NetApp HCI 1.6

Deployment Guide

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Contents

NetApp HCI overview

NetApp HCI provides both storage and compute resources, combining them to build a VMware vSphere environment backed by the capabilities of NetApp Element software.

After successful deployment of NetApp HCI, you manage the system from the VMware vSphere Web Client. The NetApp Element Plug-in for vCenter Server (also referred to as the vCenter Plug-in, or VCP) is used to manage storage resources, including datastores, volumes, Quality of Service, storage cluster components, and data protection. Compute nodes appear as ESXi hosts and you can manage them in vSphere.

NetApp HCI events and faults are reported in vSphere as system alarms. The management node monitors the compute nodes, and appears as a virtual machine in the cluster after deployment. All storage and compute monitoring data can be collected by NetApp SolidFire Active IQ, which performs real-time monitoring of NetApp HCI.

About this guide

This guide introduces NetApp HCI and its architecture, and covers the information needed to prepare your environment for a deployment as well as the steps needed to complete deployment. It also gives best practices for network and switch configuration to enable you to get the most out of your system. You can use this guide while you quickly deploy and configure your fully racked and powered NetApp HCI installation using the NetApp Deployment Engine.

Requirements for NetApp HCI deployment

NetApp HCI has specific physical and network requirements for proper operation in your datacenter. Ensure that you implement the following requirements and recommendations before you begin deployment.

Before you receive your NetApp HCI hardware, ensure that you complete the checklist items in the pre-deployment workbook from NetApp Professional Services. This document contains a comprehensive list of tasks you need to complete to prepare your network and environment for a successful NetApp HCI deployment.

Network and switch requirements

The switches you use for NetApp HCI require specific configuration to ensure a successful deployment. See your switch documentation for specific instructions on implementing each of the following requirements for your environment.

NetApp HCI deployment requires at least three network segments, one for each of the following types of traffic:

- Management
- VMware vMotion
- Storage/Data

Depending on the NetApp H-Series compute and storage node models and the planned cabling configuration, you can physically separate these networks using separate switches or logically separate them using VLANs. For most deployments, however, you need to logically separate these networks (and any other additional virtual machine networks) using VLANs.

Compute and storage nodes need to be able to communicate before, during, and after deployment. If you are implementing separate management networks for storage and compute nodes, ensure that these management networks have network routes between them. These networks must have gateways assigned, and there must be a route between the gateways. Ensure that each new node has a gateway assigned to facilitate communication between nodes and management networks.

NetApp HCI has the following switch requirements:

- All switch ports connected to NetApp HCI nodes must be configured as spanning tree edge ports.
- NetApp HCI nodes have redundant ports for all network functions except out-of-band management. For the best resiliency, divide these ports across two switches with redundant uplinks to either a traditional hierarchical architecture or a layer 2 spine-and-leaf architecture.
- The switches handling storage, virtual machine, and vMotion traffic must support speeds of at least 10GbE per port (up to 25GbE per port is supported).
- The switches handling management traffic must support speeds of at least 1GbE per port.
- You must configure jumbo frames on the switch ports handling storage and vMotion traffic. Hosts must be able to send 9000 byte packets end-to-end for a successful installation.
- Round-trip network latency between all storage and compute nodes should not exceed 2ms.

All NetApp HCI nodes provide additional out-of-band management capabilities via a dedicated management port. NetApp H300S, H300E, H500S, H500E, H700S, H700E and H410C nodes also allow for shared IPMI access via Port A. As a best practice, you should ease remote management of NetApp HCI by configuring out-of-band management for all nodes in your environment.

Note: The management network of the management node needs a configuration that includes a gateway address to be able to communicate with NetApp Cloud Services. Enabling NetApp cloud services will fail if a valid gateway address is not in place.

Network ports used by NetApp HCI

You might need to allow the following ports through your datacenter's edge firewall so that you can manage the system remotely and allow clients outside of your datacenter to connect to resources. Some of these ports might not be required, depending on how you use the system. All ports are TCP unless stated otherwise, and should be open bidirectionally.

The following abbreviations are used in the table:

- MIP: Management IP address, a per-node address
- SIP: Storage IP address, a per-node address
- MVIP: Management virtual IP address
- SVIP: Storage virtual IP address

Source	Destination	Port	Description
iSCSI clients	Storage cluster MVIP	443	(Optional) UI and API access
iSCSI clients	Storage cluster SVIP	3260	Client iSCSI communications
iSCSI clients	Storage node SIP	3260	Client iSCSI communications
Management node	sfsupport.solidfire.com	22	Reverse SSH tunnel for support access
Management node	Storage node MIP	22	SSH access for support
Management node	DNS servers	53 TCP/UDP	DNS lookup
Management node	Storage node MIP	442	UI and API access to storage node and Element software upgrades
Management node	Online software repository: • `https://repo.netapp.com/bintray/api/package` • `https://netapp-downloads.bintray.com`	443	Management node service upgrades
Management node	monitoring.solidfire.com	443	Storage cluster reporting to Active IQ
Management node	Storage cluster MVIP	443	UI and API access to storage node and Element software upgrades
SNMP server	Storage cluster MVIP	161 UDP	SNMP polling

Source	Destination	Port	Description
SNMP server	Storage node MIP	161 UDP	SNMP polling
Storage node MIP	DNS servers	53 TCP/UDP	DNS lookup
Storage node MIP	Management node	80	Element software upgrades
Storage node MIP	S3/Swift endpoint	80	(Optional) HTTP communication to S3/Swift endpoint for backup and recovery
Storage node MIP	NTP server	123 UDP	NTP
Storage node MIP	Management node	162 UDP	(Optional) SNMP traps
Storage node MIP	SNMP server	162 UDP	(Optional) SNMP traps
Storage node MIP	LDAP server	389 TCP/UDP	(Optional) LDAP lookup
Storage node MIP	Remote storage cluster MVIP	443	Remote replication cluster pairing communication
Storage node MIP	Remote storage node MIP	443	Remote replication cluster pairing communication
Storage node MIP	S3/Swift endpoint	443	(Optional) HTTPS communication to S3/Swift endpoint for backup and recovery
Storage node MIP	Management node	10514 TCP/UDP 514 TCP/UDP	Syslog forwarding
Storage node MIP	Syslog server	10514 TCP/UDP 514 TCP/UDP	Syslog forwarding
Storage node MIP	LDAPS server	636 TCP/UDP	LDAPS lookup
Storage node MIP	Remote storage node MIP	2181	Intercluster communication for remote replication
Storage node SIP	S3/Swift endpoint	80	(Optional) HTTP communication to S3/Swift endpoint for backup and recovery
Storage node SIP	S3/Swift endpoint	443	(Optional) HTTPS communication to S3/Swift endpoint for backup and recovery
Storage node SIP	Remote storage node SIP	2181	Intercluster communication for remote replication
Storage node SIP	Storage node SIP	3260	Internode iSCSI

Source	Destination	Port	Description
Storage node SIP	Remote storage node SIP	4000 through 4020	Remote replication node-to-node data transfer
Storage node SIP	Compute node SIP	442	Compute node API, configuration and validation, and access to software inventory
System administrator PC	Storage node MIP	80	(NetApp HCI only) Landing page of NetApp Deployment Engine
System administrator PC	Management node	442	HTTPS UI access to management node
System administrator PC	Storage node MIP	442	HTTPS UI and API access to storage node
			(NetApp HCI only) Configuration and deployment monitoring in NetApp Deployment Engine
System administrator PC	Management node	443	HTTPS UI and API access to management node
System administrator PC	Storage cluster MVIP	443	HTTPS UI and API access to storage cluster
System administrator PC	Storage node MIP	443	HTTPS storage cluster creation, post-deployment UI access to storage cluster
vCenter Server	Storage cluster MVIP	443	vCenter Plug-in API access
vCenter Server	Management node	8443	(Optional) vCenter Plug-in QoSSIOC service.
vCenter Server	Storage cluster MVIP	8444	vCenter VASA provider access (VVols only)
vCenter Server	Management node	9443	vCenter Plug-in registration. The port can be closed after registration is complete.

Network cable requirements

You can use the following guidelines to ensure that you have enough of the right type of network cables for the size of your deployment. For RJ45 ports, you must use Cat 5e or Cat 6 rated cables.

- Two-cable compute node configuration: Each compute node must to be connected to a 10/25GbE network via two SFP+/SFP28 interfaces (one additional Cat 5e/6 cable is optional for out-of-band management).
- Six-cable compute node configuration: Each compute node must to be connected to a 10/25GbE network via four SFP+/SFP28 interfaces and to a 1/10GbE network via two Cat 5e/6 cables (one additional Cat 5e/6 cable is optional for out-of-band management).

- Each storage node must be connected to a 10/25GbE network via two SFP+/SFP28 interfaces and to a 1/10GbE network via two Cat 5e/6 cables (one additional Cat 5e/6 cable is optional for out-of-band management).
- Ensure the network cables you use to connect the NetApp HCI system to your network are long enough to comfortably reach your switches.

For example, a deployment containing four storage nodes and three compute nodes (using the six-cable configuration) requires the following number of network cables:

- (14) Cat 5e/6 cables with RJ45 connectors (plus seven cables for IPMI traffic, if desired)
- (20) Twinax cables with SFP28/SFP+ connectors

This is due to the following reasons:

- Four storage nodes require eight (8) Cat 5e/6 cables and eight (8) Twinax cables.
- Three compute nodes using the six-cable configuration require six (6) Cat 5e/6 cables and twelve (12) Twinax cables.

Network configuration

NetApp HCI can utilize multiple different network cabling and VLAN configurations. It is important to plan your network configuration to ensure a successful deployment.

Required network segments

NetApp HCI requires a minimum of three network segments: management, storage, and virtualization traffic (which includes virtual machines and vMotion traffic). You can also separate virtual machine and vMotion traffic. These network segments usually exist as logically separated VLANs in the NetApp HCI network infrastructure.

How compute and storage nodes connect to these networks depends on how you design the network and cable the nodes. The sample network illustrations in this guide assume the following networks:

Network name	VLAN ID
Management	100
Storage	105
vMotion	107
Virtual machines	200, 201

For automatic discovery and configuration of your NetApp HCI nodes in the NetApp Deployment Engine, you must have a network segment that is available as an untagged or native VLAN on all switch ports that are used for the SFP+/SFP28 interfaces on the nodes. This will provide layer 2 communication between all nodes for discovery and deployment. Without a native VLAN, you must configure the SFP+/SFP28 interfaces of all nodes manually with a VLAN and IPv4 address to be discoverable. In the network configuration examples in this document, the management network (VLAN ID 100) is used for this purpose.

The NetApp Deployment Engine enables you to quickly configure networks for compute and storage nodes during the initial deployment. You can place certain built-in management components such as vCenter and the management node on their own network segment if needed. These network segments require routing to allow vCenter and the management node to communicate with storage and compute management networks. In most deployments those components use the same management network (in this example, VLAN ID 100).

Note: You configure virtual machine networks using vCenter. The default virtual machine network (port group "VM_Network") in NetApp HCI deployments is configured without a VLAN tag and uses the native VLAN of the interfaces used for vMotion. These are intended to be changed after deployment. If you plan to use multiple tagged virtual machine networks (VLAN IDs 200, 201 in the example above), be sure to include them in the initial network planning.

Network configuration and cabling options

You can use a two-cable network configuration for the H300E, H500E, H700E, and H410C compute nodes, simplifying cable routing. This configuration uses two SFP+/SFP28 interfaces plus an optional (but recommended) RJ45 interface for IPMI communication. These nodes can also use a six-cable configuration with two RJ45 and four SFP28/SFP+ interfaces.

All storage nodes support a network topology that uses four network ports; this topology uses ports A through D on H300S, H500S, H700S, and H610S nodes. Compute nodes support three network topologies:

Configuration option	Cabling and description
Option A	Two-cable configuration using ports D and E (two SFP28/SFP+ interfaces) on H300E, H500E, H700E and H410C nodes
Option B	Six-cable configuration using ports A through F (two RJ45 and four SFP28/SFP+ interfaces) on H300E, H500E, H700E and H410C nodes
Option C	Cable configuration similar to option B, but using native VLANs (or "access ports") on the switch for the management, storage, and vMotion networks

Nodes that do not have the correct number of connected cables cannot participate in the deployment. For example, you cannot deploy a compute node in a six-cable configuration if it only has ports D and E connected.

Note: You can adjust the NetApp HCI network configuration after deployment to meet infrastructure needs. However, when you expand NetApp HCI resources, remember that new nodes must have the same cable configuration as the existing compute and storage nodes.

Related concepts

Supported networking changes on page 32

Configuration option A: Two cables for compute nodes

The NetApp H300E, H500E, H700E, H410C, and H610C compute nodes support using two network cables for connectivity to all NetApp HCI networks. This configuration requires that the storage, vMotion and any virtual machine networks use VLAN tagging. All compute and storage nodes must use the same VLAN ID scheme. This configuration uses vSphere Distributed Switches that require VMware vSphere Enterprise Plus licensing.

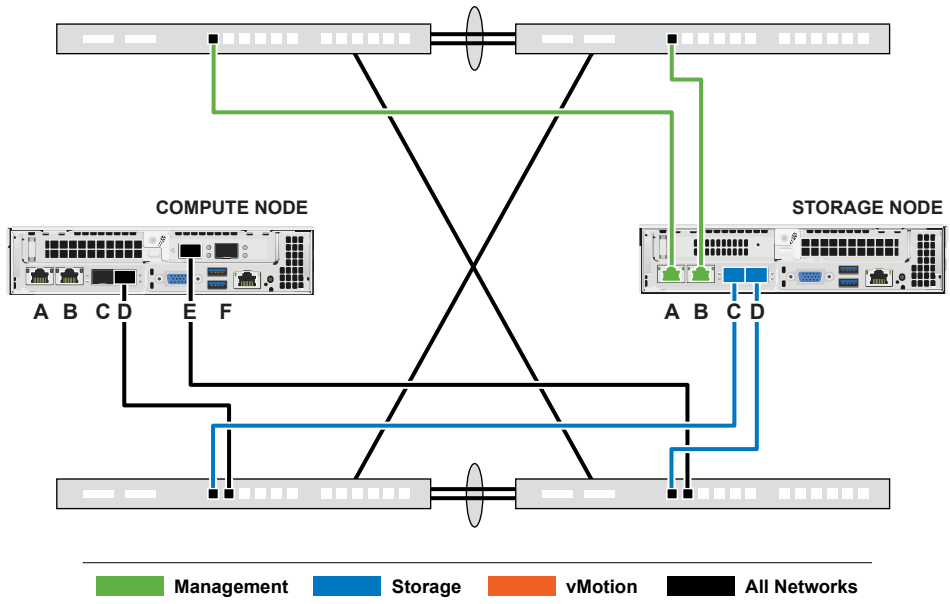
VLAN configuration

As a best practice, you should configure the required network segments on all switch ports that the nodes are using. For example:

Network name	VLAN ID	Switch port configuration
Management	100	Native
Storage	105	Tagged

Network name	VLAN ID	Switch port configuration
vMotion	107	Tagged
Virtual machines	200, 201	Tagged

The following illustration shows the recommended cabling configuration for two-cable H300E, H500E, H700E, and H410C compute nodes and four-cable H300S, H500S, H700S, and H410S storage nodes. All switch ports in this example share the same configuration.



Example switch commands

You can use the following example commands to configure all switch ports used for NetApp HCI nodes. These commands are based on a Cisco configuration, but might require only small changes to apply to Mellanox switches. See your switch documentation for the specific commands you need to implement this configuration. Replace the interface name, description, and VLANs with the values for your environment.

```
interface {interface name, such as EthernetX/Y or GigabitEthernetX/Y/Z}
description {desired description, such as NetApp-HCI-NodeX-PortY}
mtu 9216
switchport mode trunk
switchport trunk native vlan 100
switchport trunk allowed vlan 105,107,200,201
spanning-tree port type edge trunk
```

Note: Some switches might require inclusion of the native VLAN in the allowed VLAN list. See the documentation for your specific switch model and software version.

Configuration option B: Six cables for compute nodes

As a secondary network configuration option, the H300E, H500E, H700E and H410C compute nodes support using six network cables for connectivity to all NetApp HCI networks. This configuration requires that the storage, vMotion and any virtual machine networks use VLAN tagging. You can use

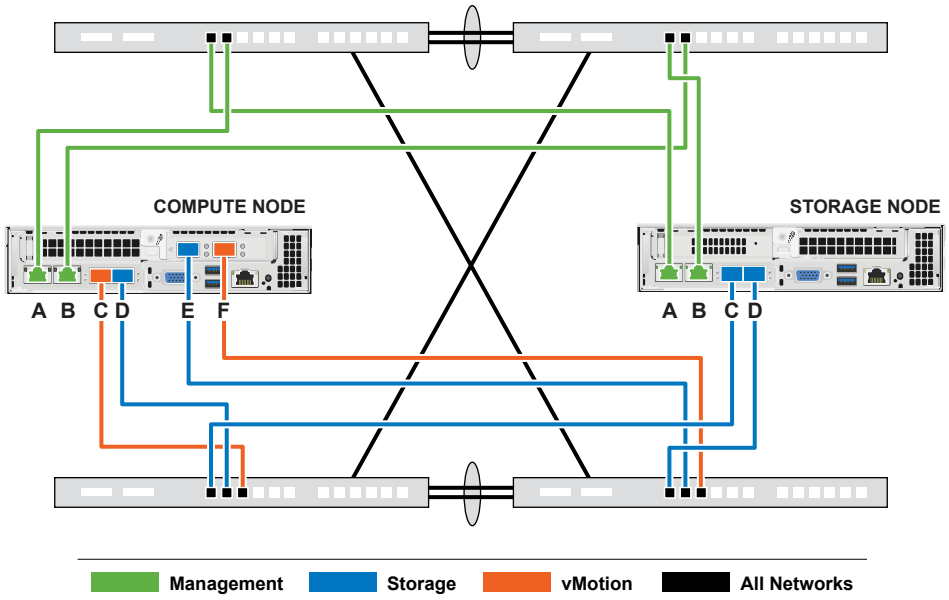
this configuration with vSphere Standard Switches or vSphere Distributed Switches (which require VMware vSphere Enterprise Plus licensing).

VLAN configuration

When you deploy compute nodes using six cables and storage nodes using four cables, as a best practice, you should configure the required network segments on all switch ports that the nodes are using. For example:

Network name	VLAN ID	Switch port configuration
Management	100	Native
Storage	105	Tagged
vMotion	107	Tagged
Virtual machines	200, 201	Tagged

The following illustration shows the recommended cabling configuration for six-cable compute nodes and four-cable storage nodes. All switch ports in this example share the same configuration.



Example switch commands

You can use the following example commands to configure all switch ports used for NetApp HCI nodes. These commands are based on a Cisco configuration, but might require only small changes to apply to Mellanox switches. See your switch documentation for the specific commands you need to implement this configuration. Replace the interface name, description, and VLANs with the values for your environment.

```
interface {interface name, such as EthernetX/Y or GigabitEthernetX/Y/Z}
description {desired description, such as NetApp-HCI-NodeX-PortY}
mtu 9216
switchport mode trunk
switchport trunk native vlan 100
switchport trunk allowed vlan 105,107,200,201
spanning-tree port type edge trunk
```

Note: Some switches might require inclusion of the native VLAN in the allowed VLAN list. See the documentation for your specific switch model and software version.

Configuration option C: Six cables for compute nodes with native VLANs

You can deploy NetApp HCI without using tagged VLANs for storage and virtualization traffic, and instead rely on the switch configuration to separate the network segments. You can use this configuration with vSphere Standard Switches or vSphere Distributed Switches (which require VMware vSphere Enterprise Plus licensing).

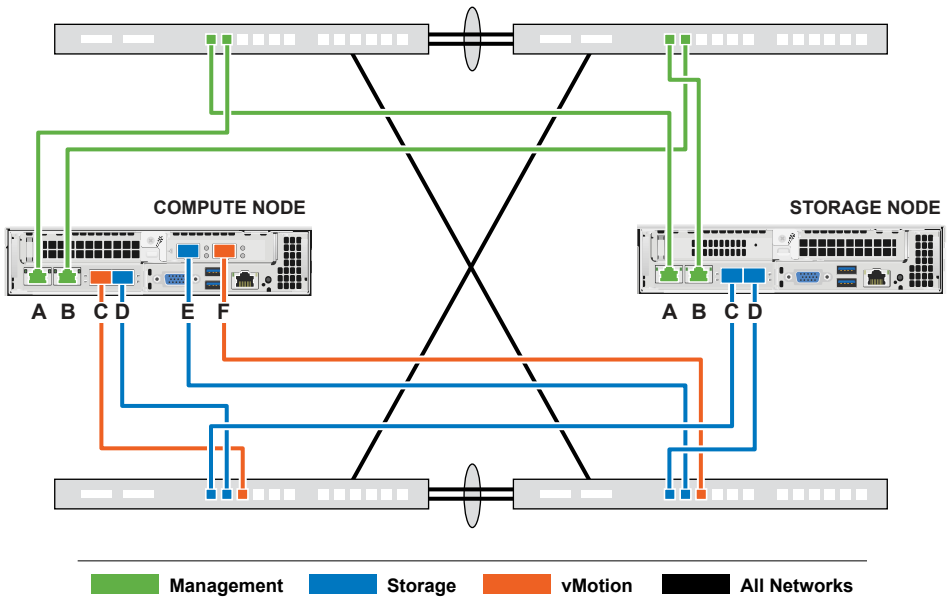
VLAN configuration

This topology option uses the following VLAN configuration:

Node ports used	Network name	VLAN ID	Connected switch port configuration
Ports A and B on compute and storage nodes	Management	100	Native
Ports D and E on compute nodes	Storage	105	Native
Ports C and D on storage nodes	Storage	105	Native
Ports C and F on compute nodes	vMotion	107	Native
Ports C and F on compute nodes	Virtual machines	200, 201	Tagged

Caution: Deploying this configuration requires careful switch port configuration. Configuration errors in this network topology can result in deployment problems that are difficult to diagnose.

The following illustration shows the network configuration overview for this topology option. In the example, individual switch ports are configured with the appropriate network segment as the native network.



Example switch commands

You can use the following example switch commands to configure switch ports used for the NetApp HCI nodes. These commands are based on a Cisco configuration, but might require only minimal changes to apply to Mellanox switches. See your switch documentation for the specific commands you need to implement this configuration.

You can use the following example commands to configure the switch ports used for the management network. Replace the interface name, description, and VLANs with the values for your configuration.

```
interface {interface name, such as EthernetX/Y or GigabitEthernetX/Y/Z}
description {desired description, such as NetApp-HCI-NodeX-PortA|B}
switchport access vlan 100
spanning-tree port type edge
```

You can use the following example commands to configure the switch ports used for the storage network. Replace the interface name, description, and VLANs with the values for your configuration.

```
interface {interface name, such as EthernetX/Y or GigabitEthernetX/Y/Z}
description {desired description, such as NetApp-HCI-NodeX-PortC|D}
mtu 9216
switchport access vlan 105
spanning-tree port type edge
```

You can use the following example commands to configure the switch ports used for the vMotion and virtual machines network. Replace the interface name, description, and VLANs with the values for your configuration.

```
interface {interface name, such as EthernetX/Y or GigabitEthernetX/Y/Z}
description {desired description, such as NetApp-HCI-NodeX-PortC|F}
mtu 9216
switchport mode trunk
switchport trunk native vlan 107
switchport trunk allowed vlan 200,201
spanning-tree port type edge trunk
```

Note: Some switches might require inclusion of the native VLAN in the allowed VLAN list. See the documentation for your specific switch model and software version.

IP address requirements

NetApp HCI has specific IP address requirements that depend on the size of your deployment. Note that by default the initial IP addresses you assign to each node before using the NetApp Deployment Engine to deploy the system are temporary and cannot be reused. You need to set aside a second permanent set of unused IP addresses that you can assign during final deployment.

It is best if the storage network and the management network each use separate contiguous ranges of IP addresses. Use the following table to determine how many IP addresses you need for your NetApp HCI deployment:

System component	Management network IP addresses needed	Storage network IP addresses needed	vMotion network IP addresses needed	Total IP addresses needed per component
Compute node	1	2	1	4
Storage node	1	1		2
Storage cluster	1	1		2

System component	Management network IP addresses needed	Storage network IP addresses needed	vMotion network IP addresses needed	Total IP addresses needed per component
VMware vCenter	1			1
Management node	1	1		2

Configuring LACP for optimal storage performance

For optimal NetApp HCI storage cluster performance, you should configure Link Aggregation Control Protocol (LACP) on the switch ports used for each of the storage nodes.

Before you begin

- You have configured the switch ports connected to the 10/25GbE interfaces of NetApp HCI storage nodes as LACP port channels.
- You have set the LACP timers on the switches handling storage traffic to “fast mode (1s)” for optimal failover detection time. During deployment, the Bond1G interfaces on all storage nodes are automatically configured for active/passive mode.
- You have configured Cisco Virtual PortChannel (vPC) or the equivalent switch stacking technology for the switches handling the storage network. Switch stacking technology eases configuration of LACP and port channels, and provides a loop-free topology between switches and the 10/25GbE ports on the storage nodes.

Steps

1. Follow your switch vendor recommendations for enabling LACP on the switch ports used for NetApp H-series storage nodes.
2. Change the bond mode on all storage nodes to LACP in the on-node user interface (also known as the terminal user interface, or TUI) before you deploy NetApp HCI.

Configuring the IPMI ports

Dynamic Host Configuration Protocol (DHCP) is enabled for the Intelligent Platform Management Interface (IPMI) port of each NetApp HCI node. If your IPMI network does not use DHCP, you can manually assign a static IPv4 address to the IPMI port.

Before you begin

You have a keyboard, video, mouse (KVM) or monitor and keyboard you can use to access the BIOS of each node.

About this task

Use the arrow keys to navigate in the BIOS. Select a tab or option by pressing `Enter`. Go back to previous screens by pressing `ESC`.

Steps

1. Power on the node.

2. Upon booting, enter the BIOS by pressing the `Del` key.
3. Select the **IPMI** tab.
4. Select **BMC Network Configuration** and press `Enter`.
5. Choose **Yes** and press `Enter`.
6. Select **Configuration Address Source** and press `Enter`.
7. Choose **Static** and press `Enter`.
8. Select **Station IP address** and enter a new IP address for the IPMI port. Press `Enter` when finished.
9. Select **Subnet mask** and enter a new subnet mask for the IPMI port. Press `Enter` when finished.
10. Select **Gateway IP address** and enter a new gateway IP address for the IPMI port. Press `Enter` when finished.
11. Connect one end of an Ethernet cable to the IPMI port and the other end to a switch.

    The IPMI port for this node is ready to use.
12. Repeat this procedure for any other NetApp HCI nodes with IPMI ports that are not configured.

Related tasks

Changing the IPMI password on page 17

Changing the IPMI password

You should change the password for the default IPMI ADMIN account on each node as soon as you configure the IPMI port.

Before you begin

You have configured the IPMI IP address for each node.

Steps

1. Open a web browser on a computer that can reach the IPMI network and browse to the IPMI IP address for the node.
2. Enter the username ADMIN and password ADMIN in the login prompt.
3. Upon logging in, click the **Configuration** tab.
4. Click **Users**.
5. Select the ADMIN user and click **Modify User**.
6. Select the **Change Password** check box.
7. Enter a new password in the **Password** and **Confirm Password** fields.
8. Click **Modify**, and then click **OK**.
9. Repeat this procedure for any other NetApp HCI nodes with default passwords for the IPMI ADMIN account.

Related tasks

Configuring the IPMI ports on page 16

DNS and timekeeping requirements

Before deployment, you might need to prepare Domain Name System (DNS) records for your NetApp HCI system and gather NTP server information.

Make the following DNS and timeserver preparations before deploying NetApp HCI:

- Create any needed DNS entries for hosts (such as individual compute or storage nodes) and document how the host entries map to the respective IP addresses. During deployment, you will need to assign a prefix to your storage cluster that will be applied to each host; to avoid confusion, keep your DNS naming plans in mind when choosing a prefix.
- If you are deploying NetApp HCI with a new VMware vSphere installation using a fully qualified domain name, you must create one Pointer (PTR) record and one Address (A) record for vCenter Server on any DNS servers in use before deployment.
- If you are deploying NetApp HCI with a new vSphere installation using only IP addresses, you do not need to create new DNS records for vCenter.
- NetApp HCI requires a valid NTP server for timekeeping. You can use a publicly available time server if you do not have one in your environment.

Environmental requirements

Ensure that the power for the rack used to install NetApp HCI is supplied by AC power outlets, and that your datacenter provides adequate cooling for the size of your NetApp HCI installation.

For detailed capabilities of each component of NetApp HCI, see the NetApp HCI *datasheet*.

Note: The H410C compute node operates only on high-line voltage (200-240 VAC). You must ensure that the power requirements are met when you add H410C nodes to an existing NetApp HCI installation.

Protection Domains

NetApp Element software supports Protection Domains functionality, which optimizes data layout on storage nodes for the best data availability. To use this feature, you should split storage capacity evenly across three or more NetApp H-series chassis for optimal storage reliability. In this scenario, the storage cluster automatically enables Protection Domains.

Related information

Managing storage with Element software

Final preparations

You must ensure that you complete the following final items before you deploy NetApp HCI.

- Gather all relevant information about your network, current or planned VMware infrastructure, and planned user credentials.
- Rack, cable, and power on the NetApp HCI installation.
- Ensure that storage capacity is split evenly across all chassis containing storage nodes. This ensures the best storage reliability possible.

Deploying NetApp HCI

The NetApp Deployment Engine enables you to quickly deploy NetApp HCI. During deployment, you can let the NetApp Deployment Engine automatically set many of the networking configuration details for you. After deployment, NetApp HCI will be ready to serve highly available compute and storage resources in a production environment.

Before you begin

You have ensured that all compute and storage nodes that will be part of the initial deployment are running the same versions of Element software (for storage nodes) and Bootstrap OS (for compute nodes).

If you are joining an existing VMware vSphere environment, you have completely logged out of vCenter Server.

Steps

Accessing the NetApp Deployment Engine

To deploy NetApp HCI, you need to access the NetApp Deployment Engine on one of the NetApp H-Series storage nodes via the IPv4 address assigned to the Bond1G interface, which is the logical interface that combines ports A and B for storage nodes. This storage node becomes the controlling storage node for the deployment process. Depending on your environment, you need to either configure the IPv4 address or retrieve it from one of the storage nodes.

Note: You can only access the NetApp Deployment Engine using the Bond1G interface of a storage node. Using the Bond10G interface, the logical interface that combines ports C and D for storage nodes, is not supported.

Use one of the following methods that best describes your network environment to access the NetApp Deployment Engine.

Scenario	Method
You do not have DHCP in your environment	*Accessing the NetApp Deployment Engine in environments without DHCP*
You have DHCP in your environment	*Accessing the NetApp Deployment Engine in environments with DHCP*
You want to assign all IP addresses manually	*Manually assigning IP addresses to access the NetApp Deployment Engine*

Accessing the NetApp Deployment Engine in environments without DHCP

When DHCP is not in use on the network, you need to set a static IPv4 address on the Bond1G interface of one of the storage nodes (also known as a controlling storage node) that you will use to access the NetApp Deployment Engine. The NetApp Deployment Engine on the controlling storage node will discover and communicate with other compute and storage nodes using IPv4 addresses that have been auto-configured on the Bond10G interfaces of all nodes. You should use this method unless your network has special requirements.

Before you begin

- You or your network administrator have completed the tasks in the *Installation and Setup Instructions* document.
- You have physical access to the NetApp HCI nodes.
- All of the NetApp HCI nodes are powered on.
- DHCP is not enabled for the NetApp HCI networks and the NetApp HCI nodes have not obtained IP addresses from DHCP servers.
- The NetApp HCI management network is configured as the native VLAN on the Bond1G and Bond10G interfaces of all nodes.

Steps

1. Plug a KVM into the back of one of the NetApp HCI storage nodes (this node will become the controlling storage node).
2. Configure the IP address, subnet mask, and gateway address for Bond1G in the user interface. You can also configure a VLAN ID for the Bond1G network if needed.

   Note: You cannot reuse this IPv4 address later during deployment with the NetApp Deployment Engine.

3. Open a web browser on a computer that can access the NetApp HCI management network.
4. Browse to the IP address you assigned to the controlling storage node. For example:

   ```
   http://<Bond1G IP address>
   ```

   This takes you to the NetApp Deployment Engine user interface.

Related information

NetApp HCI Compute and Storage Nodes Installation and Setup Instructions

Accessing the NetApp Deployment Engine in environments with DHCP

In environments where servers automatically acquire IPv4 configuration from DHCP, you can access the NetApp Deployment Engine using the IPv4 address assigned to the Bond1G interface on one of the storage nodes. You can use a USB stick to retrieve the IPv4 address from one of the storage nodes. The NetApp Deployment Engine will automatically discover other compute and storage nodes

that use DHCP-assigned IPv4 addresses. You should not use this method unless your network has special requirements.

Before you begin

- You or your network administrator have completed the tasks in the *Installation and Setup Instructions* document.
- You have physical access to the NetApp HCI nodes.
- All of the NetApp HCI nodes are powered on.
- DHCP is enabled on the NetApp HCI management and storage networks.
- The DHCP address pool is large enough to accommodate two IPv4 addresses per NetApp HCI node.

Note: For the NetApp HCI deployment to succeed, all nodes in the deployment must either have DHCP-acquired or auto-configured IPv4 addresses (you cannot mix IPv4 address assignment methods).

About this task

If DHCP is in use only for the storage network (Bond10G interfaces), you should use the steps outlined in *Accessing the NetApp Deployment Engine in environments without DHCP* on page 20 to access the NetApp Deployment Engine.

Steps

1. Wait several minutes for the nodes to request IP addresses.
2. Choose a storage node and insert a USB stick into the node. Leave it in for at least five seconds.
3. Remove the USB stick, and insert it into your computer.
4. Open the `readme.html` file. This takes you to the NetApp Deployment Engine user interface.

Related information

NetApp HCI Compute and Storage Nodes Installation and Setup Instructions

Manually assigning IP addresses to access the NetApp Deployment Engine

You can manually assign static IPv4 addresses to the Bond1G and Bond10G interfaces on all NetApp HCI nodes to access the NetApp Deployment Engine and deploy NetApp HCI. You should not use this method unless your network has special requirements.

Before you begin

Attention: All IP addresses you assign manually before using the NetApp Deployment Engine to deploy the system are temporary and cannot be reused. If you choose to manually assign IP addresses, you need to set aside a second permanent set of unused IP addresses that you can assign during final deployment.

- You or your network administrator have completed the tasks in the *Installation and Setup Instructions* document.
- You have physical access to the NetApp HCI nodes.
- All of the NetApp HCI nodes are powered on.

- DHCP is not enabled for the NetApp HCI networks and the NetApp HCI nodes have not obtained IP addresses from DHCP servers.

About this task

In this configuration, compute and storage nodes will use static IPv4 addresses to discover and communicate with other nodes during deployment. This configuration is not recommended.

Steps

1. Plug a KVM into the back of one of the NetApp HCI storage nodes (this node will become the controlling storage node).
2. Configure the IP address, subnet mask, and gateway address for Bond1G and Bond10G in the user interface. You can also configure a VLAN ID for each network if needed.
3. Repeat step 2 for the remaining storage and compute nodes.
4. Open a web browser on a computer that can access the NetApp HCI management network.
5. Browse to the Bond1G IP address you assigned to the controlling storage node. For example:

   ```
   http://<Bond1G IP address>
   ```

   This takes you to the NetApp Deployment Engine user interface.

Related information

NetApp HCI Compute and Storage Nodes Installation and Setup Instructions

Starting your deployment

Before continuing with your NetApp HCI deployment, you need to read and understand the end user license agreements.

Steps

1. On the **Welcome to NetApp HCI** page, click **Get Started**.
2. On the **Prerequisites** page, perform the following actions:
   a. Ensure each prerequisite is met, and click each associated checkbox to confirm.
   b. Click **Continue**.
3. On the **End User Licenses** page, perform the following actions:
   a. Read the NetApp End User License Agreement.
   b. If you accept the terms, click **I accept** at the bottom of the agreement text.
   c. Read the VMware End User License Agreement.
   d. If you accept the terms, click **I accept** at the bottom of the agreement text.
   e. Click **Continue**.

VMware vSphere configuration

NetApp HCI uses the vCenter Server and ESXi components of VMware vSphere. vCenter Server is used to manage and monitor the VMware ESXi hypervisor installed on each compute node. You can install and configure a new vSphere deployment, which also installs the NetApp Element Plug-in for vCenter Server, or you can join and extend an existing vSphere deployment.

Be aware of the following caveats when you use the NetApp Deployment Engine to install a new vSphere deployment:

- The NetApp Deployment Engine installs the new vCenter Server Appliance with the Small deployment size option.
- The vCenter Server license is a temporary evaluation license. For continued operation after the evaluation period, you need to obtain a new license key from VMware and add it to the vCenter Server license inventory.

Note: If your vSphere inventory configuration uses a folder to store the NetApp HCI cluster within the vCenter datacenter, some operations, such as expanding NetApp HCI compute resources, will fail. Ensure that the NetApp HCI cluster is directly under the datacenter in the vSphere web client inventory tree, and is not stored in a folder. See the NetApp Knowledgebase article for more information.

Related tasks

Configuring a new VMware vSphere environment on page 23

Related information

Using VCP to manage NetApp HCI
NetApp Knowledgebase article: Possible errors when expanding compute nodes

Configuring a new VMware vSphere environment

You can deploy a new vSphere environment as part of the NetApp HCI installation process by providing some of the network information that vSphere should use. Note that if you configure vSphere using an IP address, the address cannot be changed after installation.

Before you begin

You have obtained the network information for the planned vSphere environment.

Steps

1. Click **Configure a new vSphere deployment**.
2. Select which version of vSphere the system should install during deployment.
3. Configure the new vSphere environment using one of the following options:

Option	Steps
Use a domain name (recommended).	**a.** Click **Configure Using a Fully Qualified Domain Name**. **b.** Enter the vCenter Server domain name in the **vCenter Server Fully Qualified Domain Name** field. **c.** Enter the DNS server IP address in the **DNS Server IP Address** field. **d.** Click **Continue**.
Use an IP address.	**a.** Click **Configure Using an IP Address**. **b.** Click **Continue**.

Joining an existing VMware vSphere deployment

Configure NetApp HCI to take advantage of an existing vSphere deployment by providing the vCenter Server network information and credentials.

Before you begin

- If you are joining an existing vSphere 6.7 deployment, make sure vCenter Server is running version 6.7 Update 1.
- If you are joining an existing vSphere 6.5 deployment, make sure vCenter Server is running version 6.5 Update 2 or later.
- Obtain the network details and administrator credentials for your existing vSphere deployment.

About this task

- When you join an existing vSphere deployment, NetApp HCI does not configure a vSphere Distributed Switch during deployment. This is to avoid interfering with any existing distributed switch configurations.
- If you join multiple vCenter Server systems that are connected using vCenter Linked Mode, NetApp HCI only recognizes one of the vCenter Server systems.

Steps

1. Click **Join and extend an existing vSphere deployment**.
2. Enter the domain name or IP address in the **vCenter Server Domain Name or IP address** field.

   If you enter a domain name, you also need to enter the IP address of an active DNS server in the **DNS Server IP Address** field that appears.
3. Enter the credentials of a vSphere administrator in the **User Name** and **Password** fields.
4. Click **Continue**.

Configuring credentials

During deployment, you define a common set of credentials to be used for the newly deployed VMware vSphere environment, the NetApp HCI compute and storage resources, and the

management node. If you are joining an existing vSphere environment, these credentials are not applied to the existing vCenter Server.

About this task

Remember the following points about the credentials you set in the NetApp HCI Deployment Engine:

- To log in to a vSphere environment installed as part of deployment, use the same user name that you enter on this page with the following suffix:

  `@vsphere.local`

- To log in to ESXi after deployment, use `root` as the user name and the same password you enter on this page.

Steps

1. On the **Credentials** page, enter a user name in the **User Name** field.
2. Enter a password in the **Password** field.

   The password must conform to the password criteria visible in the **Password must contain** box.
3. Confirm the password in the **Re-enter Password** field.
4. Click **Continue**.

Selecting a network topology

When cabling NetApp HCI nodes, you have the option of using different network cable configurations depending on your needs. For each compute node, you can use all six network ports, with different types of traffic assigned to each pair of ports, or you can use two ports with all types of traffic assigned to the ports. Storage nodes use the standard four-cable configuration. Your choice affects which compute nodes are selectable in the inventory.

Before you begin

If you choose the two-cable network topology for compute nodes, consider the following requirements:

- You have a VMware vSphere Enterprise Plus license ready to apply after deployment is complete.
- You have verified that the configuration of your network and network switches is correct.
- VLAN tagging is required for storage and vMotion networks for all compute and storage nodes.

Steps

1. On the **Network Topology** page, select a compute node topology that fits the way you installed compute nodes for NetApp HCI:

   - **6 Cable Option**: The six-cable option provides dedicated ports for each type of traffic (management, virtual machine, and storage). You can optionally enable vSphere Distributed Switch (VDS). Enabling VDS configures a distributed switch, enabling simplified, centralized management of virtual machine network configuration after NetApp HCI deployment is complete. If you enable it, you must have a vSphere Enterprise Plus license ready to apply after deployment.

- **2 Cable Option**: The two-cable option combines management, virtual machine, and storage traffic on two bonded ports. This cabling option requires VDS, and automatically enables it. You must have a vSphere Enterprise Plus license ready to apply after deployment.

2. Some cabling options display multiple back panel views of different types of node hardware. Cycle through the back panel views to see how to connect the network cables for that specific node model and cabling option.
3. When finished, click **Continue**.

Related concepts

Network configuration and cabling options on page 11

Selecting inventory

On the **Inventory** page, the NetApp Deployment Engine automatically detects available compute and storage nodes, enabling you to select and add all NetApp HCI resources to the deployment.

About this task

The storage node that is hosting the NetApp Deployment Engine is automatically selected, and cannot be deselected. If a node does not meet the requirements for deployment, it is not selectable and problems are indicated in red. You can position your cursor over the error to see an explanation.

Note: If no nodes or only a subset of nodes appear in the inventory, verify that the switch ports used for NetApp HCI nodes (all SFP+/SFP28 interfaces) are configured with jumbo frames.

Compute nodes must meet the following requirements to be selectable as inventory:

- The CPU generations in all compute nodes must match for proper VMware vMotion functionality. After you select a compute node from the inventory, you cannot select compute nodes with different CPU generations.
- You cannot intermix compute nodes with GPU-enabled compute nodes in the same cluster. If you select a GPU-enabled compute node, CPU-only compute nodes become unselectable, and vice versa.
- The software version running on the compute node must match the major and minor version of the NetApp Deployment Engine hosting the deployment. If this is not the case, you need to reimage the compute node using the RTFI process. See the NetApp Knowledgebase articles regarding RTFI for instructions.
- The compute node must have the cabling configuration you selected on the **Network Topology** page to be selectable in the **Compute Nodes** list.

Note: Depending on node hardware configuration, H410S storage nodes might appear in the inventory list labeled as H300S, H500S, or H700S storage nodes.

Steps

1. On the **Inventory** page, view the list of available nodes.

   If the system cannot detect any inventory, it displays an error. Correct the error before continuing.

   If your system uses DHCP for IP address assignment, the storage and compute resources might not appear in the inventory immediately.

2. Optional: If a resource does not appear in the inventory immediately, or if you address an error and need to refresh the inventory, click **Refresh Inventory**. You might need to refresh the inventory multiple times.
3. Optional: To filter the inventory on node attributes, such as node type:
   a. Click **Filter** in the header of the **Compute Nodes** or **Storage Nodes** lists.
   b. Choose criteria from the drop-down lists.
   c. Below the drop-down lists, enter information to satisfy the criteria.
   d. Click **Add Filter**.
   e. Clear individual filters by clicking **X** next to an active filter, or clear all filters by clicking **X** above the list of filters.
4. Select all compute nodes that shipped with your system from the **Compute Nodes** list.

   You need to select at least two compute nodes to proceed with deployment.
5. Select all storage nodes that shipped with your system from the **Storage Nodes** list.

   You need to select at least four storage nodes to proceed with deployment.
6. Optional: If a storage node selection box is flagged, that storage node exceeds 33% of the total storage cluster capacity. Perform one of the following steps:
   - Clear the selection box for the flagged storage node.
   - Select additional storage nodes to more equally distribute the storage cluster capacity between nodes.
7. Click **Continue**.

Related information

How to RTFI using a USB key (login required)
How to RTFI using the IPMI management console (login required)

Configuring network settings

NetApp HCI provides a network settings page with an easy form to simplify network configuration. When you complete the easy form, NetApp HCI automatically populates much of the rest of the information on the network settings page. You can then enter final network settings and verify that the network configuration is correct before proceeding. You do not need to complete the form in its entirety.

Before you begin

- You have obtained the following information:
  - The planned naming prefix for the hosts and storage cluster
  - All planned subnet mask, starting IP address, default gateway, and VLAN IDs for the management, iSCSI, and vMotion networks
  - The IP address, default gateway, VLAN IDs, and subnet mask information for any planned VMware vCenter deployment
  - The Network Time Protocol (NTP) server address for NetApp HCI

    - The DNS server IP address information for NetApp HCI

- If you are deploying a vSphere Distributed Switch, you have a vSphere Enterprise Plus license ready to apply after deployment is complete.
- If you assigned VLAN IDs to node ports during terminal user interface (TUI) configuration, you have configured those ports with the same VLAN ID during network configuration. You do not need to configure tagged host ports as access ports or native VLANs on the connected switch ports.
- You have verified that your network switch configuration is correct. Incorrect switch configurations (such as incorrect VLANs or MTU size) will cause deployment errors.

About this task

If you selected the two-cable network topology for compute nodes, you must use VLAN IDs for the vMotion and storage networks for all compute and storage nodes in the deployment (VLAN IDs are optional for the management networks).

Note: In environments that require host-side VLAN tagging before deployment, if you have configured VLAN IDs on compute and storage nodes so they are discoverable by the NetApp Deployment Engine, ensure you use the correct VLANs when configuring network settings in the NetApp Deployment Engine.

Steps

1. Optional: To disable live validation of network information you enter on this page, toggle the **Live network validation for this page is currently** switch to **Off**. If you enter a VLAN ID during configuration (including the easy form), or if you are using the two-cable compute node topology, network validation is automatically disabled.
2. In the **Infrastructure Services** section of the **Network Settings** page, enter the DNS and NTP server information for NetApp HCI in the following fields:

Field	Description
DNS Server IP Address 1	The IP address of the primary DNS server for NetApp HCI. If you specified a DNS server on the **vCenter Configuration** page, this field is populated and read-only.
DNS Server IP Address 2 (Optional)	An optional IP address of a secondary DNS server for NetApp HCI.
NTP Server Address 1	The IP address or fully qualified domain name of the primary NTP server for this infrastructure.
NTP Server Address 2 (Optional)	An optional IP address or fully qualified domain name of the secondary NTP server for this infrastructure.

3. Click **To save time, launch the easy form to enter fewer network settings**.

   The **Network Settings Easy Form** dialog box appears.
4. Enter a naming prefix in the **Naming Prefix** field.

   The naming prefix is applied to the hostname of each host and the name of the storage cluster. Prefixes can contain letters, numbers, and hyphens, and cannot exceed 55 characters.
5. Choose one of the following options for assigning VLAN IDs.

At any time when using the form, click **Clear** next to a row to clear input from a row of fields.

Note: When you assign VLAN IDs, you are configuring VLAN tags that NetApp HCI will apply to the network traffic. You do not need to enter your native VLAN as a VLAN ID; to use the native VLAN for a network, leave the appropriate field empty.

Option	Steps
Assign VLAN IDs	**a.** Select **Yes** for the **Will you assign VLAN IDs** option. **b.** In the **VLAN ID** column, enter a VLAN ID for each type of network traffic you want to assign to a VLAN. Both compute vMotion traffic and iSCSI traffic must use an unshared VLAN ID. **c.** Click **Next**. **d.** In the **Subnet** column, enter subnet definitions in CIDR format for each type of network traffic in each network; for example, `192.168.1.0/24`. **e.** In the **Default Gateway** column, enter the IP address of the default gateway for each type of network traffic in each network. **f.** In the **Starting IP** column, enter the first useable IP address for each network subnet in each network.
Do not assign VLAN IDs	**a.** Select **No** for the **Will you assign VLAN IDs** radio button. **b.** In the **Subnet** column, enter subnet definitions in CIDR format for each type of network traffic in each network; for example, `192.168.1.0/24`. **c.** In the **Default Gateway** column, enter the IP address of the default gateway for each type of network traffic in each network. **d.** In the **Starting IP** column, enter the first useable IP address for each type of network traffic in each network.

6. Click **Apply to Network Settings**.
7. Click **Yes** to confirm.

   This populates the **Network Settings** page with the settings you entered in the easy form.
8. Verify that the automatically populated data is correct.
9. Click **Continue**.

Reviewing and deploying the configuration

You can review the information you provided before beginning deployment. You can also correct any incorrect or incomplete information before you proceed.

About this task

Note: During deployment, the management node installation process creates volumes with names beginning with `NetApp-HCI-` in the Element storage cluster, and a SolidFire account beginning with the name "tenant_". Do not delete these volumes or accounts; doing so will cause a loss in management functionality.

Steps

1. Optional: Click the  icon to download installation information in CSV format.

   You can save this file and refer to it later for configuration information.

2. Expand each section and review the information. To expand all sections at once, click **Expand All**.

3. Optional: To make changes to information in any displayed section:

   a. Click **Edit** in the corresponding section.

   b. Make the necessary changes.

   c. Click **Continue** until you reach the **Review** page. Your previous settings are saved on each page.

   d. Repeat steps 2 and 3 to make any other necessary changes.

4. If you do not want to send cluster statistics and support information to NetApp-hosted SolidFire Active IQ servers, clear the final checkbox.

   This disables real-time health and diagnostic monitoring for NetApp HCI. Disabling this feature removes the ability for NetApp to proactively support and monitor NetApp HCI to detect and resolve problems before production is affected.

5. If all information is correct, click **Start Deployment**.

   A dialog box appears. In the event of network connectivity issues or power loss during the final setup process, or if your browser session is lost, you can copy the URL displayed in the dialog and use it to browse to the final setup progress page.

6. Review the information in the dialog and click **Copy to Clipboard** to copy the URL to your clipboard.

7. Save the URL to a text file on your computer.

8. When you are ready to proceed with deployment, click **OK**.

   Deployment begins and a progress page is displayed. Do not close the browser window or navigate away from the progress page until deployment is complete. If your browser session is lost for any reason, you can browse to the URL you copied earlier (and accept any security warnings that appear) to regain access to the final setup progress page.

   Note: If the deployment fails, save any error message text and contact NetApp Support.

After you finish

- Ensure that you can use the NetApp HCI management application by *updating management services*.
- Begin using NetApp HCI by clicking **Launch vSphere**.

  Note: For NetApp HCI installations using vSphere 6.7, this link launches the HTML5 vSphere web interface. For installations using vSphere 6.5, this link launches the Adobe Flash vSphere web interface.

Updating management services

NetApp provides periodic updates to the management functionality that is deployed as part of NetApp HCI. After deployment, you can check for and update to the latest management services using the NetApp Deployment Engine. This is a one-time procedure that enables NetApp Hybrid Cloud Control functionality on NetApp HCI.

Steps

1. Open a web browser on a computer that can reach the management network and browse to the management IP address of a storage node. For example:

   ```
   https://<StorageNodeMIP>:442/nde
   ```

2. Click **Update Services**.
3. Optional: If an **Authentication Required** dialog box appears:

   a. Enter the management node IP address and NetApp HCI storage cluster credentials.

   b. Click **Update**.

   The system attempts to communicate with the management node. If an error appears, your browser does not trust the management node SSL certificate. Follow the instructions in the error message, accept the SSL certificate, and try the update again. If authentication is successful, the dialog closes and the update begins.

4. After a successful update, click **Launch NetApp HCI** to open NetApp Hybrid Cloud Control, the NetApp HCI management application.

Related information

Working with the management node

Post-deployment tasks

Depending on your choices during the deployment process, you need to complete some final tasks before your NetApp HCI system is ready for production use, such as migrating to an existing vSphere instance (if needed).

Supported networking changes

After you deploy NetApp HCI, you can make limited changes to the default networking configuration. However, certain settings are required for smooth operation and proper network detection. Changing these settings will cause unexpected behavior, and might prevent you from expanding compute and storage resources.

After you deploy your system, you can make the following changes to the default network configuration in VMware vSphere as dictated by your network requirements:

- Change vSwitch names
- Change port group names
- Add and remove additional port groups
- Change the vmnic interface failover order for any additional port groups you have added

NetApp HCI requires that the following vmk to vmnic interface mappings be in place.

Physical interface	VSS six-cable compute virtual interfaces	VDS six-cable compute virtual interfaces	VDS two-cable compute virtual interfaces
Management interface	vmk0: vmnic2, vmnic3	vmk0: vmnic2, vmnic3	vmk0: vmnic1, vmnic5
vMotion interface	vmk1: vmnic0, vmnic4	vmk3: vmnic0, vmnic4	vmk3: vmnic1, vmnic5
iSCSI-A interface	vmk2: vmnic1	vmk1: vmnic5	vmk1: vmnic1
iSCSI-B interface	vmk3: vmnic5	vmk2: vmnic1	vmk2: vmnic5

Keeping VMware vSphere up to date

After deploying NetApp HCI, you should use VMware vSphere Update Manager to apply the latest security patches for the version of VMware vSphere used with NetApp HCI.

Use the *Interoperability Matrix Tool* to ensure that all versions of software are compatible. See the VMware vSphere Update Manager *documentation* for more information.

Installing GPU drivers for GPU-enabled compute nodes

Compute nodes with NVIDIA graphics processing units (GPUs), like the NetApp H610C, need the NVIDIA software drivers installed in VMware ESXi so that they can take advantage of the increased

processing power. After deploying compute nodes with GPUs, you need to perform these steps on each GPU-enabled compute node to install the GPU drivers in ESXi.

Steps

1. Open a browser and browse to the NVIDIA licensing portal at the following URL:

   ```
   https://nvid.nvidia.com/dashboard/
   ```

2. Download one of the following driver packages to your computer, depending on your environment:

vSphere version	Driver package
vSphere 6.0	`NVIDIA-GRID-vSphere-6.0-390.94-390.96-392.05.zip`
vSphere 6.5	`NVIDIA-GRID-vSphere-6.5-410.92-410.91-412.16.zip`
vSphere 6.7	`NVIDIA-GRID-vSphere-6.7-410.92-410.91-412.16.zip`

3. Extract the driver package on your computer.

   The resulting .VIB file is the uncompressed driver file.

4. Copy the .VIB driver file from your computer to ESXi running on the compute node. The following example commands for each version assume that the driver is located in the `$HOME/NVIDIA/ESX6.x/` directory on the management host. The SCP utility is readily available in most Linux distributions, or available as a downloadable utility for all versions of Windows:

Option	Description
ESXi 6.0	`scp $HOME/NVIDIA/ESX6.0/NVIDIA**.vib root@<ESXi_IP_ADDR>:/.`
ESXi 6.5	`scp $HOME/NVIDIA/ESX6.5/NVIDIA**.vib root@<ESXi_IP_ADDR>:/.`
ESXi 6.7	`scp $HOME/NVIDIA/ESX6.7/NVIDIA**.vib root@<ESXi_IP_ADDR>:/.`

5. Use the following steps to log in as `root` to the ESXi host and install the NVIDIA vGPU manager in ESXi.

   a. Run the following command to log in to the ESXi host as the `root` user:

      ```
      ssh root@<ESXi_IP_ADDRESS>
      ```

   b. Run the following command to verify that no NVIDIA GPU drivers are currently installed:

      ```
      nvidia-smi
      ```

      This command should return the message "`nvidia-smi: not found`".

   c. Run the following commands to enable maintenance mode on the host and install the NVIDIA vGPU Manager from the VIB file:

      ```
      esxcli system maintenanceMode set --enable true
      esxcli software vib install -v /NVIDIA**.vib
      ```

You should see the message "`Operation finished successfully`".

d. Run the following command and verify that all eight GPU drivers are listed in the command output:

```
nvidia-smi
```

e. Run the following command to verify that the NVIDIA vGPU package was installed and loaded correctly:

```
vmkload_mod -l | grep nvidia
```

The command should return output similar to the following: `nvidia 816 13808`

f. Run the following commands to exit maintenance mode and reboot the host:

```
esxcli system maintenanceMode set –enable false
reboot -f
```

6. Repeat steps 4-6 for any other newly deployed compute nodes with NVIDIA GPUs.
7. Perform the following tasks using the instructions in the NVIDIA documentation site:
   a. Install the NVIDIA license server.
   b. Configure the virtual machine guests for NVIDIA vGPU software.
   c. If you are using vGPU-enabled desktops in a virtual desktop infrastructure (VDI) context, configure VMware Horizon View for NVIDIA vGPU software.

Related tasks

Installing GPU drivers for GPU-enabled compute nodes on page 32

Related information

NVIDIA GRID license server installation instructions
NVIDIA vGPU driver installation instructions for virtual machine guests
NVIDIA vGPU Deployment Guide for VMware Horizon 7.5 on VMware vSphere 6.7

Updating compute node firmware

For the H410C, H610C, H300E, H500E, and H700E compute nodes, you can update the firmware for hardware components such as the BMC, BIOS, and NIC using the RTFI image while leaving the ESXi installation and other configuration data in place. After the update, the compute node boots into ESXi and works as before, retaining the configuration.

Before you begin

- Download the RTFI image for the desired software version from *The NetApp Support Site*.
- Write the raw contents of the compute node RTFI image to a USB thumb drive with at least 32GB capacity (using dd or Etcher).
- See the firmware and driver matrix for your hardware in *NetApp KB article 1088658 (login required)*.

About this task

In production environments, only update the firmware on one compute node at a time.

As an alternative to using the USB thumb drive method described in this procedure, you can mount the compute node RTFI image on the compute node using the **Virtual CD/DVD** option in the **Virtual Console** in the Baseboard Management Controller (BMC) interface. The BMC method takes considerably longer than the USB thumb drive method. Ensure your workstation or server has the necessary network bandwidth and that your browser session with the BMC does not time out.

Steps

1. Place the compute node in maintenance mode using VMware vCenter, and evacuate all virtual machines from the host.

   Note: If VMware Distributed Resource Scheduler (DRS) is enabled on the cluster (this is the default in NetApp HCI installations), virtual machines will automatically be migrated to other nodes in the cluster.

2. Insert the USB thumb drive into a USB port on the compute node and reboot the compute node using VMware vCenter.
3. During the compute node POST cycle, press **F11** to open the **Boot Manager**. You may need to press **F11** multiple times in quick succession. You can perform this operation by connecting a video/keyboard or by using the console in BMC.
4. Select **One Shot > USB Flash Drive** from the menu that appears. If the USB thumb drive does appear in the menu, verify that USB Flash Drive is part of the legacy boot order in the BIOS of the system.
5. Press **Enter** to boot the system from the USB thumb drive. The firmware flash process begins.

   After firmware flashing is complete and the node reboots, it might take a few minutes for ESXi to start.

6. After the reboot is complete, exit maintenance mode on the updated compute node using vCenter.
7. Remove the USB flash drive from the updated compute node.
8. Repeat this task for other compute nodes in your ESXi cluster until all compute nodes are updated.

Updating compute node drivers

For the H410C, H610C, H300E, H500E, and H700E compute nodes, you can update the drivers used on the nodes using VMware Update Manager.

Before you begin

- Download the VMware ESXi driver bundle for the desired compute node and software version from *The NetApp Support Site*.
- Extract the downloaded driver bundle for your compute nodes and the desired version of ESXi to your local computer.

  Note: The NetApp driver bundle includes one or more VMware Offline Bundle ZIP files; do not extract these ZIP files.

- See the firmware and driver matrix for your hardware in *NetApp KB article 1088658 (login required)*.

About this task

Only perform one of these update operations at a time.

Steps

1. After upgrading the firmware on the compute nodes, go to **VMware Update Manager** in vCenter.
2. Import the driver offline bundle file for the compute nodes into the **Patch Repository**.
3. Create a new Host Baseline for the compute node.
4. Choose **Host Extension** for **Name** and **Type** and select all imported driver packages to be included in the new baseline.
5. In the **Host and Clusters** menu in vCenter, select the cluster with the compute nodes you would like to update and navigate to the **Update Manager** tab.
6. Click **Remediate** and the select the newly created host baseline. Ensure that drivers included in the baseline are selected.
7. Proceed through the wizard to the **Host Remediation Options** and ensure that the **Do Not Change VM Power State** option is selected to keep virtual machines online during the driver update.

   Note: If VMware Distributed Resource Scheduler (DRS) is enabled on the cluster (this is the default in NetApp HCI installations), virtual machines will automatically be migrated to other nodes in the cluster.

8. Proceed to the **Ready to Complete** page in the wizard and click **Finish**.

   The drivers for all compute nodes in the cluster are update one node at a time while virtual machines stay online.

Accessing NetApp Hybrid Cloud Control

NetApp Hybrid Cloud Control enables you to manage NetApp HCI. You can upgrade management services, expand and monitor your installation, and enable NetApp Cloud Services. You log in to NetApp Hybrid Cloud Control by browsing to the IP address of the management node.

Before you begin

If you cannot access NetApp Hybrid Cloud Control , ensure that you have updated the management services using the NetApp Deployment Engine. See *Updating management services* for more information.

Updating management services on page 31

Steps

1. Open a web browser and browse to the IP address of the management node. For example:

   ```
   https://<ManagementNodeIP>/manager/login
   ```

2. Log in to NetApp Hybrid Cloud Control by providing the NetApp HCI storage cluster administrator credentials.
3. Click **Manage**.

   The NetApp Hybrid Cloud Control interface appears.

Upgrading the NetApp HCI installation

Using NetApp Hybrid Cloud Control, you can upgrade your NetApp installation. This upgrades management services, NetApp Hybrid Cloud Control, and other software components.

Steps

1. Open a web browser and browse to the IP address of the management node. For example:

   ```
   https://<ManagementNodeIP>/manager/login
   ```

2. Log in to NetApp Hybrid Cloud Control by providing the NetApp HCI storage cluster administrator credentials.

3. In the **Upgrade Installation** pane, click **Upgrade**.

   On the **Upgrades** page, you can see the current and available versions of software. If your installation cannot access the internet, only the current software version is shown.

4. Click **Begin Upgrade**.

   The upgrade begins, and you can monitor the progress.

Enabling cloud services on NetApp HCI

THIS DOCUMENTATION IS PROVIDED AS A TECHNOLOGY PREVIEW. With NetApp HCI, a hybrid cloud infrastructure that serves as a deployment engine supporting NetApp Kubernetes Service, you can set up a cloud native development pipeline quickly and easily. With NetApp HCI and NetApp Kubernetes Service, you can deploy your applications as you would with a public cloud provider—all in a self-service mode without IT involvement. This enables you to treat your datacenter as a deployable region of your multi-cloud.

Before you begin

You must have already completed these requirements:

- You must have already deployed NetApp HCI using the NetApp Deployment Engine.
- You should have already configured the required vSphere distributed switch (VDS) port groups (ports between the vCenter and the management node) in the NetApp Element Plug-in for vCenter Server. We recommend creating three Kubernetes-specific port groups; however, this is optional.
  Network ports used by NetApp HCI on page 7
- You must have already upgraded the NetApp HCI management services. See management services information in the *NetApp Element User Guide*.
  Managing storage with Element software
- NetApp Hybrid Cloud Control is available on the management node of your system.

About this task

Enabling cloud services on NetApp HCI with a Kubernetes data control mechanism on NetApp Cloud Central enables you to:

- Deploy applications across public cloud providers and your private cloud.
- Work with multiple cloud providers, not just one.
- Port the apps and data across a hybrid cloud architecture regardless of cloud location without compromising service-level agreements.
- Spin up cloud-native applications yourself without involving DevOps and IT.

Steps

1. Understanding NetApp Cloud Central and Kubernetes information on page 40
   As you work with cloud services, NetApp Cloud Central, and Kubernetes clusters, you might find it helpful to understand the process used to build the different types of clusters and understand Kubernetes terminology.
2. Getting a NetApp Kubernetes Service API token on page 42
   Enabling cloud services for NetApp HCI requires a NetApp Kubernetes Service API token that is associated with your NetApp Cloud Central account. You can complete these steps before enabling cloud services or during the process, when a wizard displays a link to get the API token.
3. Enabling cloud services with NetApp Hybrid Cloud Control on page 43
   Enabling NetApp cloud services provides access to Kubernetes clusters and cloud volumes on NetApp HCI. You also gain the ability to use the NetApp Kubernetes Service to deploy and manage Kubernetes clusters. Enabling cloud services is performed using NetApp Hybrid Cloud Control.
4. Viewing the Kubernetes cluster on the NetApp Kubernetes Service on page 49
   Using the NetApp Kubernetes Service on NetApp Cloud Central, you can view the Kubernetes clusters.
5. Creating Kubernetes clusters on page 49
   After you enable cloud services, you can create Kubernetes workload clusters using the NetApp Kubernetes Service. You want to create clusters on which you can later place pre-designed or your own applications. After you create the clusters, those clusters are ready to accept application workloads.
6. Creating a project within a NetApp Kubernetes Service workspace on page 51
   When you create Kubernetes workload clusters, you select a workspace in the NetApp Kubernetes Service. You can create a project within that workspace and later add a solution to the project.
7. Adding applications to your Kubernetes cluster on page 52
   After you create your Kubernetes workload cluster, you can easily add any number of applications to that cluster. Using this feature, you gain tremendous efficiency of spinning up or down applications as needed.
8. Converting your trial license to a production license on page 53
   When you first enable cloud services on NetApp HCI, the installation process configures a 90-day trial license. After that time elapses, you must convert the trial license to a production license for continued use.
9. Creating cloud volumes with NetApp Fabric Orchestrator on page 54
   You can create cloud volumes on the Kubernetes cluster by using another cloud service, the NetApp Fabric Orchestrator.

Understanding NetApp Cloud Central and Kubernetes information

As you work with cloud services, NetApp Cloud Central, and Kubernetes clusters, you might find it helpful to understand the process used to build the different types of clusters and understand Kubernetes terminology.

Cloud Central accounts

Each NetApp HCI system that has cloud services enabled is associated with a NetApp Cloud Central account. A Cloud Central account is a container for your systems and the *workspaces* in which you deploy cloud services on NetApp HCI.

The account is maintained in Cloud Central, so any changes that you make to it are available to other NetApp cloud data services.

A Cloud Central account enables multi-tenancy:

- A single Cloud Central account can include multiple NetApp HCI systems that serve different business needs. Because users are associated with the Cloud Central account, there's no need to configure users for each individual NetApp HCI system.
- Within each NetApp HCI system, multiple users can deploy and manage NetApp HCI systems in isolated environments called *workspaces*. These workspaces are invisible to other users, unless they are shared.

When you deploy NetApp HCI, you select the Cloud Central account to associate with the system. Account admins can then modify the settings for this account by managing users, workspaces, and service connectors.

Using Cloud Central, you can set up accounts as individual accounts or as Federated accounts:

- You can make a new account with name, email, and password and then you are logged in. This is the simplest type of account.
- If you are part of a Cloud Central Federated organization, you enter your email and are then routed to the organization login.

What happens behind the scenes

Behind the scenes, NetApp HCI creates a bootstrap agent that establishes an encrypted communication tunnel to the NetApp Kubernetes Service control plane and creates a service cluster.

The *service cluster*, connected to NetApp Kubernetes Service, acts as a service orchestrator to deploy services and update itself. The NetApp Kubernetes Service agent maintains the tunnel, maintains deployed service clusters, and enables you to create *workload clusters* on which you can place applications or solutions.

After a service cluster is deployed on your system, NetApp HCI is able to push requested software along with updates to your NetApp HCI systems.

Types of clusters on NetApp HCI

Enabling cloud services on NetApp HCI involves different types of clusters.

Service cluster

Connected to NetApp Kubernetes Service, a service cluster acts as an orchestrator to deploy services and update itself. The service cluster is a set of compute nodes and storage resources that form a Kubernetes environment. Each cluster has at least one master node, which is responsible for overall management of the cluster, and three worker nodes, on which containers are scheduled to execute.

Workload clusters

These are clusters on which you add any number of applications. These clusters are maintained in NetApp Kubernetes Service.

Kubernetes pods, volumes, and projects

Cloud services on NetApp HCI involves pods, volumes, and projects that you create and manage by using NetApp Kubernetes Service.

Each Kubernetes pod is a set of one or more containers. Pods run in several replicas of each service ensuring no single point of failure for critical services. In the Kubernetes architecture, a set of containers can be deployed and scaled together. This is achieved by using pods, which are the minimum unit of deployment in a Kubernetes cluster that enable more than one container to share the same resources, such as IP address and file systems.

A Kubernetes volume is storage provisioned directly to a pod. NetApp Kubernetes Service supports a wide variety of volume types, including Amazon EBS, Azure Disk Storage, Google Persistent Disk, NFS, and many more. Volumes enable the containers within a pod to share information and are destroyed when their parent pod is deleted.

With NetApp Kubernetes Service, you can use a persistent volume, one that exists independently of any specific pod and with its own lifetime. Persistent volumes can be used to support stateful applications, such as database services, enabling all components of an enterprise solution to be deployed and managed by NetApp Kubernetes Service. Using Trident to manage persistent volume claims (PVCs) insulates the developers creating pods from the lower-level implementation details of the storage that they are accessing.

A Kubernetes project is a construct for grouping applications, for example, Wordspace or MySQL. Aproject is a namespace with RBAC on the Kubernetes cluster.

Getting a NetApp Kubernetes Service API token

Enabling cloud services for NetApp HCI requires a NetApp Kubernetes Service API token that is associated with your NetApp Cloud Central account. You can complete these steps before enabling cloud services or during the process, when a wizard displays a link to get the API token.

Steps

1. Open a web browser and browse to NetApp Cloud Central for NetApp Kubernetes Service.

   https://nks.netapp.io

2. Log in to NetApp Kubernetes Service by providing the NetApp HCI storage cluster administrator credentials.

   If you do not have an account, click **Sign Up** and provide the required information.

3. Click the user icon at the top right of the screen.

4. In the resulting menu, click **Edit Profile**.

5. In the **API Tokens** section, click **Add Token**, enter a token name, and click **Create**.

   A new token is created; the cURL command changes to include the new token string.

6. Run the displayed cURL command in a Unix or Mac command terminal.

   A response of `[]` indicates that the token registration was a success.

7. Copy the token and save it in a file so that you can later paste it when needed.

Enabling cloud services with NetApp Hybrid Cloud Control

Enabling NetApp cloud services provides access to Kubernetes clusters and cloud volumes on NetApp HCI. You also gain the ability to use the NetApp Kubernetes Service to deploy and manage Kubernetes clusters. Enabling cloud services is performed using NetApp Hybrid Cloud Control.

About this task

This process enables cloud volumes with a 90-day trial license. You can later upload the NetApp license file (`.nlf` file) to convert the trial license to a production license.

A wizard takes you through the following tasks:

- Select the cloud services you want to enable.
- Obtain a Kubernetes API token and register your installation with NetApp Cloud Central.
- Select the vCenter resources.
- Configure networking.

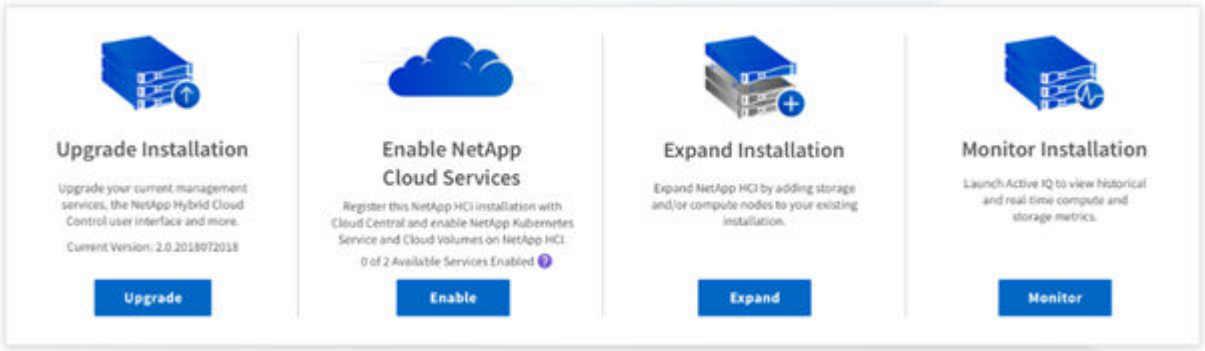
Steps

1. Access NetApp Hybrid Cloud Control by opening a web browser and browsing to the IP address of the management node.

   ```
   https://<ManagementNodeIP
   ```

   For details, see accessing NetApp Hybrid Cloud Control information.

   Accessing NetApp Hybrid Cloud Control on page 37

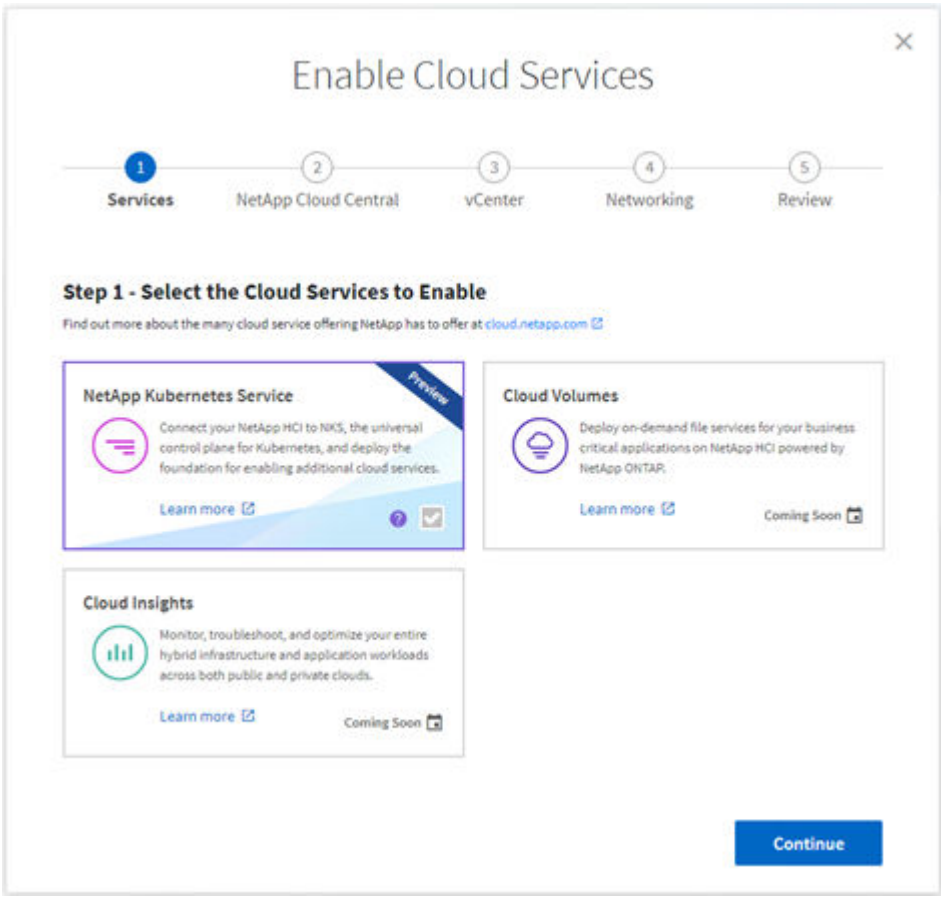
2. Click **Enable**.
3. If you do not have a Cloud Central account, on the Cloud Central Login page, click **Sign Up**.

   Using Cloud Central, you can set up accounts either as individual accounts or as Federated accounts:

   - You can make a new account with name, email, and password and then you will be logged in. This is the simplest type of account.
   - If you are part of a Cloud Central Federated organization, you enter your email and are then routed to the organization login.

4. On the Cloud Central Login page, enter your Cloud Central login credentials and click **Login**.

   The Enable Cloud Services page appears.



5. On the **Enable Cloud Services > Services** page, select the services you want to enable.

   - **NetApp Kubernetes Service**: You must use NetApp Kubernetes Service, a SaaS platform that enables you to deploy a Kubernetes cluster in the cloud with the major cloud providers and also with NetApp private cloud. This is required to enable cloud services on NetApp HCI. This service is installed as a VM on a NetApp HCI compute node.
   - **Cloud Volumes**: To manage cloud volumes on NetApp HCI, select this service. This service offers an on-demand shared file systems feature on your premises. The Cloud Volumes option enables Data Fabric replication to and from public clouds.
   - **Cloud Insights**: To monitor cloud services on NetApp HCI, select this service.

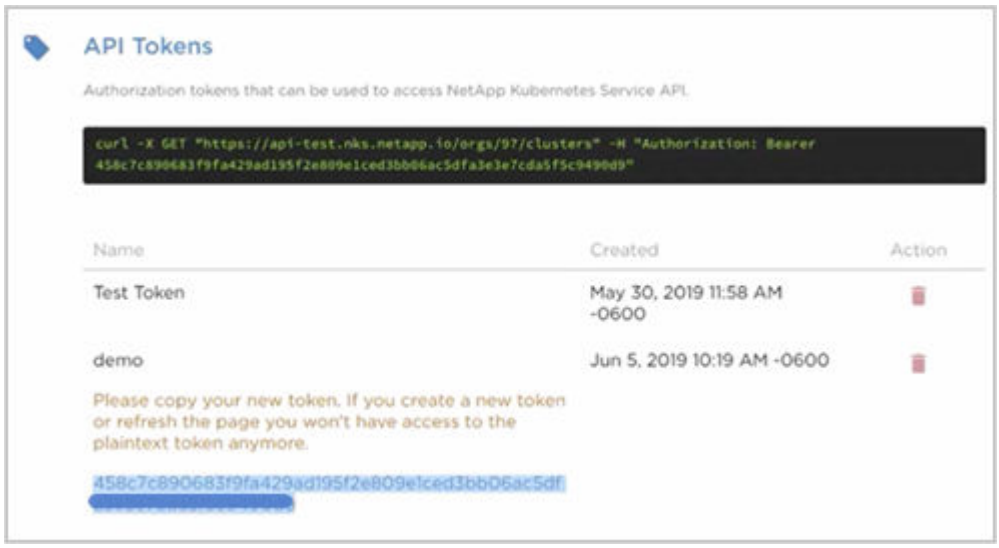
   SERVICES ARE PROVIDED in a TECHNOLOGY PREVIEW mode. You might see a different set of services than those listed above.

6. Click **Continue**.

7. On the Enable Cloud Services > NetApp Cloud Central page, click the **API token** link to get a Kubernetes Service API token if you do not already have one.

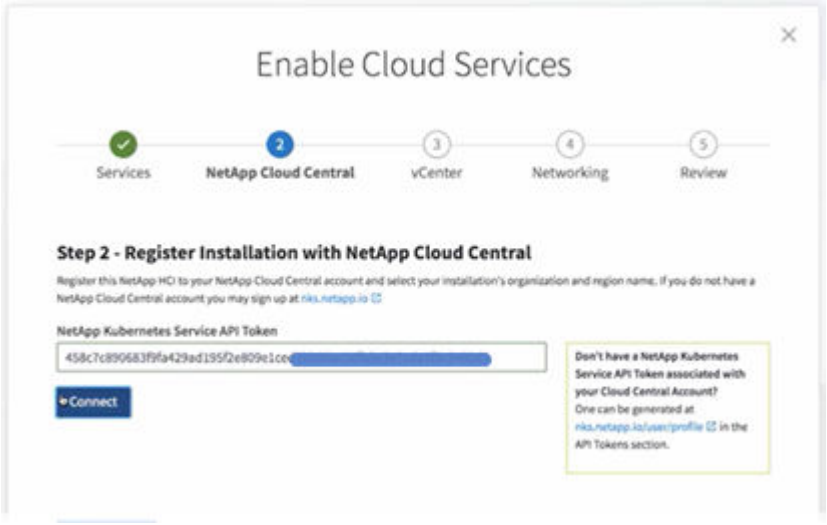
   Enabling cloud services for NetApp HCI requires a NetApp Kubernetes Service API token that is associated with your Cloud Central account. You can complete these steps prior to enabling cloud services or during the process.

   a. Enter a token name and click **Create**.



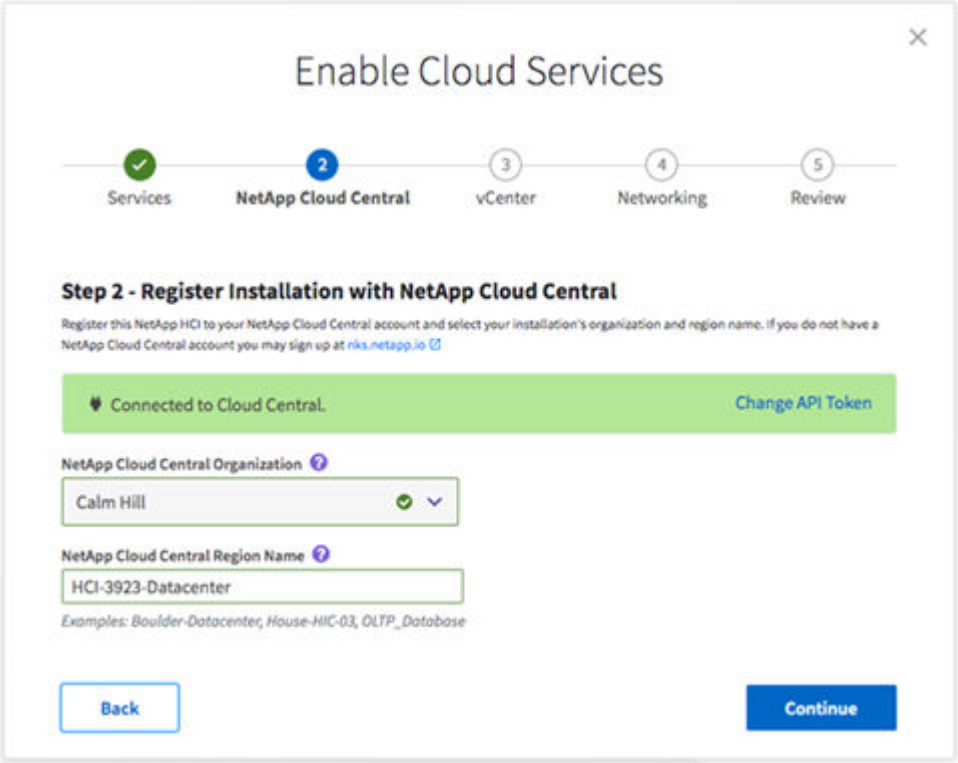
b. Copy the token.

c. Return to NetApp Hybrid Cloud Control and paste it into the NetApp Kubernetes Service API Token field.



d. Click **Connect**.

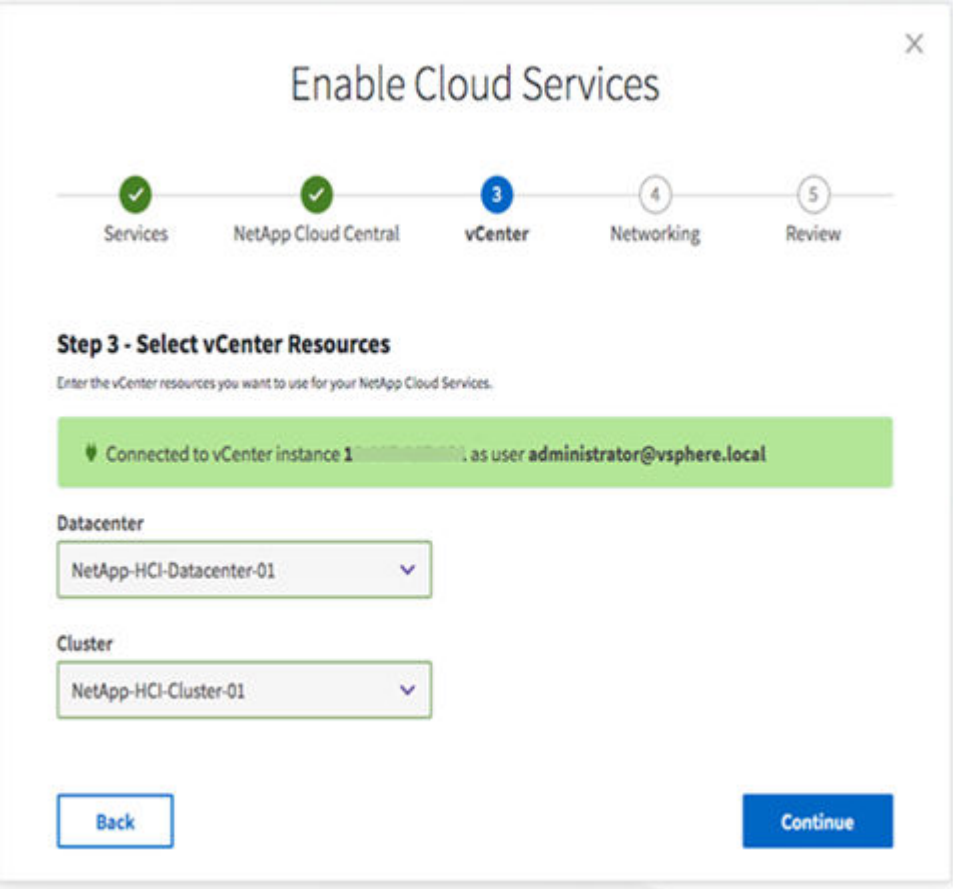
Now, the registration is established and you are connected to Cloud Central. The Organization and Region Name fields appear listing the datacenters and regions available for this Cloud Central connection.



8. Select your Cloud Central organization and region.

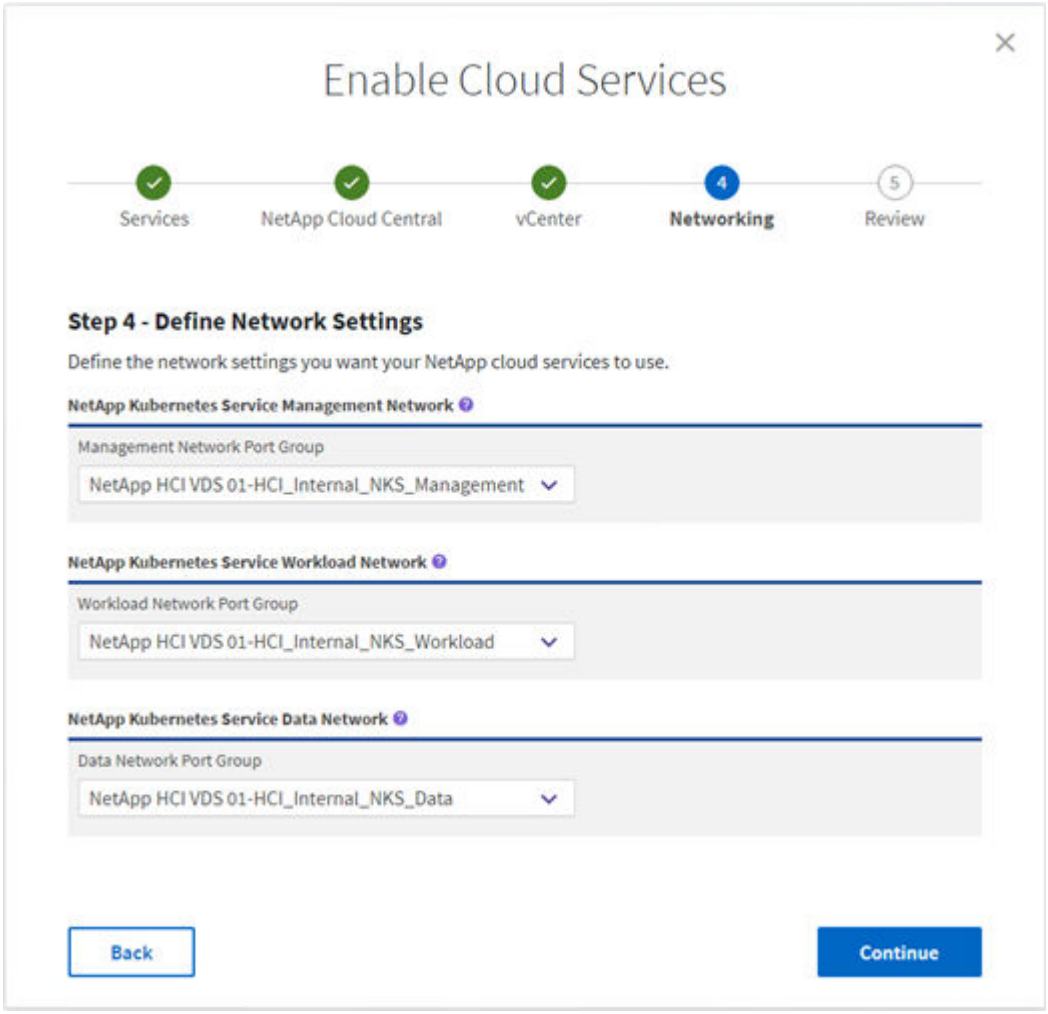
   Note: The region name is used to identify this NetApp HCI installation and is used as the site name for any NetApp Kubernetes Service clusters created on this installation.

9. Click **Continue** to go to the **vCenter Resources** page.



10. On the **vCenter Resources** page, enter or select the following:
    - **Datacenter**: Select a datacenter from those configured on the NetApp HCI system.
    - **Cluster**: Select a cluster from those configured on the NetApp HCI system.

    The vCenter instance and the admin user connected to it are displayed.
11. Click **Continue** to go to the **Networking** page.



12. On the **Networking** page, review the hover text for each field and configure networking information:
    - **NetApp Kubernetes Service Management Network**: Enter IP addresses and information needed for service and workload clusters for the NetApp Kubernetes Service.
    - **NetApp Kubernetes Service Workload Network**: Enter network information needed to support your workload clusters, on which you place your applications. When you create your workload clusters, NetApp Kubernetes Service uses the IP addresses entered here.
    - **NetApp Kubernetes Service Data Network**: Enter network information needed to connect your Kubernetes workload clusters to persistent volume claims (PVCs) on your NetApp HCI system.
13. Click **Continue**.
14. On the **Review** page, review your choices by expanding each option and then click **Continue**.

Result

NetApp HCI cloud services are enabled and the NetApp Hybrid Cloud Control opening page reappears. The Enable NetApp Cloud Services tile on this page shows the number of services enabled. During the process, you can close the window at any time.

NetApp HCI uses the NetApp Kubernetes Service to create a service cluster, which is a Kubernetes cluster that consists of four VMs (one Kubernetes master node and three Kubernetes worker compute nodes).

After you finish

Next, view your Kubernetes service cluster and add workload clusters on your NetApp HCI system by using the NetApp Kubernetes Service.

Viewing the Kubernetes cluster on the NetApp Kubernetes Service

Using the NetApp Kubernetes Service on NetApp Cloud Central, you can view the Kubernetes clusters.

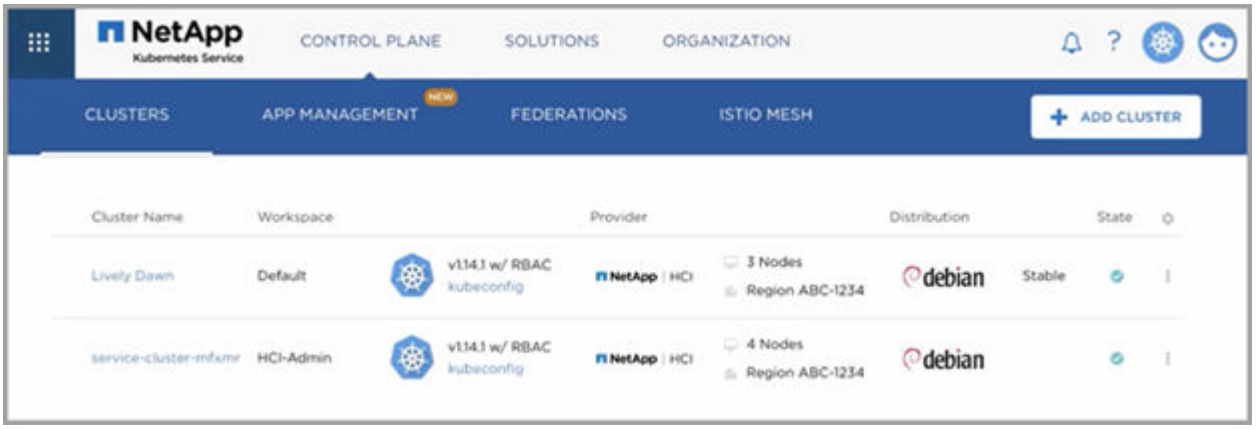
Steps

1. From NetApp Cloud Central, select **Products > NetApp Kubernetes Service**.

   cloud.netapp.com

2. Log in using your Cloud Central credentials.
3. Select **Control Plane > Clusters**.

Result



The Kubernetes service cluster is listed with “NetApp HCI” as the provider.

Creating Kubernetes clusters

After you enable cloud services, you can create Kubernetes workload clusters using the NetApp Kubernetes Service. You want to create clusters on which you can later place pre-designed or your own applications. After you create the clusters, those clusters are ready to accept application workloads.

About this task

You create Kubernetes clusters, add them to a workspace, create a project within that workspace, and later add a solution to the project.

Steps

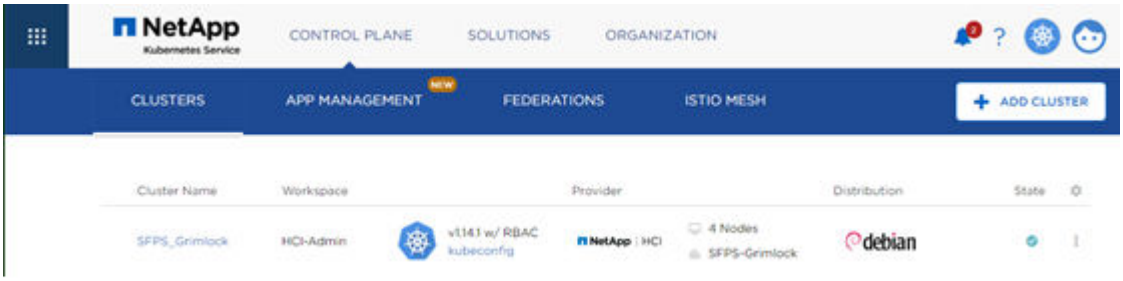
1. From NetApp Cloud Central, select **Products > NetApp Kubernetes Service**.

   cloud.netapp.com

2. Log in using your Cloud Central credentials.

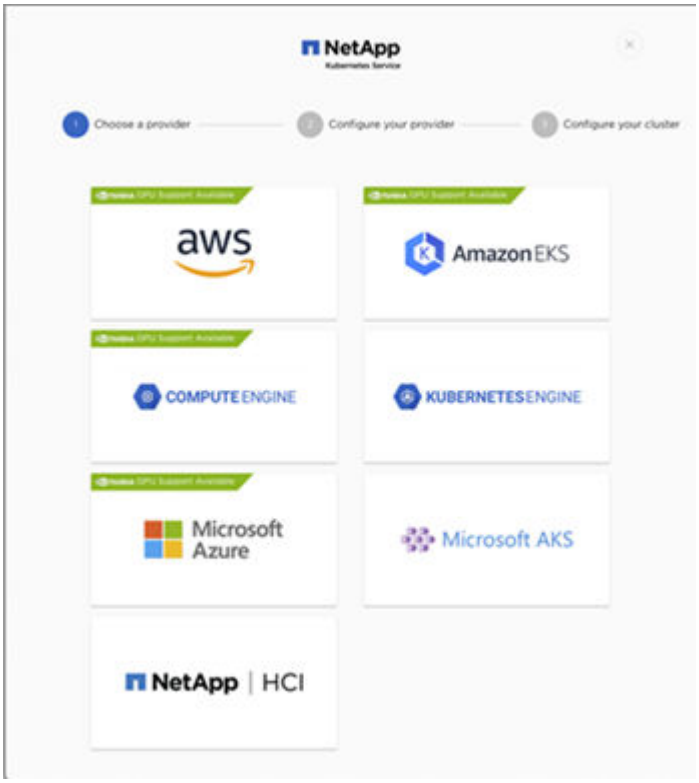
3. Click **Organizations** and choose your organization.

4. Click **Control Plane**.

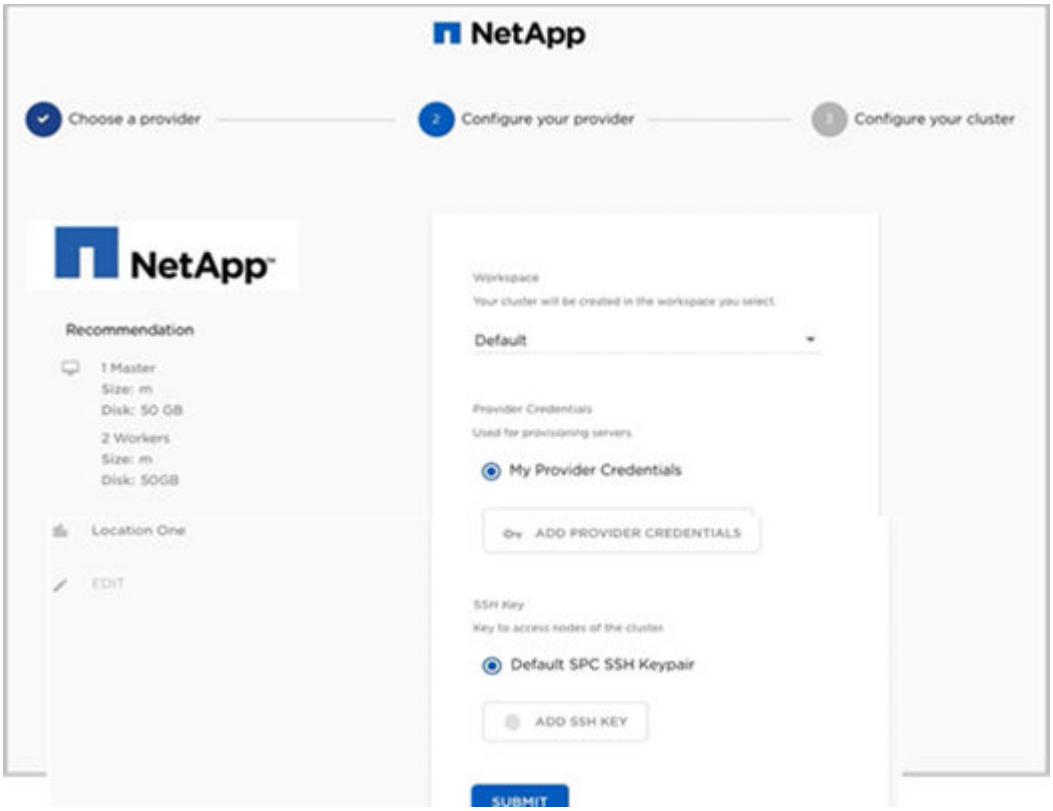


5. Click **Add Cluster**.

   A list of providers appears, including **NetApp HCI**.



6. Choose **NetApp HCI** as the provider.



7. Configure your provider. Select the region, the workspace in which the cluster will be located, and SSH key pair for the cluster.
8. To edit any of the default values for the cluster nodes, click **Edit** and customize the number, size, and disk space allotted to the cluster nodes. If there is more than one NetApp HCI installation in the organization, you can select additional systems.
9. Click **Submit** to configure your cluster.
10. Configure your Kubernetes cluster by entering the cluster name and typically by using the default settings.
11. Click **Submit**.

    NetApp Kubernetes Service creates the Kubernetes cluster and displays it on the Clusters page.

After you finish

Next, create a project within the workspace you specified when creating the cluster so that you can later add applications or solutions to the project.

Creating a project within a NetApp Kubernetes Service workspace

When you create Kubernetes workload clusters, you select a workspace in the NetApp Kubernetes Service. You can create a project within that workspace and later add a solution to the project.

About this task

Steps

1. From NetApp Cloud Central, select **Products > NetApp Kubernetes Service**.

   cloud.netapp.com

2. Log in using your Cloud Central credentials.
3. Click **Organization**.
4. To add a team, to which you can later add to your workspace, click **Teams**, click **Add Team**, add a team name, select members, and click **Submit**.
5. To add a workspace, to which you can later add projects, click **Workspaces**, click **Add Workspace**, add a workspace name, select teams, and click **Submit**.

After you finish

Next, you can add applications or solutions to the cluster or project.

Adding applications to your Kubernetes cluster

After you create your Kubernetes workload cluster, you can easily add any number of applications to that cluster. Using this feature, you gain tremendous efficiency of spinning up or down applications as needed.

About this task

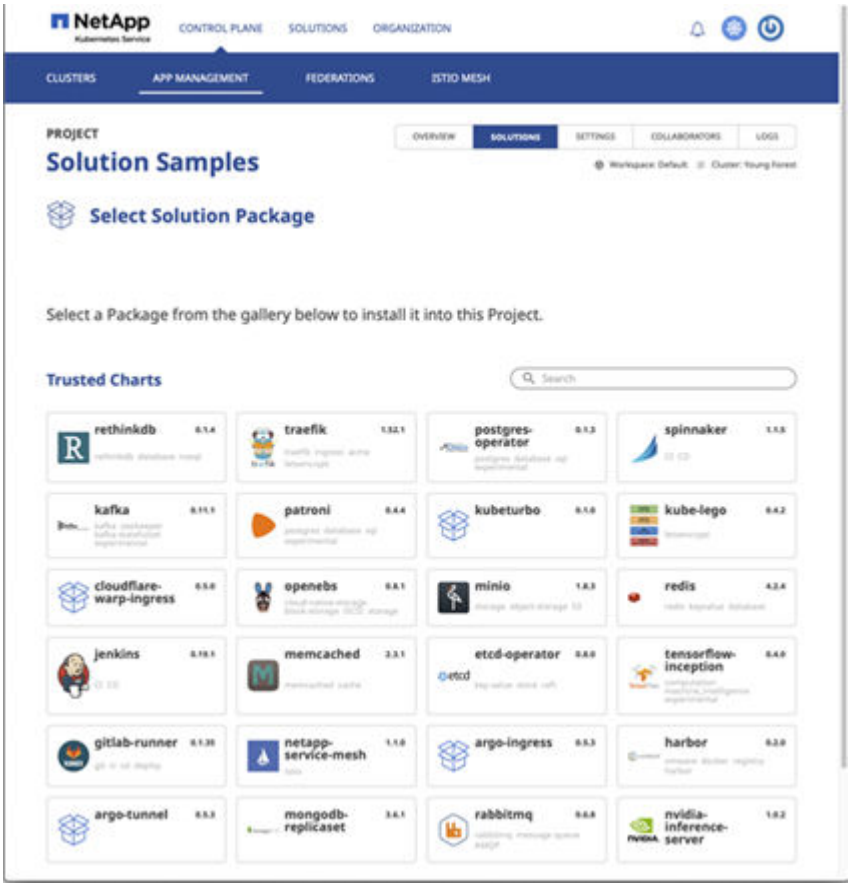
You can deploy applications on the cluster that resides on NetApp HCI by using the NetApp Kubernetes Service.

Steps

1. From NetApp Cloud Central, select **Products > NetApp Kubernetes Service**.

   cloud.netapp.com

2. To add an application to your existing Kubernetes cluster, click **Solutions**.



Converting your trial license to a production license

When you first enable cloud services on NetApp HCI, the installation process configures a 90-day trial license. After that time elapses, you must convert the trial license to a production license for continued use.

About this task

Information about your license appears in the NetApp Hybrid Cloud Control banner.

You can upload the NetApp license file (.nlf file) via NetApp Hybrid Cloud Control.

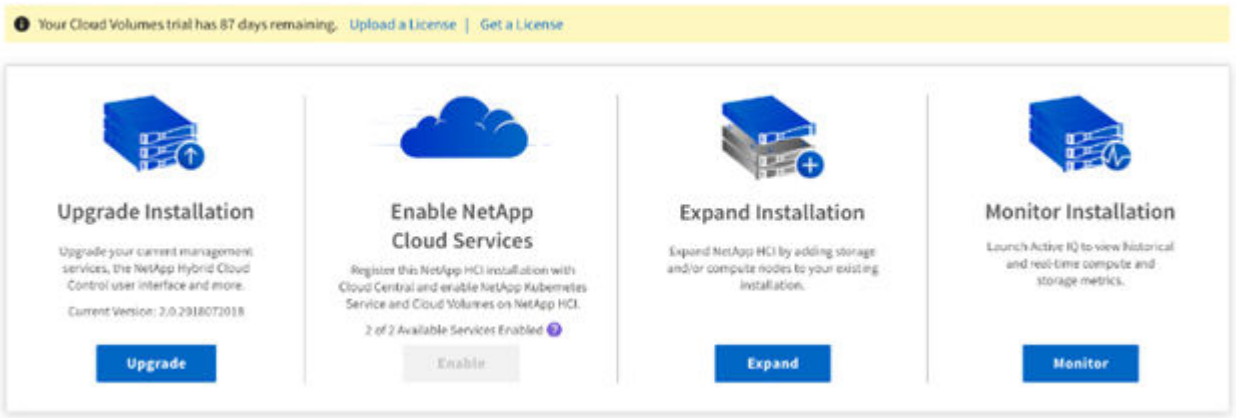
Steps

1. Access NetApp Hybrid Cloud Control by opening a web browser and browsing to the IP address of the management node.

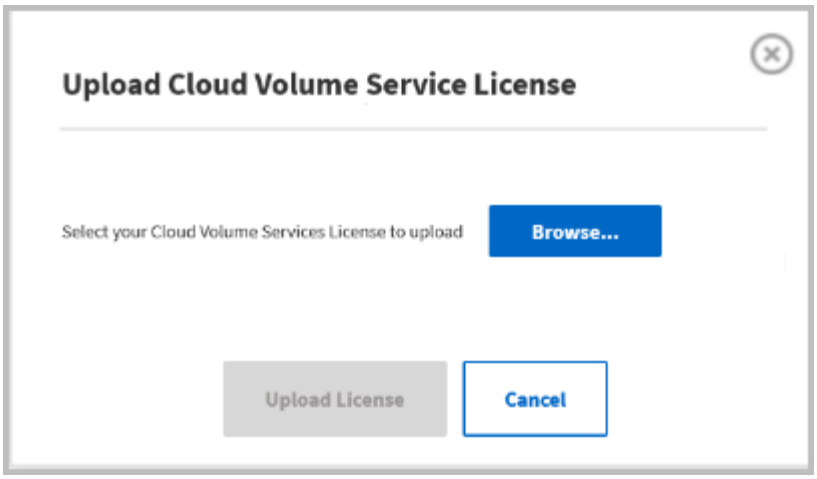
   ```
   https://<ManagementNodeIP
   ```

   For details, see accessing NetApp Hybrid Cloud Control information.

   Accessing NetApp Hybrid Cloud Control on page 37



2. From the NetApp Hybrid Cloud Control banner, click the **Upload a License** link.



3. Browse to locate your license file and click **Upload License**.

Result

The updated license information is displayed in the NetApp Hybrid Cloud Control banner.

Creating cloud volumes with NetApp Fabric Orchestrator

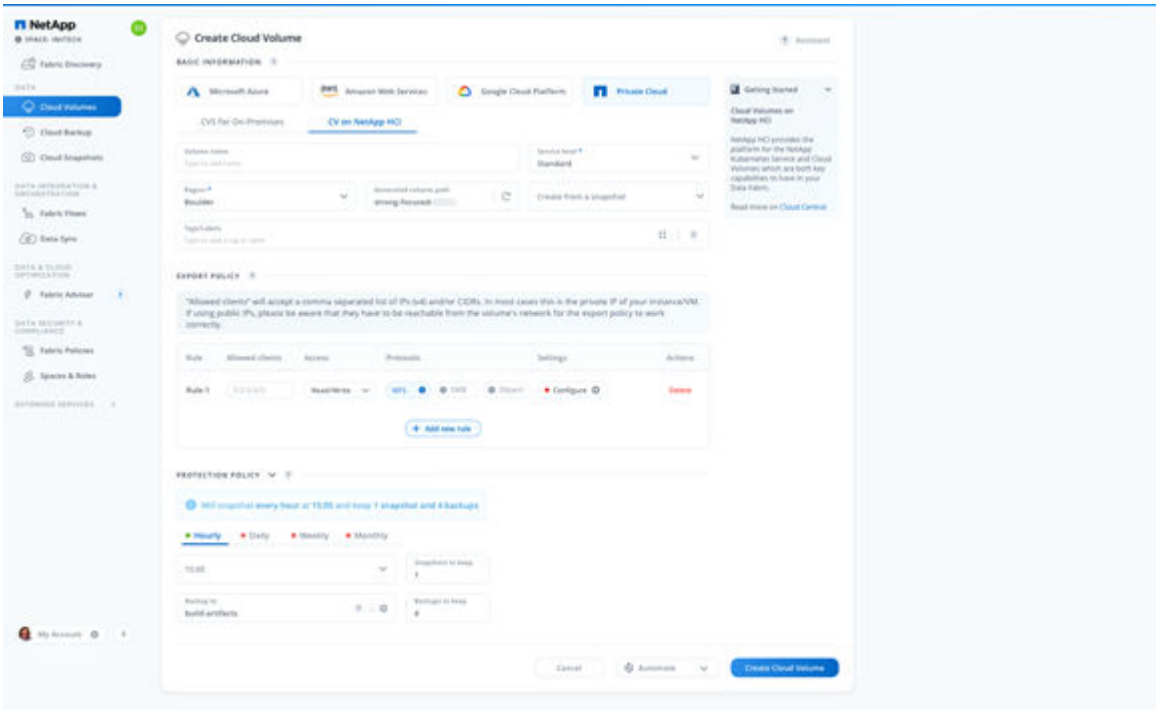
You can create cloud volumes on the Kubernetes cluster by using another cloud service, the NetApp Fabric Orchestrator.

Steps

1. From NetApp Cloud Central, select **Products > NetApp Fabric Orchestrator**.

   cloud.netapp.com

2. Click **Create Cloud Volumes**.



3. On the **Create Cloud Volumes** page, enter or select the following:
   a. Choose **NetApp Private Cloud** as the provider.
   b. On the **NetApp HCI** tab, select the cloud volume.
   c. Select the service level and region.
   d. Enter any tags or labels.
   e. Edit the export policy and protection policy.
4. Click **Create Cloud Volumes**.

Expanding your NetApp HCI installation

After deployment, you can expand NetApp HCI storage and compute resources either separately or at the same time. After installing the node in the NetApp HCI chassis, you use NetApp Hybrid Cloud Control to configure NetApp HCI to utilize the new resources. NetApp HCI detects the existing network configuration and offers you configuration options within the existing networks and VLANs, if any.

Note that NetApp HCI uses VMware Enhanced vMotion Compatibility (EVC) to ensure vMotion functionality when there are compute nodes with different CPU generations in the vSphere cluster. When EVC is required for expansion, NetApp HCI enables it automatically whenever possible. In the following situations, you might need to manually change EVC settings in the vSphere client to complete expansion:

- The existing compute nodes have a newer CPU generation than the compute nodes you are trying to add.
- The controlling vCenter instance does not support the required EVC level.
- The compute nodes you are trying to add have an older CPU generation than the EVC setting of the controlling vCenter instance.

If you install a new vCenter Server, you can install a vSphere standard switch or a vSphere distributed switch (VDS) during network configuration. A VDS enables a simplified, centralized management of virtual machine network configuration after NetApp HCI deployment.

Expanding NetApp HCI storage resources

After deployment, you can expand and configure NetApp HCI storage resources using NetApp Hybrid Cloud Control.

Before you begin

- You have free and unused IPv4 addresses on the same network segment as existing nodes (each new node must be installed on the same network as existing nodes of its type).
- You have one of the following types of SolidFire storage cluster accounts:
  - The native Administrator account that was created during initial deployment
  - A custom user account with Cluster Admin, Drives, Volumes, and Nodes permissions
- You have performed the following actions with each new node:
  - Installed the new node in the NetApp HCI chassis by following the installation and setup instructions available in the NetApp HCI Documentation Center
  - Cabled and powered on the new node
- You have the management IPv4 address of an already installed storage node. You can find the IP address in the **NetApp Element Management** > **Cluster** > **Nodes** tab of the NetApp Element Plug-in for vCenter Server.
- Each new node uses the same network topology and cabling as the existing storage or compute clusters.

Tip: When expanding storage resources, storage capacity should be split evenly across all chassis for the best reliability.

Steps

1. Open a web browser and browse to the IP address of the management node. For example:

   ```
   https://<ManagementNodeIP>/manager/login
   ```

2. Log in to NetApp Hybrid Cloud Control by providing the NetApp HCI storage cluster administrator credentials.
3. In the **Expand Installation** pane, Click **Expand**.

   The browser opens the NetApp Deployment Engine.

4. Log in to the NetApp Deployment Engine by providing the NetApp HCI storage cluster administrator credentials.
5. On the **Welcome** page, select **No**.
6. Click **Continue**.
7. On the **Available Inventory** page, select the storage nodes you want to add to the existing NetApp HCI installation.
8. Click **Continue**.
9. On the **Network Settings** page, some of the network information has been detected from the initial deployment. Each new storage node is listed by serial number, and you need to assign new network information to it. For each new storage node, perform the following steps:

   a. If NetApp HCI detected a naming prefix, copy it from the **Detected Naming Prefix** field, and insert it as the prefix for the new unique hostname you add in the **Hostname** field.

   b. In the **Management IP Address** field, enter a management IP address for the new storage node that is within the management network subnet.

   c. In the **Storage (iSCSI) IP Address** field, enter an iSCSI IP address for the new storage node that is within the iSCSI network subnet.

   d. Click **Continue**.

      Note: NetApp HCI might take some time to validate the IP addresses you enter. The **Continue** button becomes available when IP address validation is complete.

10. On the **Review** page in the **Network Settings** section, new nodes are shown in bold text. If you need to make changes to information in any section, perform the following steps:

    a. Click **Edit** for that section.

    b. When finished making changes, click **Continue** on any subsequent pages to return to the **Review** page.

11. Optional: If you do not want to send cluster statistics and support information to NetApp-hosted Active IQ servers, clear the final checkbox.

    This disables real-time health and diagnostic monitoring for NetApp HCI. Disabling this feature removes the ability for NetApp to proactively support and monitor NetApp HCI to detect and resolve problems before production is affected.

12. Click **Add Nodes**.

    You can monitor the progress while NetApp HCI adds and configures the resources.

13. Optional: Verify that any new storage nodes are visible in the VMware vSphere Web Client.

Expanding NetApp HCI compute resources

After deployment, you can expand and configure NetApp HCI compute resources using NetApp Hybrid Cloud Control.

Before you begin

- Ensure that the vSphere instance NetApp HCI is using has vSphere Enterprise Plus licensing if you are expanding a deployment with Virtual Distributed Switches.
- Ensure that none of the vCenter or vSphere instances in use with NetApp HCI have expired licenses.
- Ensure that you have free and unused IPv4 addresses on the same network segment as existing nodes (each new node must be installed on the same network as existing nodes of its type).
- Ensure that you have the vCenter administrator account credentials ready.
- Ensure that you have performed the following actions with each new node:
  - Installed the new node in the NetApp HCI chassis by following the installation and setup instructions available in the NetApp HCI Documentation Center
  - Cabled and powered on the new node
- Ensure that each new node uses the same network topology and cabling as the existing storage or compute clusters.

Steps

1. Open a web browser and browse to the IP address of the management node. For example:

   ```
   https://<ManagementNodeIP>/manager/login
   ```

2. Log in to NetApp Hybrid Cloud Control by providing the NetApp HCI storage cluster administrator credentials.
3. In the **Expand Installation** pane, Click **Expand**.

   The browser opens the NetApp Deployment Engine.
4. Log in to the NetApp Deployment Engine by providing the NetApp HCI storage cluster administrator credentials.
5. On the **Welcome** page, select **Yes**.
6. On the **End User License** page, perform the following actions:
   a. Read the VMware End User License Agreement.
   b. If you accept the terms, click **I accept** at the end of the agreement text.
7. Click **Continue**.
8. On the **vCenter** page, perform the following steps:
   a. Enter a FQDN or IP address and administrator credentials for the vCenter instance associated with your NetApp HCI installation.
   b. Click **Continue**.

c. Select an existing vSphere datacenter to which to add the new compute nodes, or select **Create New Datacenter** to add the new compute nodes to a new datacenter.

Note: If you select **Create New Datacenter**, the **Cluster** field is automatically populated.

d. If you selected an existing datacenter, select a vSphere cluster with which the new compute nodes should be associated.

Note:

If the NetApp HCI cannot recognize the network settings of the cluster you have selected for expansion, ensure that the vmkernel and vmnic mapping for the management, storage and vMotion networks are set to the deployment defaults. See *Supported networking changes* for more information.

e. Click **Continue**.

9. On the **ESXi Credentials** page, enter an ESXi root password for the compute node or nodes you are adding.

You should use the same password that was created during the initial NetApp HCI deployment.

10. Click **Continue**.

11. If you created a new vSphere datacenter cluster, on the **Network Topology** page, select a network topology to match the new compute nodes you are adding.

Note: You can only select the two-cable option if your compute nodes are using the two-cable topology and the existing NetApp HCI deployment is configured with VLAN IDs.

12. On the **Available Inventory** page, select the nodes you want to add to the existing NetApp HCI installation.

Important: For some compute nodes, you might need to enable EVC at the highest level your vCenter version supports before you can add them to your installation. You need to use the vSphere client to enable EVC for these compute nodes. After you enable it, refresh the **Inventory** page and try adding the compute nodes again.

13. Click **Continue**.

14. Optional: If you created a new vSphere datacenter cluster, on the **Network Settings** page, import network information from an existing NetApp HCI deployment by selecting the **Copy Setting from an Existing Cluster** checkbox.

This populates the default gateway and subnet information for each network.

15. On the **Network Settings** page, some of the network information has been detected from the initial deployment. Each new compute node is listed by serial number, and you need to assign new network information to it. For each new compute node, perform the following steps:

a. If NetApp HCI detected a naming prefix, copy it from the **Detected Naming Prefix** field, and insert it as the prefix for the new unique hostname you add in the **Hostname** field.

b. In the **Management IP Address** field, enter a management IP address for the compute node that is within the management network subnet.

c. In the **vMotion IP Address** field, enter a vMotion IP address for the compute node that is within the vMotion network subnet.

d. In the **iSCSI A - IP Address** field, enter an IP address for the first iSCSI port of the compute node that is within the iSCSI network subnet.

e. In the **iSCSI B - IP Address** field, enter an IP address for the second iSCSI port of the compute node that is within the iSCSI network subnet.

16. Click **Continue**.
17. On the **Review** page in the **Network Settings** section, new nodes are shown in bold text. If you need to make changes to information in any section, perform the following steps:

    a. Click **Edit** for that section.

    b. When finished making changes, click **Continue** on any subsequent pages to return to the **Review** page.

18. Optional: If you do not want to send cluster statistics and support information to NetApp-hosted SolidFire Active IQ servers, clear the final checkbox.

    This disables real-time health and diagnostic monitoring for NetApp HCI. Disabling this feature removes the ability for NetApp to proactively support and monitor NetApp HCI to detect and resolve problems before production is affected.

19. Click **Add Nodes**.

    You can monitor the progress while NetApp HCI adds and configures the resources.

20. Optional: Verify that any new compute nodes are visible in vCenter.

Related concepts

Supported networking changes on page 32

Related information

NetApp HCI Compute and Storage Nodes Installation and Setup Instructions
VMware Knowledge Base: Enhanced vMotion Compatibility (EVC) processor support

Expanding NetApp HCI storage and compute resources at the same time

After deployment, you can expand and configure NetApp HCI compute and storage resources at the same time using NetApp Hybrid Cloud Control.

Before you begin

- Ensure that the vSphere instance NetApp HCI is using has vSphere Enterprise Plus licensing if you are expanding a deployment with Virtual Distributed Switches.
- Ensure that none of the vCenter or vSphere instances in use with NetApp HCI have expired licenses.
- Ensure that you have free and unused IPv4 addresses on the same network segment as existing nodes (each new node must be installed on the same network as existing nodes of its type).
- Ensure that you have the vCenter administrator account credentials ready.
- Ensure that you have one of the following types of SolidFire storage cluster accounts:
  - The native Administrator account that was created during initial deployment
  - A custom user account with Cluster Admin, Drives, Volumes, and Nodes permissions
- Ensure that you have performed the following actions with each new node:

  - Installed the new node in the NetApp HCI chassis by following the installation and setup instructions available in the NetApp HCI Documentation Center
  - Cabled and powered on the new node
- Ensure that each new node uses the same network topology and cabling as the existing storage or compute clusters.

About this task

Note:

- You can intermix the H410C compute node with existing NetApp HCI compute and storage nodes in the same chassis and cluster.
- You cannot intermix compute nodes and GPU-enabled compute nodes in the same cluster. If you select a GPU-enabled compute node, CPU-only compute nodes become unselectable, and vice versa.
- If you are adding compute nodes with CPU generations that are different than the CPU generation of the existing compute nodes and Enhanced vMotion Compatibility (EVC) is disabled on the controlling vCenter instance, you must enable EVC before proceeding. This ensures vMotion functionality after expansion is complete.

Steps

1. Open a web browser and browse to the IP address of the management node. For example:

   ```
   https://<ManagementNodeIP>/manager/login
   ```

2. Log in to NetApp Hybrid Cloud Control by providing the NetApp HCI storage cluster administrator credentials.
3. In the **Expand Installation** pane, Click **Expand**.

   The browser opens the NetApp Deployment Engine.
4. Log in to the NetApp Deployment Engine by providing the NetApp HCI storage cluster administrator credentials.
5. On the **Welcome** page, select **Yes**.
6. On the **End User License** page, perform the following actions:
   a. Read the VMware End User License Agreement.
   b. If you accept the terms, click **I accept** at the end of the agreement text.
7. Click **Continue**.
8. On the **vCenter** page, perform the following steps:
   a. Enter a FQDN or IP address and administrator credentials for the vCenter instance associated with your NetApp HCI installation.
   b. Click **Continue**.
   c. Select an existing vSphere datacenter to which to add the new compute nodes, or select **Create New Datacenter** to add the new compute nodes to a new datacenter.

      Note: If you select **Create New Datacenter**, the **Cluster** field is automatically populated.

d. If you selected an existing datacenter, select a vSphere cluster with which the new compute nodes should be associated.

Note:

If the NetApp HCI cannot recognize the network settings of the cluster you have selected for expansion, ensure that the vmkernel and vmnic mapping for the management, storage and vMotion networks are set to the deployment defaults. See *Supported networking changes* for more information.

e. Click **Continue**.

9. On the **ESXi Credentials** page, enter an ESXi root password for the compute node or nodes you are adding.

You should use the same password that was created during the initial NetApp HCI deployment.

10. Click **Continue**.

11. If you created a new vSphere datacenter cluster, on the **Network Topology** page, select a network topology to match the new compute nodes you are adding.

Note: You can only select the two-cable option if your compute nodes are using the two-cable topology and the existing NetApp HCI deployment is configured with VLAN IDs.

12. On the **Available Inventory** page, select the storage and compute nodes you want to add to the existing NetApp HCI installation.

Important: For some compute nodes, you might need to enable EVC at the highest level your vCenter version supports before you can add them to your installation. You need to use the vSphere client to enable EVC for these compute nodes. After you enable it, refresh the **Inventory** page and try adding the compute nodes again.

13. Click **Continue**.

14. Optional: If you created a new vSphere datacenter cluster, on the **Network Settings** page, import network information from an existing NetApp HCI deployment by selecting the **Copy Setting from an Existing Cluster** checkbox.

This populates the default gateway and subnet information for each network.

15. On the **Network Settings** page, some of the network information has been detected from the initial deployment. Each new node is listed by serial number, and you need to assign new network information to it. For each node listed, perform the following steps:

a. If NetApp HCI detected a naming prefix, copy it from the **Detected Naming Prefix** field, and insert it as the prefix for the new unique hostname you add in the **Hostname** field.

b. In the **Management IP Address** field, enter a management IP address for the node that is within the management network subnet.

c. In the **vMotion IP Address** field, enter a vMotion IP address for the node that is within the vMotion network subnet.

d. In the **iSCSI A - IP Address** field, enter an IP address for the first iSCSI port of the node that is within the iSCSI network subnet.

e. In the **iSCSI B - IP Address** field, enter an IP address for the second iSCSI port of the node that is within the iSCSI network subnet.

16. Click **Continue**.

17. On the **Review** page in the **Network Settings** section, new nodes are shown in bold text. If you need to make changes to information in any section, perform the following steps:

    a. Click **Edit** for that section.

    b. When finished making changes, click **Continue** on any subsequent pages to return to the **Review** page.

18. Optional: If you do not want to send cluster statistics and support information to NetApp-hosted SolidFire Active IQ servers, clear the final checkbox.

    This disables real-time health and diagnostic monitoring for NetApp HCI. Disabling this feature removes the ability for NetApp to proactively support and monitor NetApp HCI to detect and resolve problems before production is affected.

19. Click **Add Nodes**.

    You can monitor the progress while NetApp HCI adds and configures the resources.

20. Optional: Verify that the new nodes are visible in vCenter (for compute nodes) or the Element Plug-in for vCenter Server (for storage nodes).

Related concepts

Supported networking changes on page 32

Related information

NetApp HCI Compute and Storage Nodes Installation and Setup Instructions
VMware Knowledge Base: Enhanced vMotion Compatibility (EVC) processor support

Monitoring your NetApp HCI installation

By default, NetApp HCI sends performance and alert statistics to the NetApp SolidFire Active IQ service. As part of your normal support contract, NetApp Support monitors this data and alerts you to any performance bottlenecks or potential system issues. You need to create a NetApp Support account if you do not already have one (even if you have an existing NetApp SolidFire Active IQ account) so that you can take advantage of this service.

Steps

1. Open a web browser and browse to the IP address of the management node. For example:

   ```
   https://<ManagementNodeIP>/manager/login
   ```

2. Log in to NetApp Hybrid Cloud Control by providing the NetApp HCI storage cluster administrator credentials.

3. Click **Monitor**.

   The browser opens the NetApp SolidFire Active IQ interface at *https://activeiq.solidfire.com*.

4. Do one of the following:

Scenario	Steps
You do not have a NetApp Support account (or you currently have an existing NetApp SolidFire Active IQ account)	**a.** Click **Sign up now**. The NetApp Support account registration pages appear. **b.** Follow the instructions on these pages to register for a NetApp Support account. **c.** After your account is activated, reopen the *https://activeiq.solidfire.com* login page and proceed with the steps in the following option.
You have an existing NetApp Support account (or have just created an account)	**a.** On the login page that appears, log in with your NetApp Support credentials. **b.** When you are logged in, the Dashboard appears and you can monitor your NetApp HCI installation usage statistics. **c.** See the online help documentation within the NetApp SolidFire Active IQ interface.

5. After you log in and can see the Active IQ interface, verify that the NetApp HCI compute and storage nodes are reporting telemetry correctly to Active IQ:

   a. If you have more than one NetApp HCI installation, click **Select a Cluster** and choose the correct cluster from the list.

   b. In the left-hand navigation pane, click **Nodes**.

   c. Click Storage or Compute to see a list of all storage or compute nodes that are properly reporting data to Active IQ from this installation.

6. If a node or nodes are missing from the list, contact NetApp Support.

Contacting NetApp Support

If you need help with or have questions or comments about NetApp products, contact NetApp Support.

- Web:
  mysupport.netapp.com
- Phone:
  - 888.4.NETAPP (888.463.8277) (US and Canada)
  - 00.800.44.638277 (EMEA/Europe)
  - +800.800.80.800 (Asia/Pacific)

Where to find product documentation and other information

You can learn more about using and managing NetApp HCI and SolidFire all-flash storage from the resources available in the Documentation Centers and Resources pages for both products.

In the Documentation Centers, you can also find information about hardware installation and maintenance, additional content resources available, links to known issues and resolved issues, and the latest release notes. On the Resources pages, you can find links to data sheets, technical reports, white papers, and videos.

- *NetApp HCI Documentation Center*
- *NetApp HCI Resources page*
- *SolidFire and Element 11.3 Documentation Center*
- *SolidFire Resources page*

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doccomments@netapp.com

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You can also contact us in the following ways:

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