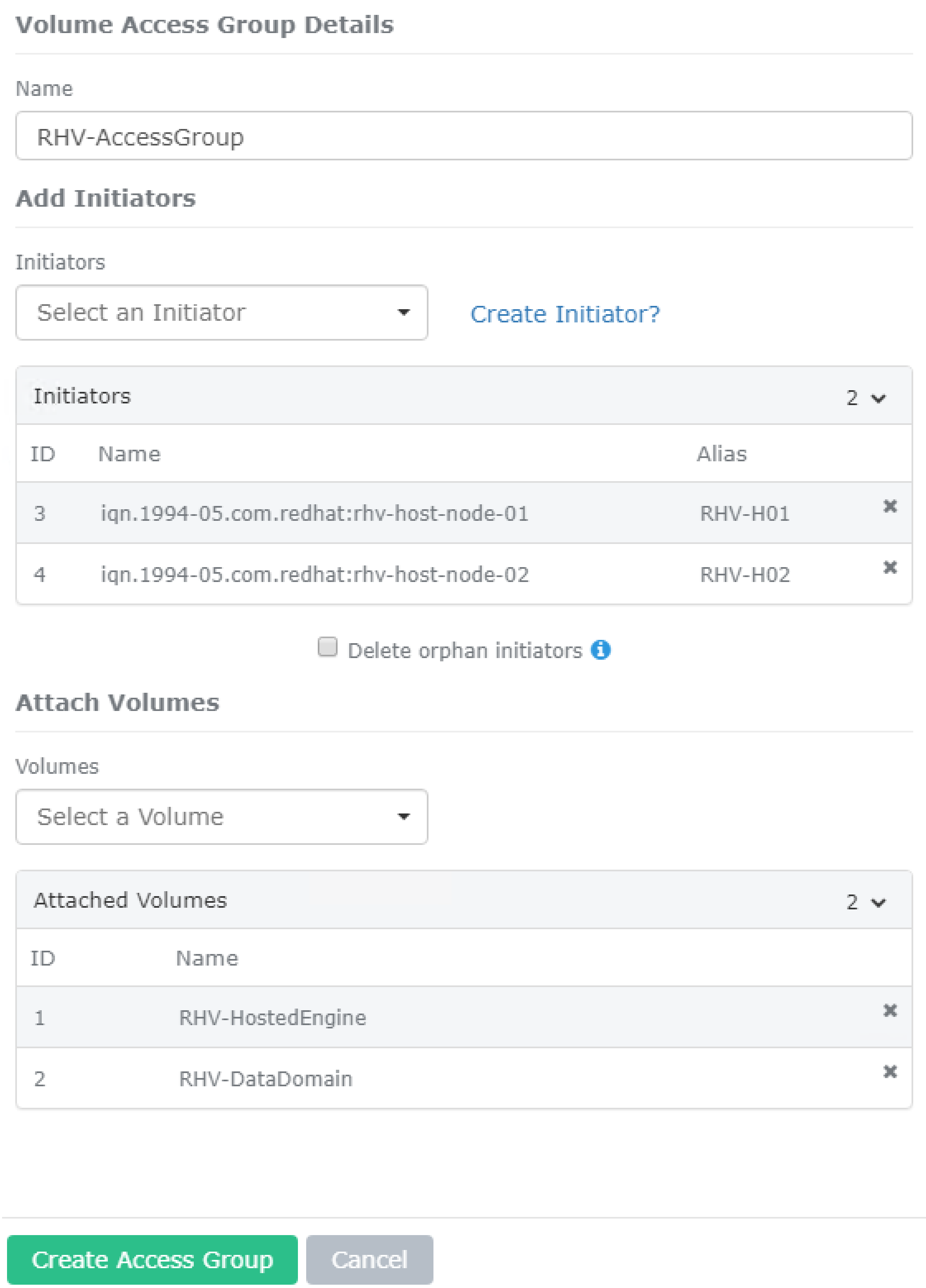


The size of the data domain depends on the kind of VMs run in the environment and the space required to support them. Adjust the size of this volume to meet the needs of your environment.

3. To create initiators, complete the following steps:
   a. Go to the Initiators sub-tab and click Create Initiator.
   b. Select the Bulk Create Initiators radio button and enter the initiators' details of both the RHV-H nodes with comma separated values. Then click Add Initiators, enter the aliases for the initiators, and click the tick button. Verify the details and click Create Initiators.



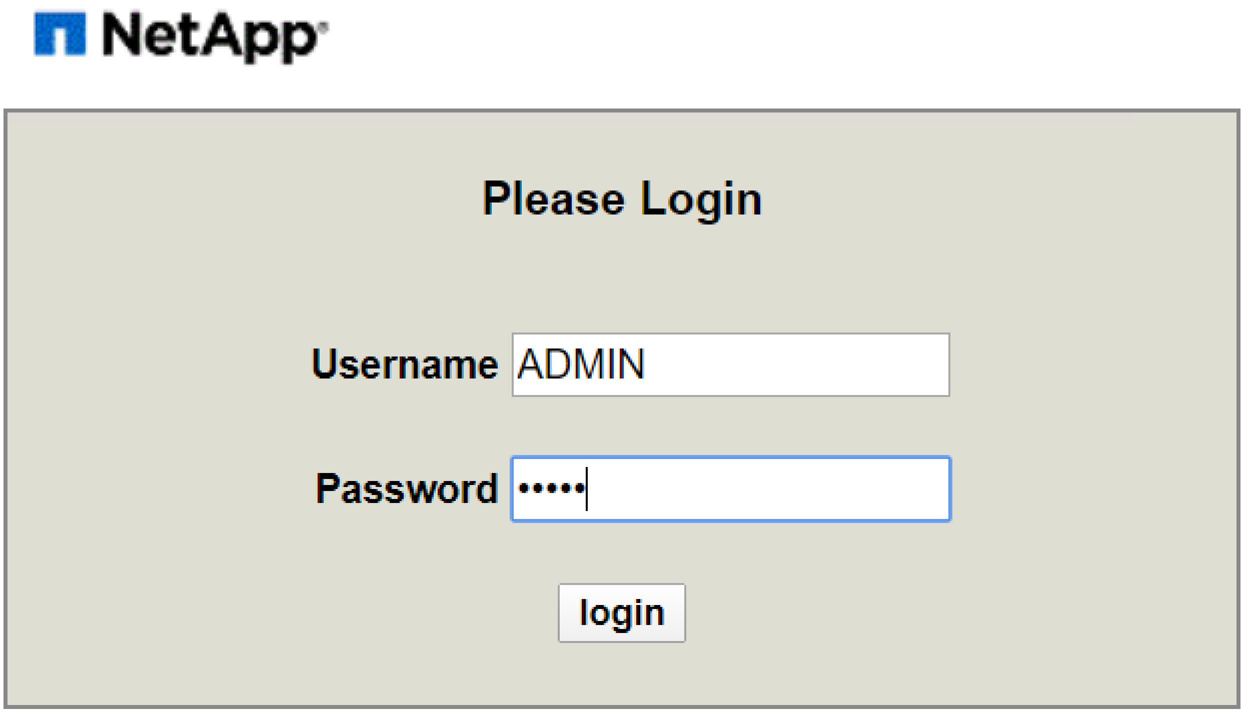
4. To create access groups, complete the following steps:
   a. Go to the Access Groups sub-tab and click Create Access Groups.
   b. Enter the name of your choice, select the initiators for both RHV-H nodes that were created in the previous step, select the volumes, and click Create Access Group.



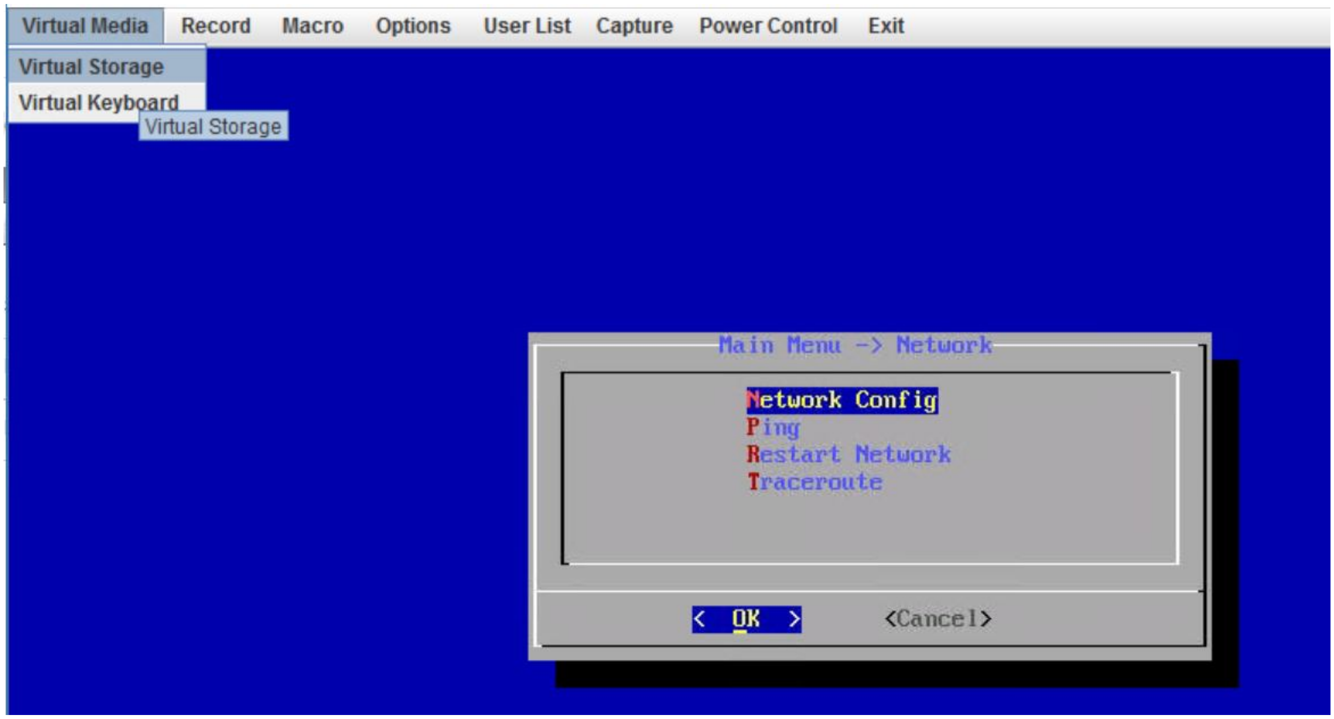
4. Deploy the RHV-H Hypervisor on the HCI Compute Nodes: NetApp HCI with RHV

This solution employs the recommended self-hosted engine architecture of RHV deployment with the minimum setup (two self-hosted engine nodes). These steps begin after the nodes have been racked and cabled and the IPMI port has been configured on each node for using the console. To deploy the RHV-H hypervisor on HCI compute nodes, complete the following steps:

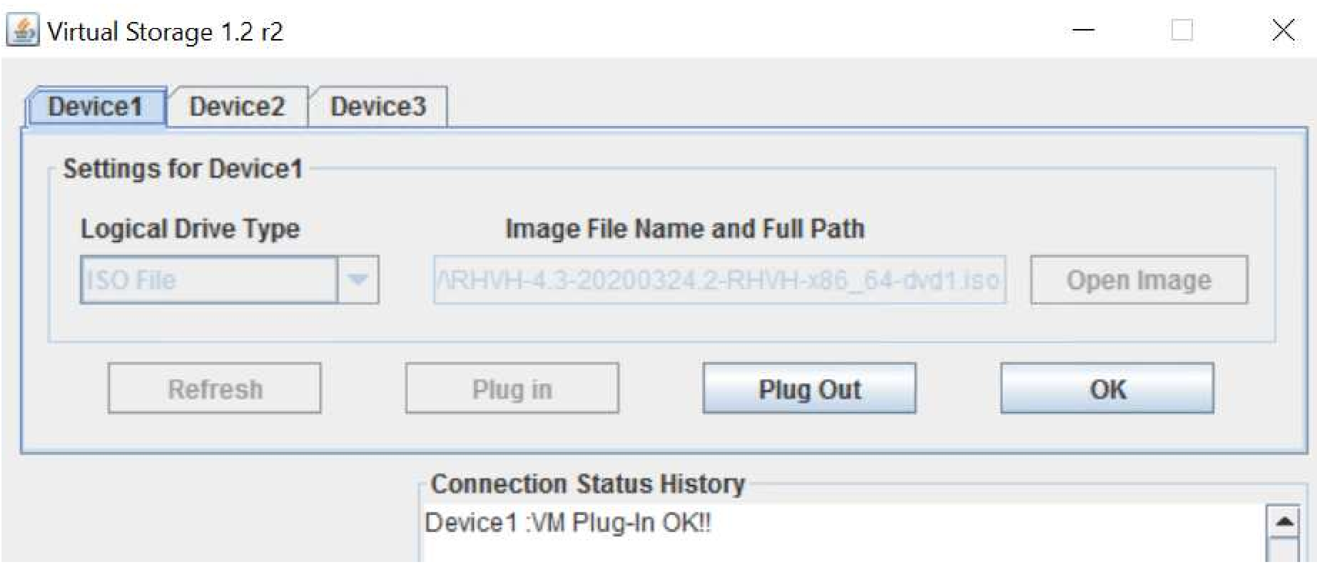
1. Access the out-of-band management console for the compute nodes in the cluster and log in with the default credentials ADMIN/ADMIN.



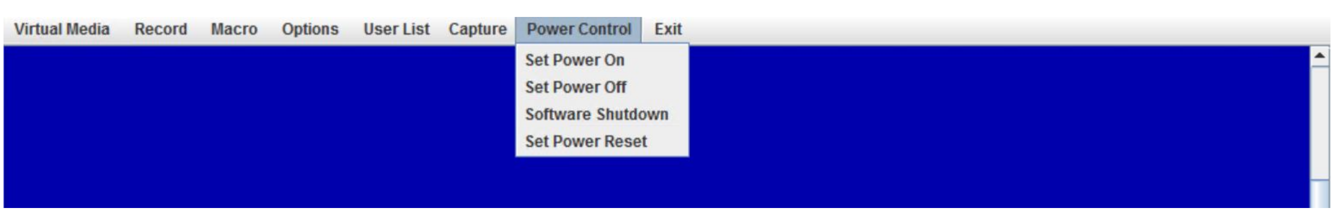
2. Click the Remote Console Preview image in the center of the screen to download a JNLP file launched by Java Web Start, which launches an interactive console to the system.
3. After the virtual console launches, attach the RHV-H 4.3.9 ISO by navigating to and clicking Virtual Media > Virtual Storage.



4. For Logical Drive Type, select ISO File from the drop down. Provide the full path and full name of the RHV-H 4. 3.9 ISO file or attach it by clicking the Open Image button. Then click Plug In.

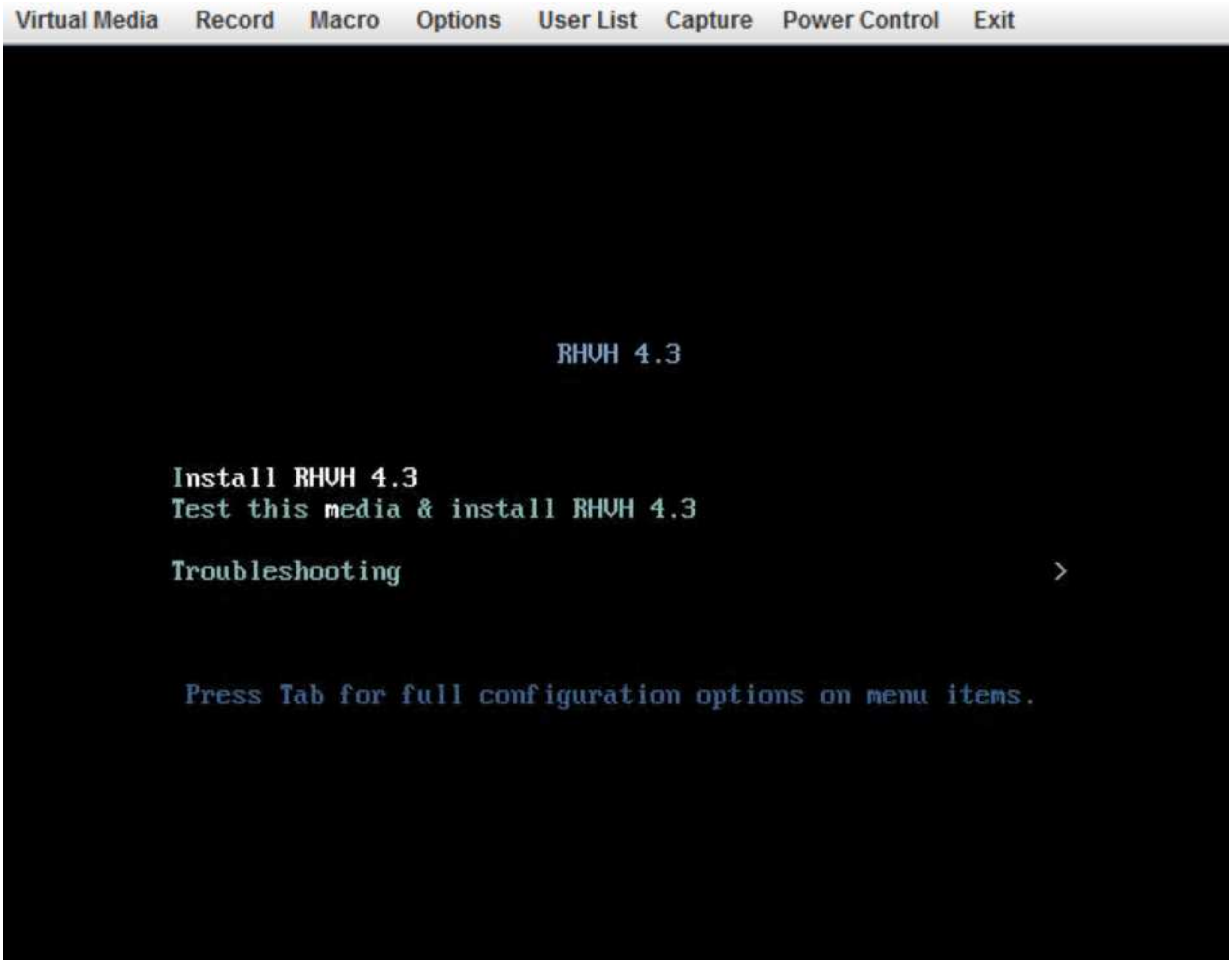


5. Reboot the server so that it boots using RHV-H 4.3.9 ISO by navigating and clicking Power Control > Set Power Reset.

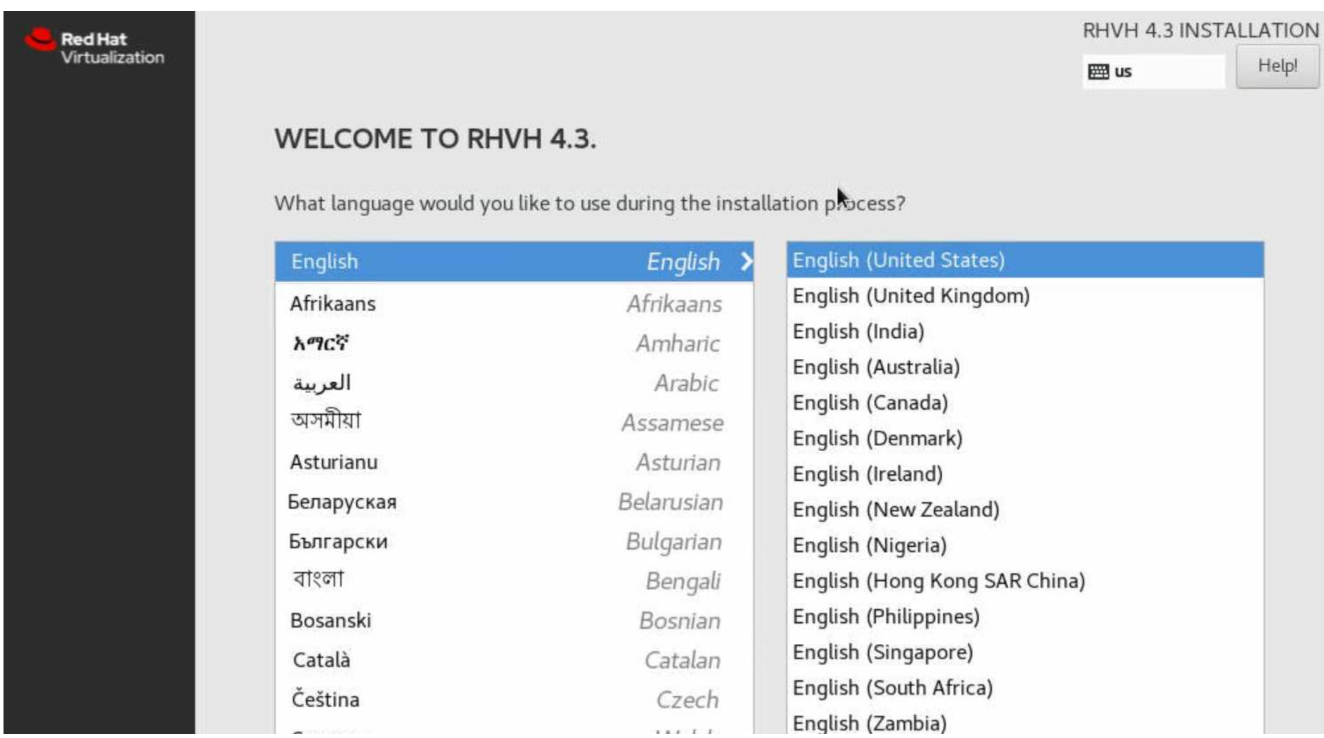


6. When the node reboots and the initial screen appears, press F11 to enter the boot menu. From the boot menu, navigate to and click ATEN Virtual CDROM YSOJ.

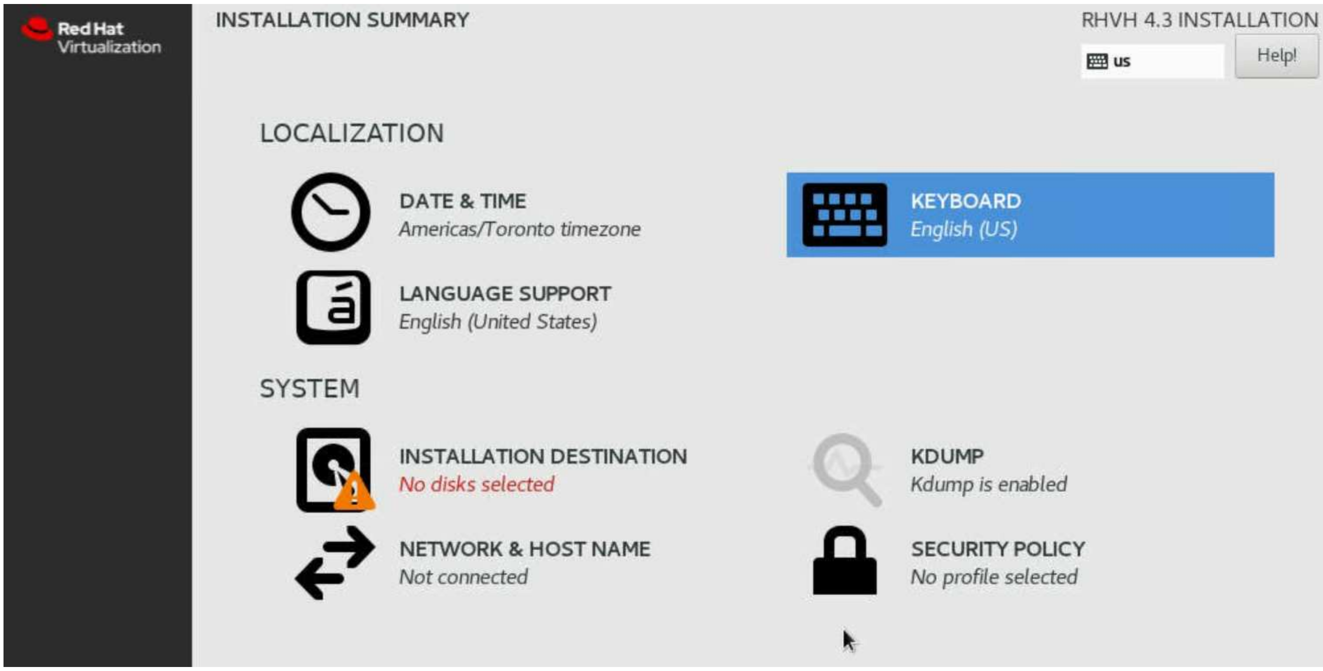
7. On the next screen, navigate to and click Install RHV 4.3. This loads the image, runs the pre-installation scripts, and starts Anaconda, the Red Hat Enterprise Linux system installer.



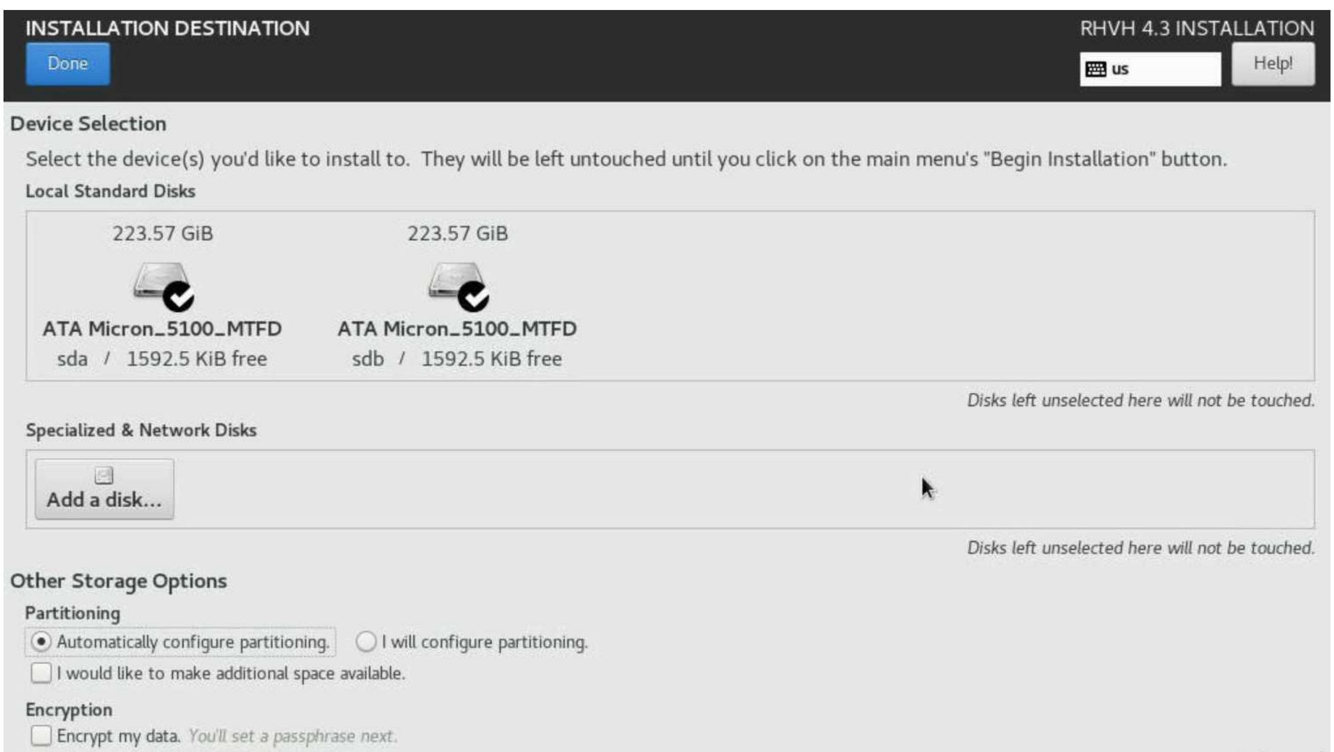
8. The installation welcome screen appears. Select the preferred language and click Next.



9. In the next screen, select your time zone under Date & Time. The default is UTC. However, NetApp recommends that you configure NTP servers for your environment on this screen. Then select the keyboard language and click Done.

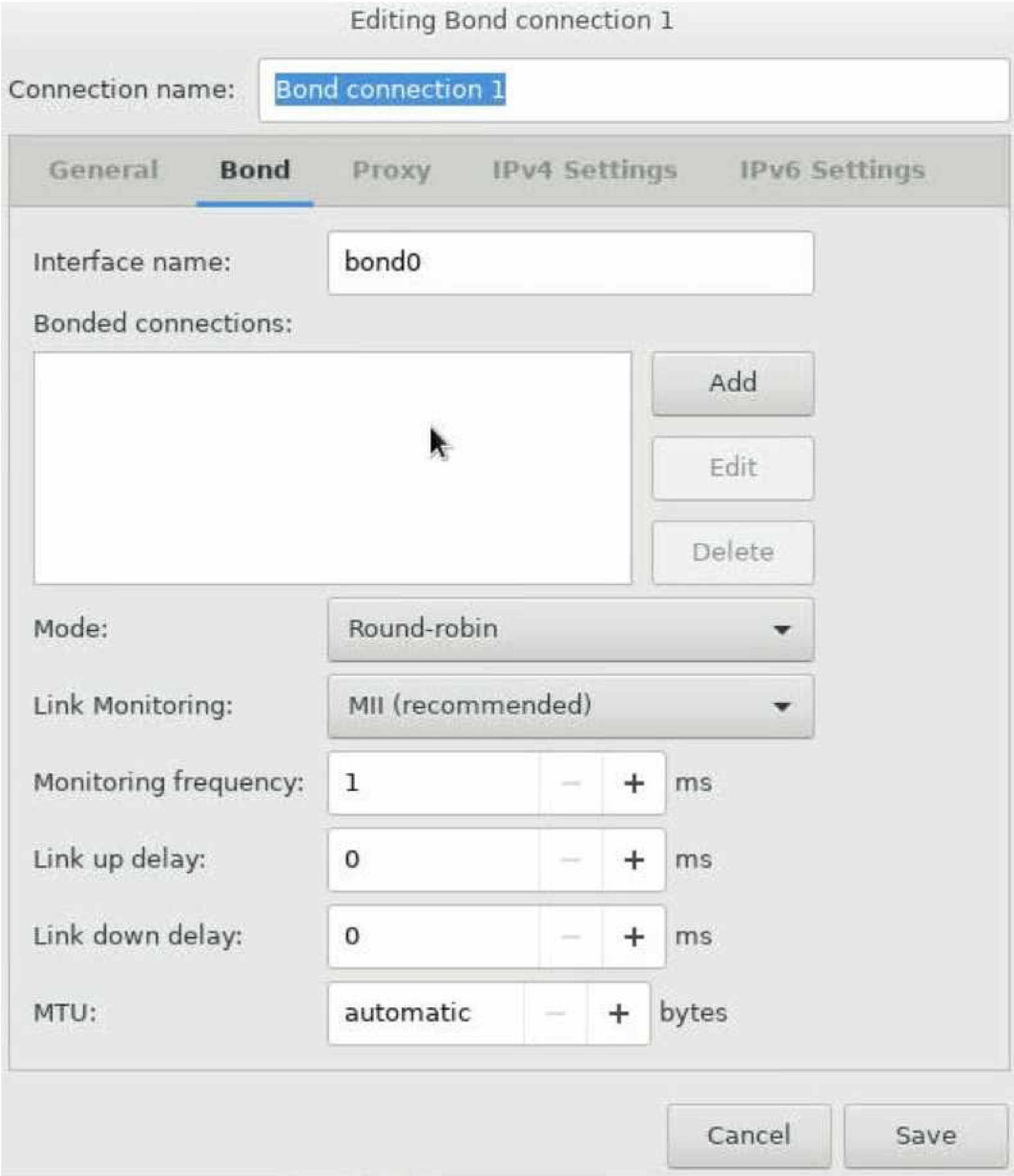


10. Next, click Installation Destination. In the Installation Destination screen, select the drives on which you want to install RHV-H. Verify that Automatically Configure Partitioning is selected in the Partitioning section. Optionally, you can enable encryption by checking the box next to Encrypt My Data. Click Done to confirm the settings.



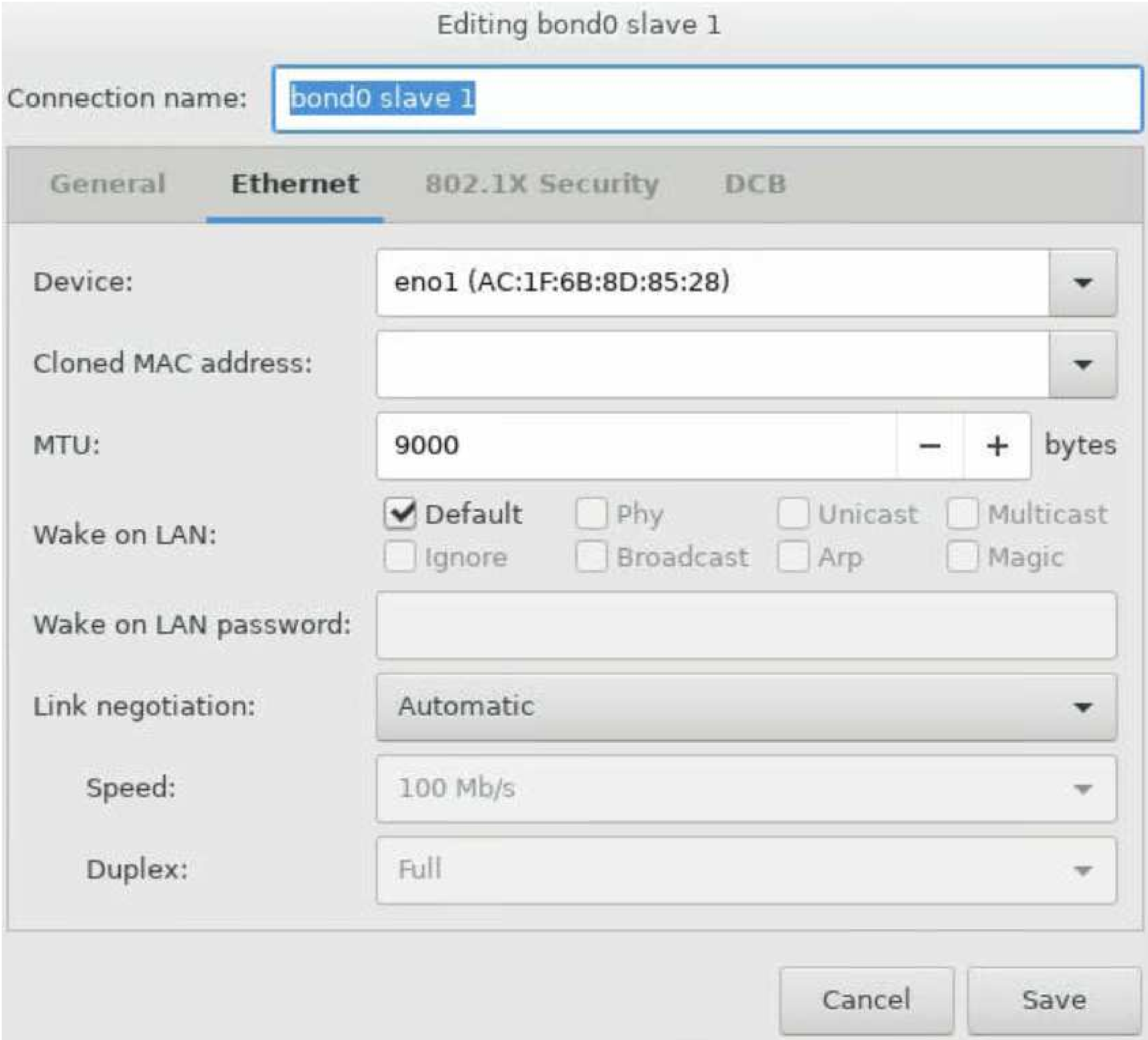
11. Click Network & Host Name. Provide the desired host name at the bottom of the screen. Then click the (+) button at the bottom. Select the Bond from the drop down and click Add.

12. Next, in the bond configuration screen, click Add to add the member interfaces to the bond interface.

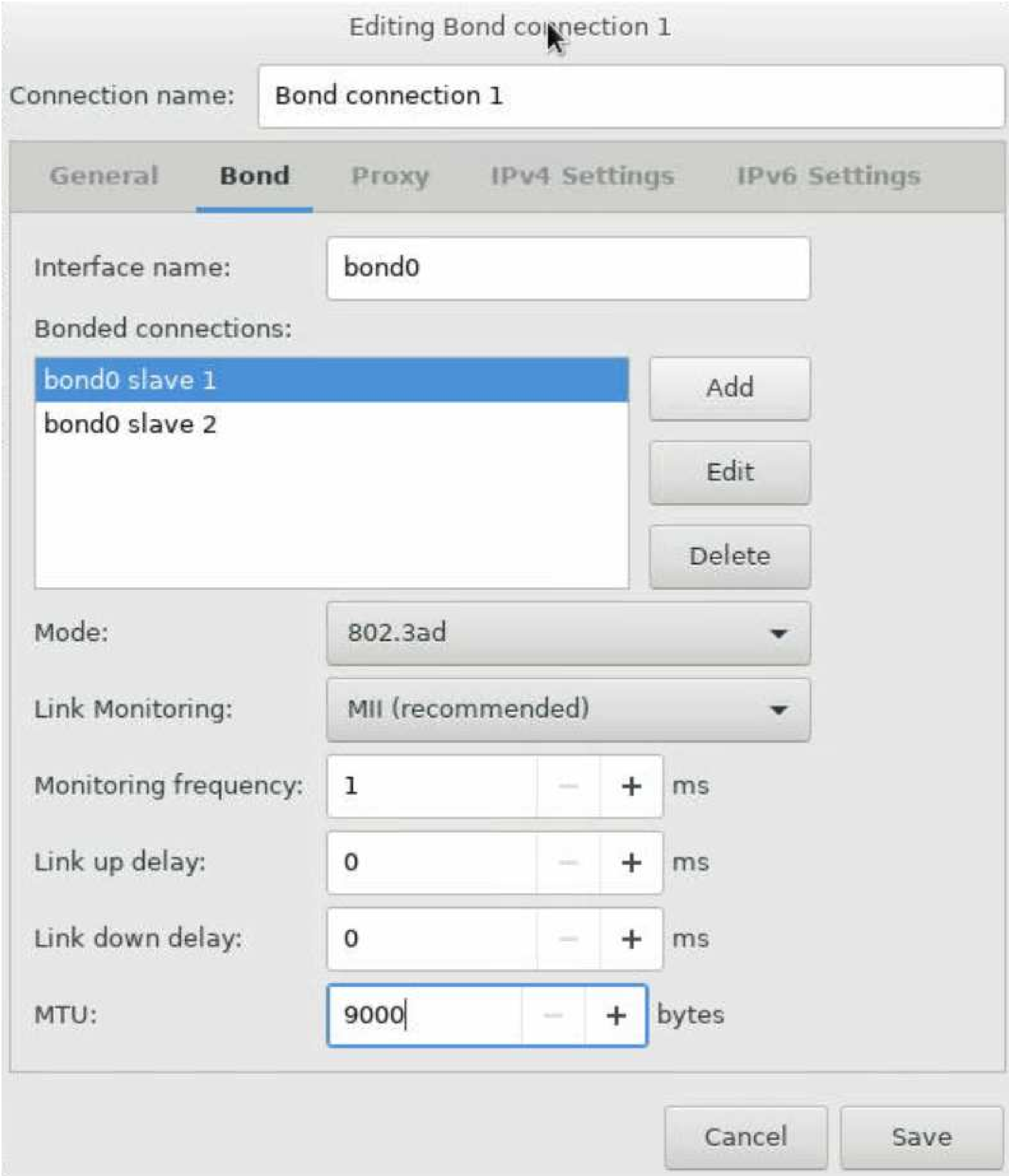


13. Select Ethernet from the drop down, indicating that the Ethernet interface is added as a member to the bond interface. Click Create.

14. From the Device dropdown in the slave 1 configuration screen, select the Ethernet interface. Verify that the MTU is set to 9000. Click Save.

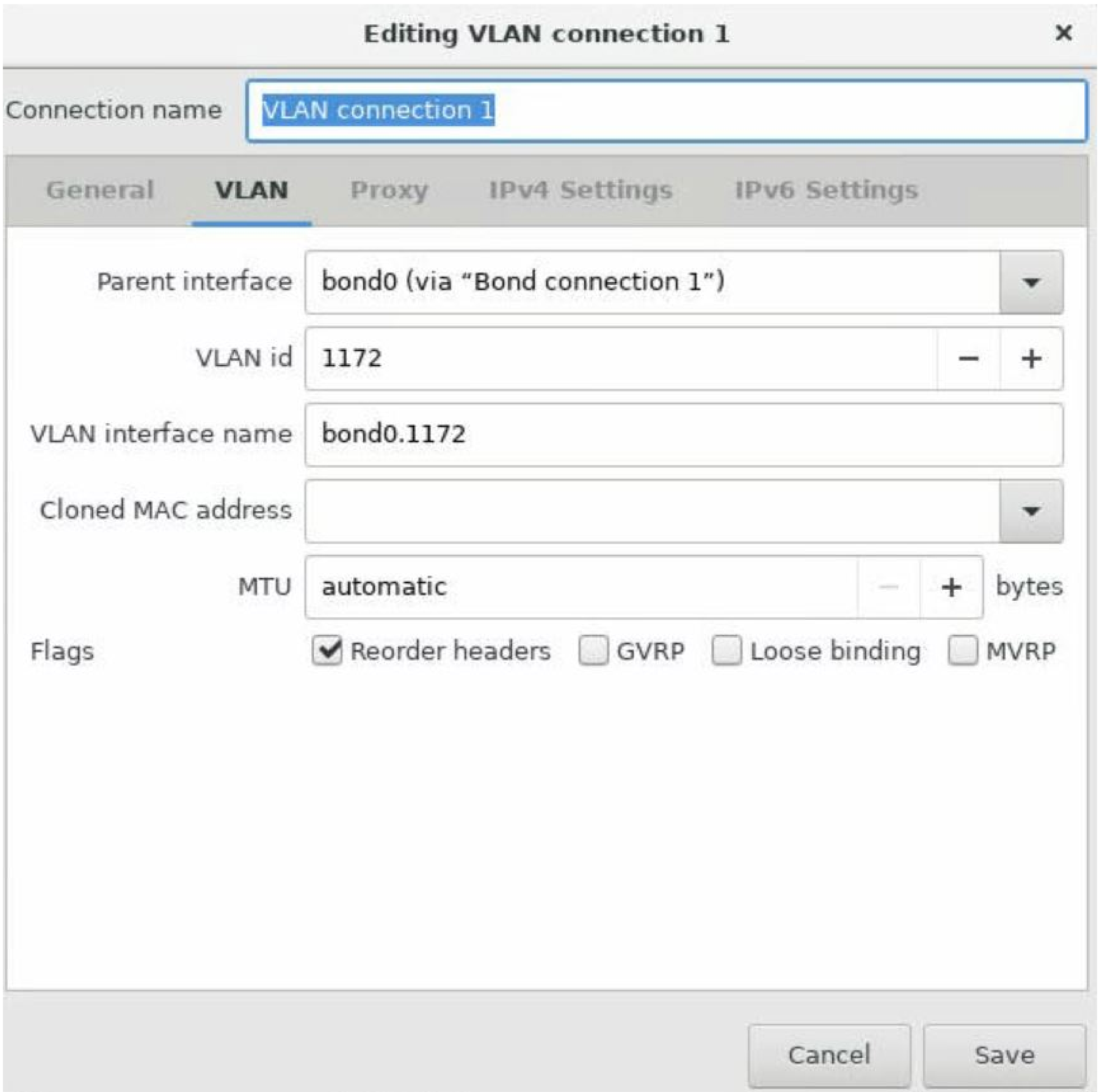


15. Repeat steps 12, 13, and 14 to add the other Ethernet port to the bond0 interface.
16. From the Mode dropdown in the bond configuration screen, select 802.3ad for LACP. Verify that the MTU is set to 9000. Then click Save.

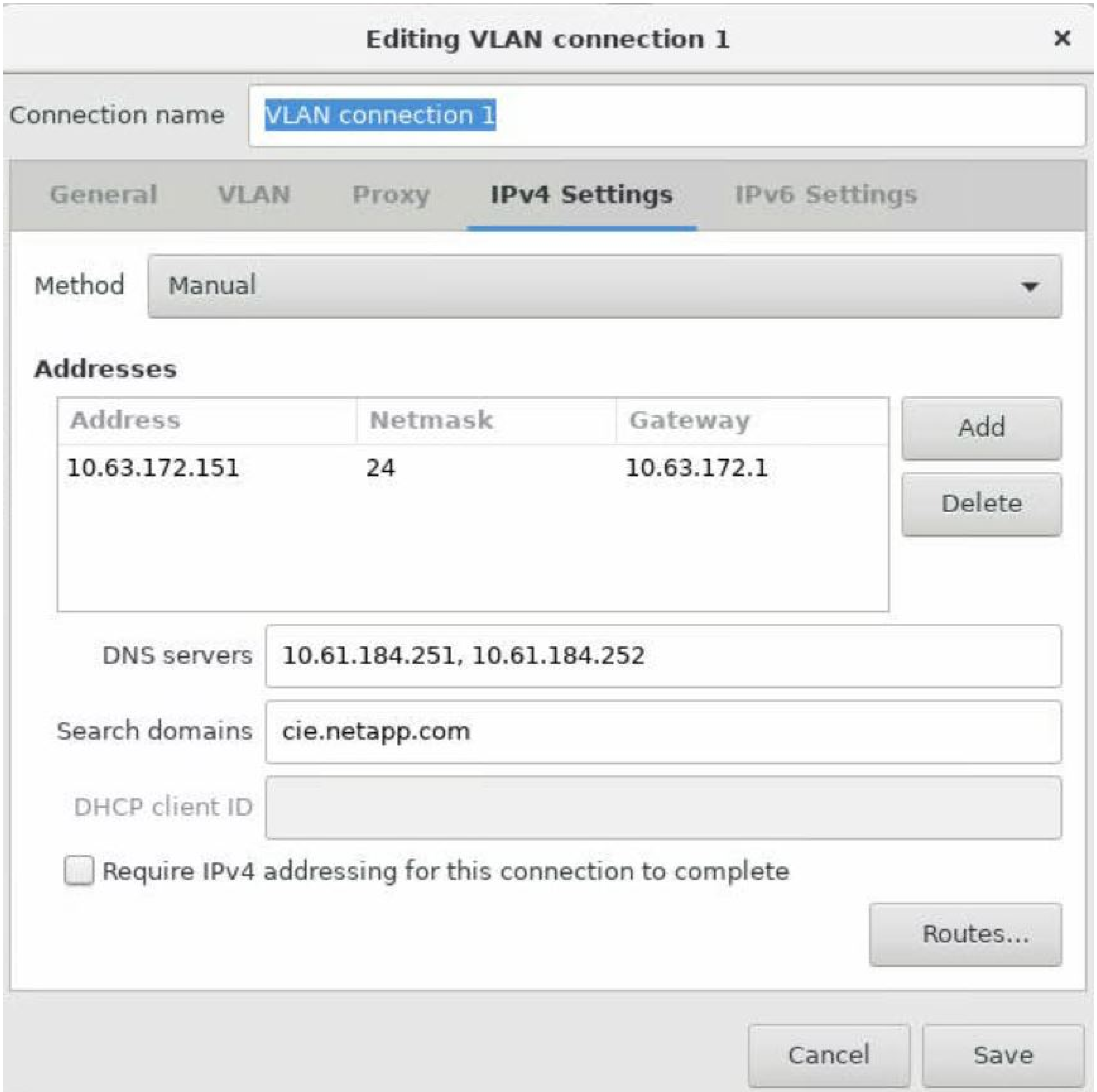


17. Create the VLAN interface for the in-band management network. Click the (+) button again, select VLAN from the dropdown and click Create.

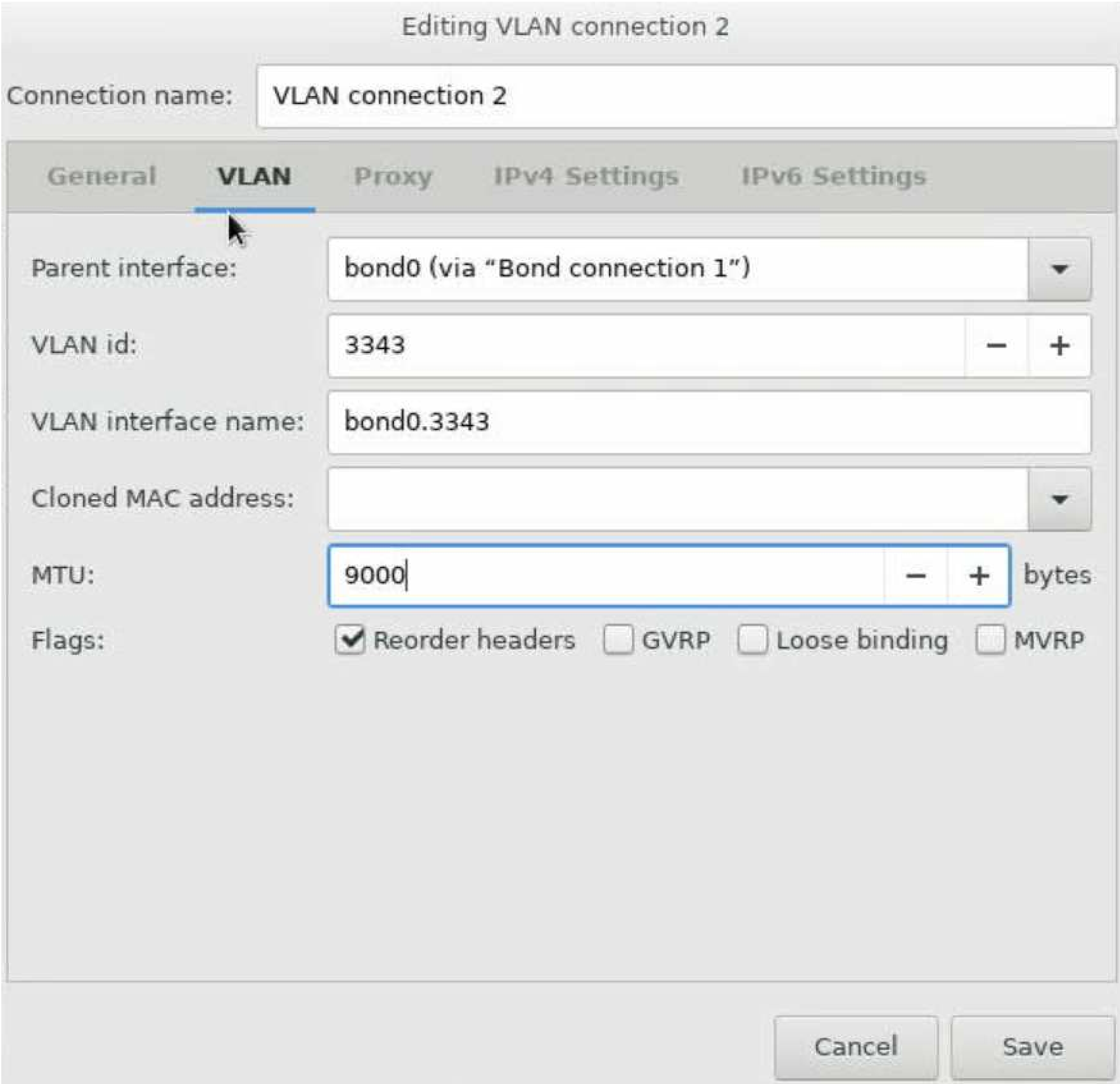
18. In the Editing VLAN connection screen, select bond0 in the Parent Interface dropdown, enter the VLAN ID of the in-band management network. Provide the name of the VLAN interface in `bond0.<vlan_id>` format.



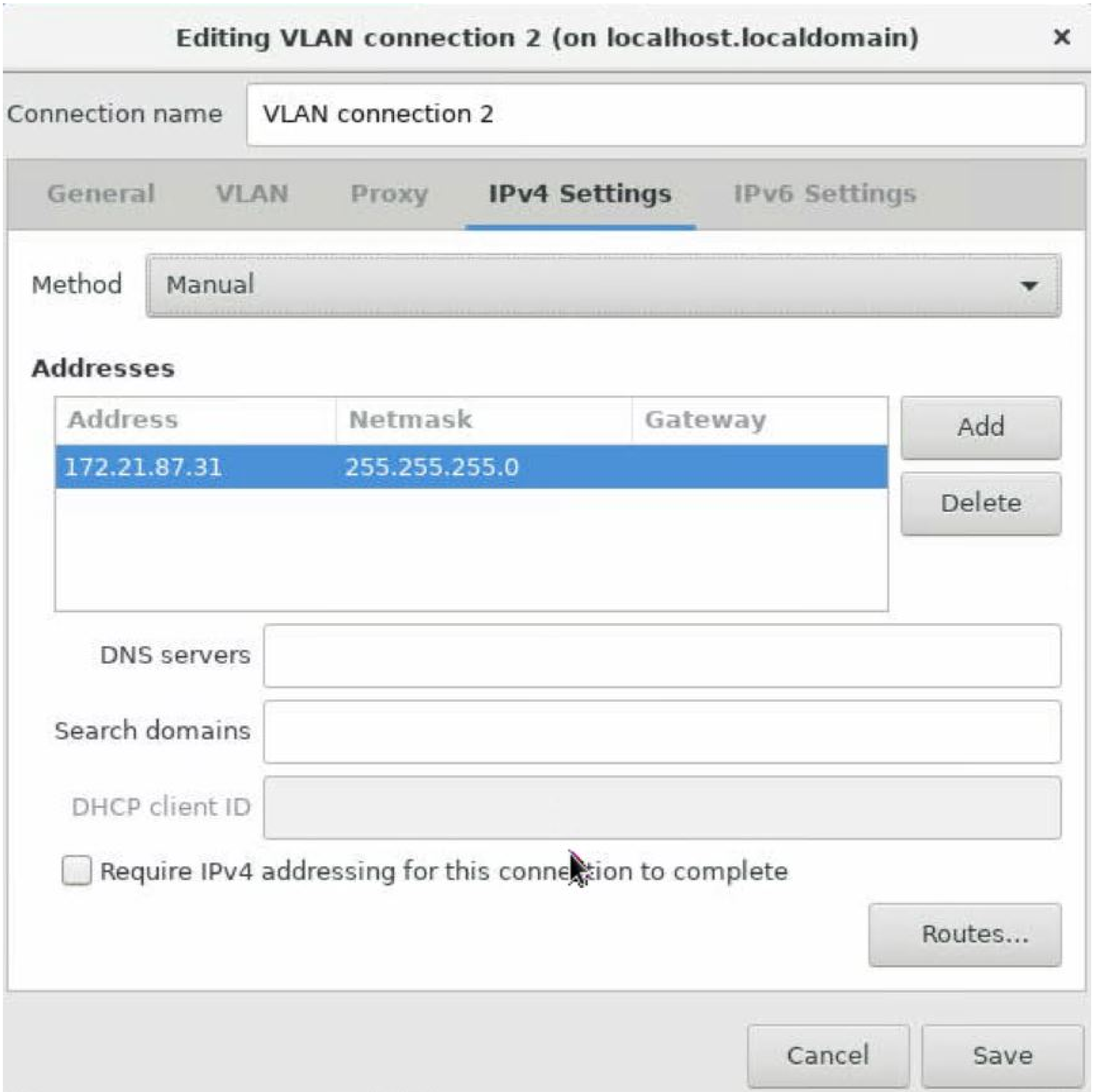
19. In the Editing VLAN connection screen, click the IPv4 Settings sub-tab. In the IPv4 Settings sub-tab, configure the network address, netmask, gateway, and DNS servers corresponding to the in-band management network. Click Save to confirm the settings.



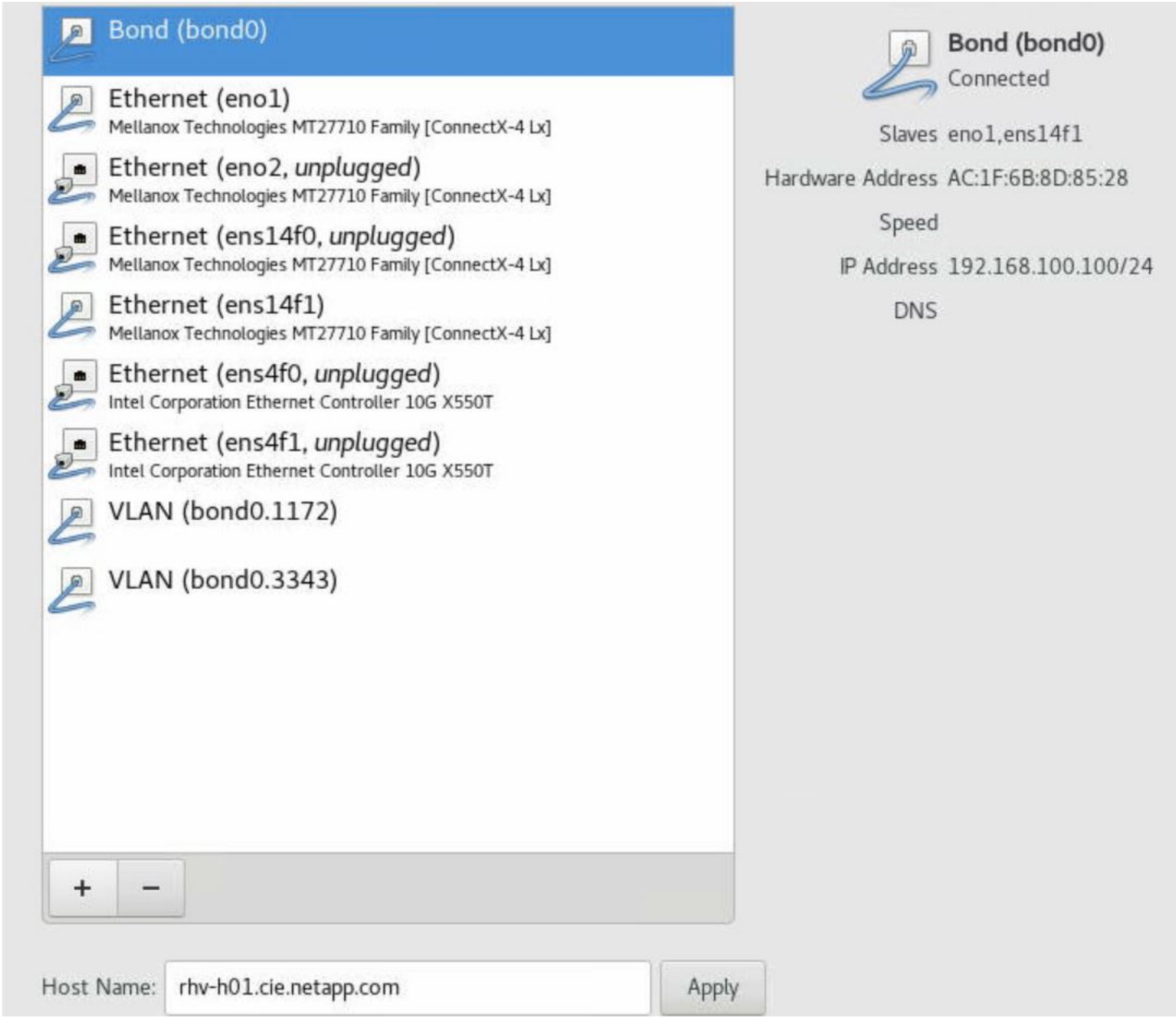
20. Create the VLAN interface for the storage network. Click the (+) button again, select VLAN from the dropdown, and click Create. In the Editing VLAN Connection screen, select bond0 in the Parent Interface dropdown, enter the VLAN ID of the storage network, provide the name of the VLAN interface in the `bond0.<vlan_id>` format. Adjust the MTU to 9000 to allow jumbo frame support. Click Save.



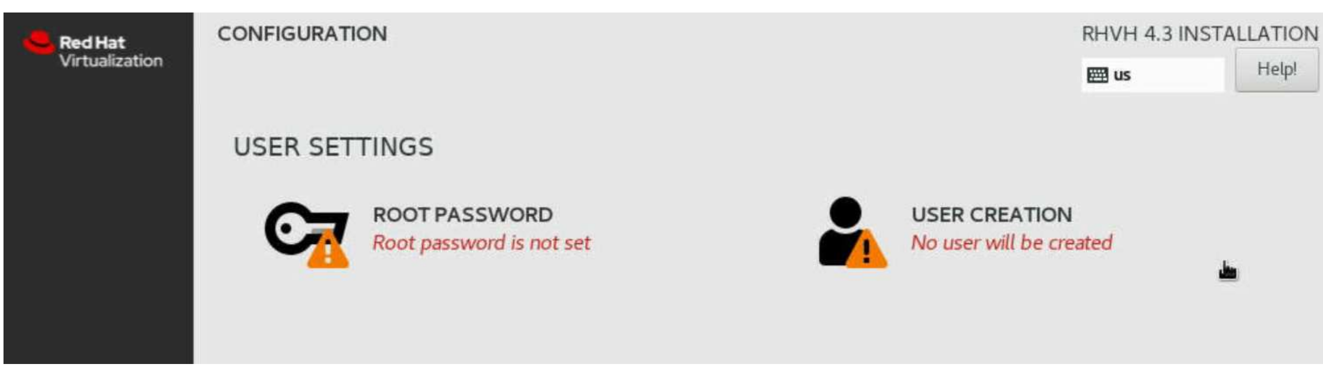
21. In the Editing VLAN Connection screen, click the IPv4 Settings sub-tab. In the IPv4 Settings sub-tab, configure the network address and the netmask corresponding to the storage network. Click Save to confirm the settings.



22. Confirm that the network interfaces are up and click Done.

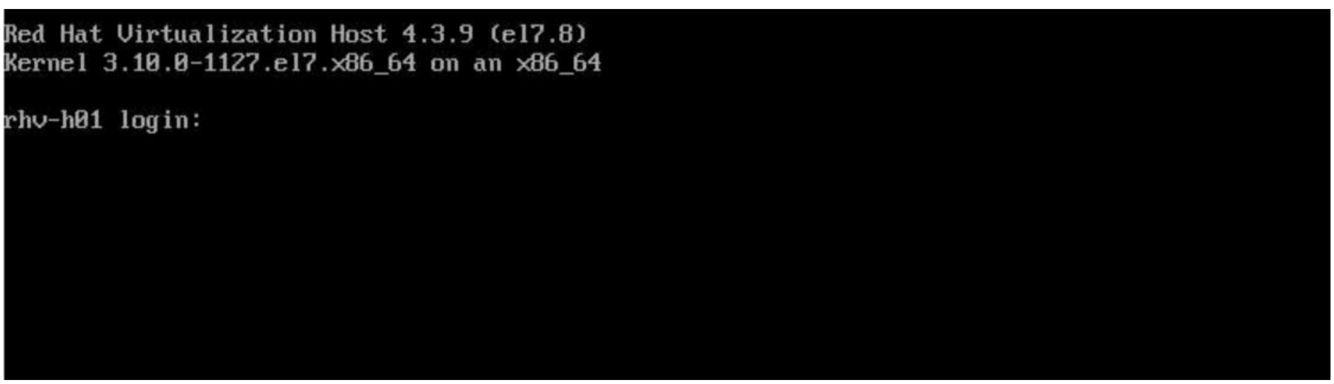


23. After the wizard navigates back to the configuration page, click Begin Installation. The next screen prompts you to configure the root password and optionally to create another user for logging into RHV-H.

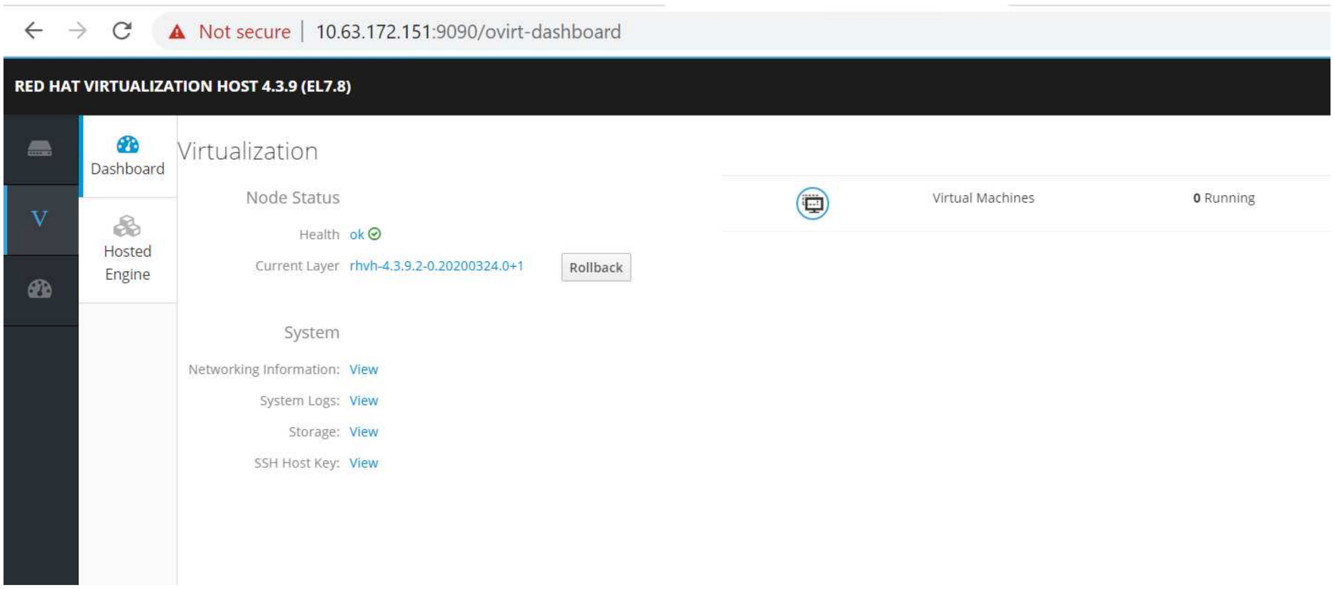


24. After the installation completes, unmount the ISO file by navigating to Virtual media > Virtual Storage in the virtual console and click Plug Out. Then click Reboot on the Anaconda GUI to complete the installation process. The node then reboots.

After the node comes up, it displays the login screen.

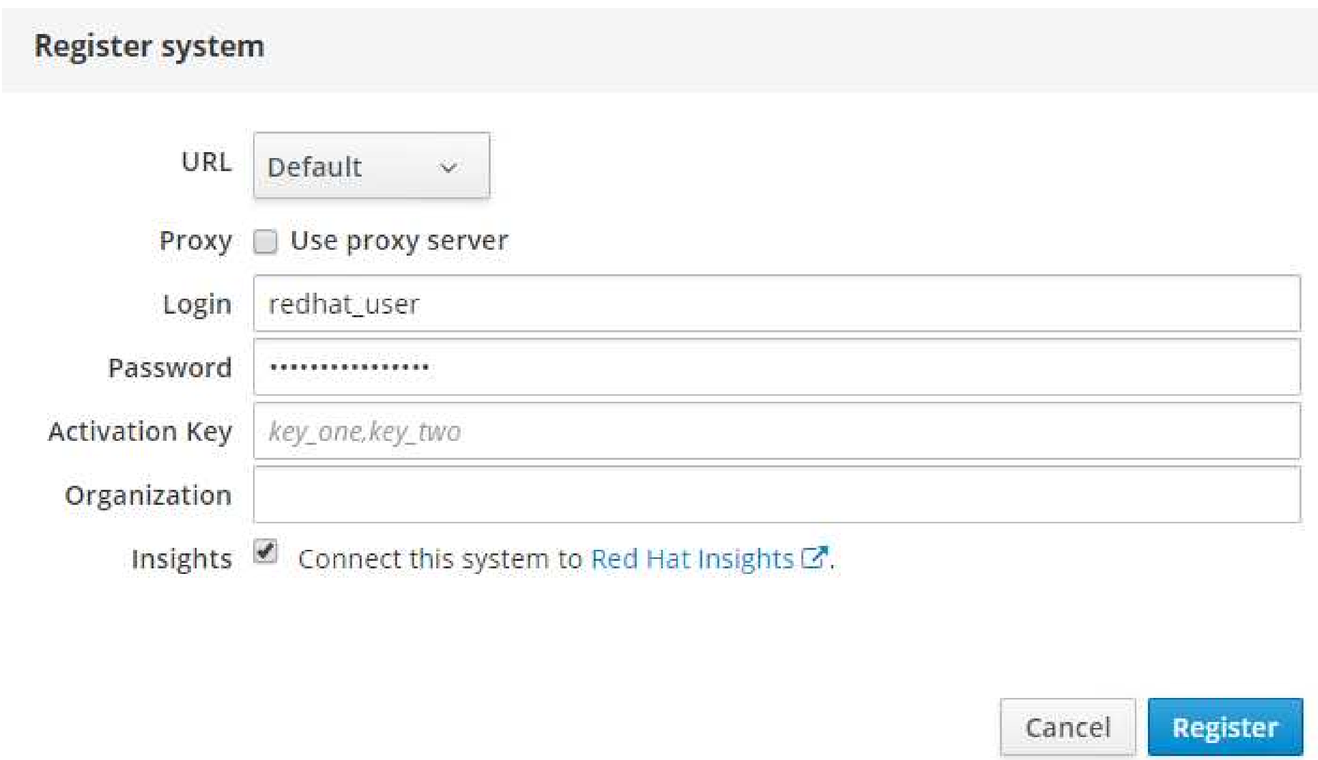


25. Now that the installation is complete, you must then register RHV-H and enable the required repositories. Open a browser and log in to the Cockpit user interface at `https://<HostFQDN/IP>:9090` using the root credentials provided during the installation.



26. Navigate to localhost > Subscriptions and click Register. Enter your Red Hat Portal username and password, click the check box Connect this System to Red Hat Insights, and click Register. The system automatically subscribes to the Red Hat Virtualization Host entitlement.

    Red Hat Insights provide continuous analysis of registered systems to proactively recognize threats to availability, security, performance, and stability across physical, virtual, and cloud environments.



27. Navigate to localhost > Terminal to display the CLI. Optionally you can use any SSH client to log in to the RHV- H CLI. Confirm that the required subscription is attached, and then enable the Red Hat Virtualization Host 7 repository to allow further updates and make sure that all other repositories are disabled.

```
# subscription-manager list
+-------------------------------------------+
    Installed Product Status
+-------------------------------------------+
Product Name:   Red Hat Virtualization Host
Product ID:     328
Version:        4.3
Arch:           x86_64
Status:         Subscribed
# subscription-manager repos --disable=*
Repository 'rhel-7-server- rhvh-4-source-rpms' is disabled for this
system.
Repository 'rhvh-4-build-beta-for-rhel-8-x86_64-source-rpms' is disabled
for this system.
Repository 'rhel-7-server- rhvh-4-beta-debug-rpms' is disabled for this
system.
Repository 'rhvh-4-beta-for-rhel-8-x86_64-debug-rpms' is disabled for
this system.
Repository 'jb-eap-textonly-1-for-middleware-rpms' is disabled for this
system.
Repository 'rhvh-4-build-beta-for-rhel-8-x86_64-rpms' is disabled for
this system.
Repository 'rhvh-4-beta-for-rhel-8-x86_64-source-rpms' is disabled for
this system.
Repository 'rhel-7-server- rhvh-4-debug-rpms' is disabled for this
system.
Repository 'rhvh-4-build-beta-for-rhel-8-x86_64-debug-rpms' is disabled
for this system.
Repository 'rhel-7-server- rhvh-4-beta-source-rpms' is disabled for this
system.
Repository 'rhel-7-server- rhvh-4-rpms' is disabled for this system.
Repository 'jb-coreservices-textonly-1-for-middleware-rpms' is disabled
for this system.
Repository 'rhvh-4-beta-for-rhel-8-x86_64-rpms' is disabled for this
system.
Repository 'rhel-7-server- rhvh-4-beta-rpms' is disabled for this
system.
# subscription-manager repos --enable=rhel-7-server- rhvh-4-rpms
Repository 'rhel-7-server- rhvh-4-rpms' is enabled for this system.
```

28. From the console, modify the iSCSI initiator ID to match the one you set in the Element access group previously by running the following command.

```
rhv-h01 # echo InitiatorName=iqn.1994-05.com.redhat:rhv-host-node- 01 >
/etc/iscsi/initiatorname.iscsi
```

29. Enable and restart the iscsid service.

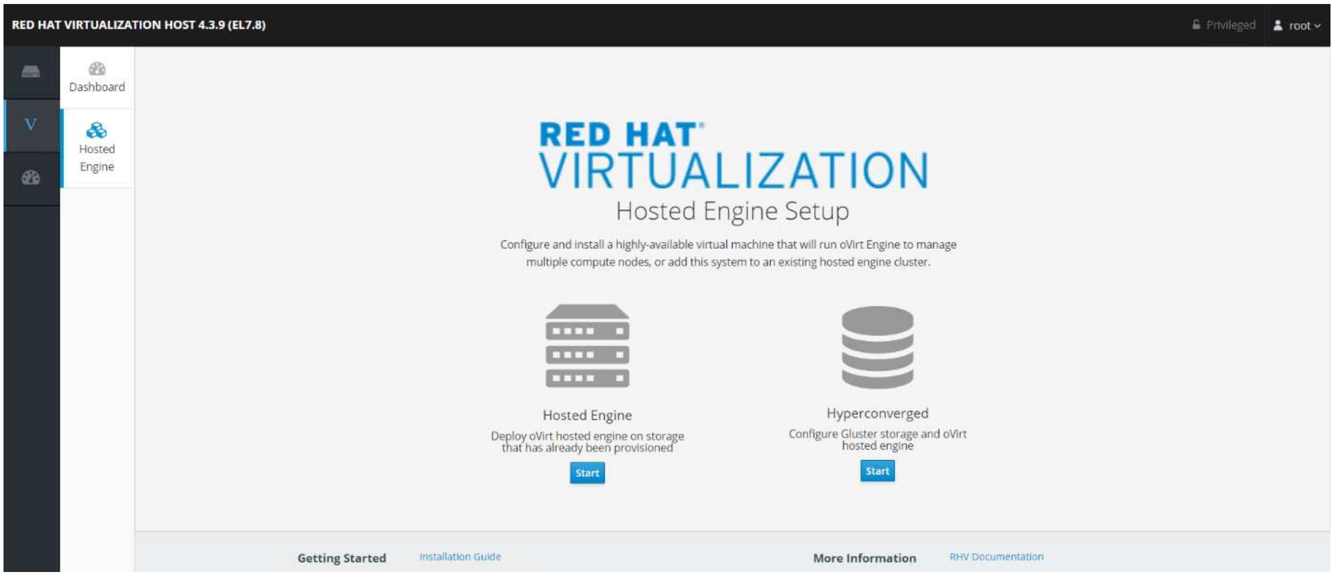
```
 # systemctl enable iscsid
Created symlink from /etc/systemd/system/multi-
user.target.wants/iscsid.service to
/usr/lib/systemd/system/iscsid.service
 # systemctl start iscsid
 # systemctl status iscsid
● iscsid.service - Open-iSCSI
   Loaded: loaded (/usr/lib/systemd/system/iscsid.service; enabled;
vendor preset: disabled)
   Active: active (running) since Thu 2020-05-14 16:08:52 EDT; 3 days
ago
     Docs: man:iscsid(8)
           man:iscsiuio(8)
           man:iscsiadm(8)
 Main PID: 5422 (iscsid)
   Status: "Syncing existing session(s)"
   CGroup: /system.slice/iscsid.service
           ├─5422 /sbin/iscsid -f
           └─5423 /sbin/iscsid -f
```

30. Install and prepare the other RHV host by repeating the steps 1 to 29.

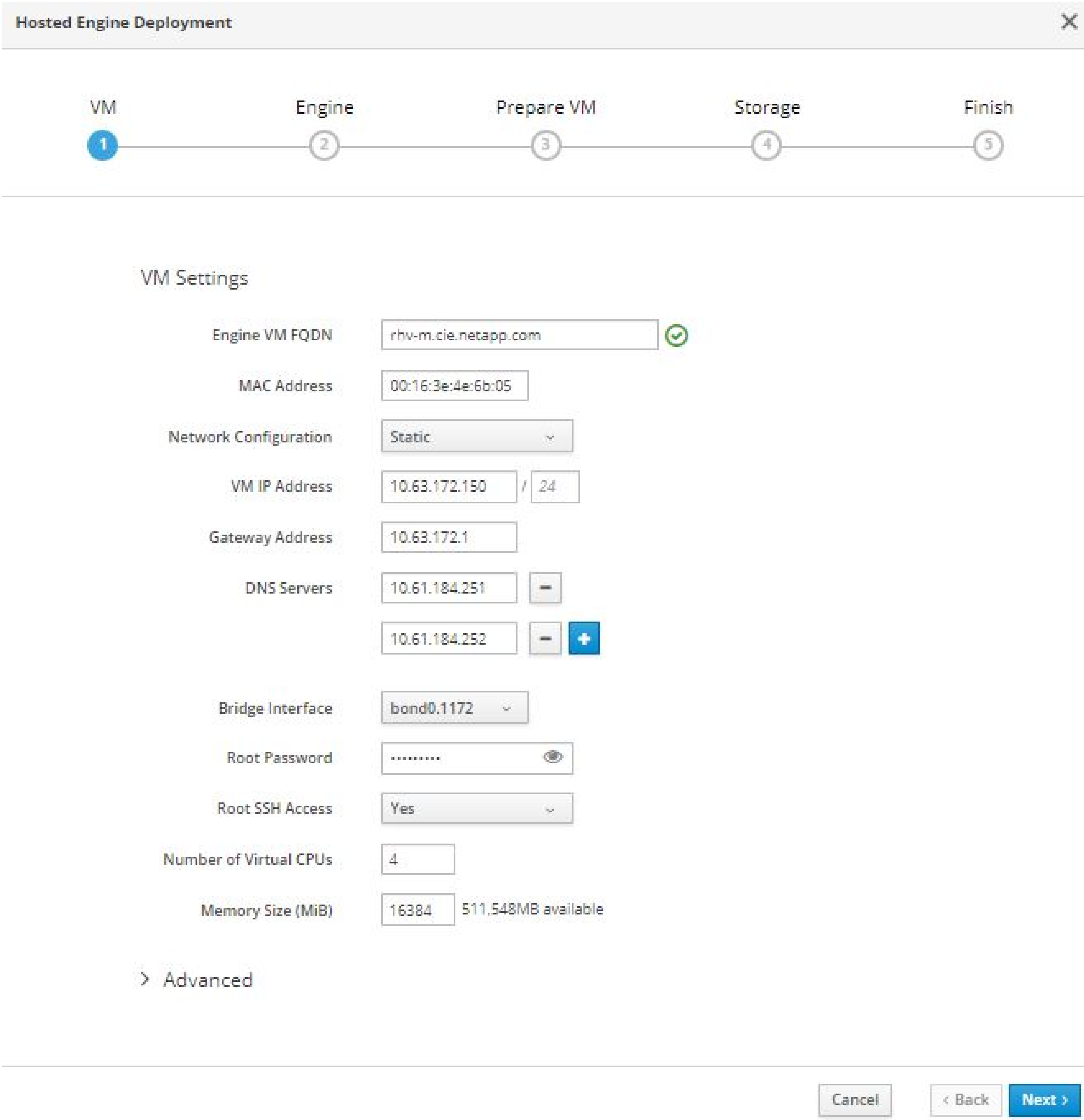
5. Deploy the RHV Manager as a Self-Hosted Engine: NetApp HCI with RHV

This section describes the detailed steps for installing the Red Hat Virtualization Manager as a self-hosted engine. These steps begin after the RHV hosts are registered and the Cockpit GUI is accessible.

1. Log in to the Cockpit GUI of one of the RHV hosts at `https://<HostFQDN/IP>:9090` using the root credentials. Navigate to the Virtualization sub-tab and click Hosted Engine. Then click the Start button below the Hosted Engine content to initiate the engine deployment.

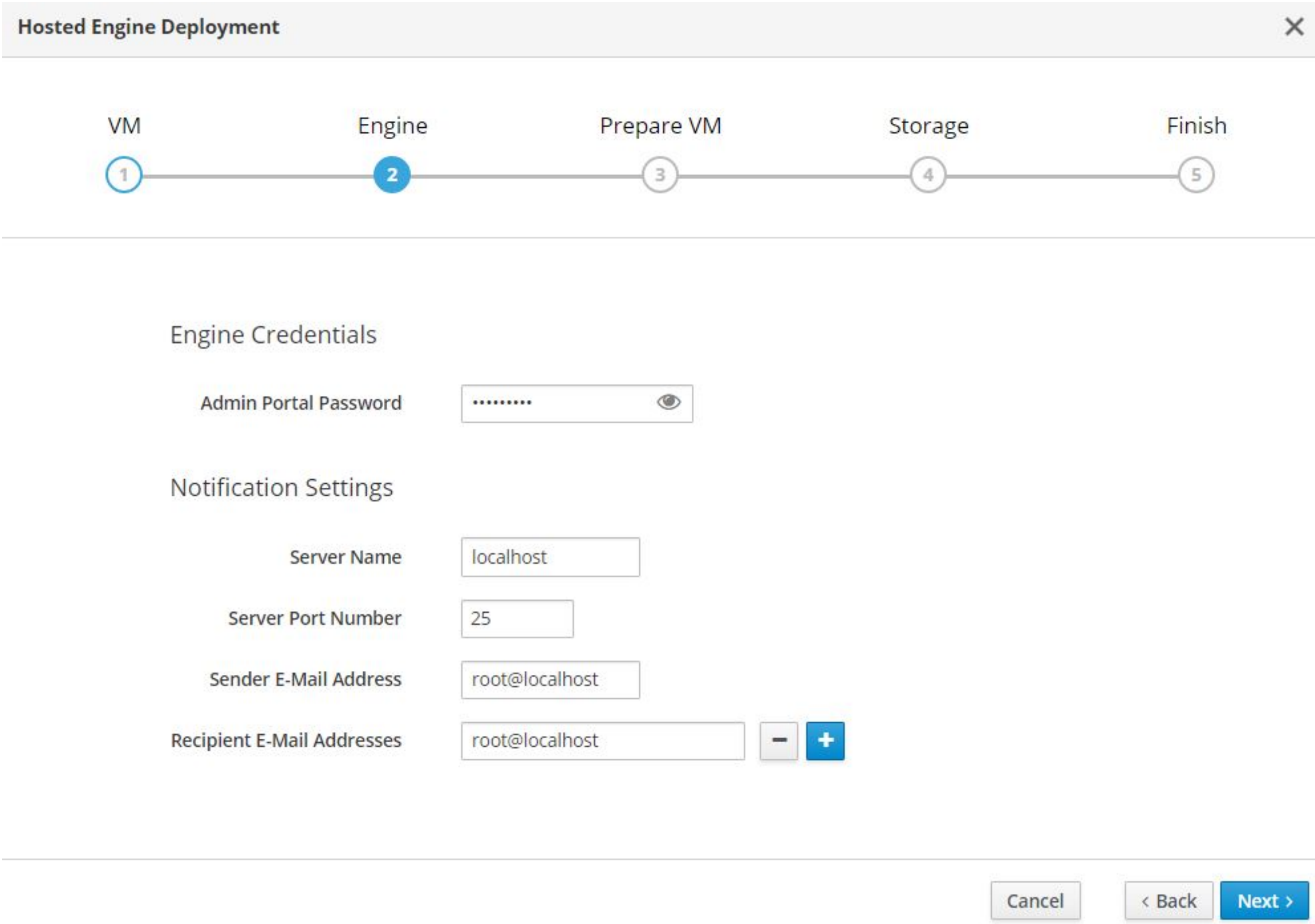


2. In the first screen of engine deployment, configure the RHV-M FQDN, network related configuration, root password, and resources for the engine VM (at least 4 CPUs and 16GB memory). Confirm the other configuration settings as required and click Next.

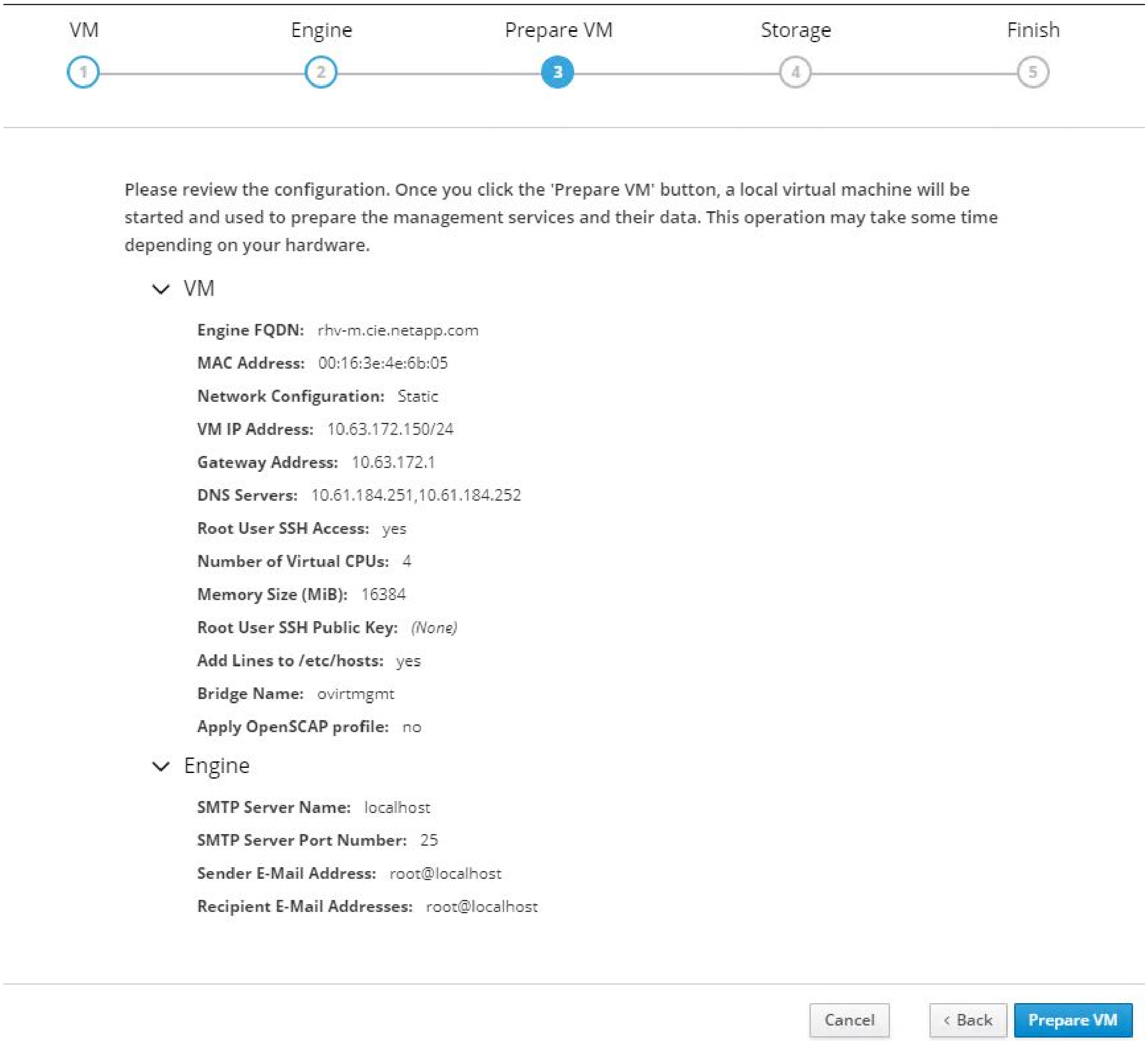


Make sure that the engine VM FQDN is resolvable by the specified DNS servers.

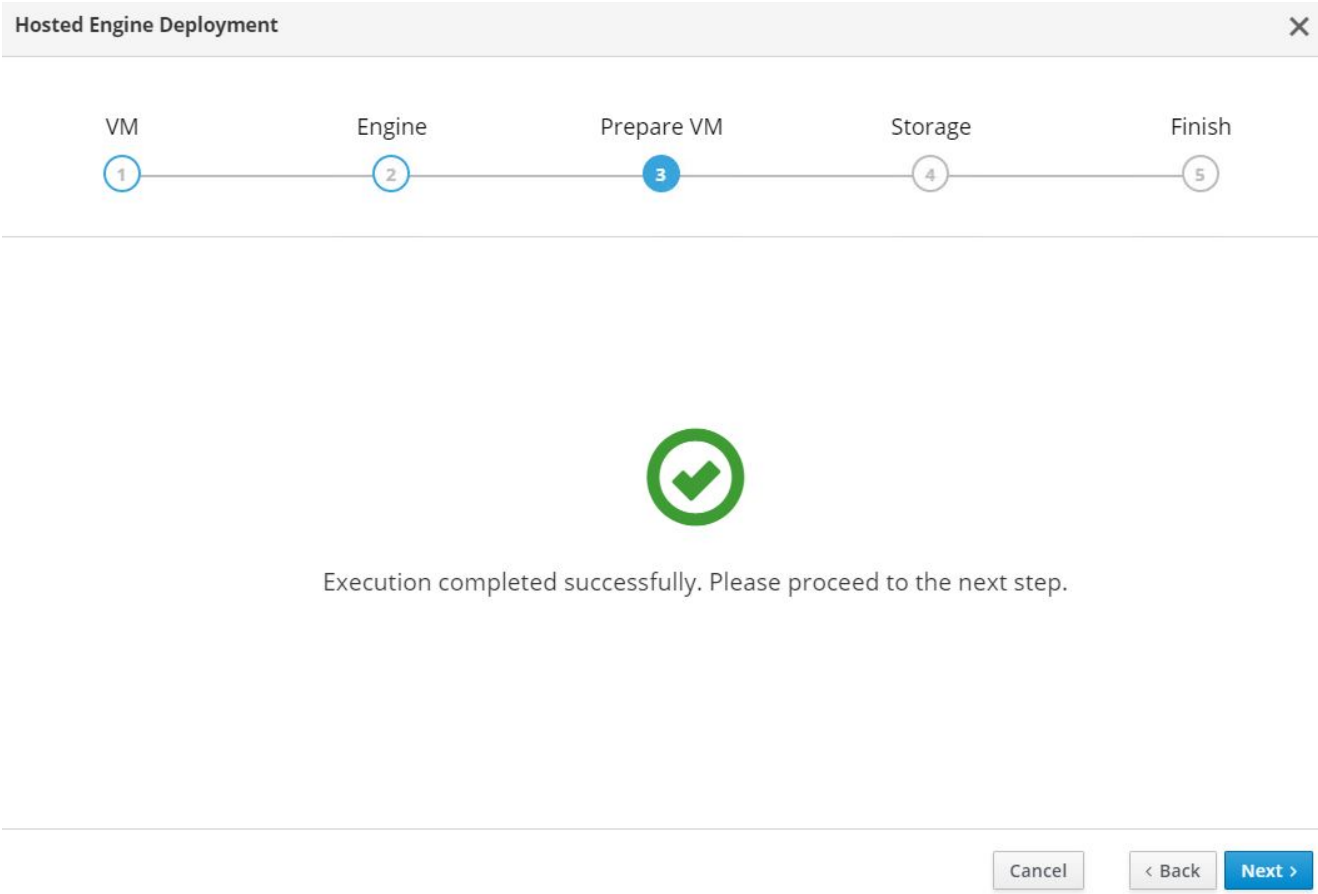
3. In the next screen, enter the admin portal password. Optionally, enter the notification settings for alerts to be sent by email. Then click Next.



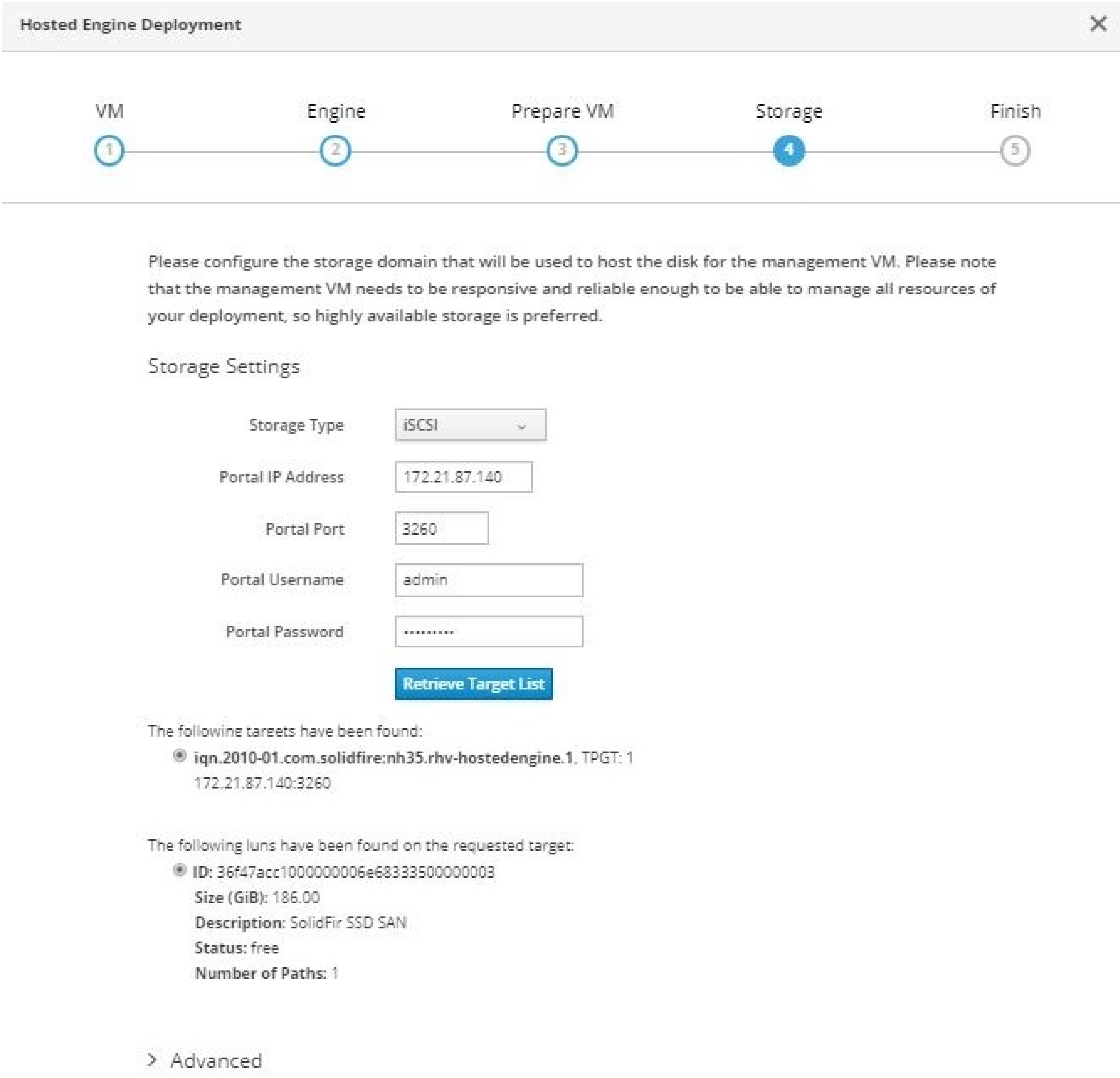
4. In the next screen, review the configuration for the engine VM. If any changes are desired, go back at this point and make them. If the information is correct, click Prepare the VM.



5. The VM installation begins and can take some time to complete as it downloads a machine image and stages the VM locally. After it has completed, it displays the Execution Completed Successfully message. Click Next.

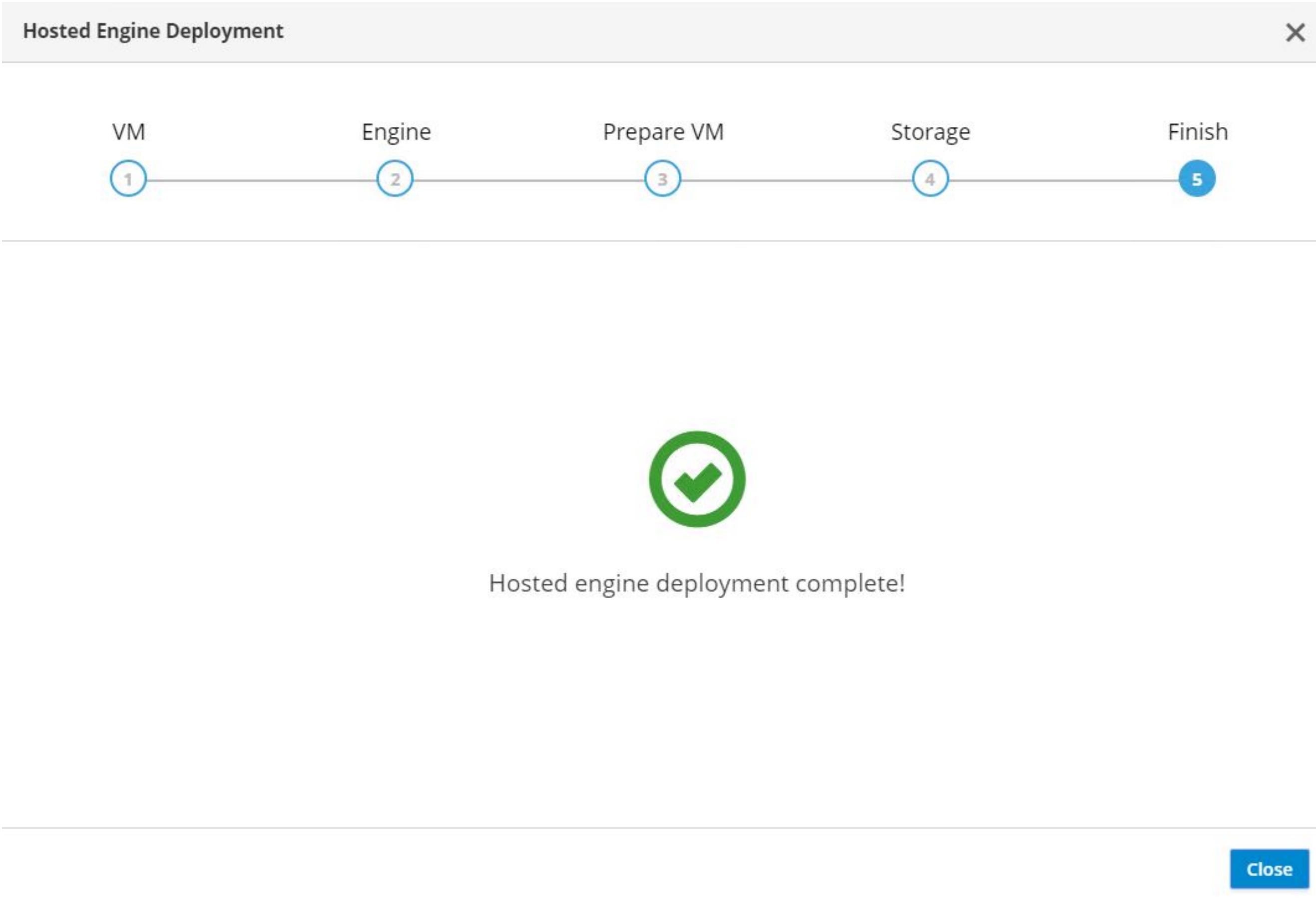


6. After RHV-M is installed, enter the details of the hosted engine storage domain where it copies the VM from local storage to the shared storage domain to facilitate a high availability engine quorum.
7. Enter the Storage Type as iSCSI, provide the iSCSI portal details, click Retrieve Target List, which fetches the iSCSI target list corresponding to the portal, and select the volume and LUN to be mapped to the hosted engine storage domain. Click Next.



If the Hosted Engine setup is unable to discover the storage, open an interactive SSH session to the node and verify that you can reach the SVIP IP address through your node's storage interface. If the network is reachable, you might need to manually discover or log in to the iSCSI LUN intended for the Hosted Engine install.

8. On the next screen, review the storage configuration and, if any changes are desired, go back and make them. If the information is correct, click Finish Deployment. It takes some time as the VM is copied to the storage domain. After deployment is complete, click Close.



9. The next step is to register and enable the Red Hat Virtualization Manager repositories. Log in to the RHV-M VM with SSH to register it with Subscription Manager.

```
# subscription-manager register
Registering to: subscription.rhsm.redhat.com:443/subscription
Username: redhat_user
Password:  redhat_password
The system has been registered with ID: 99d06fcb-a3fd74-41230f-bad583-
0ae61264f9a3
The registered system name is: rhv-m.cie.netapp.com
```

10. After registration, list the available subscriptions and record the pool ID for RHV-M.

```
# subscription-manager list --available
<snip>
Subscription Name:   Red Hat Virtualization Manager
Provides:            Red Hat Beta
                     Red Hat Enterprise Linux Server
                     Red Hat CodeReady Linux Builder for x86_64
                     Red Hat Enterprise Linux for x86_64
                     Red Hat Virtualization Manager
                     Red Hat OpenShift Container Platform
                     Red Hat Ansible Engine
                     Red Hat Enterprise Linux Fast Datapath
                     Red Hat JBoss Core Services
                     JBoss Enterprise Application Platform
SKU:                 RV00045
Contract:
Pool ID:             8a85f9937a1a2a57c0171a366b5682540112a313 ß Pool ID
Provides Management: No
Available:           6
Suggested:           0
Service Type:        L1-L3
Roles:
Service Level:       Layered
Usage:
Add-ons:
Subscription Type:   Stackable
Starts:              04/22/2020
Ends:                04/21/2021
Entitlement Type:    Physical
<snip>
```

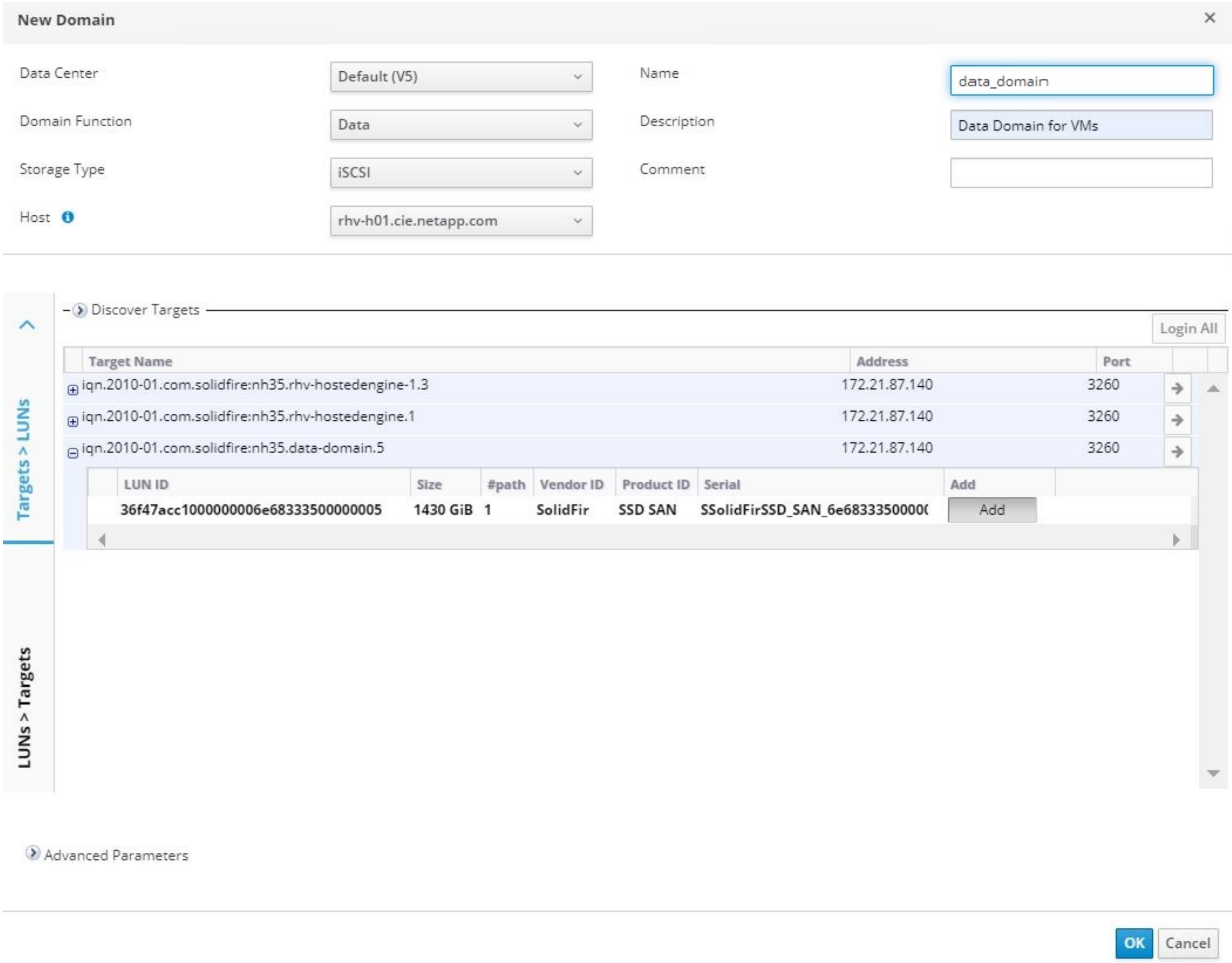
11. Attach the RHV-M subscription using the recorded pool ID.

```
# subscription-manager attach
--pool=8a85f9937a1a2a57c0171a366b5682540112a313
Successfully attached a subscription for: Red Hat Virtualization Manager
```

12. Enable the required RHV-M repositories.

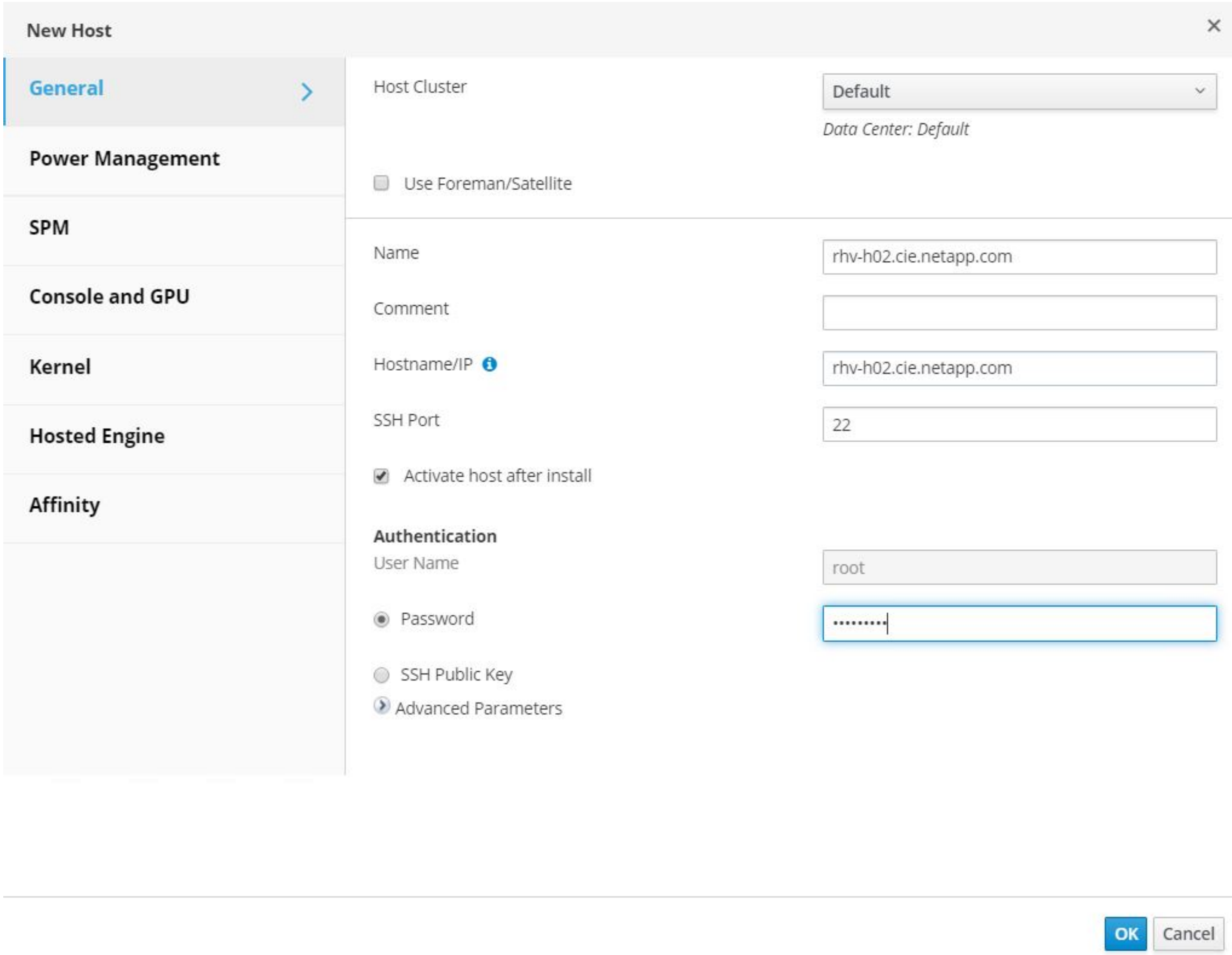
```
# subscription-manager repos \
    --disable='*' \
    --enable=rhel-7-server-rpms \
    --enable=rhel-7-server-supplementary-rpms \
    --enable=rhel-7-server-rhv-4.3-manager-rpms \
    --enable=rhel-7-server-rhv-4-manager-tools-rpms \
    --enable=rhel-7-server-ansible-2-rpms \
    --enable=jb-eap-7.2-for-rhel-7-server-rpms
Repository 'rhel-7-server-ansible-2-rpms' is enabled for this system.
Repository 'rhel-7-server-rhv-4-manager-tools-rpms' is enabled for this
system.
Repository 'rhel-7-server-rhv-4.3-manager-rpms' is enabled for this
system.
Repository 'rhel-7-server-rpms' is enabled for this system.
Repository 'jb-eap-7.2-for-rhel-7-server-rpms' is enabled for this
system.
Repository 'rhel-7-server-supplementary-rpms' is enabled for this
system.
```

13. Next, create a storage domain to hold the VM disks or OVF files for all VMs in the same datacenter as that of the hosts.
14. To log into the RHV-M Administrative portal using a browser, log into `https://<ManagerFQDN>/ovirt-engine`, select Administrative Portal, and log in as the `admin @ internal` user.
15. Navigate to Storage > Storage Domains and click New Domain.
16. From the dropdown menu, select Data for the Domain Function, select iSCSI for the Storage Type, select the host to map the volume, enter a name of your choice, confirm that the data center is correct, and then expand the data domain iSCSI target and add the LUN. Click OK to create the domain.

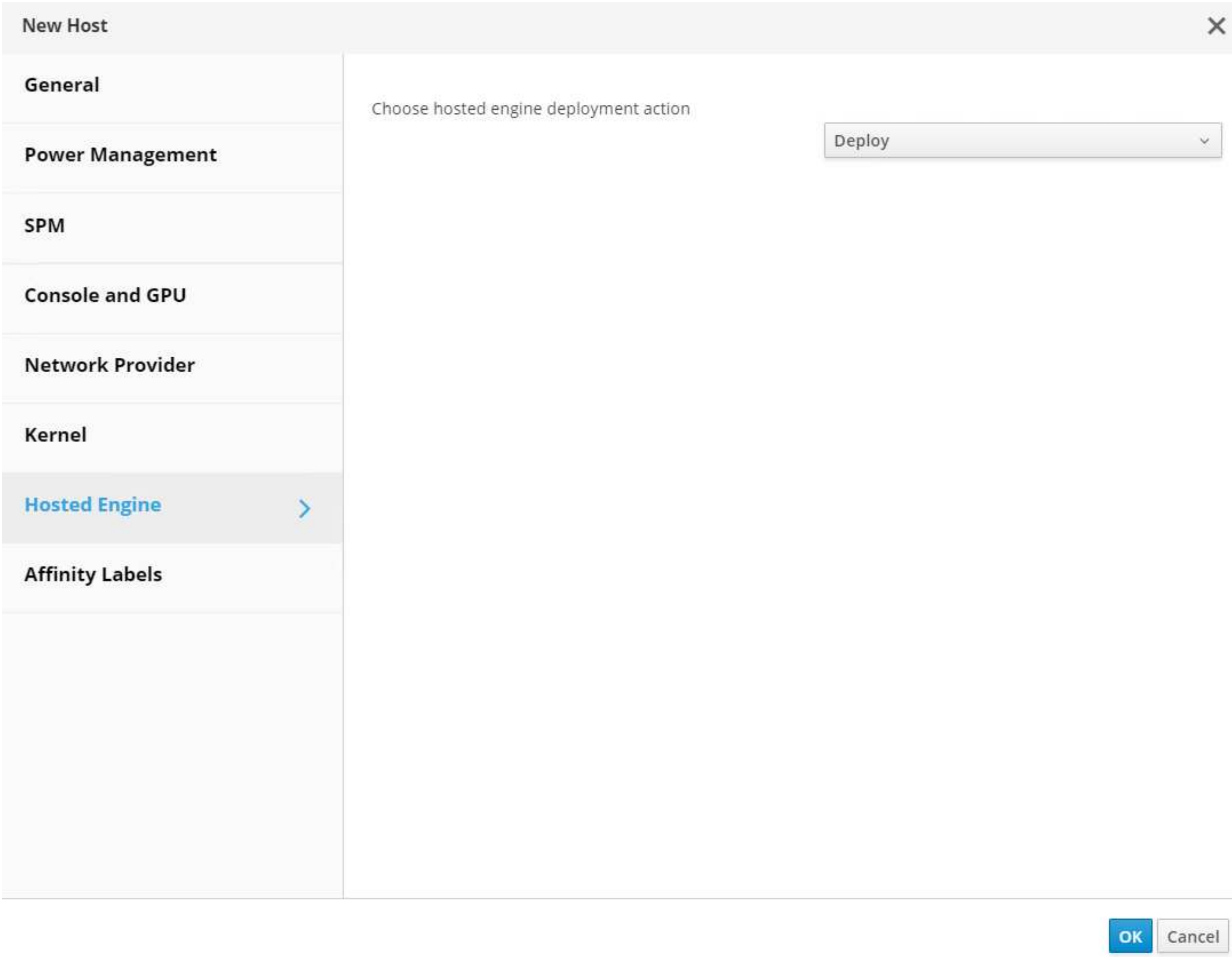


If the Hosted Engine setup is unable to discover the storage, you might need to manually discover or log in to the iSCSI LUN intended for the data domain.

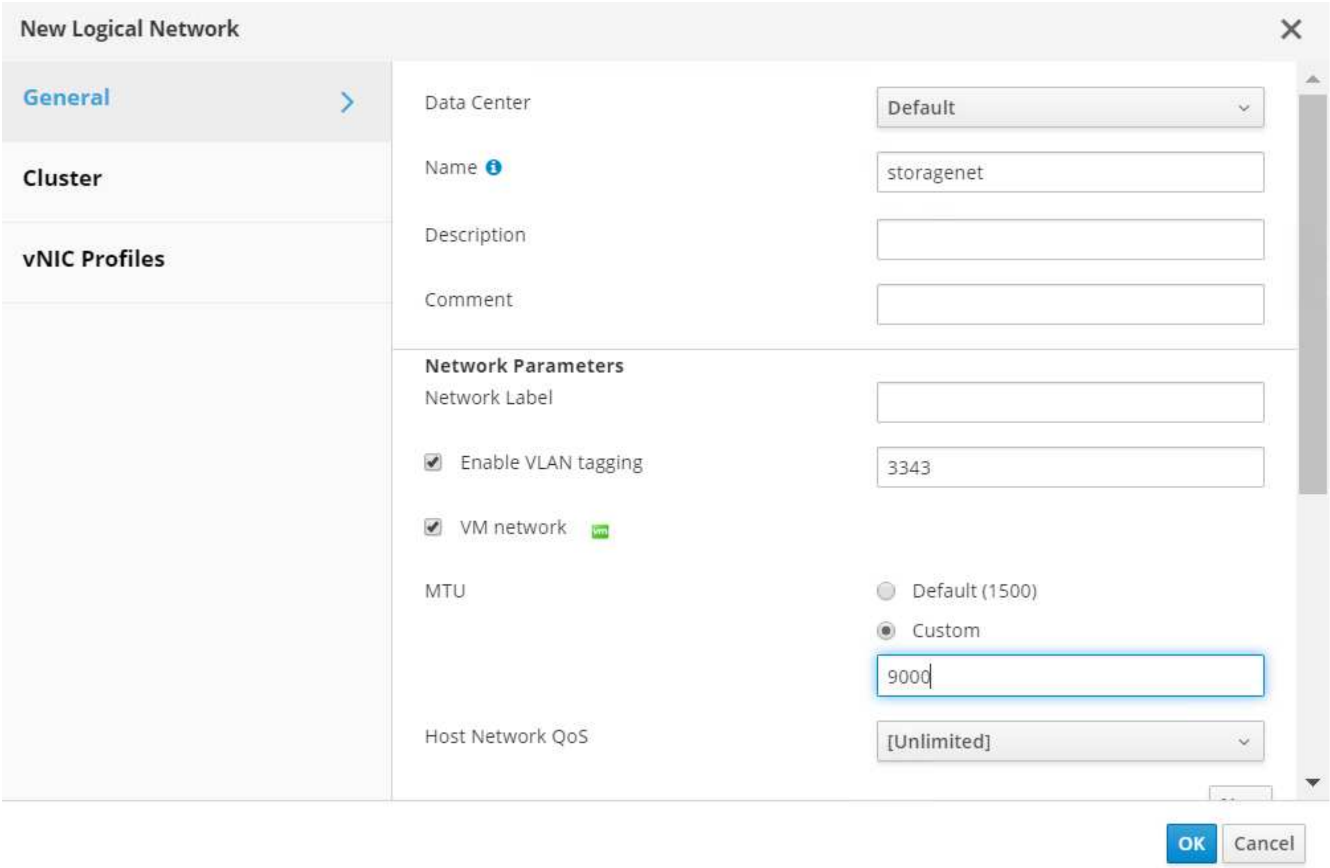
17. Add the second host to the hosted engine quorum. Navigate to Compute > Hosts and click New. In the New Host pane, select the appropriate cluster, provide the details of the second host, and check the Activate Host After Install checkbox.



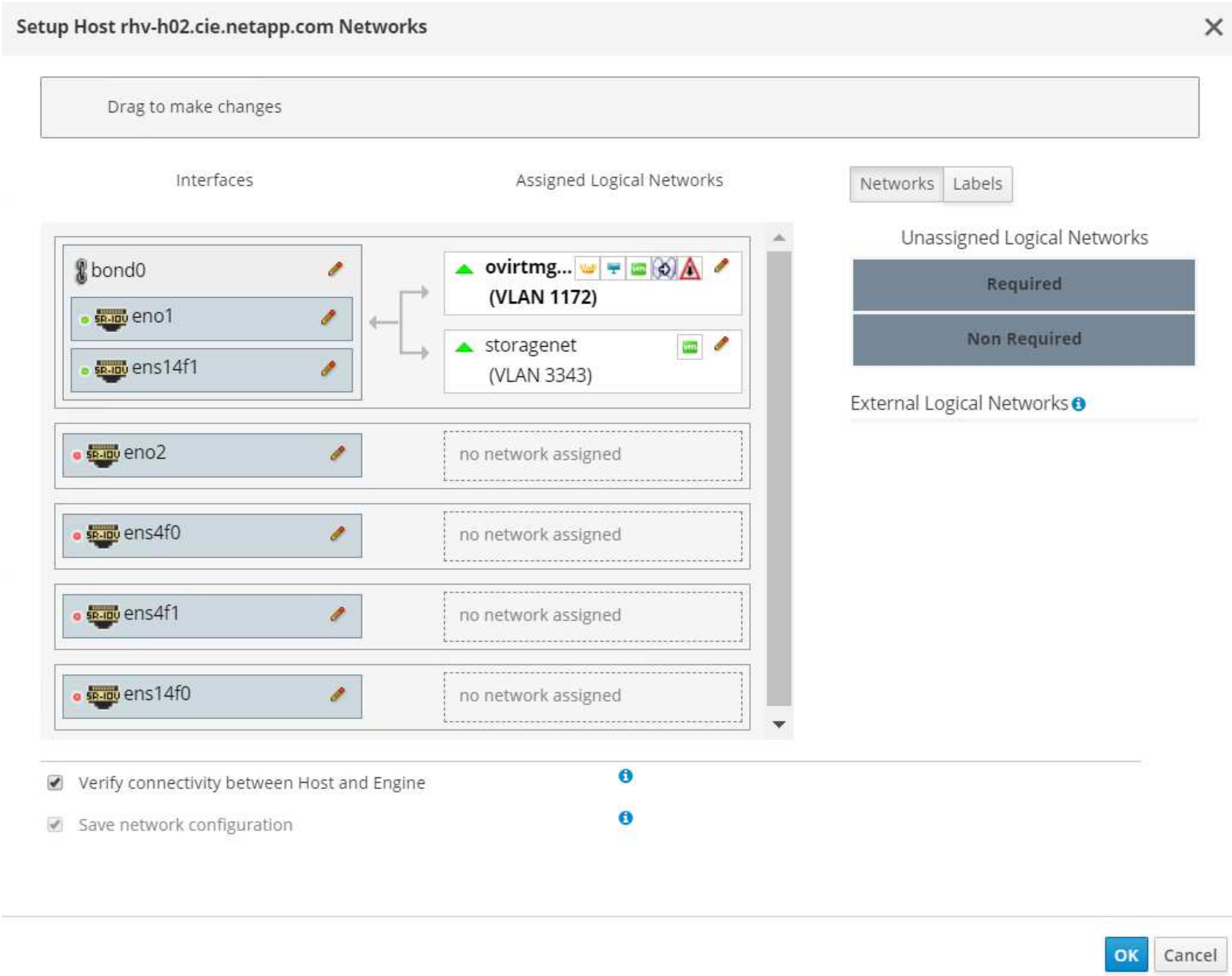
18. Click the Hosted Engine sub-tab in the New Host pane dropdown and select Deploy from the hosted engine deployment action. Click OK to add the host to the quorum. This begins the installation of the necessary packages to support the hosted engine and activate the host. This process might take a while.



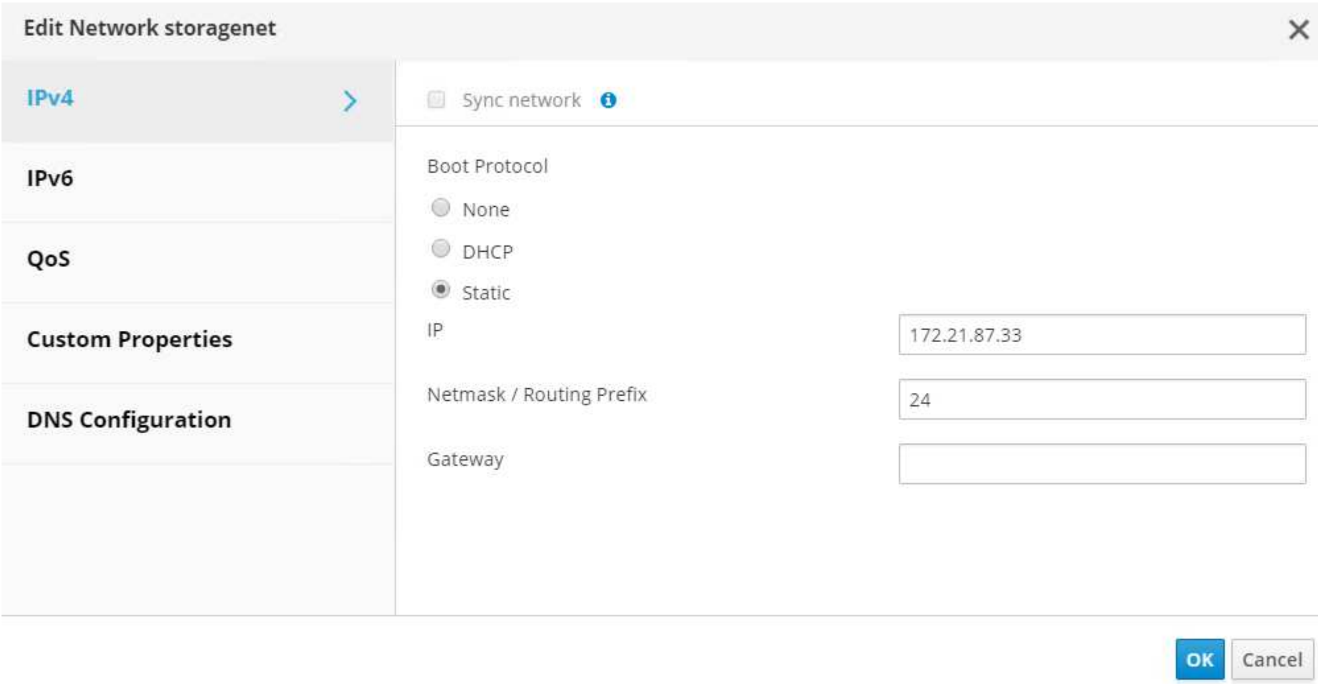
19. Next, create a storage virtual network for hosts. Navigate to Network > Networks and click New. Enter the name of your choice, enable VLAN tagging, and enter the VLAN ID for the Storage network. Confirm that the VM Network checkbox is checked and that the MTU is set to 9000. Go to the Cluster sub-tab and make sure that Attach and Require are checked. Then click OK to create the storage network.



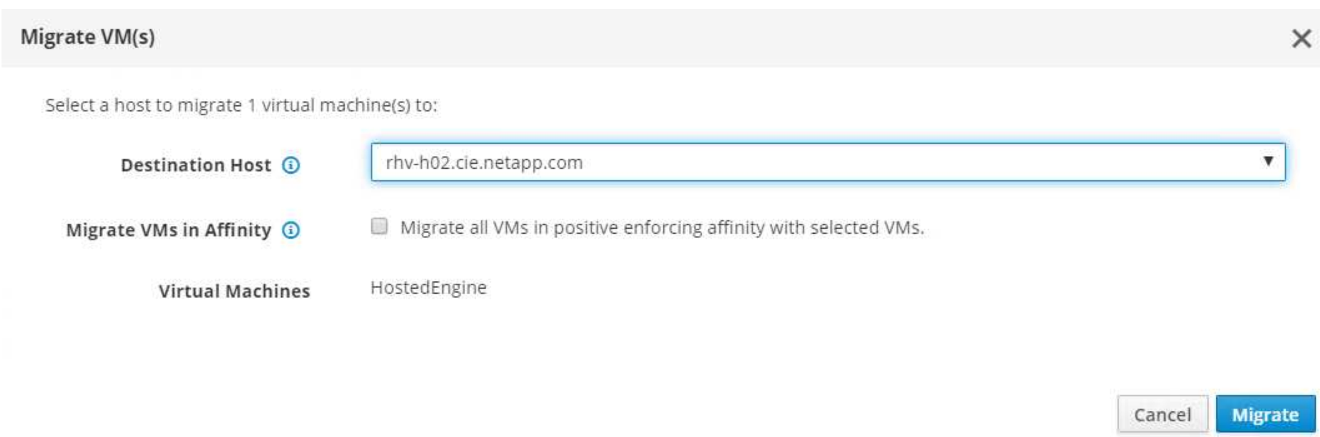
20. Assign the storage logical network to the second host in the cluster or to whichever host is not currently hosting the hosted engine VM.
21. Navigate to Compute > Hosts, and click the host that has silver crown in the second column. Then navigate to the Network Interfaces sub-tab, click Setup Host Networks, and drag and drop the storage logical network into the Assigned Logical Networks column to the right of bond0.



22. Click the pen symbol on the storage network interface under bond0. Configure the IP address and the netmask, and then click OK. Click OK again in the Setup Host Networks pane.

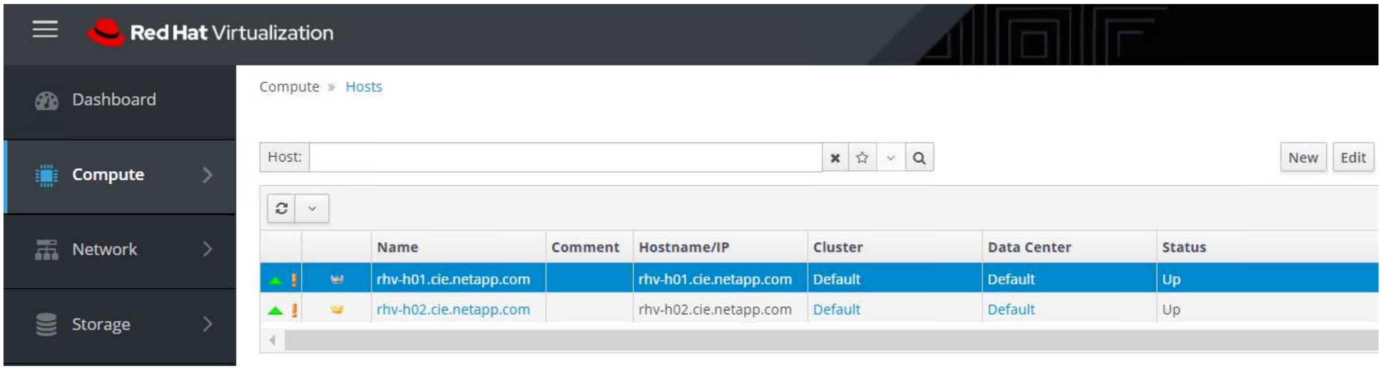


23. Migrate the hosted engine VM to the host that was just configured so that the storage logical network can be configured on the second host. Navigate to Compute > Virtual Machines, click HostedEngine and then click Migrate. Select the second host from the dropdown menu Destination Host and click Migrate.



After the migration is successful and the hosted engine VM is migrated to the second host, repeat steps 21 and 22 for the host that currently possesses the silver crown.

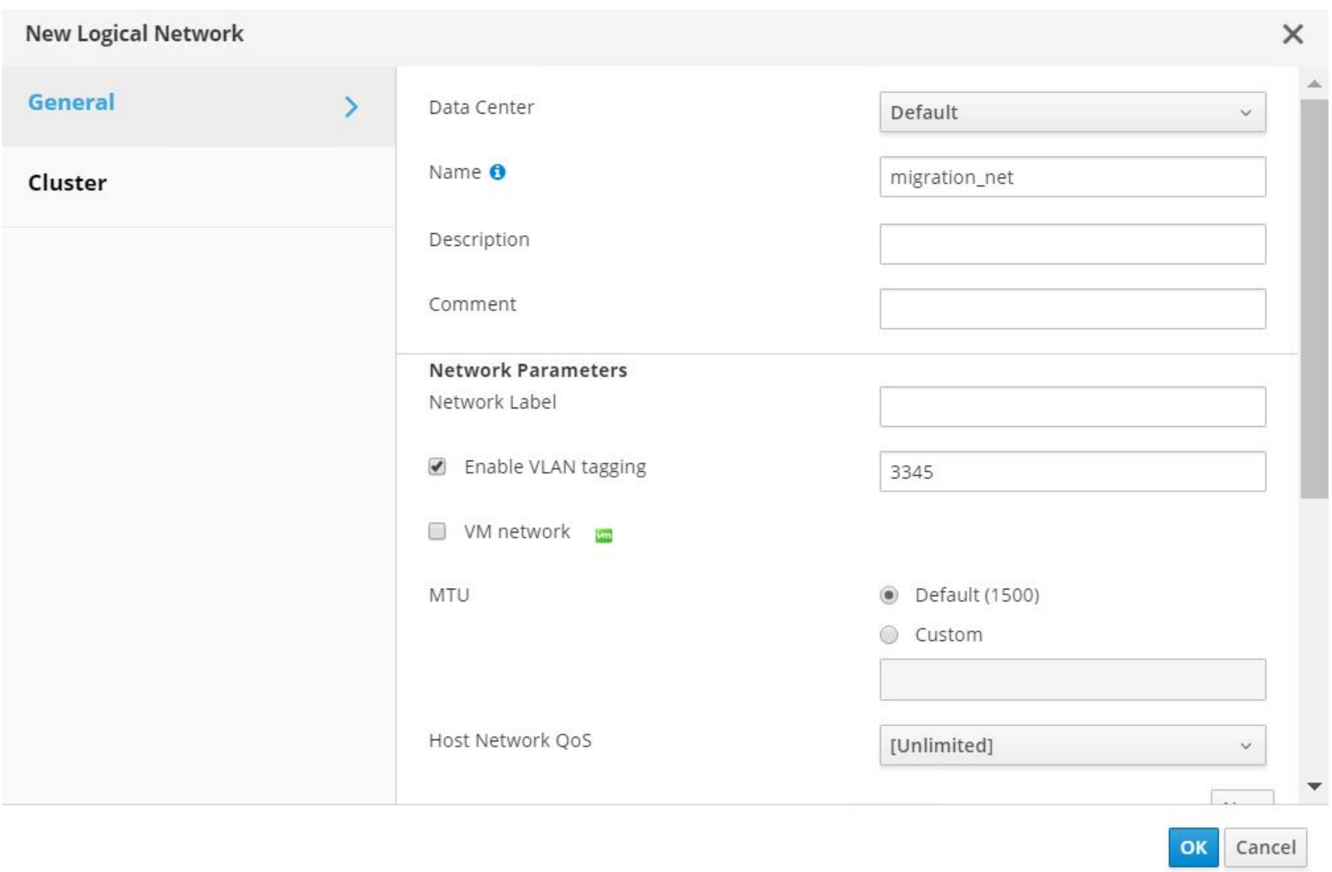
24. After you have completed this process, you should see that both the hosts are up. One of the hosts has a golden crown, indicating that it is hosting the hosted engine VM, and the other host has a silver crown indicating that it is capable of hosting the hosted engine VM.



6. Configure RHV-M Infrastructure: NetApp HCI with RHV

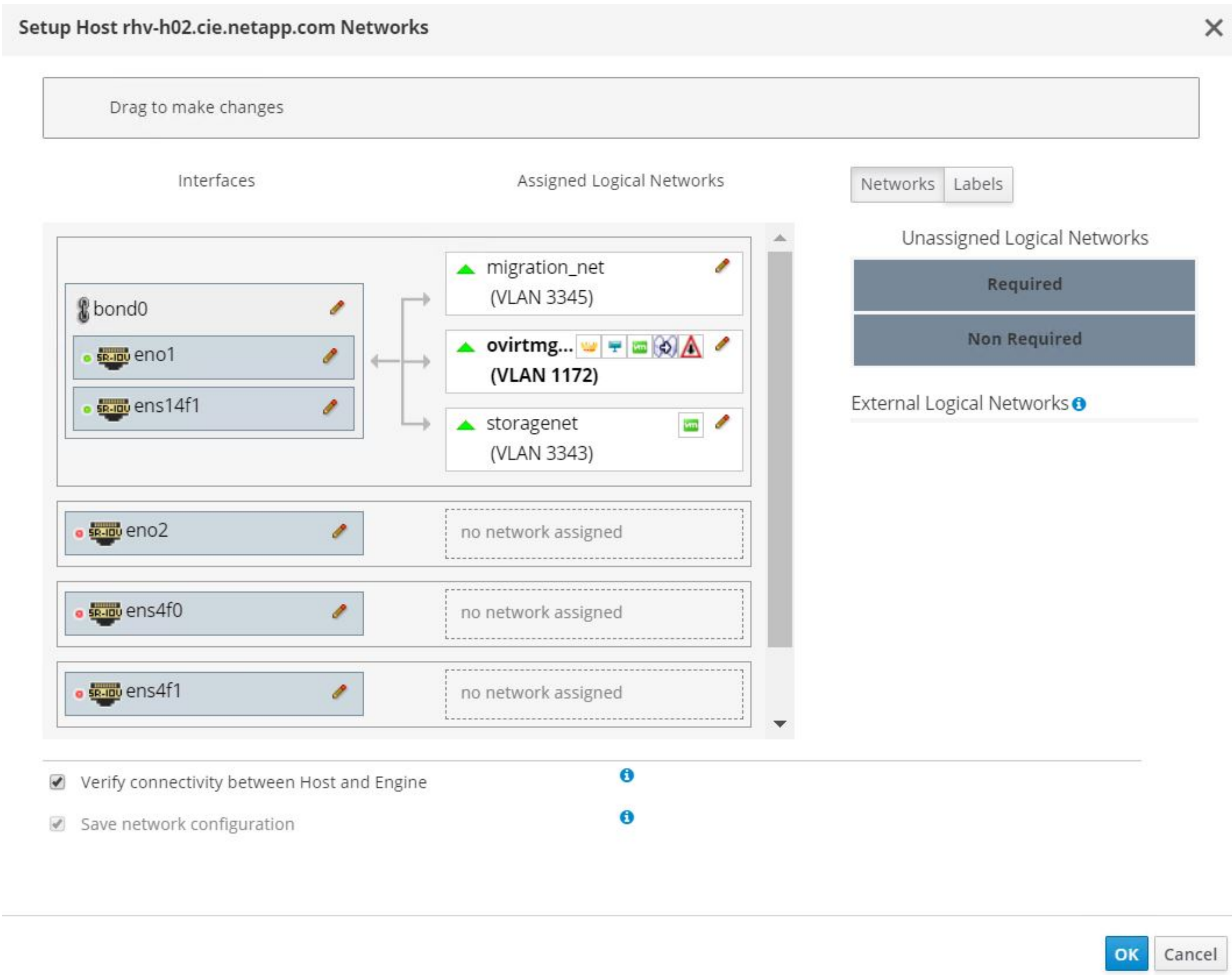
To configure the RHV-M infrastructure, complete the following steps:

1. By default, the ovirtmgmt network is used for all purposes, including the migration of VMs and virtual guest data.
2. It is a best practice to specify different networks for these purposes. To configure the migration network, navigate to Network > Networks and click New. Enter the name of your choice, enable VLAN tagging, and enter the VLAN ID for the migration network.
3. Make sure that the VM Network checkbox is unchecked. Go to the Cluster sub-tab and make sure that Attach and Require are checked. Then click OK to create the network.

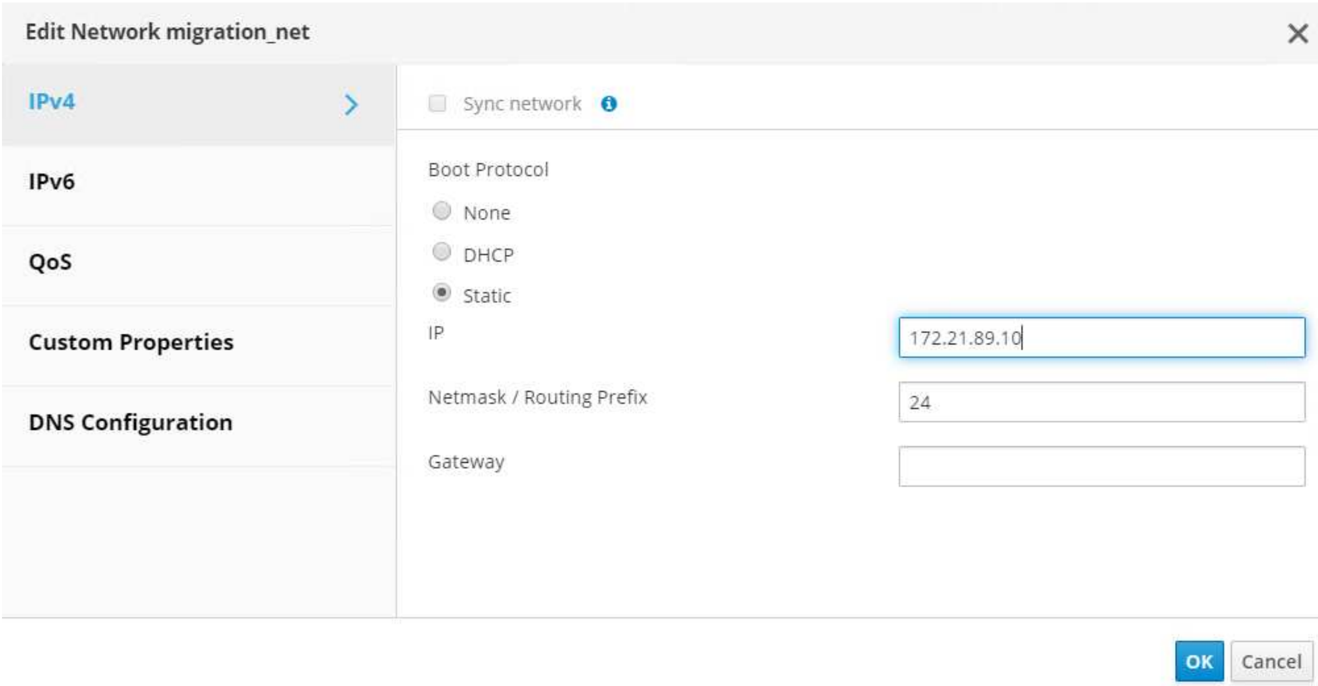


4. To assign the migration logical network to both the hosts, navigate to Compute > Hosts, click the hosts, and navigate to the Network Interfaces sub-tab.

5. Then click Setup Host Networks and drag and drop the migration logical network into the Assigned Logical Networks column to the right of bond0.

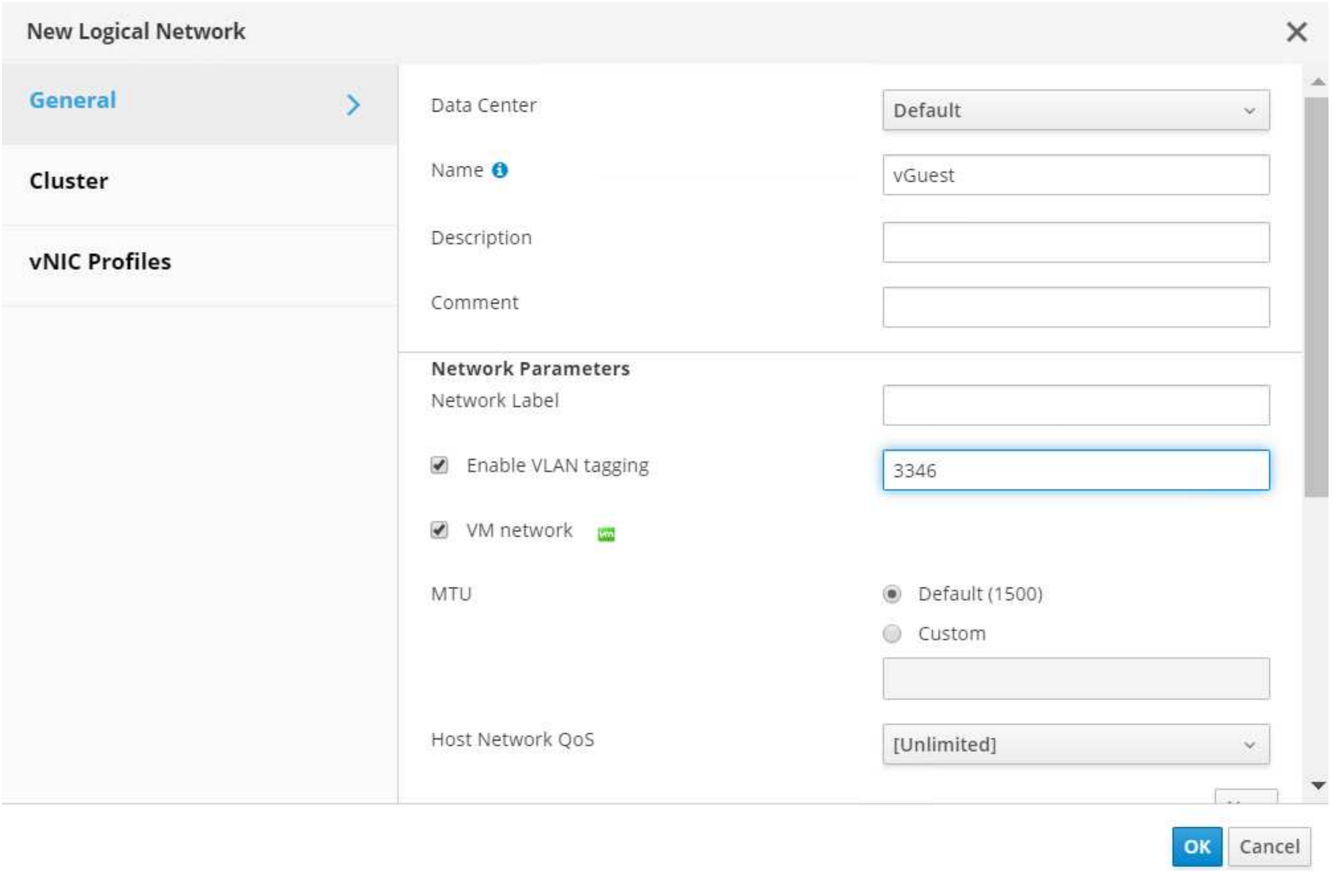


6. Click the pen symbol on the migration network interface under bond0. Configure the IP address details and click OK. Then click OK again in the Setup Host Networks pane.



7. Repeat steps 4 through 6 for the other host as well.
8. The newly created network must be assigned the role of the migration network. Navigate to Compute > Clusters and click the cluster that the RHV hosts belong to, click the Logical Networks sub-tab, and click Manage Networks. For the migration network, enable the checkbox under Migration Network column. Click OK.

9. Next, as a best practice, create a separate VM network rather than using the ovirtmgmt network for VMs.
10. Navigate to Network > Networks and click New. Enter the name of your choice, enable VLAN tagging, and enter the VLAN ID for the VM guest network. Make sure that the checkbox VM Network is checked. Go to the Cluster's sub-tab and make sure that Attach and Require are checked. Then click OK to create the VM guest network.



11. Assign the VM guest logical network to both the hosts. Navigate to Compute > Hosts, click the host names and navigate to the Network Interfaces sub-tab. Then click Setup Host Networks and drag and drop the VM guest logical network into the Assigned Logical Networks column to the right of bond0. There is no need to assign an IP to this logical network, because it provides passthrough networking for the VMs.

    The VM guest network should be able to reach the internet to allow guests to register with Red Hat Subscription Manager.

7. Deploy the NetApp mNode: NetApp HCI with RHV

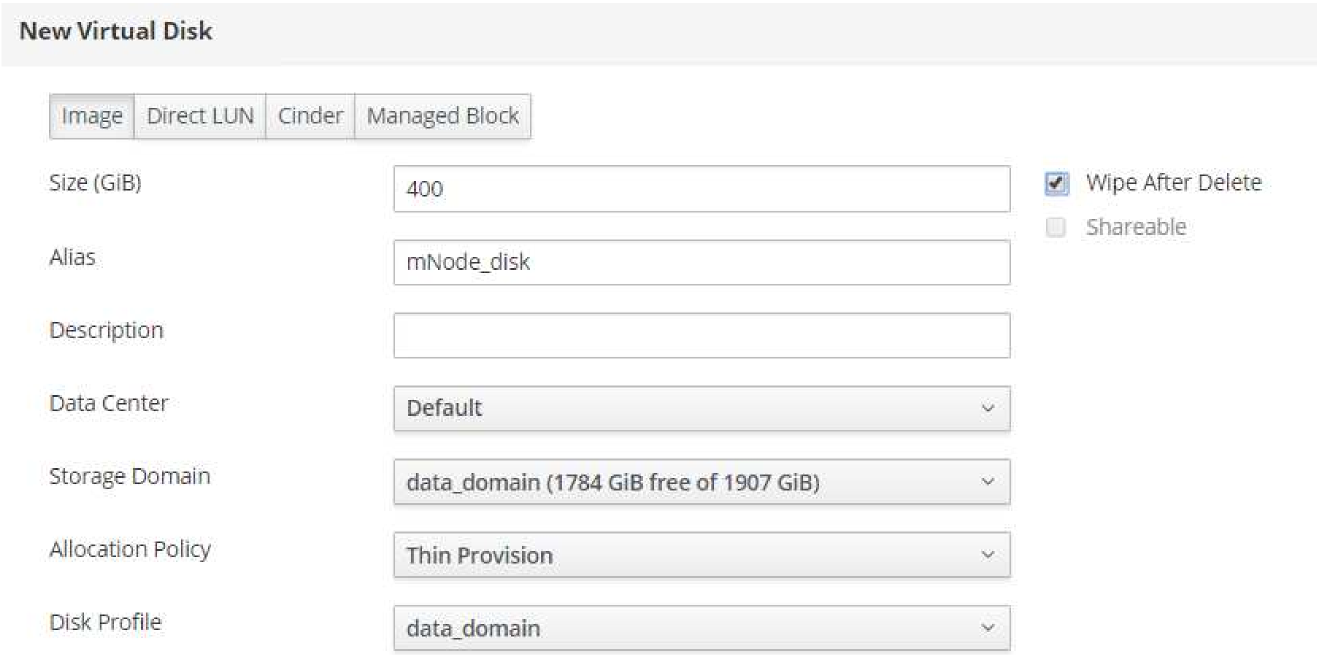
The management node (mNode) is a VM that runs in parallel with one or more Element software-based storage clusters. It is used for the following purposes:

- Providing system services including monitoring and telemetry
- Managing cluster assets and settings
- Running system diagnostic tests and utilities
- Enabling callhome for NetApp ActiveIQ for additional support

To install the NetApp mNode on Red Hat Virtualization, complete the following steps:

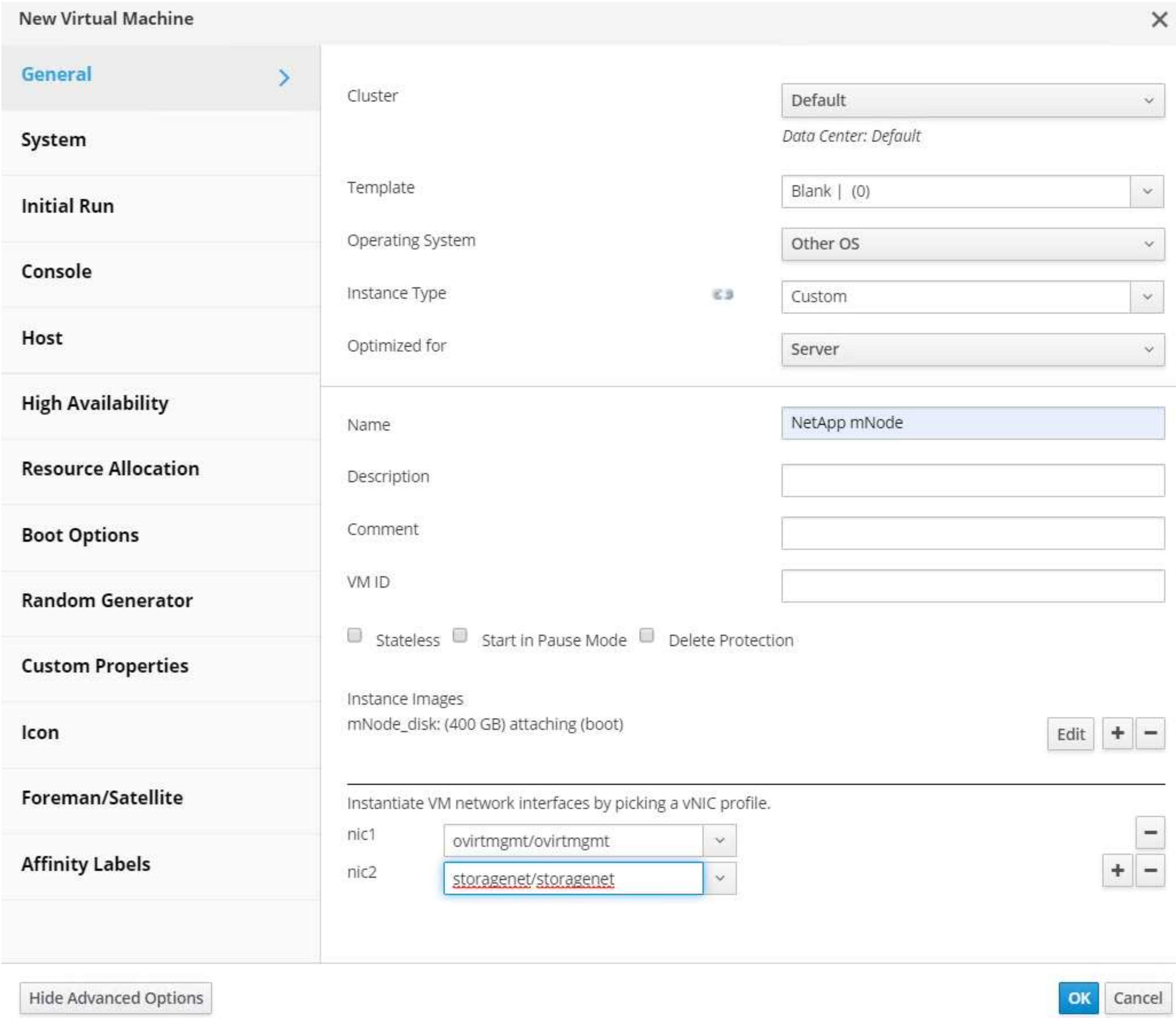
1. Upload the mNode ISO as a disk to the storage domain. Navigate to Storage > Disks > Upload and click Start. Then click Upload Image and select the downloaded mNode ISO image. Verify the storage domain, the host to perform the upload, and additional details. Then click OK to upload the image to the domain. A progress bar indicates when the upload is complete and the ISO is usable.
2. Create a VM disk by navigating to Storage > Disks and click New. The mNode disk must be at least 400

GB in size but can be thin-provisioned. In the wizard, enter the name of your choice, select the proper data center, make sure that the proper storage domain is selected, select Thin Provisioning for the allocation policy, and check the Wipe After Delete checkbox. Click OK.

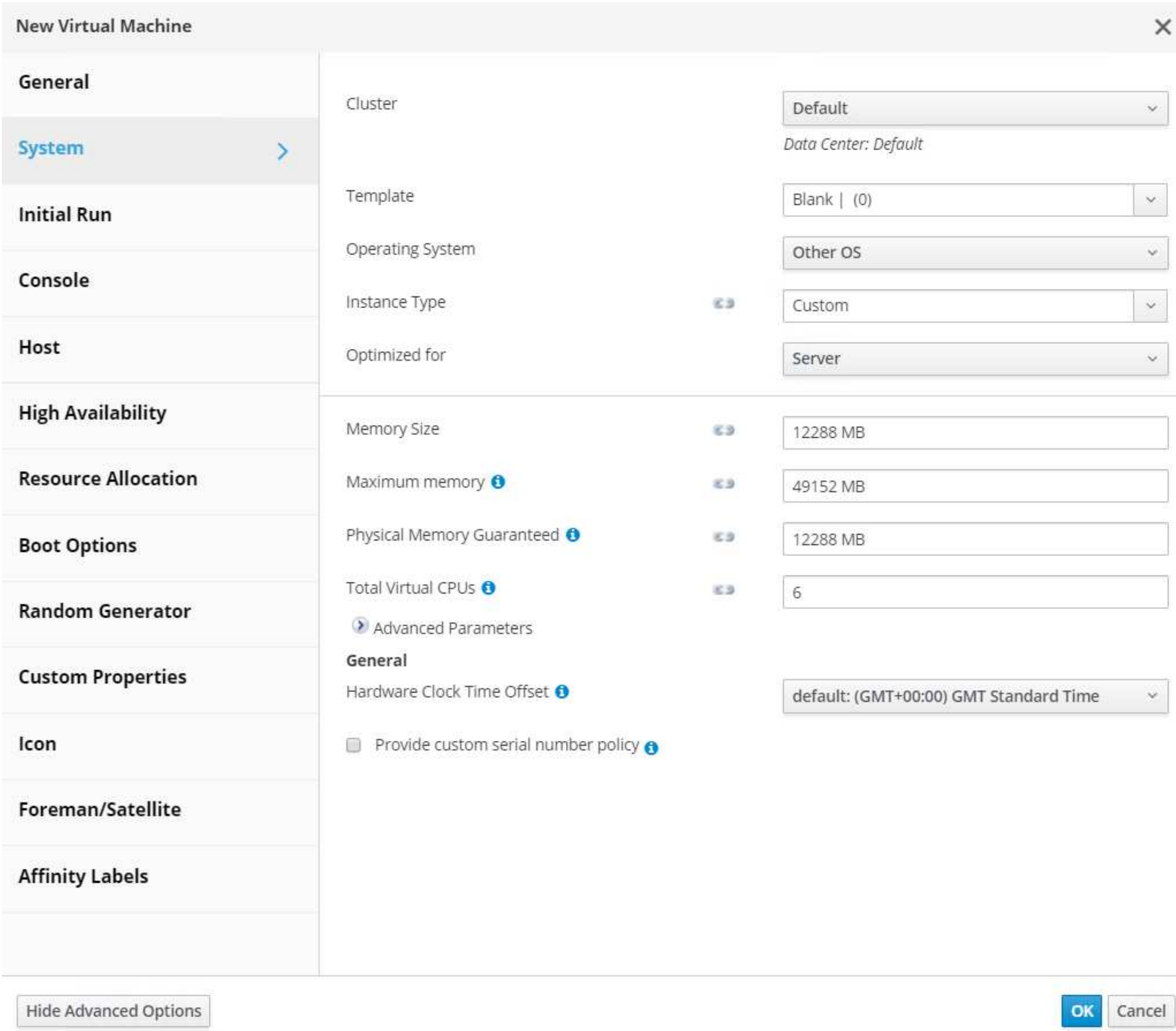


3. Next, navigate to Compute > Virtual Machines and click New. In the General sub-tab, select the appropriate cluster, enter the name of your choice, click attach, and select the disk created in the previous step. Check the box below OS to emphasize that it is a bootable drive. Click OK.

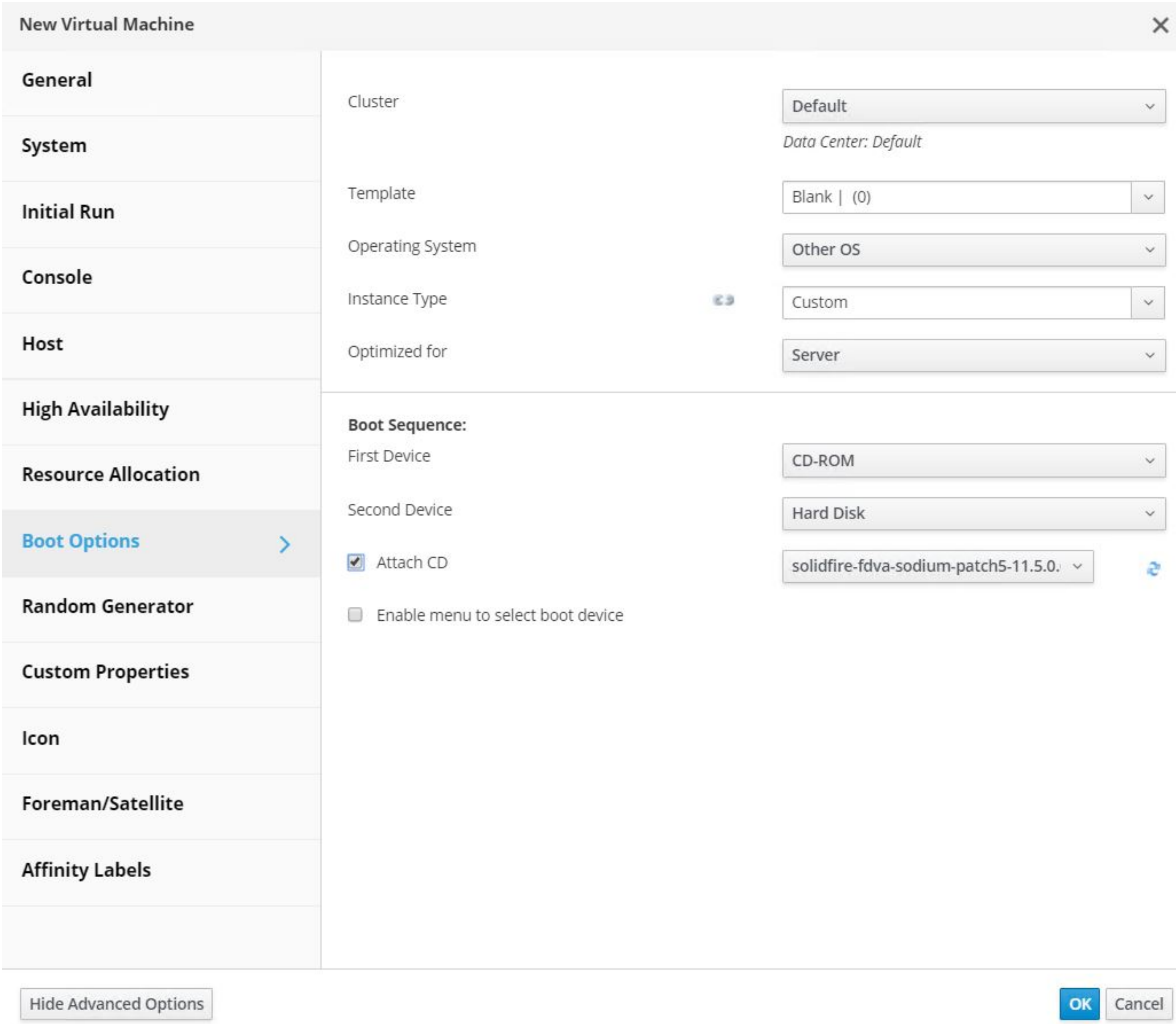
4. Select ovirtmgmt from the dropdown for nic1. Click the (+) sign and select the storage network interface from the dropdown list for nic2.



5. Click the System sub-tab and make sure that it has at least 12GB of memory and 6 virtual CPUs as recommended.



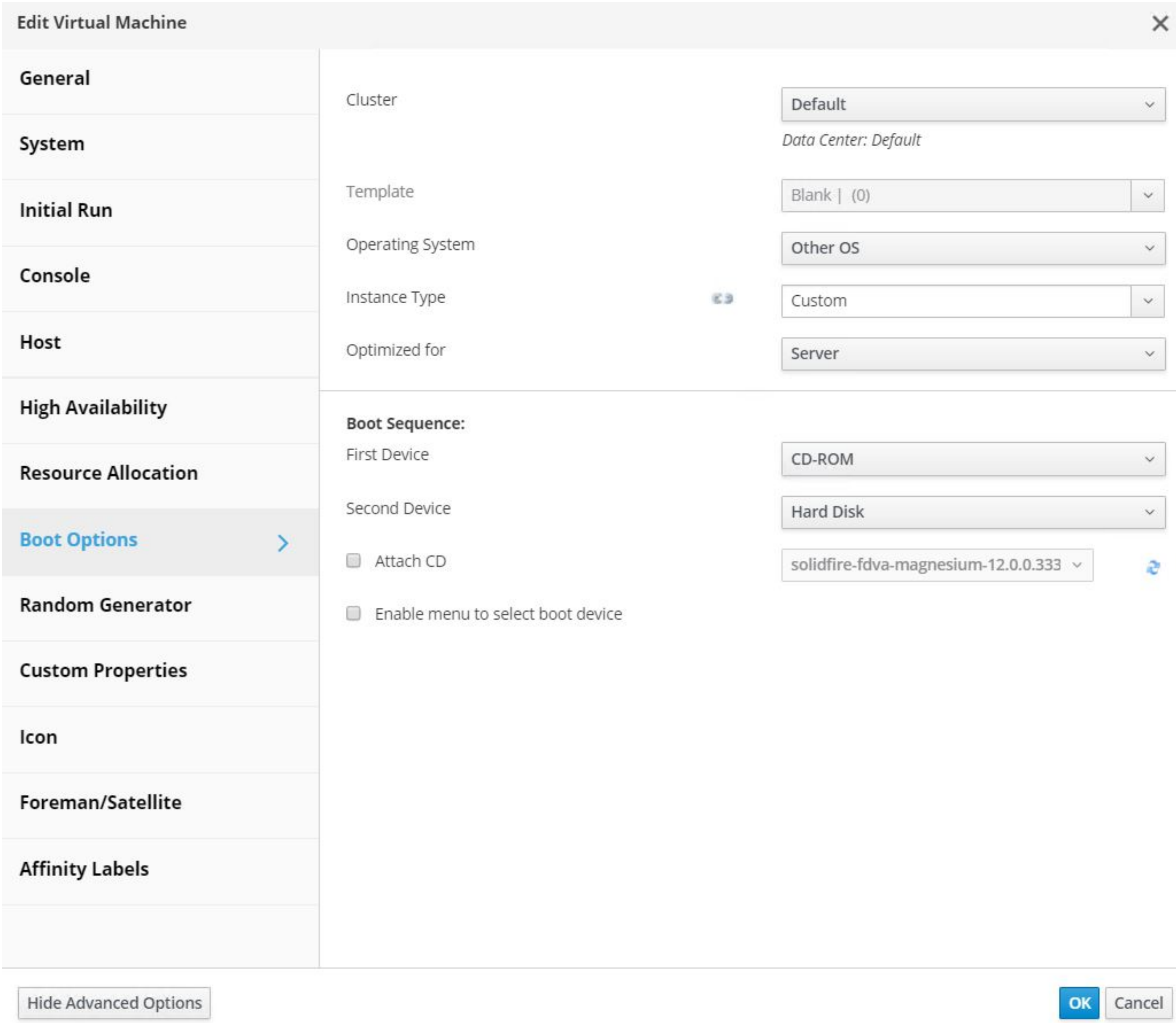
6. Click the Boot Options sub-tab, select CD-ROM as the first device in the boot sequence, select Hard Drive as the second device. Enable Attach CD and attach the mNode ISO. Then click OK.



The VM is created.

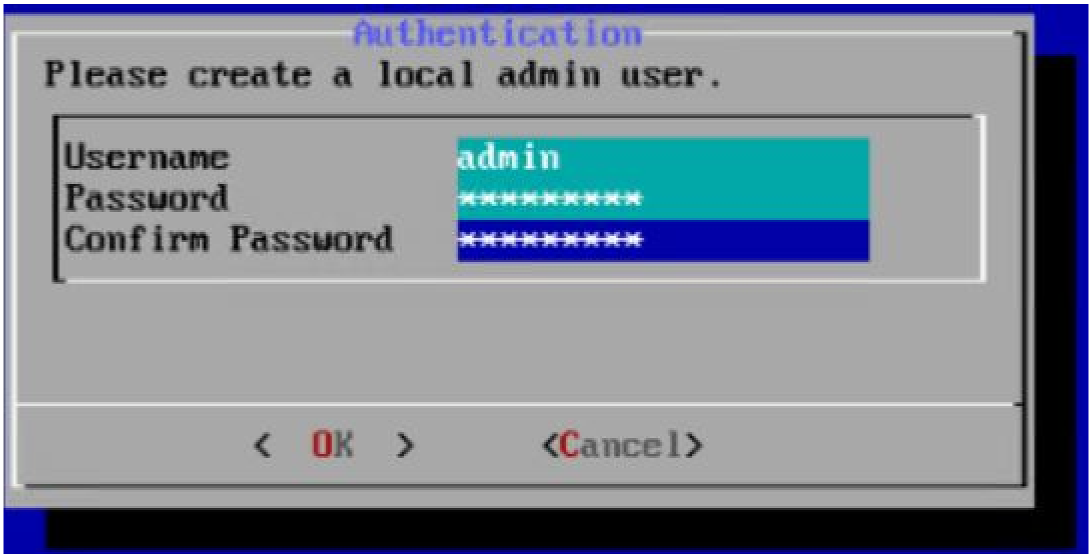
7. After the VM becomes available, power it on, and open a console to it. It begins to load the NetApp Solidfire mNode installer. When the installer is loaded, you are prompted to start the RTFI magnesium installation; type `yes` and press Enter. The installation process begins, and after it is complete, it automatically powers off the VM.

8. Next, click the mNode VM and click Edit. In the Boot Options sub-tab, uncheck the Attach CD checkbox and click the OK button.

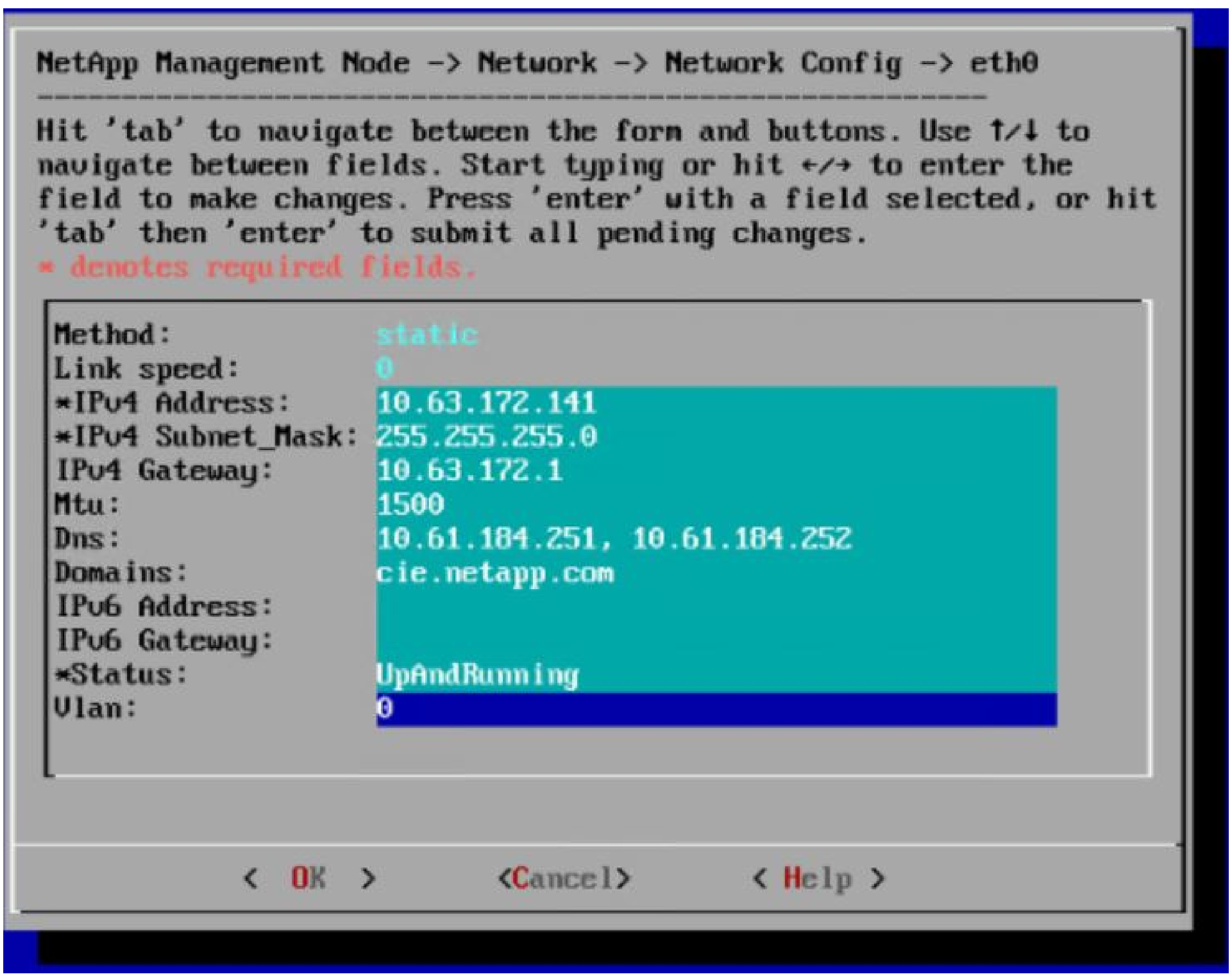


9. Power on the mNode VM. Using the terminal user interface (TUI), create a management node admin user.

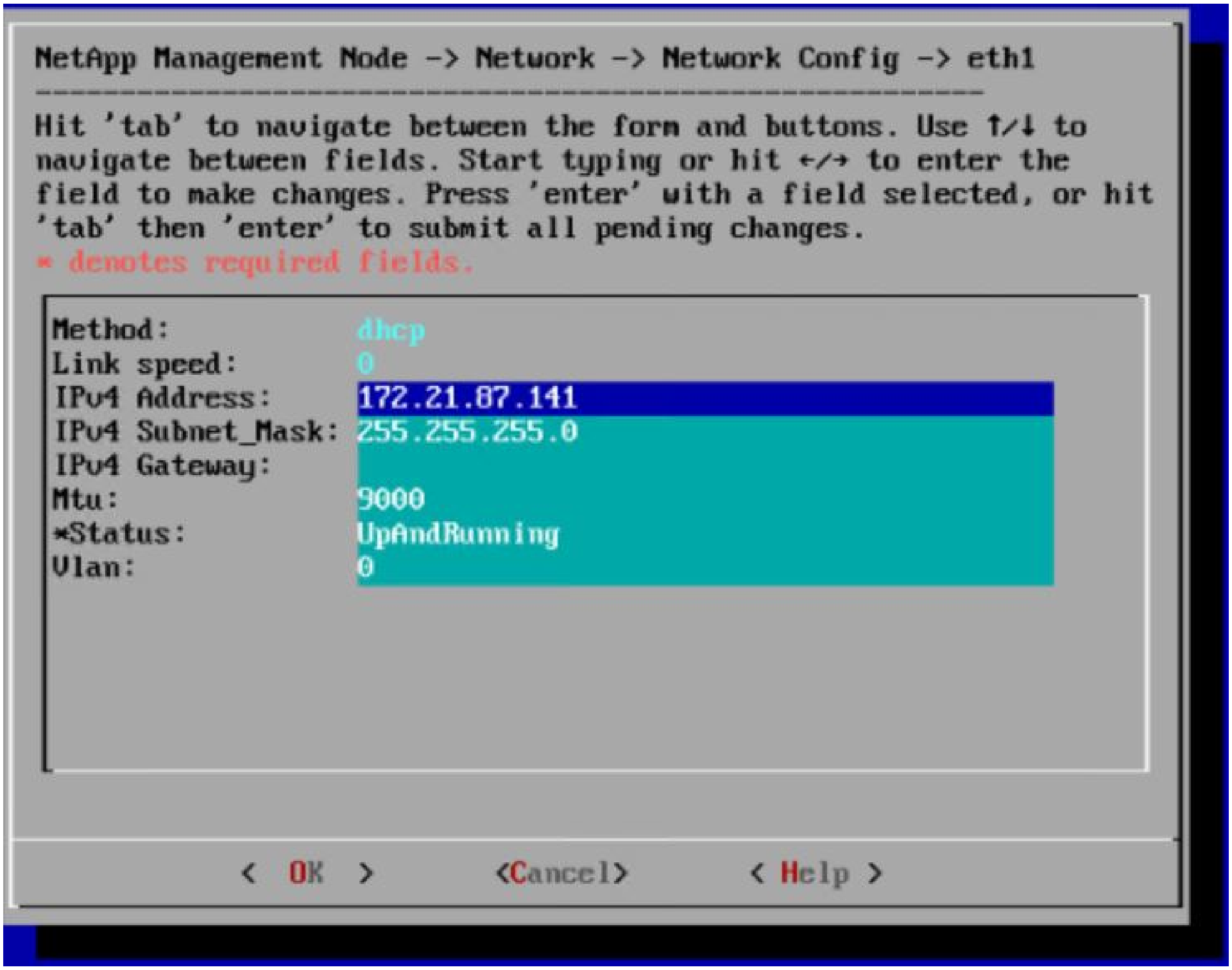
> To move through the menu options, press the Up or Down arrow keys. To move through the buttons, press Tab. To move from the buttons to the fields, press Tab. To navigate between fields, press the Up or Down arrow keys.



10. After the user is created, you are returned to a login screen. Log in with the credentials that were just created.
11. To configure the network interfaces starting with the management interface, navigate to Network > Network Config > eth0 and enter the IP address, netmask, gateway, DNS servers, and search domain for your environment. Click OK.



12. Next, configure eth1 to access the storage network. Navigate to Network > Network Config > eth1 and enter the IP address and netmask. Verify that the MTU is 9000. Then click OK.



You can now close the TUI interface.

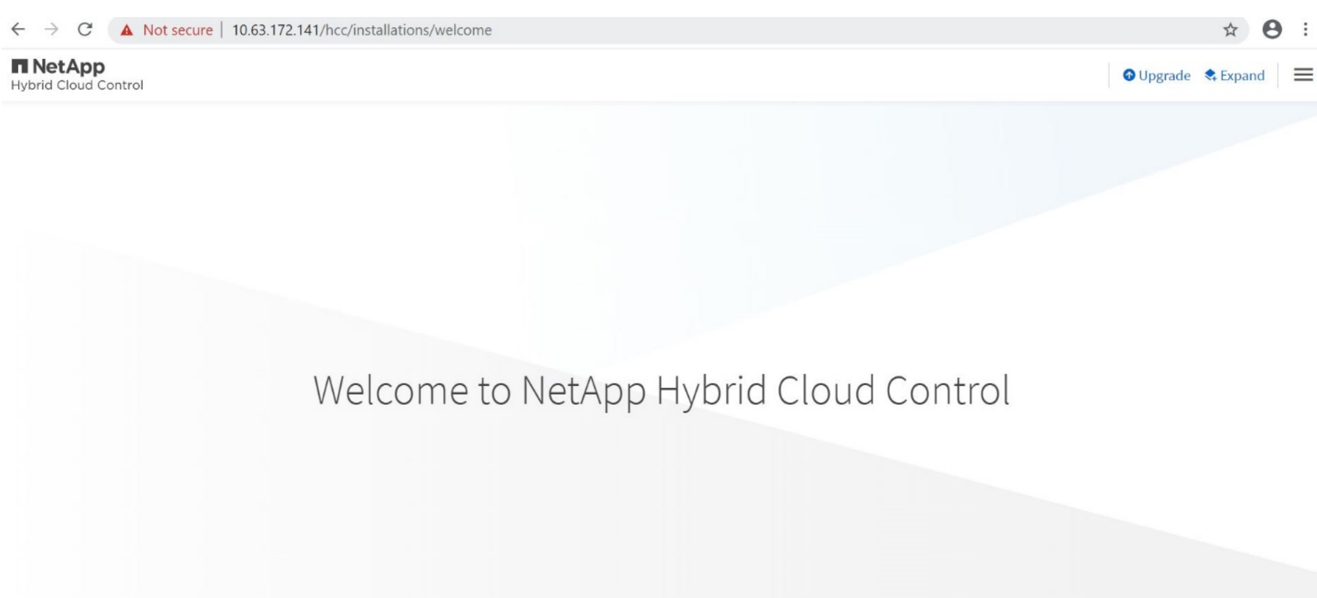
13. SSH into the management node using the management IP, escalate to root and register the mNode with the HCI storage cluster.

```
admin@SF-3D1C ~ $ sudo su

SF-3D1C /home/admin # /sf/packages/mnode/setup-mnode --mnode_admin_user
admin --storage_mvip 10.63.172.140 --storage_username admin
--telemetry_active true

Enter the password for storage user admin:
Enter password for mNode user admin:
[2020-05-21T17:19:53.281657Z]:[setup_mnode:296] INFO:Starting mNode
deployment
[2020-05-21T17:19:53.286153Z]:[config_util:1313] INFO:No previously
running mNode. Continuing with deployment.
```

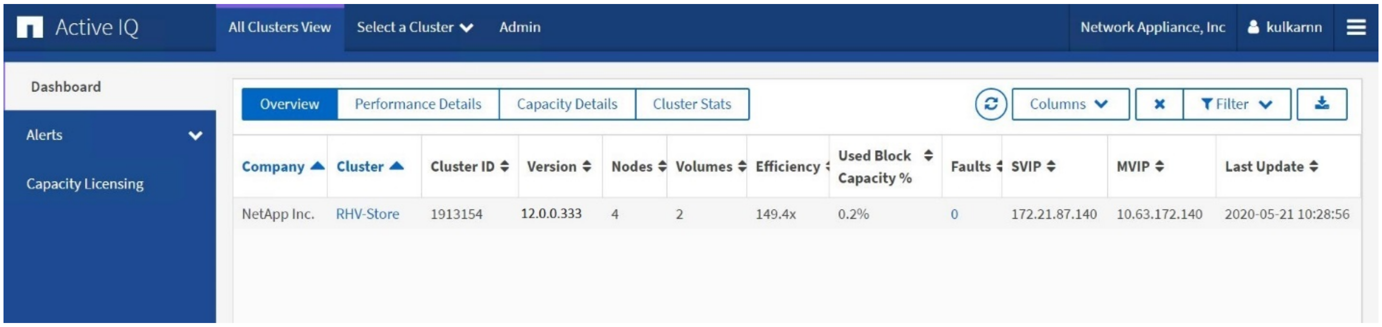
```
[2020-05-21T17:19:53.286687Z]:[config_util:1320] INFO:Validating
credentials for mNode host.
[2020-05-21T17:19:53.316270Z]:[config_util:1232] INFO:Checking Cluster
information.
[2020-05-21T17:19:53.380168Z]:[config_util:112] INFO:Cluster credentials
verification successful.
[2020-05-21T17:19:53.380665Z]:[config_util:1252] INFO:Cluster version
check successful.
[2020-05-21T17:19:53.458271Z]:[config_util:112] INFO:Successfully
queried system configuration
[2020-05-21T17:19:53.463611Z]:[config_util:497] INFO:CIDR range
172.16.0.0/22 open. Using for docker ingress.
[2020-05-21T17:19:53.464179Z]:[mnodecfg:141] INFO:Configuring mNode
[2020-05-21T17:19:53.464687Z]:[config_util:194] INFO:Wait for ping of
127.0.0.1 to succeed
[2020-05-21T17:19:53.475619Z]:[mnodecfg:145] INFO:Validating the
supplied MNode network configuration
[2020-05-21T17:19:53.476119Z]:[mnodecfg:155] INFO:Testing the MNode
network configuration
[2020-05-21T17:19:53.476687Z]:[config_util:353] INFO:Testing network
connection to storage MVIP: 10.63.172.140
[2020-05-21T17:19:53.477165Z]:[config_util:194] INFO:Wait for ping of
10.63.172.140 to succeed
[2020-05-21T17:19:53.488045Z]:[config_util:356] INFO:Successfully
reached storage MVIP: 10.63.172.140
[2020-05-21T17:19:53.488569Z]:[mnodecfg:158] INFO:Configuring MNode
storage (this can take several minutes)
[2020-05-21T17:19:57.057435Z]:[config_util:536] INFO:Configuring MNode
storage succeeded.
[2020-05-21T17:19:57.057938Z]:[config_util:445] INFO:Replacing default
ingress network.
[2020-05-21T17:19:57.078685Z]:[mnodecfg:163] INFO:Extracting services
tar (this can take several minutes)
[2020-05-21T17:20:36.066185Z]:[config_util:1282] INFO:Extracting
services tar succeeded
[2020-05-21T17:20:36.066808Z]:[mnodecfg:166] INFO:Configuring MNode
authentication
[2020-05-21T17:20:36.067950Z]:[config_util:1485] INFO:Updating element-
auth configuration
[2020-05-21T17:20:41.581716Z]:[mnodecfg:169] INFO:Deploying MNode
services (this can take several minutes)
[2020-05-21T17:20:41.810264Z]:[config_util:557] INFO:Deploying MNode
services succeeded
[2020-05-21T17:20:41.810768Z]:[mnodecfg:172] INFO:Deploying MNode Assets
[2020-05-21T17:20:42.162081Z]:[config_util:122] INFO:Retrying 1/45
time...
```

```
[2020-05-21T17:20:42.162640Z]:[config_util:125] INFO:Waiting 10 seconds
before next attempt.
[2020-05-21T17:20:52.199224Z]:[config_util:112] INFO:Mnode is up!
[2020-05-21T17:20:52.280329Z]:[config_util:112] INFO:Root asset created.
[2020-05-21T17:20:52.280859Z]:[config_util:122] INFO:Retrying 1/5
time...
[2020-05-21T17:20:52.281280Z]:[config_util:125] INFO:Waiting 10 seconds
before next attempt.
[2020-05-21T17:21:02.299565Z]:[config_util:112] INFO:Successfully
queried storage assets
[2020-05-21T17:21:02.696930Z]:[config_util:112] INFO:Storage asset
created.
[2020-05-21T17:21:03.238455Z]:[config_util:112] INFO:Storage asset
registered.
[2020-05-21T17:21:03.241966Z]:[mnodecfg:175] INFO:Attempting to set up
VCP-SIOC credentials
[2020-05-21T17:21:03.242659Z]:[config_util:953] INFO:No VCP-SIOC
credential given from NDE. Using default credentials for VCP-SIOC
service.
[2020-05-21T17:21:03.243117Z]:[mnodecfg:185] INFO:Configuration
Successfully Completed
```

14. Using a browser, log into the management node GUI using `https://<mNodeIP` >. mNode or Hybrid Cloud Control facilitates expansion, monitoring, and upgrading the Element cluster.



15. Click the three parallel lines on the top right and click View Active IQ. Search for the HCI storage cluster by filtering the cluster name and make sure that it is logging the most recent updates.



Best Practices for Production Deployments

Updating RHV Manager and RHV-H Hosts: NetApp HCI with RHV

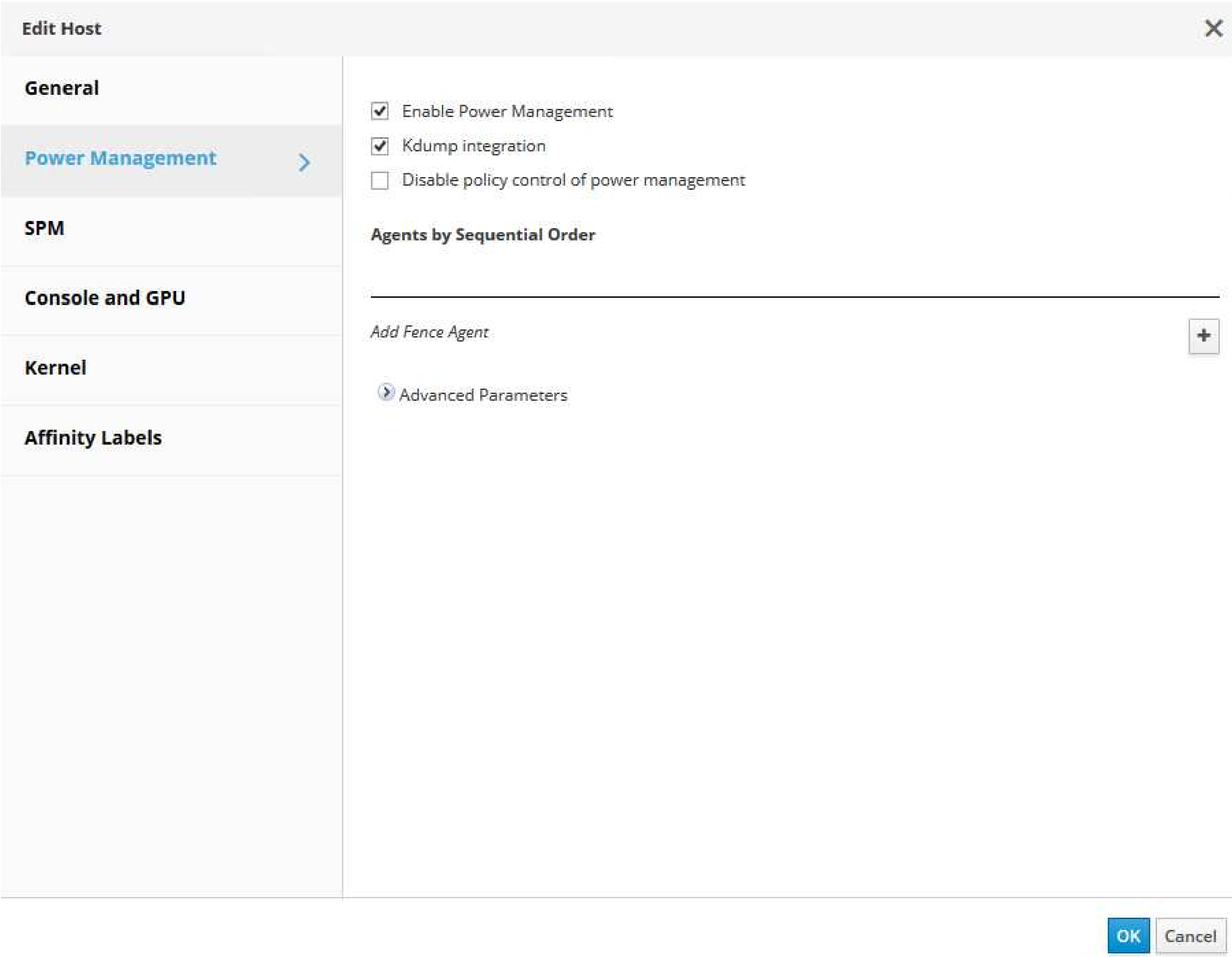
It is a recommended best practice to make sure that both the RHV Manager and the RHV-H hosts have the latest security and stability updates applied to make sure that the environment is protected and continues to run as expected. To apply the updates to the hosts in the deployment, they must first be subscribed to either the Red Hat Content Delivery Network or a local Red Hat Satellite repository. The tasks involved in updating the platform include updating the manager VM and afterward updating each physical host non-disruptively after ensuring virtual guests are migrated to another node in the cluster.

Official documentation to support the upgrade of RHV 4.3 between minor releases can be found here.

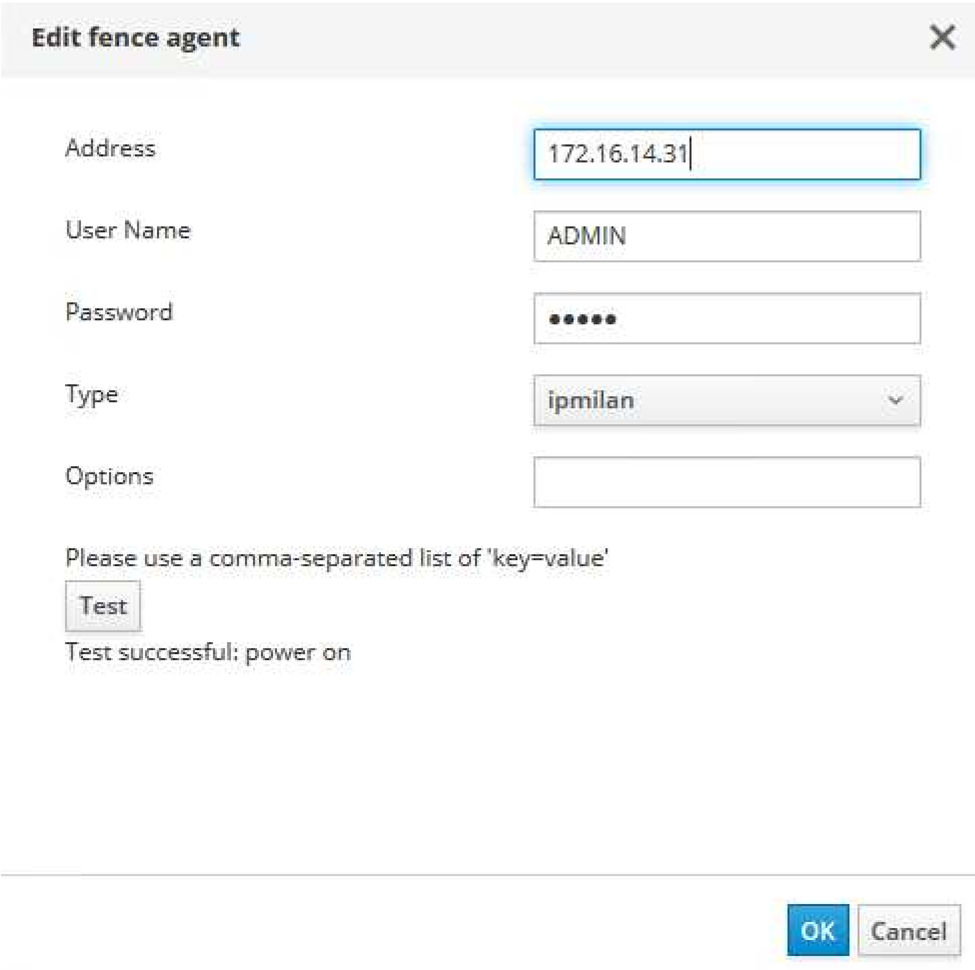
Enabling Fencing for RHV-H Hosts: NetApp HCI with RHV

Fencing is a process by which the RHV Manager can provide high availability of the VMs in the environment by automatically shutting down a non-responsive hypervisor host. It does this by sending commands to a fencing agent, which in the case of NetApp HCI is available through the IPMI out-of-band management interface on the compute nodes and rebooting the host. This action releases the locks that the non-responsive hypervisor node has on VM disks and allows for those virtual guests to be restarted on another node in the cluster without risking data corruption. After the host completes its boot process, it automatically attempts to rejoin the cluster it was a part of prior to the shutdown. If it is successful, it is once again allowed to host VMs.

To enable fencing, each host must have power management enabled; this can be found by highlighting the host and clicking the Edit button in the upper right-hand corner or by right-clicking on the host and selecting Edit.



After power management is enabled, the next step involves configuring a fencing agent. Click on the plus sign (+) near the Add Fence Agent, and a new window pops up that must be filled out with the information for the IPMI connection on the NetApp HCI compute nodes. The type of connection is IPMILAN, and the agent needs the IP address, username, and password for the console login. After you have provided this information, you can click test to validate the configuration. If properly configured, it should report the current power status of the node.



With fencing enabled, the RHV environment is configured to support a highly available deployment should one of the hypervisor nodes become nonresponsive.

Optimizing Memory for Red Hat Virtualization: NetApp HCI with RHV

One of the primary benefits for deploying a virtual infrastructure is to enable the more efficient use of physical resources in the environment. In a case in which the guest VMs underutilize the memory allotted, you can use memory overcommitment to optimize memory usage. With this feature, the sum of the memory allocated to guest VMs on a host is allowed to exceed the amount of physical memory on that host.

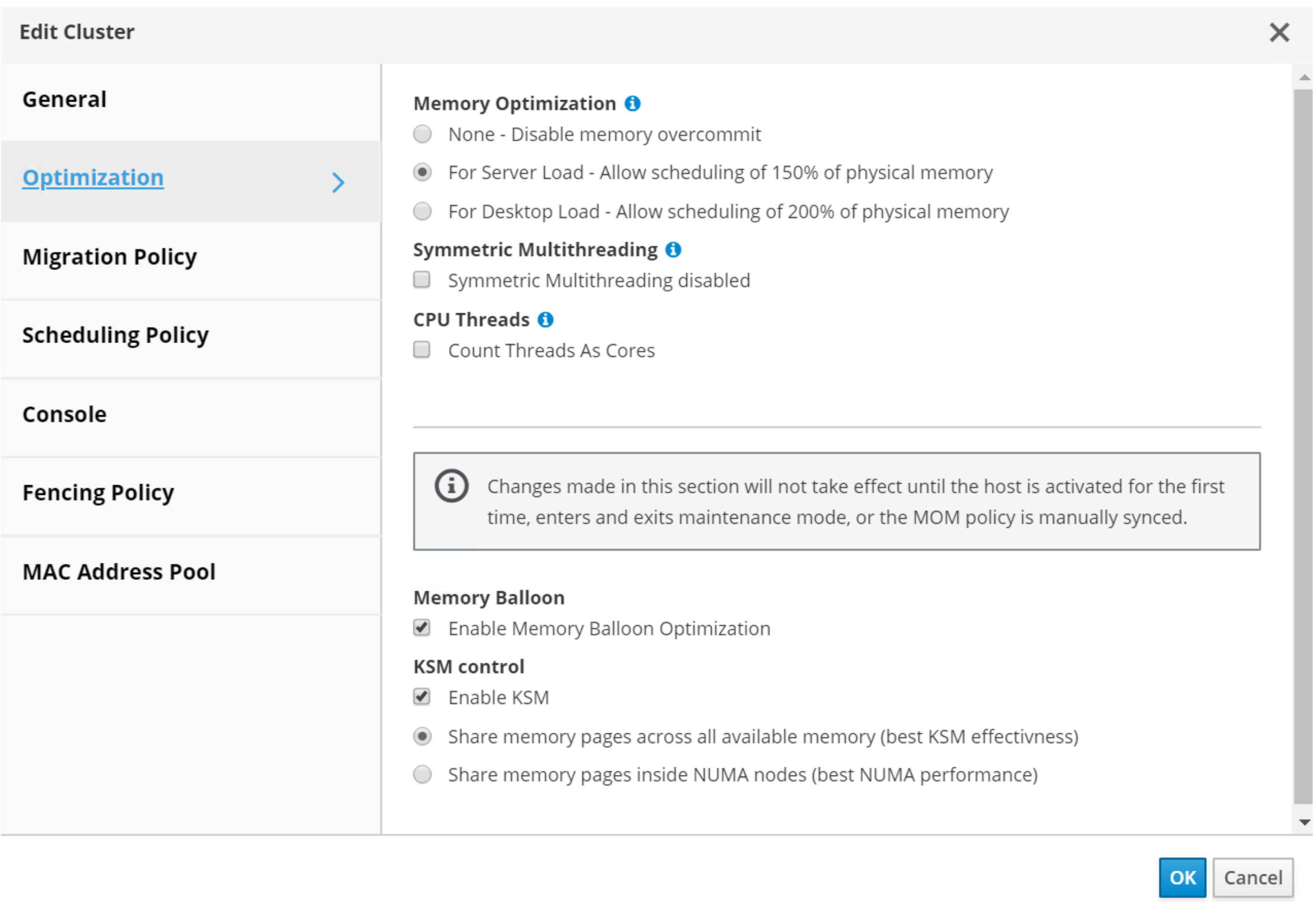
The concept behind memory overcommitment is similar to thin provisioning of storage resources. At any given moment, every VM on the host does not use the total amount of memory allocated to it. When one VM has excess memory, its unused memory is available for other VMs to use. Therefore, an end user can deploy more VMs that the physical infrastructure would not normally allow. Memory overcommitment on the hosts in the cluster is handled by Memory Overcommit Manager (MoM). Techniques like memory ballooning and Kernel Same-page Merging (KSM) can improve memory overcommitment depending on the kind of workload.

Memory ballooning is a memory management technique which allows a host to artificially expand its memory by reclaiming unused memory that was previously allocated to various VMs, with a limitation of the guaranteed memory size of every VM. For memory ballooning to work, each VM by default has a balloon device with the necessary drivers. Ballooning essentially is a cooperative operation between the VM driver and the host. Depending on the memory needs of the host, it instructs the guest OS to inflate (provide memory to host) or deflate (regain the memory) the balloon which is controlled by the balloon device.

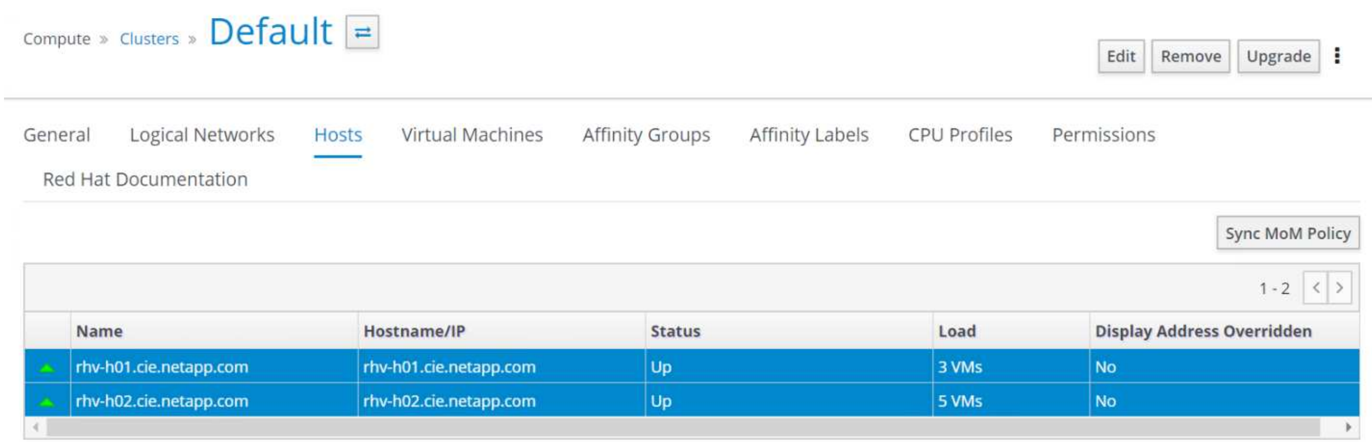
Kernel Same-page Merging (KSM) allows the host kernel to examine two or more running VMs and compare their image and memory. If any memory regions or pages are identical, KSM reduces multiple identical memory pages to a single page. This page is then marked ‘copy on write’ and a new page is created for that guest VM if the contents of the page are modified by a guest VM.

Both features can be enabled at a cluster level to apply to all hosts in that cluster. To enable these features, navigate to Compute > Clusters, select the desired cluster and click Edit. Then click the Optimization sub-tab and perform the following steps based on your requirements:

1. Depending on the use-case and workload, enable Memory Optimization to allow overcommitment of memory to either 150% or 200% of the available physical memory.
2. To enable memory ballooning, check the Enable Memory Balloon Optimization checkbox.
3. To enable KSM, check the Enable KSM checkbox.
4. Click Ok to confirm the changes.



Be aware that after these changes have been applied, they do not take effect until you manually sync the MoM policy. To sync the MoM policy, navigate to Compute > Clusters and click the cluster for which you made the optimization changes. Navigate to the Hosts sub-tab, select all the hosts, and then click Sync MoM Policy.



KSM and ballooning can free up some memory on the host and facilitate overcommitment, but, if the amount of shareable memory decreases and the use of physical memory increases, it might cause an out-of-memory condition. Therefore, the administrator should be sure to reserve enough memory to avoid out-of-memory conditions if the shareable memory decreases.

In some scenarios, memory ballooning may collide with KSM. In such situations, MoM tries to adjust the balloon size to minimize collisions. Also, there can be scenarios for which ballooning might cause sub-optimal performance. Therefore, depending on the workload requirements, you can consider enabling either or both the techniques.

Where to Find Additional Information: NetApp HCI with RHV

To learn more about the information described in this document, review the following documents and/or websites:

- NetApp HCI Documentation https://www.netapp.com/us/documentation/hci.aspx
- Red Hat Virtualization Documentation https://access.redhat.com/documentation/en-us/red_hat_virtualization/4.3/