FlexPod Datacenter using IaC with Cisco UCSM M6, VMware vSphere 8, and NetApp ONTAP 9.12.1

Deployment Guide for FlexPod Datacenter using IaC with Cisco UCSM M6, VMware vSphere 8, and NetApp ONTAP 9.12.1

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Executive Summary

The FlexPod Datacenter solution is a validated approach for deploying Cisco and NetApp technologies and products to build shared private and public cloud infrastructure. Cisco and NetApp have partnered to deliver a series of FlexPod solutions that enable strategic data-center platforms. The success of the FlexPod solution is driven through its ability to evolve and incorporate both technology and product innovations in the areas of management, compute, storage, and networking. This document explains the design details of incorporating the Cisco UCS B and C-Series M6 servers in UCS Managed Mode, NetApp ONTAP 9.12.1, and VMware vSphere 8.0 into FlexPod Datacenter and the ability to monitor and manage FlexPod components from the cloud using Cisco Intersight. Some of the key advantages of integrating these components into the FlexPod infrastructure are:

- **Simpler and programmable infrastructure:** infrastructure as code delivered through a single partner integrable open API.
- **Latest Software Feature Support with Cisco UCS M6:** demonstrating the latest features of NetApp ONTAP 9.12.1 and VMware vSphere 8.0 with the Cisco UCS B and C-Series servers.
- **Introduction of the Cisco UCS 5th Generation Virtual Interface Cards (VICs) with Cisco UCS M6:** validating the Cisco UCS VIC 15411 in the Cisco UCS B200 M6, and the Cisco UCS VIC 15238 and 15428 in the Cisco UCS C220 M6.
- **Extend the capabilities of current investments:** get more capabilities out of existing Cisco UCS and NetApp hardware with the support of VMware vSphere 8.0 and NetApp ONTAP 9.12.1.

In addition to the compute-specific hardware and software innovations, the integration of the Cisco Intersight cloud platform with VMware vCenter and NetApp Active IQ Unified Manager delivers monitoring, orchestration, and workload optimization capabilities for different layers (virtualization and storage) of the FlexPod infrastructure. The modular nature of the Cisco Intersight platform also provides an easy upgrade path to additional services, such as workload optimization.

If you're interested in understanding the FlexPod design and deployment details, including the configuration of various elements of design and associated best practices, refer to Cisco Validated Designs for FlexPod, here: https://www.cisco.com/c/en/us/solutions/design-zone/data-center-design-guides/flexpod-design-guides.html
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Solution Overview

This chapter contains the following:

Introduction

The Cisco Unified Computing System (Cisco UCS) with UCS Managed Mode is a modular compute system, configured and managed from Cisco UCS Manager on Cisco UCS fabric Interconnects. It is designed to meet the needs of modern applications and to improve operational efficiency, agility, and scale through an adaptable, future-ready, modular design. The Cisco UCS Manager platform delivers simplified configuration, deployment, maintenance, and support.

Audience

The intended audience of this document includes but is not limited to IT architects, sales engineers, field consultants, professional services, IT managers, partner engineering, and customers who want to take advantage of an infrastructure built to deliver IT efficiency and enable IT innovation.

Purpose of this Document

This document provides deployment guidance using Ansible playbooks around incorporating the Cisco UCS Manager (UCSM) managed Cisco UCS M6 B-Series and C-Series platforms within the FlexPod Datacenter infrastructure. The document explains both configurations and best practices for a successful deployment. This deployment guide also highlights integration of VMware vCenter and NetApp Active IQ Unified Manager to Cisco Intersight to deliver a true cloud-based integrated approach to infrastructure management.

What's New in this Release?

The following design elements distinguish this version of FlexPod from previous models:

- Integration of the Cisco UCS 5th Generation VIC 15411 in Cisco UCS B200 M6 and the Cisco UCS 5th Generation VIC 15238 and 15428 in Cisco UCS C220 M6 into FlexPod Datacenter
- An integrated, more complete end-to-end Infrastructure as Code (IaC) Day 0 configuration of the FlexPod Infrastructure utilizing Ansible Scripts
- VMware vSphere 8.0
- Continued Integration with Cisco Intersight

Deployment Hardware and Software

This chapter contains the following:

Design Requirements

The FlexPod Datacenter with Cisco UCS and Cisco Intersight meets the following general design requirements:

- Resilient design across all layers of the infrastructure with no single point of failure
- Scalable design with the flexibility to add compute capacity, storage, or network bandwidth as needed
- Modular design that can be replicated to expand and grow as the needs of the business grow
- Flexible design that can support different models of various components with ease
- Simplified design with ability to integrate and automate with external automation tools
- Cloud-enabled design which can be configured, managed, and orchestrated from the cloud using GUI or APIs

To deliver a solution which meets all these design requirements, various solution components are connected and configured as covered in the upcoming sections.

Physical Topology

The FlexPod Datacenter solution with Cisco UCS M6, VMware 8.0, and NetApp ONTAP 9.12.1 is built using the following hardware components:

- Cisco UCS 5108 Chassis with Cisco UCS 2408 IO Modules (IOMs) and up to eight Cisco UCS B200 M6 Compute Nodes with 3rd Generation Intel Xeon Scalable CPUs
- Fourth-generation Cisco UCS 6454 Fabric Interconnects to support 100GbE, 25GbE, and 32GFC connectivity from various components
- Cisco UCS C220 M6 and C240 M6 rack mount servers with 3rd Generation Intel Xeon Scalable CPUs
- High-speed Cisco NX-OS-based Nexus 93180YC-FX switching design to support up to 100GE and 32GFC connectivity
- NetApp AFF A400 end-to-end NVMe storage with 25G or 100G Ethernet and (optional) 32G Fibre Channel connectivity
- Cisco MDS 9132T* switches to support Fibre Channel storage configuration

Note: * Cisco MDS 9132T and FC connectivity is not needed when implementing IP-based connectivity design supporting iSCSI boot from SAN, NFS, and NVMe-TCP.

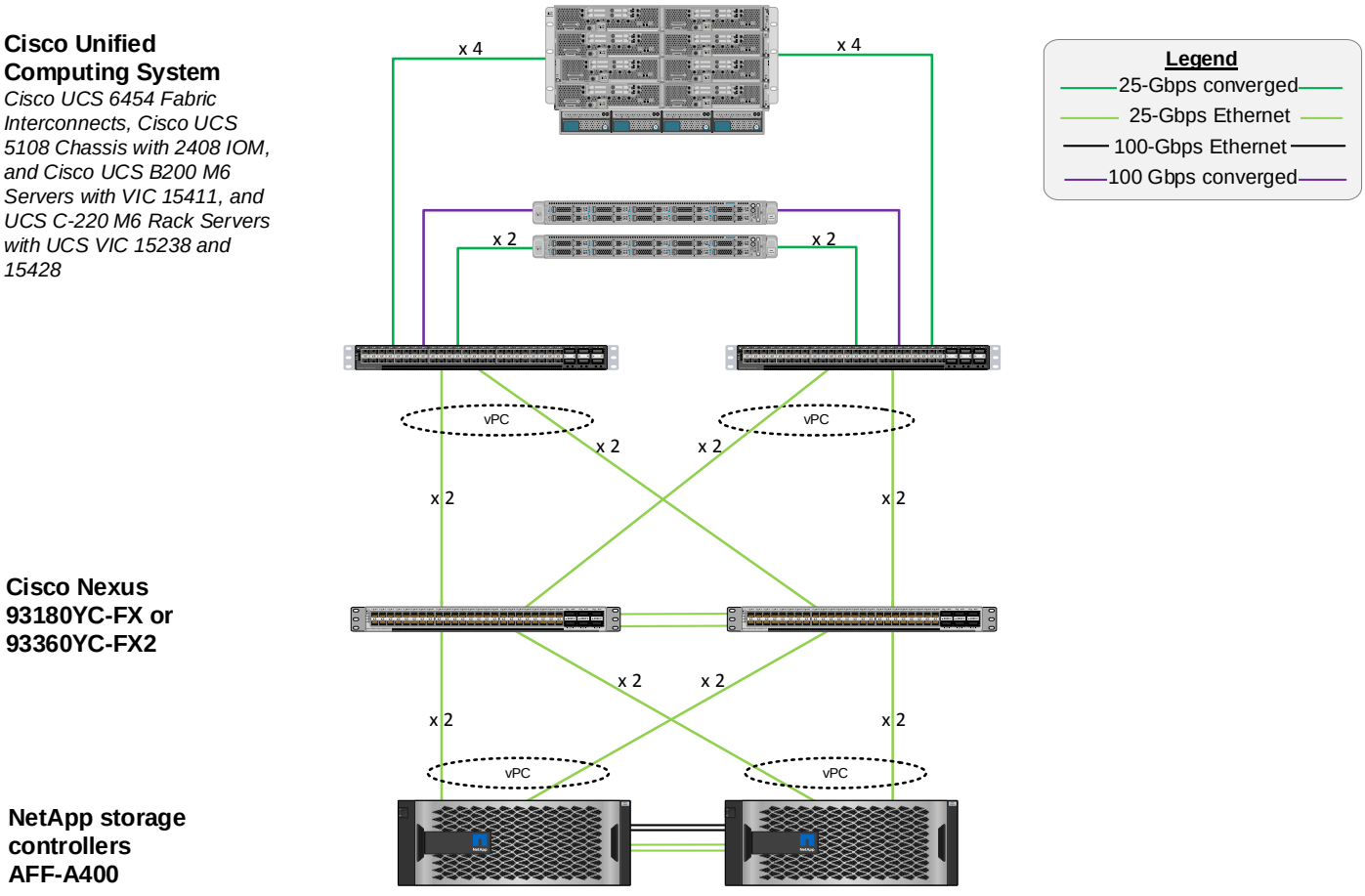
The software components of this solution consist of:

- Cisco UCS Manager to deploy, maintain, and support the Cisco UCS server components
- Cisco Intersight SaaS platform to maintain and support the FlexPod components
- Cisco Intersight Assist Virtual Appliance to help connect NetApp ONTAP, VMware vCenter, and Cisco Nexus and MDS switches with Cisco Intersight
- NetApp Active IQ Unified Manager to monitor and manage the storage and for NetApp ONTAP integration with Cisco Intersight
- VMware vCenter to set up and manage the virtual infrastructure as well as Cisco Intersight integration

FlexPod Datacenter for IP-based Storage Access

Figure 1 shows various hardware components and the network connections for the IP-based FlexPod design.

Figure 1. FlexPod Datacenter Physical Topology for IP-based Storage Access



The reference hardware configuration includes:

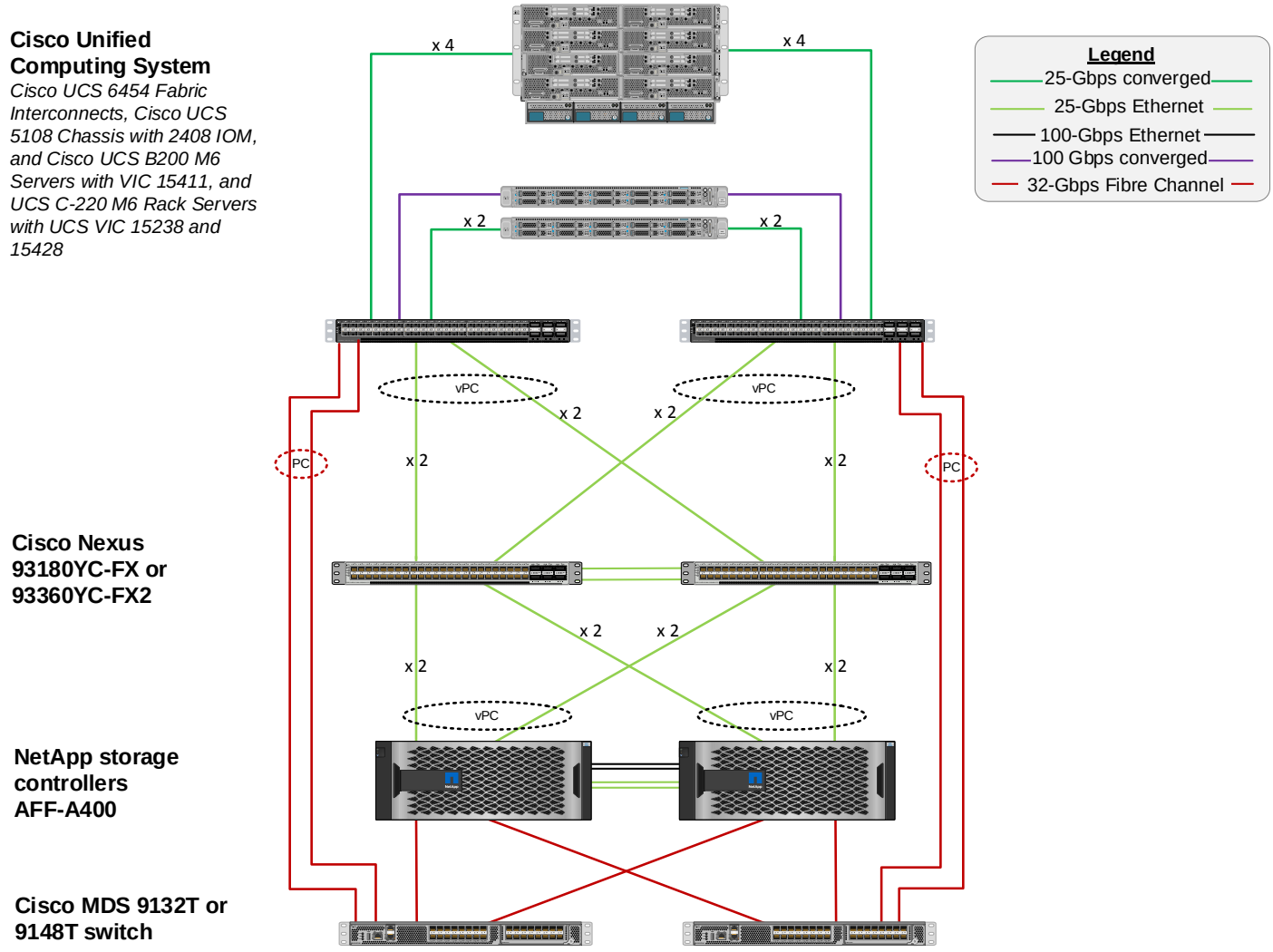
- Two Cisco Nexus 93180YC-FX Switches in Cisco NX-OS mode provide the switching fabric.

- Two Cisco UCS 6454 Fabric Interconnects (FI) provide the chassis connectivity. Two 25 Gigabit Ethernet ports from each FI, configured as a Port-Channel, are connected to each Nexus 93180YC-FX.
- One Cisco UCS 5108 Chassis connects to fabric interconnects using Cisco UCS 2408 IO Modules (IOMs), where four 25 Gigabit Ethernet ports are used on each IOM to connect to the appropriate FI. If additional bandwidth is required, all eight 25G ports can be utilized.
- One NetApp AFF A400 HA pair connects to the Cisco Nexus 93180YC-FX Switches using four 25 GE ports from each controller configured as a Port-Channel.
- One Cisco UCS C220 M6 rack mount server connects to the Fabric Interconnects using two 100 GE ports per server.
- One Cisco UCS C220 M6 rack mount server connects to the Fabric Interconnects using four 25 GE ports per server.

FlexPod Datacenter for FC-based Storage Access

Figure 2 shows various hardware components and the network connections for the FC-based FlexPod design.

Figure 2. FlexPod Datacenter Physical Topology for FC-based Storage Access



The reference hardware configuration includes:

- Two Cisco Nexus 93180YC-FX Switches in Cisco NX-OS mode provide the switching fabric.
- Two Cisco UCS 6454 Fabric Interconnects (FI) provide the chassis connectivity. Two 25 Gigabit Ethernet ports from each FI, configured as a Port-Channel, is connected to each Cisco Nexus 93180YC-FX. Two FC ports are connected to the Cisco MDS 9132T switches using 32-Gbps Fibre Channel connections configured as a single port channel for SAN connectivity.
- One Cisco UCS 5108 Chassis connects to the fabric interconnects using Cisco UCS 2408 IOMs where four 25 Gigabit Ethernet ports are used on each IOM to connect to the appropriate FI. If additional bandwidth is required, all eight 25G ports can be utilized.
- One NetApp AFF A400 HA pair connects to the Cisco Nexus 93180YC-FX Switches using four 25 GE ports from each controller configured as a Port-Channel. One 32Gbps FC port from each controller are connected to each Cisco MDS 9132T for SAN connectivity.

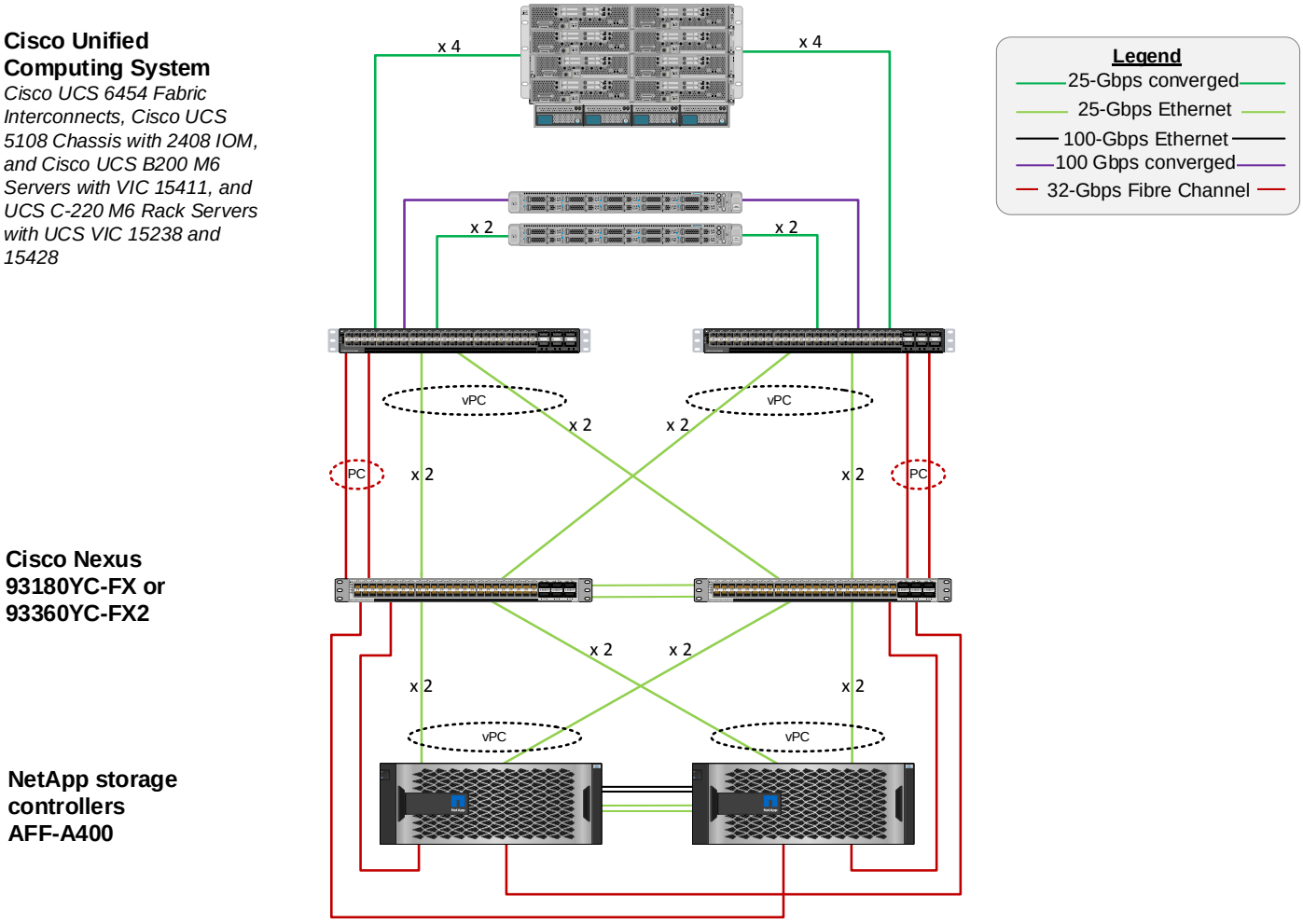
- One Cisco UCS C220 M6 rack mount server connects to the Fabric Interconnects using two 100 GE ports per server.
- One Cisco UCS C220 M6 rack mount server connects to the Fabric Interconnects four 25 GE ports per server.

Note: The NetApp storage controller and disk shelves should be connected according to best practices for the specific storage controller and disk shelves. For disk shelf cabling, refer to NetApp Support: https://docs.netapp.com/us-en/ontap-systems/index.html

FlexPod Datacenter for FC-based Storage Access with Nexus SAN Switching

Figure 3 shows various hardware components and the network connections for the FC-based FlexPod design.

Figure 3. FlexPod Datacenter Physical Topology for FC-based Storage Access with Cisco Nexus SAN Switching



The reference hardware configuration includes:

- Two Cisco Nexus 93180YC-FX Switches in Cisco NX-OS mode provide the switching fabric for both LAN and SAN.
- Two Cisco UCS 6454 Fabric Interconnects (FI) provide the chassis connectivity. Two 25 Gigabit Ethernet ports from each FI, configured as a Port-Channel, is connected to each Nexus 93180YC-FX. Two FC ports are connected to the Cisco Nexus 93180YC-FX switches using 32-Gbps Fibre Channel connections configured as a single port channel for SAN connectivity.
- One Cisco UCS 5108 Chassis connects to the fabric interconnects using Cisco UCS 2408 IOMs where four 25 Gigabit Ethernet ports are used on each IOM to connect to the appropriate FI. If additional bandwidth is required, all eight 25G ports can be utilized.
- One NetApp AFF A400 HA pair connects to the Cisco Nexus 93180YC-FX Switches using four 25 GE ports from each controller configured as a Port-Channel. One 32Gbps FC port from each controller are connected to each Cisco Nexus 93180YC-FX for SAN connectivity.
- One Cisco UCS C220 M6 rack mount server connects to the Fabric Interconnects using two 100 GE ports per server.
- One Cisco UCS C220 M6 rack mount server connects to the Fabric Interconnects four 25 GE ports per server.

Note: The NetApp storage controller and disk shelves should be connected according to best practices for the specific storage controller and disk shelves. For disk shelf cabling, refer to NetApp Support: https://docs.netapp.com/us-en/ontap-systems/index.html

VLAN Configuration

Table 1 lists VLANs configured for setting up the FlexPod environment along with their usage.

Table 1. VLAN Usage

VLAN ID	Name	Usage	IP Subnet used in this deployment
2	Native-VLAN	Use VLAN 2 as native VLAN instead of default VLAN (1).	
13	OOB-MGMT-VLAN	Out-of-band management VLAN to connect management ports for various devices	192.168.156.0/24; GW: 192.168.156.254
113	IB-MGMT-VLAN	In-band management VLAN utilized for all in-band management connectivity - for example, ESXi hosts, VM management, and so on.	10.1.156.0/24; GW: 10.1.156.254
800	VM-Traffic	VM data traffic VLAN	10.10.156.0/24; GW: 10.10.156.254
3050	NFS-VLAN	NFS VLAN for mounting datastores in ESXi servers for VMs	192.168.50.0/24 **

VLAN ID	Name	Usage	IP Subnet used in this deployment
3010*	iSCSI-A	iSCSI-A path for storage traffic including boot-from-san traffic	192.168.10.0/24 **
3020*	iSCSI-B	iSCSI-B path for storage traffic including boot-from-san traffic	192.168.20.0/24 **
3030	NVMe-TCP-A	NVMe-TCP-A path when using NVMe-TCP	192.168.30.0/24 **
3040	NVMe-TCP-B	NVMe-TCP-B path when using NVMe-TCP	192.168.40.0/24 **
3000	vMotion	VMware vMotion traffic	192.168.0.0/24 **

* iSCSI VLANs are not required if using FC storage access.

** IP gateway is not needed since no routing is required for these subnets

Some of the key highlights of VLAN usage are as follows:

- VLAN 13 allows you to manage and access out-of-band management interfaces of various devices.
- VLAN 113 is used for in-band management of VMs, ESXi hosts, and other infrastructure services.
- VLAN 3050 provides ESXi hosts access to the NFS datastores hosted on the NetApp Controllers for deploying VMs.
- A pair of iSCSI VLANs (3010 and 3020) is configured to provide access to boot LUNs for ESXi hosts. These VLANs are not needed if you are using FC-only connectivity.
- A pair of NVMe-TCP VLANs (3030 and 3040) is configured to provide access to NVMe datastores when NVMe-TCP is being used.
- VLAN 3000 is used for VM vMotion.

Table 2 lists the infrastructure VMs necessary for deployment as outlined in this document.

Table 2. Virtual Machines

Virtual Machine Description	VLAN	IP Address	Comments
vCenter Server	113	10.1.156.100	Hosted on either pre-existing management infrastructure or on FlexPod
NetApp ONTAP Tools for VMware vSphere	113	10.1.156.101	Hosted on FlexPod

Virtual Machine Description	VLAN	IP Address	Comments
NetApp SnapCenter Plug-in for VMware vSphere	113	10.1.156.104	Hosted on FlexPod
NetApp Active IQ Unified Manager	113	10.1.156.106	Hosted on FlexPod
Cisco Intersight Assist	113	10.1.156.107	Hosted on FlexPod
Nexus Dashboard Fabric Controller (NDFC)-SAN	113	10.1.156.109	Hosted on a server that is under the FlexPod Datacenter, but not part of a cluster. Consider deploying an extra server for this in the FlexPod Management Cluster and moving this server out to the Datacenter level in vCenter.

Software Revisions

Table 3 lists the software revisions for various components of the solution.

Table 3. Software Revisions

Layer	Device	Image Bundle	Comments
Compute	Cisco UCS	4.2(3d)	Cisco UCS GA release for infrastructure including FIs and IOM/IFM.
Network	Cisco Nexus 93180YC-FX NX-OS	10.2(5)M	
	Cisco MDS 9132T	9.3(2)	Requires SMART Licensing
Storage	NetApp AFF A800/A400	ONTAP 9.12.1	Latest patch release
Software	Cisco UCS B200 M6	4.2(3d)	
	Cisco UCS C225/245 M6	4.2(3d)	
	Cisco Intersight Assist Appliance	1.0.9-558	1.0.9-538 initially installed and then automatically upgraded
	VMware vCenter	8.0	Latest 8.0 Build

Layer	Device	Image Bundle	Comments
	VMware ESXi	8.0	Latest 8.0 Build
	VMware ESXi nfnic FC Driver	5.0.0.37	Supports FC-NVMe
	VMware ESXi nenic Ethernet Driver	1.0.45.0	
	NetApp ONTAP Tools for VMware vSphere	9.12	Formerly Virtual Storage Console (VSC)
	NetApp SnapCenter Plug-in for VMware vSphere	4.8	
	NetApp Active IQ Unified Manager	9.12	

FlexPod Cabling

The information in this section is provided as a reference for cabling the physical equipment in a FlexPod environment. To simplify cabling requirements, a cabling diagram was used.

The cabling diagram in this section contains the details for the prescribed and supported configuration of the NetApp AFF 400 running NetApp ONTAP 9.12.1.

Note: For any modifications of this prescribed architecture, consult the NetApp Interoperability Matrix Tool (IMT).

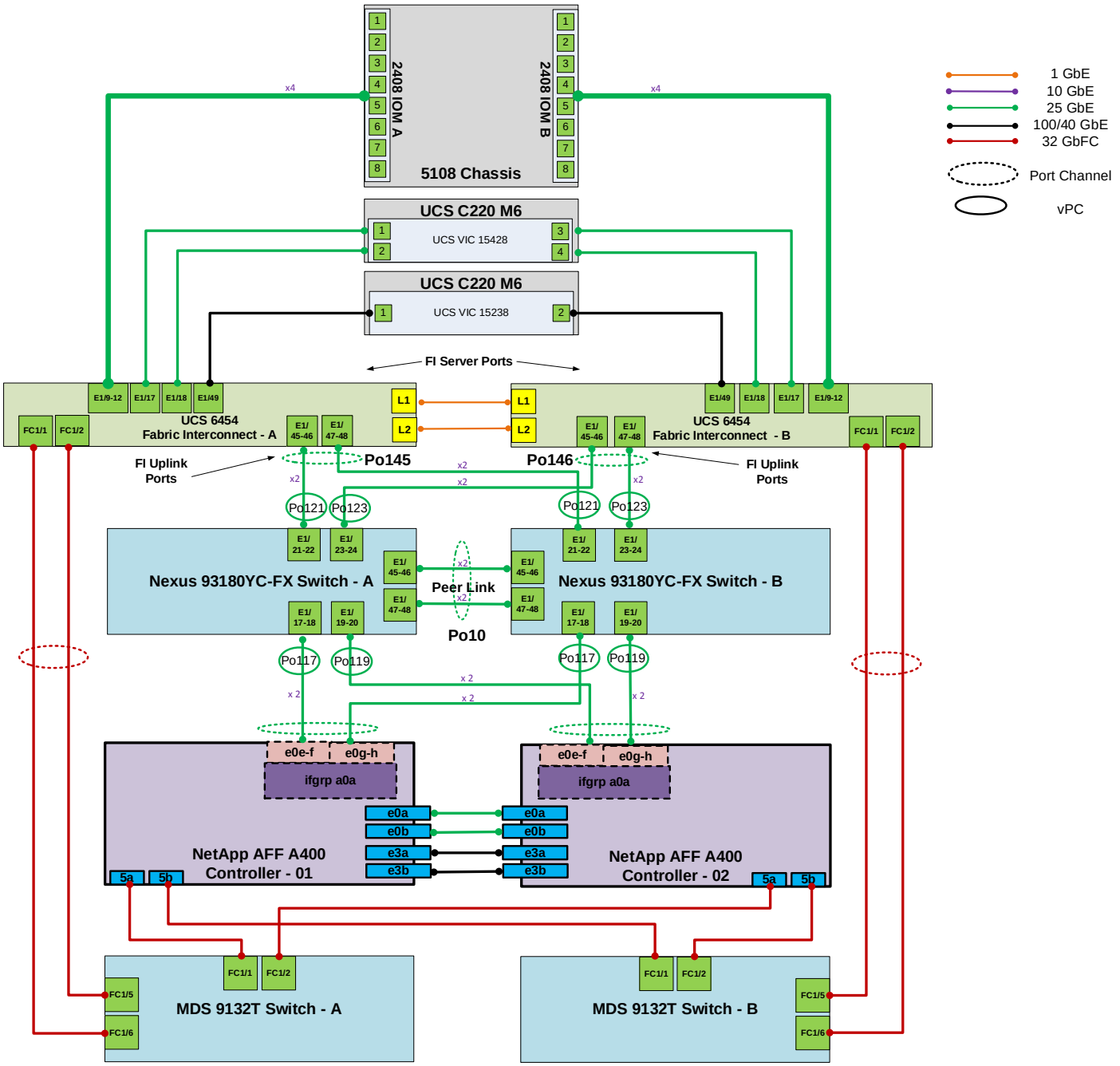
Note: This document assumes that out-of-band management ports are plugged into an existing management infrastructure at the deployment site. These interfaces will be used in various configuration steps.

Note: Be sure to use the cabling directions in this section as a guide.

The NetApp storage controller and disk shelves should be connected according to best practices for the specific storage controller and disk shelves. For disk shelf cabling, refer to NetApp Support.

Figure 4 details the cable connections used in the validation lab for the FlexPod topology based on the Cisco UCS 6454 fabric interconnect. Two 32Gb uplinks connect as port-channels from each Cisco UCS Fabric Interconnect to the MDS switches, and a total of four 32Gb links connect the MDS switches to the NetApp AFF controllers. Also, four 25Gb links connect the Cisco UCS Fabric Interconnects to the Cisco Nexus Switches and the NetApp AFF controllers to the Cisco Nexus Switches. Additional 1Gb management connections will be needed for an out-of-band network switch that sits apart from the FlexPod infrastructure. Each Cisco UCS fabric interconnect and Cisco Nexus switch is connected to the out-of-band network switch, and each AFF controller has a connection to the out-of-band network switch. Layer 3 network connectivity is required between the Out-of-Band (OOB) and In-Band (IB) Management Subnets. This cabling diagram includes both the FC-boot and iSCSI-boot configurations.

Figure 4. FlexPod Cabling with Cisco UCS 6454 Fabric Interconnect

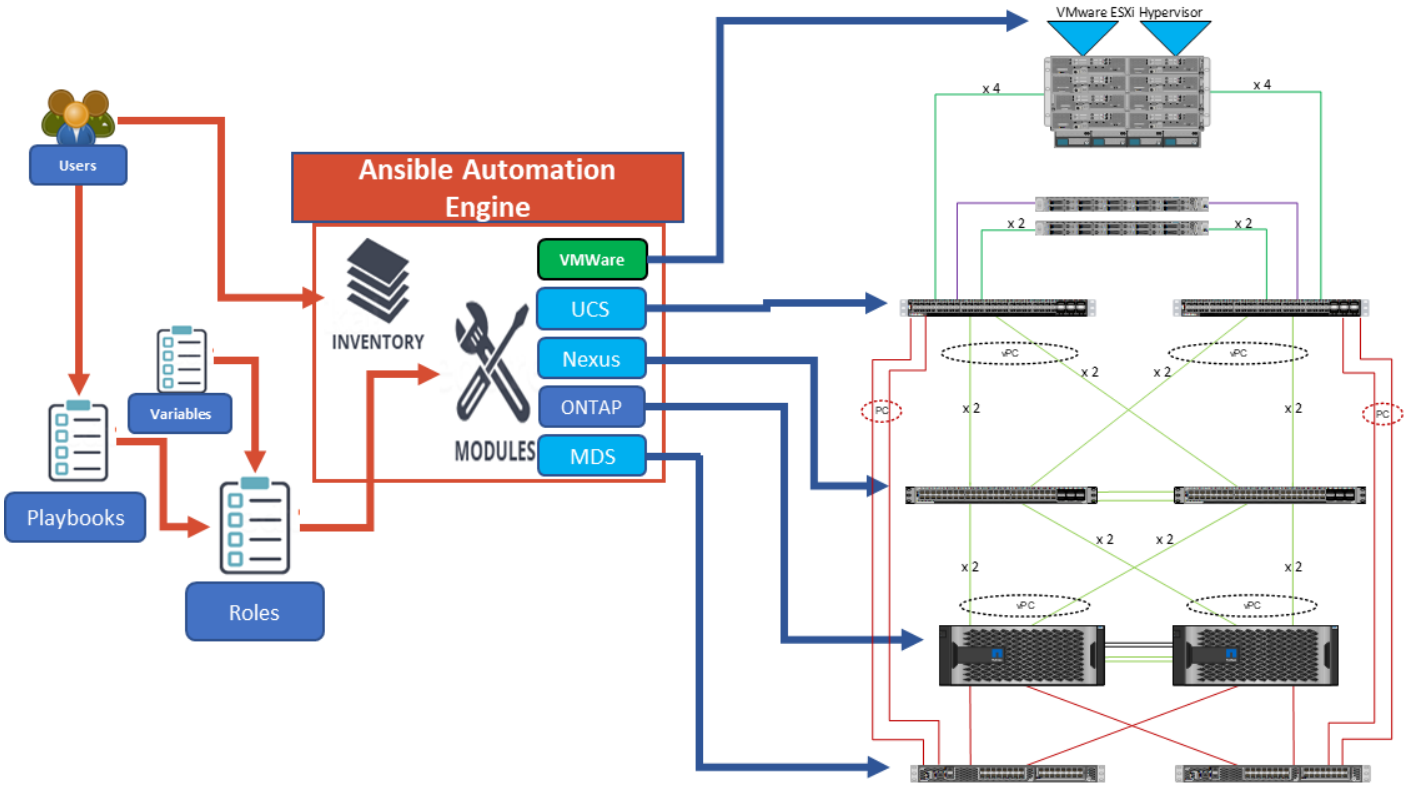


Ansible Automation Workflow and Solution Deployment

The Ansible automated FlexPod solution uses a management workstation (control machine) to run Ansible playbooks to configure Cisco Nexus, NetApp ONTAP Storage, Cisco UCS, Cisco MDS, and VMware ESXi.

Figure 5 illustrates the FlexPod solution implementation workflow which is explained in the following sections. The FlexPod infrastructure layers are first configured in the order illustrated.

Figure 5. Ansible Automation Workflow



Prerequisites

Setting up the solution begins with a management workstation or VM that has access to the Internet and with a working installation of Ansible. The management workstation commonly runs a variant of Linux or MacOS for ease of use with these command-line-based tools. Instructions for installing the workstation are not included in this document, but basic installation and configuration of Ansible is covered. A guide for getting started with Ansible can be found here: https://docs.ansible.com/ansible_community.html

- To use the Ansible playbooks demonstrated in this document, the management workstation must also have a working installation of Git and access to the Cisco DevNet public GitHub repository. The Ansible playbooks used in this document are cloned from the public repositories, located at the following links:
  - Cisco DevNet: https://developer.cisco.com/codeexchange/github/repo/ucs-compute-solutions/FlexPod-UCSM-VMware
  - GitHub repository: https://github.com/ucs-compute-solutions/FlexPod-UCSM-VMware
- The Cisco Nexus and MDS Switches, NetApp Storage, and Cisco UCS must be physically racked, cabled, powered, and configured with management IP addresses before the Ansible-based installation procedure can begin as shown in the cabling diagram (Figure 4). If necessary, upgrade the Cisco Nexus Switches to release 10.2(5)M, and the Cisco MDS Switches to release 9.3(2).
- Before running each Ansible Playbook to setup the Network, Storage, Cisco UCS, and VMware ESXi various variables have to be updated based on the customers environment and specific implementation with values

such as the VLANs, pools and ports on Cisco UCS, IP addresses for NFS, iSCSI, and NVMe-TCP interfaces and values needed for VMware ESXi.

- Day 2 Configuration tasks such as adding datastores or ESXi servers can be performed manually or with Cisco Intersight Cloud Orchestrator (ICO).

Procedure 1. Prepare Management Workstation (Control Machine)

In this procedure, the installation steps are performed on either RHEL 8.8 or Rocky Linux 8.8 (install default Server with GUI) management host to prepare the host for solution deployment to support the automation of Cisco UCS, Cisco Nexus, NetApp Storage, Cisco MDS, and VMware ESXi using Ansible Playbooks.

Note: The following steps were performed on both RHEL 8.8 and Rocky Linux 8.8 Virtual Machines as the admin user.

Step 1. Install Python 3.11.

```
sudo dnf install python3.11
```

Step 2. Install pip3.11.

```
curl https://bootstrap.pypa.io/get-pip.py -o get-pip.py
python3.11 get-pip.py
rm get-pip.py
```

Step 3. Install Ansible engine with Python 3.11.

```
python3.11 -m pip install --user ansible
```

Step 4. Configure Ansible to use python3.11.

```
echo [defaults] > ~/.ansible.cfg
echo interpreter_python=/usr/bin/python3.11 >> ~/.ansible.cfg
```

Step 5. Verify Ansible version to make sure it is release 2.9 or later.

```
ansible --version
ansible [core 2.15.2]
  config file = /home/admin/.ansible.cfg
  configured module search path = ['/home/admin/.ansible/plugins/modules', '/usr/share/ansible/plugins/modules']
  ansible python module location = /home/admin/.local/lib/python3.11/site-packages/ansible
  ansible collection location = /home/admin/.ansible/collections:/usr/share/ansible/collections
  executable location = /home/admin/.local/bin/ansible
  python version = 3.11.2 (main, Jun  6 2023, 07:39:01) [GCC 8.5.0 20210514 (Red Hat 8.5.0-18)]
(/usr/bin/python3.11)
  jinja version = 3.1.2
  libyaml = True
```

Step 6. Install sshpass.

```
sudo dnf install sshpass
```

Step 7. Install git.

```
sudo dnf install git
```

Step 8. Install NetApp specific python modules.

```
pip3.11 install netapp-lib
```

Step 9. Install UCSM SDK.

```
pip3.11 install ucsmsdk
```

Step 10. Install ansible-galaxy collections and other dependencies for Cisco Nexus (and MDS), NetApp ONTAP, Cisco UCS, VMware, and NetApp management tools as follows:

```
ansible-galaxy collection install cisco.ucs --force
ansible-galaxy collection install cisco.nxos --force
pip3.11 install ansible-pylibssh
ansible-galaxy collection install netapp.ontap --force
ansible-galaxy collection install community.vmware --force
pip3.11 install -r ~/.ansible/collections/ansible_collections/community/vmware/requirements.txt
pip3.11 install aiohttp
pip3.11 install pexpect
pip3.11 install jmespath
```

Note: The cisco.nxos collection is used for both Cisco Nexus and Cisco MDS configuration.

Procedure 2. Clone GitHub Collection

Note: You need to use a GitHub repository from one public location; the first step in the process is to clone the GitHub collection named FlexPod-UCSM-VMware (https://github.com/ucs-compute-solutions/FlexPod-UCSM-VMware.git) to a new empty folder on the management workstation. Cloning the repository creates a local copy, which is then used to run the playbooks that have been created for this solution.

Step 1. From the management workstation, create a new folder for the project. The GitHub collection will be cloned in a new folder inside this one, named /home/admin/FlexPod-UCSM-VMware.

Step 2. Open a command-line or console interface on the management workstation and change directories to the new folder just created.

Step 3. Clone the GitHub collection using the following command:

```
git clone https://github.com/ucs-compute-solutions/FlexPod-UCSM-VMware.git
```

Step 4. Change directories to the new folder named FlexPod-UCSM-VMware.

Network Switch Configuration

This chapter contains the following:

This chapter provides a detailed procedure for configuring the Cisco Nexus 93180YC-FX switches for use in a FlexPod environment. The Cisco Nexus 93180YC-FX will be used for LAN switching in this solution.

Note: The following procedures describe how to configure the Cisco Nexus switches for use in a base FlexPod environment. This procedure assumes the use of Cisco Nexus 9000 10.2(5)M.

- If using the Cisco Nexus 93180YC-FX switches or other Cisco Nexus switches for both LAN and SAN switching, please refer to section FlexPod with Cisco Nexus 93180YC-FX SAN Switching Configuration in the Appendix.
- The following procedure includes the setup of NTP distribution on both the mgmt0 port and the in-band management VLAN. The interface-vlan feature and ntp commands are used to set this up. This procedure also assumes that the default VRF is used to route the in-band management VLAN.
- This procedure sets up and uplink virtual port channel (vPC) with the IB-MGMT and OOB-MGMT VLANs allowed.
- This validation assumes that both switches have been reset to factory defaults by using the “write erase” command followed by the “reload” command.

Physical Connectivity

Follow the physical connectivity guidelines for FlexPod as explained in section FlexPod Cabling.

Initial Configuration

The following procedures describe this basic configuration of the Cisco Nexus switches for use in the FlexPod environment. This procedure assumes the use of Cisco Nexus 9000 10.2(5)M, the Cisco suggested Nexus switch release at the time of this validation.

Procedure 1. Set Up Initial Configuration from a serial console

Set up the initial configuration for the Cisco Nexus A switch on <nexus-A-hostname>.

Step 1. Configure the switch.

Note: On initial boot, the NX-OS setup automatically starts and attempts to enter Power on Auto Provisioning.

```
Abort Power On Auto Provisioning [yes - continue with normal setup, skip - bypass password and basic configuration,
no - continue with Power On Auto Provisioning] (yes/skip/no)[no]: yes
Disabling POAP.......Disabling POAP
poap: Rolling back, please wait... (This may take 5-15 minutes)

         ---- System Admin Account Setup ----

Do you want to enforce secure password standard (yes/no) [y]: Enter
```

```
Enter the password for "admin": <password>
Confirm the password for "admin": <password>
Would you like to enter the basic configuration dialog (yes/no): yes
Create another login account (yes/no) [n]: Enter
Configure read-only SNMP community string (yes/no) [n]: Enter
Configure read-write SNMP community string (yes/no) [n]: Enter
Enter the switch name: <nexus-A-hostname>
Continue with Out-of-band (mgmt0) management configuration? (yes/no) [y]: Enter
Mgmt0 IPv4 address: <nexus-A-out_of_band_mgmt0-ip>
Mgmt0 IPv4 netmask: <nexus-A-mgmt0-netmask>
Configure the default gateway? (yes/no) [y]: Enter
IPv4 address of the default gateway: <nexus-A-mgmt0-gw>
Configure advanced IP options? (yes/no) [n]: Enter
Enable the telnet service? (yes/no) [n]: Enter
Enable the ssh service? (yes/no) [y]: Enter
Type of ssh key you would like to generate (dsa/rsa) [rsa]: Enter
Number of rsa key bits <1024-2048> [1024]: Enter
Configure the ntp server? (yes/no) [n]: Enter
Configure default interface layer (L3/L2) [L2]: Enter
Configure default switchport interface state (shut/noshut) [noshut]: shut
Enter basic FC configurations (yes/no) [n]: n
Configure CoPP system profile (strict/moderate/lenient/dense) [strict]: Enter
Would you like to edit the configuration? (yes/no) [n]: Enter
```

Step 2. Review the configuration summary before enabling the configuration.

```
Use this configuration and save it? (yes/no) [y]: Enter
```

Step 3. To set up the initial configuration of the Cisco Nexus B switch, repeat steps 1 and 2 with the appropriate host and IP address information.

Ansible Nexus Switch Configuration

Procedure 1. Configure the Cisco Nexus switches from the management workstation

Step 1. Add Nexus switch ssh keys to /home/admin/.ssh/known_hosts. Adjust known_hosts as necessary if errors occur.

```
ssh admin@<nexus-A-mgmt0-ip>
exit
ssh admin@<nexus-B-mgmt0-ip>
exit
```

Step 2. Edit the following variable files to ensure proper Cisco Nexus variables are entered:

- FlexPod-UCSM-VMware/FlexPod-UCSM-VMware/inventory
- FlexPod-UCSM-VMware/FlexPod-UCSM-VMware/group_vars/all.yml
- FlexPod-UCSM-VMware/FlexPod-UCSM-VMware/host_vars/n9kA.yml
- FlexPod-UCSM-VMware/FlexPod-UCSM-VMware/host_vars/n9kB.yml
- FlexPod-UCSM-VMware/FlexPod-UCSM-VMware/roles/NEXUSconfig/defaults/main.yml

Note: Switch configuration can be done one switch at a time by commenting one switch out in inventory and running the playbook. This may need to be done if the switches are shared with other FlexPods and additional configuration needs to be added between playbook runs.

Step 3. From FlexPod-UCSM-VMware/FlexPod-UCSM-VMware, run the Setup_Nexus.yml Ansible playbook.

```
ansible-playbook ./Setup_Nexus.yml -i inventory
```

Step 4. Once the Ansible playbook has been run on both switches, it is important to configure the local time so that logging time alignment and any backup schedules are correct. For more information on configuring the time-zone and daylight savings time or summertime, please see Cisco Nexus 9000 Series NX-OS Fundamentals Configuration Guide, Release 10.2(x). Sample clock commands for the United States Eastern timezone are:

```
clock timezone EST -5 0
clock summer-time EDT 2 Sunday March 02:00 1 Sunday November 02:00 60
copy running-config startup-config
```

Step 5. ssh into each switch and execute the following commands:

```
clock timezone <timezone> <hour-offset> <minute-offset>
clock summer-time <timezone> <start-week> <start-day> <start-month> <start-time> <end-week> <end-day> <end-month>
<end-time> <offset-minutes>
copy running-config startup-config
```

NetApp ONTAP Storage Configuration

This chapter contains the following:

NetApp AFF A400 Controllers

See the following section (NetApp Hardware Universe) for planning the physical location of the storage systems:

- Site Preparation
- System Connectivity Requirements
- Circuit Breaker, Power Outlet Balancing, System Cabinet Power Cord Plugs, and Console Pinout Requirements
- AFF Series Systems

NetApp Hardware Universe

The NetApp Hardware Universe (HWU) application provides supported hardware and software components for any specific ONTAP version. It also provides configuration information for all the NetApp storage appliances currently supported by ONTAP software and a table of component compatibilities.

To confirm that the hardware and software components that you would like to use are supported with the version of ONTAP that you plan to install, follow these steps at the NetApp Support site.

Procedure 1. Confirm hardware and software components

Step 1. Access the HWU application to view the System Configuration guides. Click the Products tab to select the Platforms menu to view the compatibility between different versions of the ONTAP software and the NetApp storage appliances with your desired specifications.

Step 2. Alternatively, to compare components by storage appliance, click Utilities and select Compare Storage Systems.

Controllers

Follow the physical installation procedures for the controllers found here:
https://docs.netapp.com/us-en/ontap-systems/index.html.

Disk Shelves

NetApp storage systems support a wide variety of disk shelves and disk drives. The complete list of disk shelves that are supported by the AFF A400 is available at the NetApp Support site.

When using SAS disk shelves with NetApp storage controllers, refer to:
https://docs.netapp.com/us-en/ontap-systems/sas3/install-new-system.html for proper cabling guidelines.

When using NVMe drive shelves with NetApp storage controllers, refer to: https://docs.netapp.com/us-en/ontap-systems/ns224/hot-add-shelf.htmlfor installation and servicing guidelines.

NetApp ONTAP 9.12.1

Complete Configuration Worksheet

Before running the setup script, complete the Cluster setup worksheet in the NetApp ONTAP 9 Documentation Center. You must have access to the NetApp Support site to open the cluster setup worksheet.

Ansible NetApp ONTAP Storage Configuration

End to End ONTAP Storage Configuration for a FlexPod is automated with Ansible. ONTAP Storage can be deployed via Ansible after the ONTAP Cluster setup is complete and the Cluster management network is configured.

A playbook by the name 'Setup_ONTAP.yml' is available at the root of this repository. It calls all the required roles to complete the setup of the ONTAP storage system.

The ONTAP setup is split into three sections, use the tags - ontap_config_part_1, ontap_config_part_2, and ontap_config_part_3 to execute parts of the playbook at the appropriate stage of setup.

Execute the playbook from the Ansible Control machine as an admin/ root user using the following commands:

- After setup of Cisco Nexus switches and bringing the NetApp storage cluster online: ansible-playbook -i inventory Setup_ONTAP.yml -t ontap_config_part_1
- After setup of Cisco UCS and deploying server profiles: ansible-playbook -i inventory Setup_ONTAP.yml -t ontap_config_part_2
- After setup of VMware vSphere 8.0 Setup: ansible-playbook -i inventory Setup_ONTAP.yml -t ontap_config_part_3

If you would like to run a part of the deployment, you may use the appropriate tag that accompanies each task in the role and run the playbook by running the following command:

```
ansible-playbook -i inventory Setup_ONTAP.yml -t <tag_name>
```

Configure ONTAP Nodes

Before running the setup script, review the configuration worksheets in the Software setup section of the ONTAP 9 Documentation Center to learn about configuring ONTAP. Table 4 lists the information needed to configure two ONTAP nodes. Customize the cluster-detail values with the information applicable to your deployment.

Table 4. ONTAP Software Installation Prerequisites

Cluster Detail	Cluster Detail Value
Cluster node 01 IP address	<node01-mgmt-ip>
Cluster node 01 netmask	<node01-mgmt-mask>

Cluster Detail	Cluster Detail Value
Cluster node 01 gateway	<node01-mgmt-gateway>
Cluster node 02 IP address	<node02-mgmt-ip>
Cluster node 02 netmask	<node02-mgmt-mask>
Cluster node 02 gateway	<node02-mgmt-gateway>
ONTAP 9.12.14 URL (http server hosting ONTAP software)	<url-boot-software>

Procedure 1. Configure Node 01

Step 1. Connect to the **storage system console port**. You should see a Loader-A prompt. However, if the storage system is in a reboot loop, press **Ctrl-C** to exit the autoboot loop when the following message displays:

```
Starting AUTOBOOT press Ctrl-C to abort…
```

Step 2. Allow the system to boot up.

```
autoboot
```

Step 3. Press **Ctrl-C** when prompted.

Note: Use the latest NetApp ONTAP release patch. In this example, it is 9.12.1P4. If NetApp ONTAP 9.12.1P4 is not the version of the software being booted, continue with the following steps to install new software. If NetApp ONTAP 9.12.1P4 is the version being booted, select option 8 and `y` to reboot the node, then continue with section Set Up Node.

Step 4. To install new software, select option **7** from the menu.

Step 5. Enter `y` to continue the installation.

Step 6. Select `e0M` for the network port for the download.

Step 7. Enter `n` to skip the reboot.

Step 8. Select option **7** from the menu: `Install new software first`

Step 9. Enter `y` to continue the installation.

Step 10. Enter the IP address, netmask, and default gateway for `e0M`.

```
Enter the IP address for port e0M: <node01-mgmt-ip>
Enter the netmask for port e0M: <node01-mgmt-mask>
Enter the IP address of the default gateway: <node01-mgmt-gateway>
```

Step 11. Enter the **URL** where the software can be found.

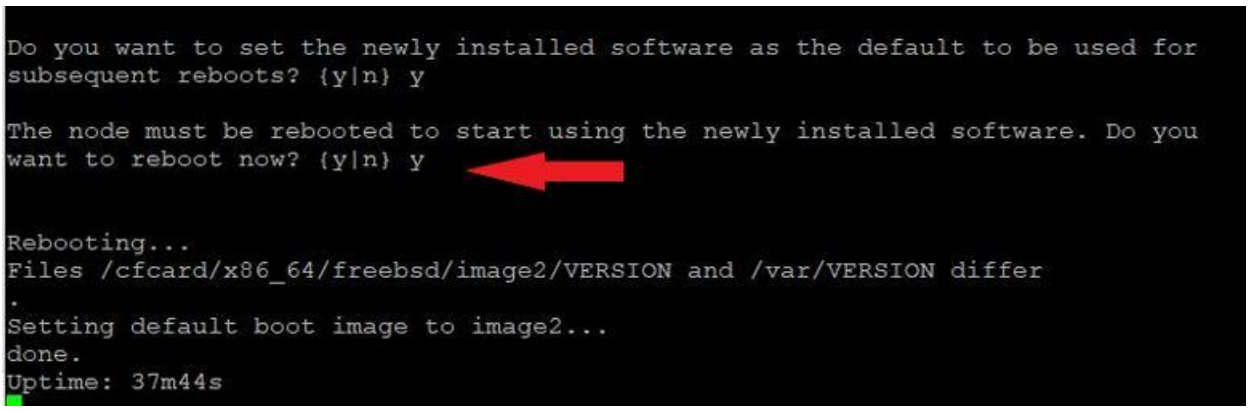
Note: The e0M interface should be connected to the management network and the web server must be reachable (using ping) from node 01.

```
<url-boot-software>
```

Step 12. Press **Enter** for the user name, indicating no user name.

Step 13. Enter `y` to set the newly installed software as the default to be used for subsequent reboots.

Step 14. Enter `y` to reboot the node now.



Note: When installing new software, the system might perform firmware upgrades to the BIOS and adapter cards, causing reboots and possible stops at the Loader-A prompt. If these actions occur, the system might deviate from this procedure.

Note: During the ONTAP installation a prompt to reboot the node requests a Y/N response.

Step 15. Press **Ctrl-C** when the following message displays:

```
Press Ctrl-C for Boot Menu
```

Step 16. Select option **4** for Clean Configuration and Initialize All Disks.

Step 17. Enter `y` to zero disks, reset config, and install a new file system.

Step 18. Enter `yes` to erase all the data on the disks.

Note: When initialization and creation of root aggregate is complete, the storage system reboots. You can continue with the configuration of node 02 while the initialization and creation of the root aggregate for node 01 is in progress. For more information about root aggregate and disk partitioning, please refer to the following NetApp ONTAP documentation on root-data partitioning:
https://docs.netapp.com/us-en/ontap/concepts/root-data-partitioning-concept.html

Procedure 2. Configure Node 02

Step 1. Connect to the **storage system console port**. You should see a Loader-B prompt. However, if the storage system is in a reboot loop, press **Ctrl-C** to exit the autoboot loop when the following message displays:

```
Starting AUTOBOOT press Ctrl-C to abort…
```

Step 2. Allow the system to boot up.

```
autoboot
```

Step 3. Press **Ctrl-C** when prompted.

Note: If NetApp ONTAP 9.12.1P4 is not the version of the software being booted, continue with the following steps to install new software. If NetApp ONTAP 9.12.1P4 is the version being booted, select option 8 and `y` to reboot the node. Continue with section Set Up Node.

Step 4. To install new software, select option **7**.

Step 5. Enter `y` to continue the installation.

Step 6. Select `e0M` for the network port you want to use for the download.

Step 7. Enter `n` to skip the reboot.

Step 8. Select option **7**: `Install new software first`

Step 9. Enter `y` to continue the installation.

Step 10. Enter the IP address, netmask, and default gateway for e0M.

```
Enter the IP address for port e0M: <node02-mgmt-ip>
Enter the netmask for port e0M: <node02-mgmt-mask>
Enter the IP address of the default gateway: <node02-mgmt-gateway>
```

Step 11. Enter the **URL** where the software can be found.

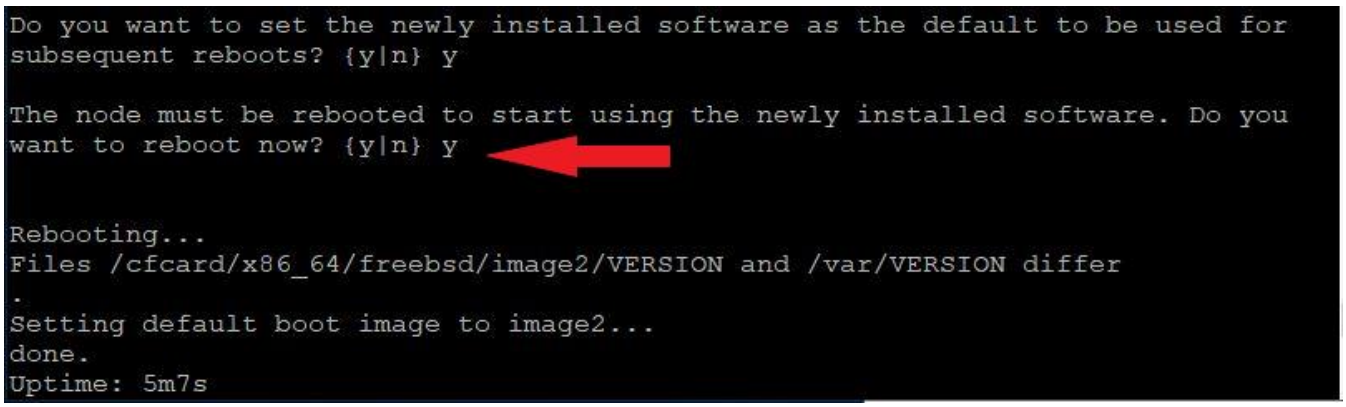
Note: The web server must be reachable (ping) from node 02.

```
<url-boot-software>
```

Step 12. Press `Enter` for the username, indicating no username.

Step 13. Enter `y` to set the newly installed software as the default to be used for subsequent reboots.

Step 14. Enter `y` to reboot the node now.



Note: When installing new software, the system might perform firmware upgrades to the BIOS and adapter cards, causing reboots and possible stops at the Loader-B prompt. If these actions occur, the system might deviate from this procedure.

Note: During the ONTAP installation a prompt to reboot the node requests a Y/N response.

Step 15. Press **Ctrl-C** when you see this message:

```
Press Ctrl-C for Boot Menu
```

Step 16. Select option **4** for Clean Configuration and Initialize All Disks.

Step 17. Enter `y` to zero disks, reset config, and install a new file system.

Step 18. Enter `yes` to erase all the data on the disks.

Note: When initialization and creation of root aggregate is complete, the storage system reboots. For more information about root aggregate and disk partitioning, please refer to the following ONTAP documentation on root-data partitioning. https://docs.netapp.com/us-en/ontap/concepts/root-data-partitioning-concept.html

Procedure 3. Set Up Node

Step 1. From a console port program attached to the storage controller A (node 01) console port, run the node setup script. This script appears when ONTAP 9.12.1 boots on the node for the first time.

Step 2. Follow the prompts to set up node 01.

```
Welcome to the cluster setup wizard.

You can enter the following commands at any time:
  "help" or "?" - if you want to have a question clarified,
  "back" - if you want to change previously answered questions, and
  "exit" or "quit" - if you want to quit the setup wizard.
     Any changes you made before quitting will be saved.

You can return to cluster setup at any time by typing “cluster setup”.
To accept a default or omit a question, do not enter a value.

This system will send event messages and weekly reports to NetApp Technical Support.
To disable this feature, enter "autosupport modify -support disable" within 24 hours.

Enabling AutoSupport can significantly speed problem determination and resolution should a problem occur on your
system.
For further information on AutoSupport, see:
http://support.netapp.com/autosupport/

Type yes to confirm and continue {yes}: yes

Enter the node management interface port [e0M]: Enter
Enter the node management interface IP address: <node01-mgmt-ip>
Enter the node management interface netmask: <node01-mgmt-mask>
Enter the node management interface default gateway: <node01-mgmt-gateway>
A node management interface on port e0M with IP address <node01-mgmt-ip> has been created.

Use your web browser to complete cluster setup by accesing https://<node01-mgmt-ip>

Otherwise press Enter to complete cluster setup using the command line interface:
```

Step 3. To complete cluster setup, open a web browser and navigate to `https://<node01-mgmt-ip>`.

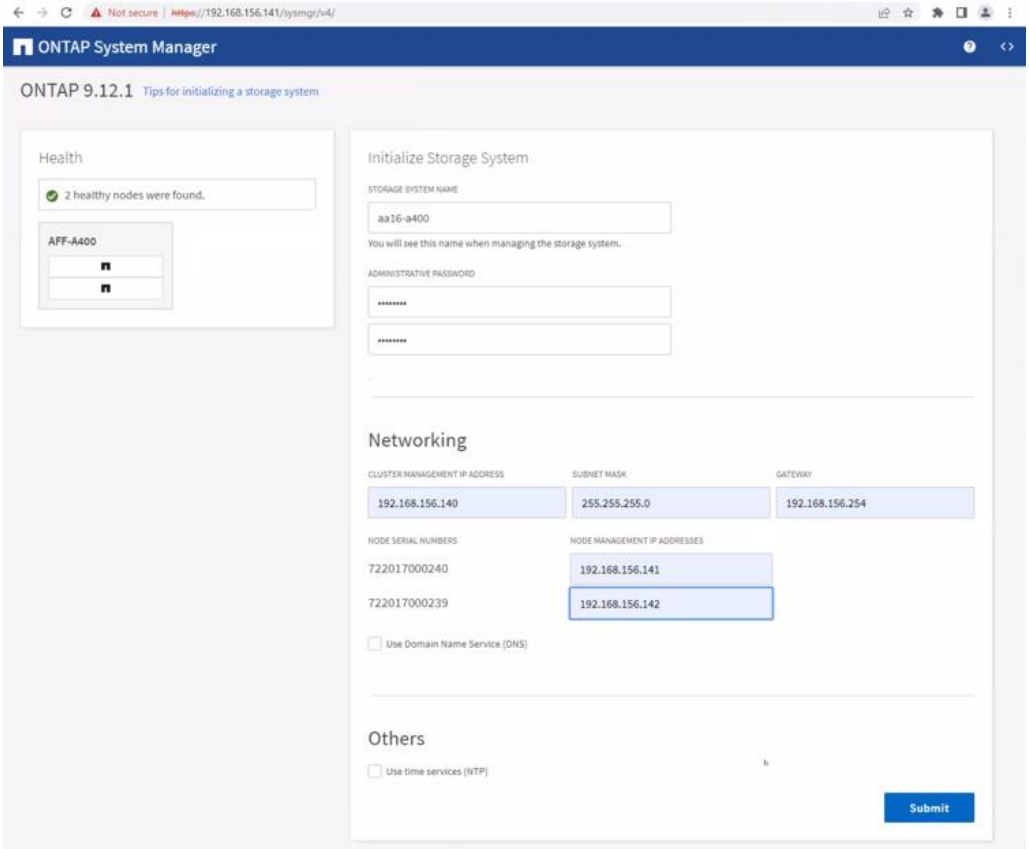
Table 5. Cluster Create in ONTAP Prerequisites

Cluster Detail	Cluster Detail Value
Cluster name	<clustername>
Cluster Admin SVM	<cluster-adm-svm>
Infrastructure Data SVM	<infra-data-svm>
ONTAP base license	<cluster-base-license-key>
Cluster management IP address	<clustermgmt-ip>
Cluster management netmask	<clustermgmt-mask>
Cluster management gateway	<clustermgmt-gateway>
Cluster node 01 IP address	<node01-mgmt-ip>

Cluster Detail	Cluster Detail Value
Cluster node 01 netmask	<node01-mgmt-mask>
Cluster node 01 gateway	<node01-mgmt-gateway>
Cluster node 02 IP address	<node02-mgmt-ip>
Cluster node 02 netmask	<node02-mgmt-mask>
Cluster node 02 gateway	<node02-mgmt-gateway>
Node 01 service processor IP address	<node01-sp-ip>
Node 01 service processor network mask	<node01-sp-mask>
Node 01 service processor gateway	<node01-sp-gateway>
Node 02 service processor IP address	<node02-sp-ip>
Node 02 service processor network mask	<node02-sp-mask>
Node 02 service processor gateway	<node02-sp-gateway>
Node 01 node name	<st-node01>
Node 02 node name	<st-node02>
DNS domain name	<dns-domain-name>
DNS server IP address	<dns-ip>
NTP server A IP address	<switch-a-ntp-ip>
NTP server B IP address	<switch-b-ntp-ip>
SNMPv3 User	<snmp-v3-usr>
SNMPv3 Authentication Protocol	<snmp-v3-auth-proto>
SNMPv3 Privacy Protocol	<snmpv3-priv-proto>

Note: Cluster setup can also be performed using the CLI. This document describes the cluster setup using the NetApp ONTAP System Manager guided setup.

Step 4. Complete the required information on the Initialize Storage System screen:



a. Enter the **cluster name** and **administrator password**.

b. Complete the Networking information for the cluster and each node.

Note: Here, the DNS and NTP server manual configuration for the cluster is optional. Ansible scripts will configure the same when ONTAP playbook with the tag "ontap_config_part_1" is executed.

Note: The nodes should be discovered automatically; if they are not, Refresh the browser page. By default, the cluster interfaces are created on all the new factory shipping storage controllers.

Note: If all the nodes are not discovered, then configure the cluster using the command line.

Note: The node management interface can be on the same subnet as the cluster management interface, or it can be on a different subnet. In this document, we assume that it is on the same subnet.

Step 5. Click **Submit**.

Note: A few minutes will pass while the cluster is configured. You can use Ansible scripts at this point to configure the ONTAP Storage Configuration via Ansible.

Procedure 4. Ansible ONTAP Storage Configuration - Part 1

Step 1. Edit the following variable files to ensure proper ONTAP Storage variables are entered:

- FlexPod-UCSM-VMware/FlexPod-UCSM-VMware/inventory
- FlexPod-UCSM-VMware/FlexPod-UCSM-VMware/group_vars/all.yml
- FlexPod-UCSM-VMware/FlexPod-UCSM-VMware/group_vars/ontap

- FlexPod-UCSM-VMware/FlexPod-UCSM-VMware/vars/ontap_main.yml

Step 2. From FlexPod-UCSM-VMware/FlexPod-UCSM-VMware, run the **Setup_ONTAP.yml** Ansible playbook with the associated tag for this section:

```
ansible-playbook -i inventory Setup_ONTAP.yml -t ontap_config_part_1
```

Note: Use the -vvv tag to see detailed execution output log.

Cisco UCS Manager Mode Configuration

This chapter contains the following:

The Cisco Intersight platform is a management solution delivered as a service with embedded analytics for Cisco and third-party IT infrastructures. The Cisco Intersight managed mode (also referred to as Cisco IMM or Intersight managed MODE) is a new architecture that manages Cisco Unified Computing System (Cisco UCS) fabric interconnect–attached systems through a Redfish-based standard model. Cisco Intersight managed mode standardizes both policy and operation management for Cisco UCS C-Series M6 and Cisco UCSX X210c M6 compute nodes used in this deployment guide.

Cisco UCS B-Series M6 servers, connected and managed through Cisco UCS FIs, are also supported by IMM. For a complete list of supported platforms, visit: https://www.cisco.com/c/en/us/td/docs/unified_computing/Intersight/b_Intersight_Managed_Mode_Configuration_Guide/b_intersight_managed_mode_guide_chapter_01010.html

Cisco UCS Manager Mode Set up

Procedure 1. Set up Cisco UCS Manager Mode on Cisco UCS Fabric Interconnects in a FlexPod environment

The Cisco UCS fabric interconnects need to be set up to support Cisco UCS Manager (UCSM) mode.

Step 1. Connect to the console port on the first Cisco UCS fabric interconnect. **Configure Fabric Interconnect A (FI-A)**. On the Basic System Configuration Dialog screen, set the management mode to **ucsm**.

```
Cisco UCS Fabric Interconnect A

  Enter the configuration method. (console/gui) ? console

  Enter the management mode. (ucsm/intersight)? ucsm

  Enter the setup mode; setup newly or restore from backup. (setup/restore) ? setup

  The Fabric Interconnect will be configured in the ucsm managed mode. Choose (y/n) to proceed: y

  Enforce strong password? (y/n) [y]: Enter

  Enter the password for "admin": <password>
  Confirm the password for "admin": <password>

  Is this Fabric Interconnect part of a cluster(select 'no' for standalone)? (yes/no) [n]: y

  Enter the switch fabric (A/B) []: A

  Enter the system name:  <ucs-cluster-name>

  Physical Switch Mgmt0 IP address : <ucsa-mgmt-ip>

  Physical Switch Mgmt0 IPv4 netmask : <ucs-mgmt-mask>

  IPv4 address of the default gateway : <ucs-mgmt-gateway>

  Cluster IPv4 address : <ucs-cluster-ip>

  Configure the DNS Server IP address? (yes/no) [n]: y
```

```
    DNS IP address : <dns-server-1-ip>

  Configure the default domain name? (yes/no) [n]: y

    Default domain name : <ad-dns-domain-name>

  Join centralized management environment (UCS Central)? (yes/no) [n]: n

  Following configurations will be applied:

    Management Mode=ucsm
    Switch Fabric=A
    System Name=<ucs-cluster-name>
    Enforced Strong Password=yes
    Physical Switch Mgmt0 IP Address=<ucsa-mgmt-ip>
    Physical Switch Mgmt0 IP Netmask=<ucs-mgmt-mask>
    Default Gateway=<ucs-mgmt-gateway>
    DNS Server=<dns-server-1-ip>
    Domain Name=<ad-dns-domain-name>

    Cluster Enabled=yes
    Cluster IP Address=<ucs-cluster-ip>

  Apply and save the configuration (select 'no' if you want to re-enter)? (yes/no): yes
  Applying configuration. Please wait.
```

Step 2. After applying the settings, make sure you can ping the fabric interconnect management IP address. When Fabric Interconnect A is correctly set up and is available, Fabric Interconnect B will automatically discover Fabric Interconnect A during its setup process as shown in the next step.

Step 3. **Configure Fabric Interconnect B (FI-B)**. For the configuration method, select **console**. Fabric Interconnect B will detect the presence of Fabric Interconnect A and will prompt you to enter the admin password for Fabric Interconnect A. Provide the management IP address for Fabric Interconnect B and apply the configuration.

```
Cisco UCS Fabric Interconnect B
Enter the configuration method. (console/gui) ? console

  Installer has detected the presence of a peer Fabric interconnect. This Fabric interconnect will be added to
the cluster. Continue (y/n) ? y

  Enter the admin password of the peer Fabric interconnect: <password>
    Connecting to peer Fabric interconnect... done
    Retrieving config from peer Fabric interconnect... done
    Peer Fabric interconnect Mgmt0 IPv4 Address: <ucsa-mgmt-ip>
    Peer Fabric interconnect Mgmt0 IPv4 Netmask: <ucs-mgmt-mask>
    Cluster IPv4 address          : <ucs-cluster-ip>

    Peer FI is IPv4 Cluster enabled. Please Provide Local Fabric Interconnect Mgmt0 IPv4 Address

  Physical Switch Mgmt0 IP address : <ucsb-mgmt-ip>

  Local fabric interconnect model(UCS-FI-6454)
  Peer fabric interconnect is compatible with the local fabric interconnect. Continuing with the installer…

  Apply and save the configuration (select 'no' if you want to re-enter)? (yes/no): yes
```

Procedure 2. Log into Cisco UCS Manager

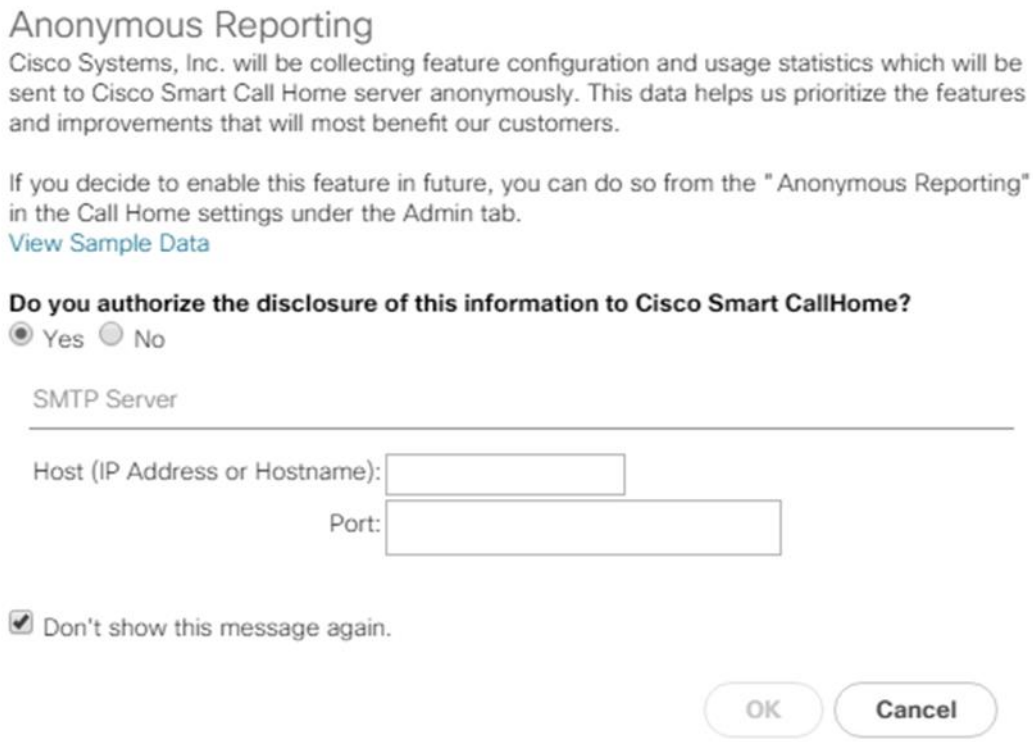
Note: It may take up to 5 minutes for Cisco UCS Manager to become available.

Step 1. Go to https://<ucs-cluster-ip> and click Launch UCS Manager.

Step 2. Enter admin for the Username and <password> for the Password. Click **Log In**.

Procedure 3. Enable Anonymous Reporting

Step 1. In the Anonymous Reporting window, decide whether to send anonymous data to Cisco for improving future products. If you select Yes, enter the IP address of your SMTP Server. Click **OK**.



Procedure 4. Upgrade Cisco UCS Manager Software to Version 4.2(3d)

This document assumes the use of Cisco UCS 4.2(3d). If you have not already upgraded, to upgrade the Cisco UCS Manager software and the Cisco UCS Fabric Interconnect software to version 4.2(3d), refer to Cisco UCS Manager Firmware Management Guide, Release 4.2.

If you used Cisco Intersight to upgrade to 4.2(3d), the Cisco UCS B and C-Series 4.2(3d) bundles need to be manually downloaded to the Cisco UCS system.

Procedure 5. Configure Cisco UCS Call Home

Note: It is highly recommended to configure Call Home in Cisco UCS Manager. Configuring Call Home will accelerate the resolution of support cases.

Step 1. In Cisco UCS Manager, click **Admin**.

Step 2. Select All > Communication Management > Call Home.

Step 3. Change the State to **On**.

Step 4. Fill in all the fields according to your Management preferences and click **Save Changes** and the click **OK** to complete configuring Call Home.

Procedure 6. Configure Password Encryption Key

It is likely that an "[FSM:FAILED]: internal system backup" Critical Alert has appeared in Cisco UCS Manager. To prevent this alert in the future, the Password Encryption should be configured.

Step 1. In Cisco UCS Manager, click **Admin**.

Step 2. Choose All > User Management > Locally Authenticated Users.

Step 3. Enter and Confirm a Password Encryption Key.

Step 4. Click **Save Changes** and **OK** to save the Password Encryption Key.

Step 5. Under Admin, choose All. Click Backup Configuration.

Step 6. Under Backup Operations, select the failed backup and click **Delete**, **Yes**, and **OK**.

Step 7. Click **OK** to close the Backup Configuration window. With the Password Encryption Key set, these automatic backups will successfully complete in the future.

Procedure 7. Configure Unified Ports (FCP) for Cisco UCS 6454

If you are configuring Fibre Channel in your configuration, complete this section. Fibre Channel port configurations differ between the Cisco UCS 6536. 6454, 6332-16UP and the 6248UP fabric interconnects. All fabric interconnects have a slider mechanism within the Cisco UCS Manager GUI interface, but the fibre channel port selection options for the 6454 are from the first 16 ports starting from the first port and configured in increments of 4 ports from the left. For the 6536 the port selections are from the last 4 ports on the right and utilize the 128G to 4x32G DS-SFP-4x32G-SW QSFP along with the fibre channel breakout harness. For the 6332-16UP the port selection options are from the first 16 ports starting from the first port, and configured in increments of the first 6, 12, or all 16 of the unified ports. With the 6248UP, the port selection options will start from the right of the 32 fixed ports, or the right of the 16 ports of the expansion module, going down in contiguous increments of 2. The remainder of this section shows configuration of the 6454. Modify as necessary for the 6536, 6332-16UP, or 6248UP.

Step 1. In Cisco UCS Manager, click **Equipment**.

Step 2. Click Equipment > Fabric Interconnects > Fabric Interconnect B (subordinate).

Step 3. Select Configure Unified Ports.

Step 4. Click **Yes** on the pop-up window warning that changes to the fixed module will require a reboot of the fabric interconnect and changes to the expansion module will require a reboot of that module.

Step 5. From Configured Fixed Ports move the gray slider bar from the left to the right to select either 4, 8, 12, or 16 ports to be set as FC Uplinks.

Configure Unified Ports

Instructions

The position of the slider determines the type of the ports.
All the ports to the left of the slider are Fibre Channel ports (Purple), while the ports to the right are Ethernet ports (Blue).

Port	Transport	If Role or Port Channel Membership	Desired If Role
Port 1	ether	Unconfigured	FC Uplink
Port 2	ether	Unconfigured	FC Uplink
Port 3	ether	Unconfigured	FC Uplink
Port 4	ether	Unconfigured	FC Uplink
Port 5	ether	Unconfigured	
Port 6	ether	Unconfigured	
Port 7	ether	Unconfigured	
Port 8	ether	Unconfigured	
Port 9	ether	Unconfigured	
Port 10	ether	Unconfigured	
Port 11	ether	Unconfigured	
Port 12	ether	Unconfigured	
Port 13	ether	Unconfigured	
Port 14	ether	Unconfigured	
Port 15	ether	Unconfigured	
Port 16	ether	Unconfigured	

OK Cancel

Step 6. Click **OK**, then click **Yes**, then click **OK** to continue.

Step 7. Click Equipment > Fabric Interconnects > Fabric Interconnect A (primary).

Step 8. Select Configure Unified Ports.

Step 9. From Configured Fixed Ports move the gray slider bar from the left to the right to select either 4 or 8 ports to be set as FC Uplinks.

Step 10. Click **Yes** in the warning that changes to the fixed module will require a reboot of the fabric interconnect and changes to the expansion module will require a reboot of that module.

Step 11. Click **OK**, then click **Yes**, then click **OK** to continue.

Step 12. Wait for both Fabric Interconnects to reboot.

Step 13. Log back into Cisco UCS Manager.

Procedure 8. Ansible Cisco UCS Manager Configuration

To configure the Cisco UCS from the Ansible management workstation, follow the steps in this procedure. The group_vars/ucs.yml file contains one important variable:

- vic_type – 4G or 5G – 5G is the latest 15000-series VICs while 4G is all previous generations

Step 1. Edit the following variable files to ensure proper UCS variables are entered:

- FlexPod-UCSM-VMware/FlexPod-UCSM-VMware/inventory
- FlexPod-UCSM-VMware/FlexPod-UCSM-VMware/group_vars/all.yml
- FlexPod-UCSM-VMware/FlexPod-UCSM-VMware/group_vars/ucs.yml
- FlexPod-UCSM-VMware/FlexPod-UCSM-VMware/roles/UCSM/UCSequipment/defaults/main.yml
- FlexPod-UCSM-VMware/FlexPod-UCSM-VMware/roles/UCSM/UCSadmin/defaults/main.yml
- FlexPod-UCSM-VMware/FlexPod-UCSM-VMware/roles/UCSM/UCSlan/defaults/main.yml
- FlexPod-UCSM-VMware/FlexPod-UCSM-VMware/roles/UCSM/UCSsan/defaults/main.yml
- FlexPod-UCSM-VMware/FlexPod-UCSM-VMware/roles/UCSM/UCSserver/defaults/main.yml

Note: It is critical when entering values in the variable files that either the FC and FC-NVMe NetApp LIF WWPNs or Infrastructure SVM iSCSI IQN be entered into the all.yml file so that UCS SAN boot and MDS device alias can be properly configured. LIF WWPNs can be queried by connecting to the NetApp cluster CLI interface and running "network interface show -vserver <svm-name>." If iSCSI SAN boot is being configured, the Infrastructure SVM's iSCSI IQN can be queried by running "vserver iscsi show -vserver <svm-name>."

Step 2. From FlexPod-UCSM-VMware/FlexPod-UCSM-VMware, run the Setup_UCS.yml Ansible playbook.

```
ansible-playbook ./Setup_UCS.yml -i inventory
```

Cisco UCS Manager Setup Completion

Complete the following procedures after performing an Ansible configuration of Cisco UCS.

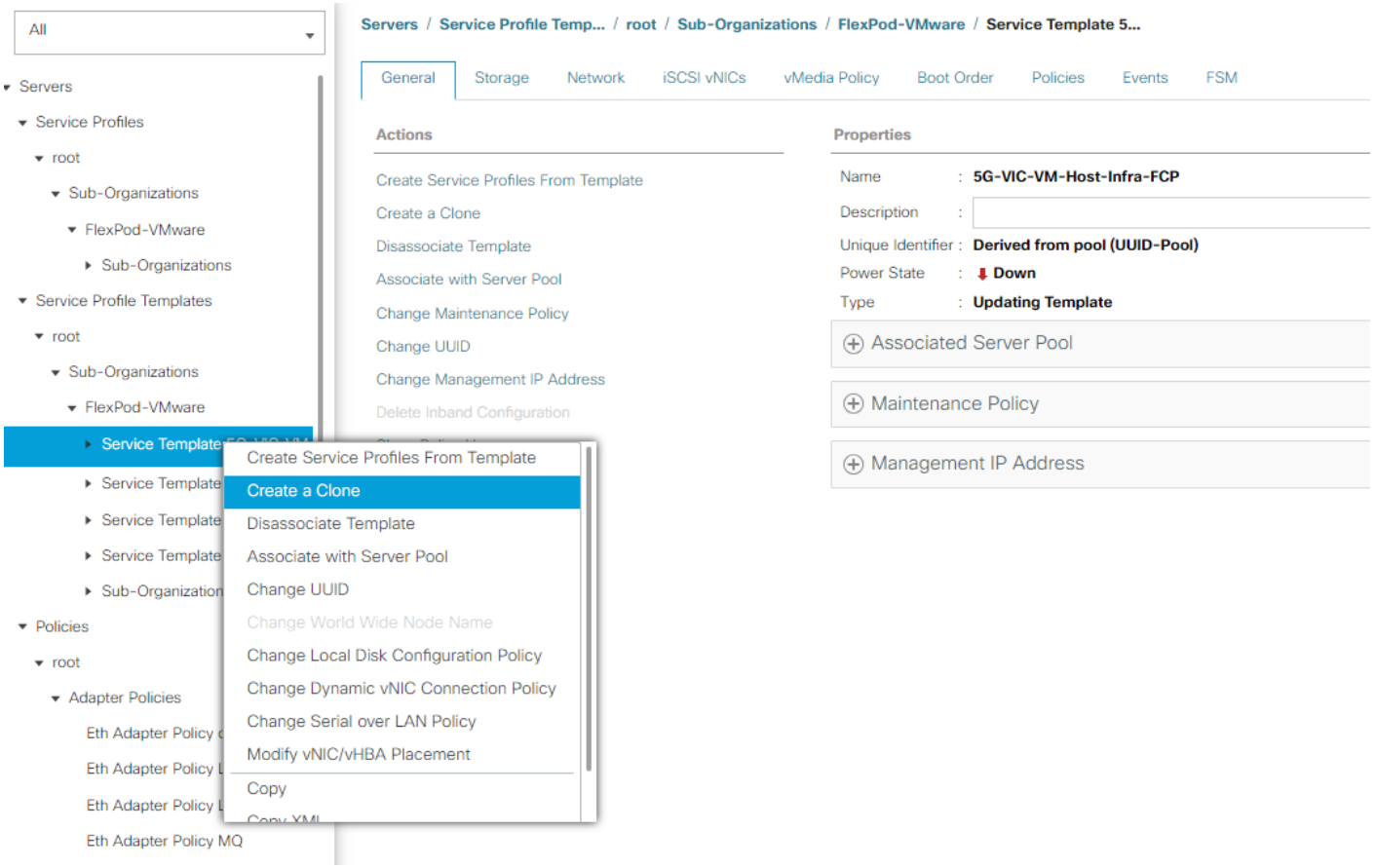
Procedure 1. Clone and Modify Service Profile Templates

In the Ansible configuration, a VIC type (4G or 5G) was specified, and templates were built with the LAN Connectivity policy for that VIC type. The Ansible scripts put in LAN Connectivity policies for both VIC types. If you have servers with both 4G and 5G VICs, you can clone the template created by the Ansible scripts and modify the cloned template with the LAN Connectivity policy for the other type of VIC. The templates created also include the virtualization BIOS policy for Intel M6 servers with Intel CPUs, but the Ansible scripts also put in virtualization BIOS policies for M5 servers with Intel CPUs, C125 (M5) servers with AMD CPUs, and M6 servers with AMD CPUs. Additionally, Persistent Memory Policies, were put in for both Memory Mode and App Direct Mode. Cloned Service Profile Templates can be modified for any of these additional features.

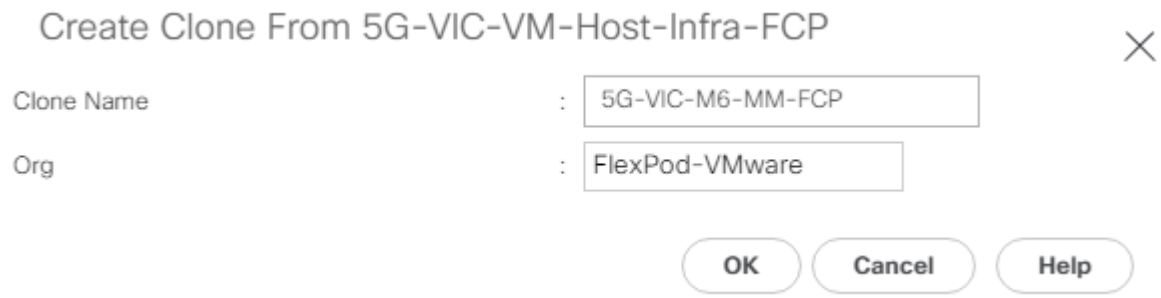
Step 1. In Cisco UCS Manager, go to Servers > Service Profile Templates > root > <FlexPod-Organization>, and select the appropriate Service Profile Template.

Note: Do not choose the -vM template. The -vM template will be created at the end of this section.

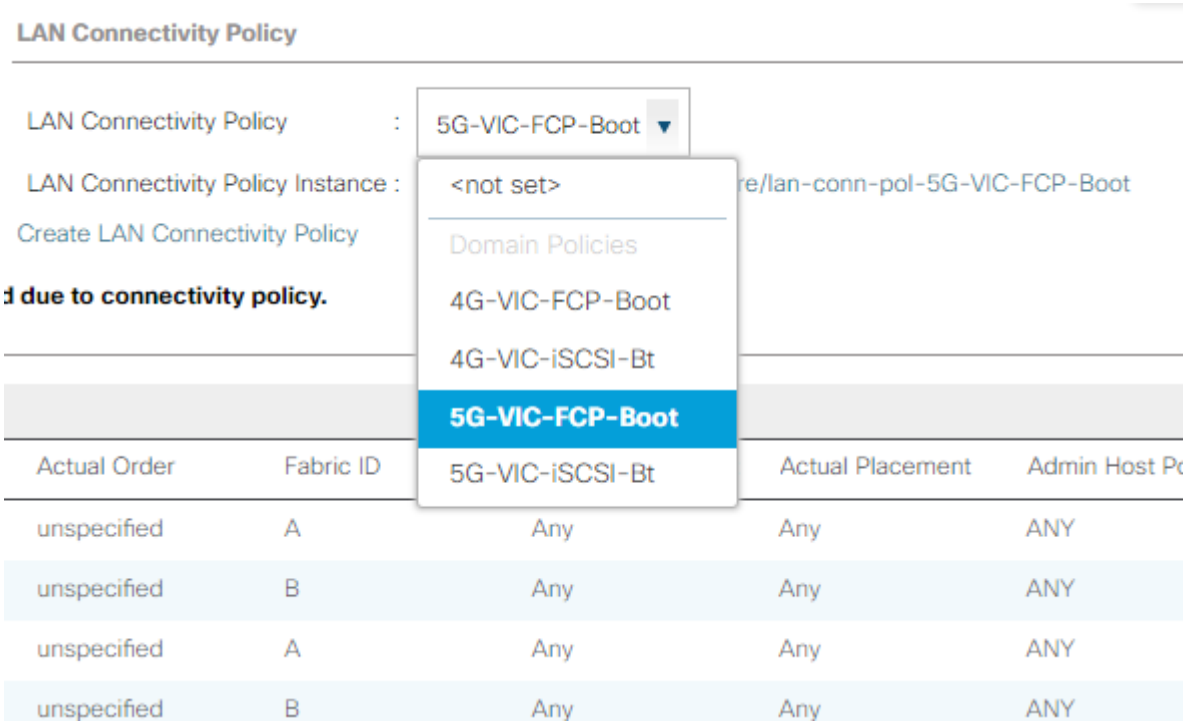
Step 2. Right-click the selected **Service Profile Template** and select **Create a Clone**.



Step 3. Provide an appropriate name for the cloned template and click **OK** and then click **OK** again.



Step 4. In the list under <FlexPod-Organization>, select the newly cloned template. In the center pane, select the **Network** tab. If necessary, select a different LAN Connectivity policy.

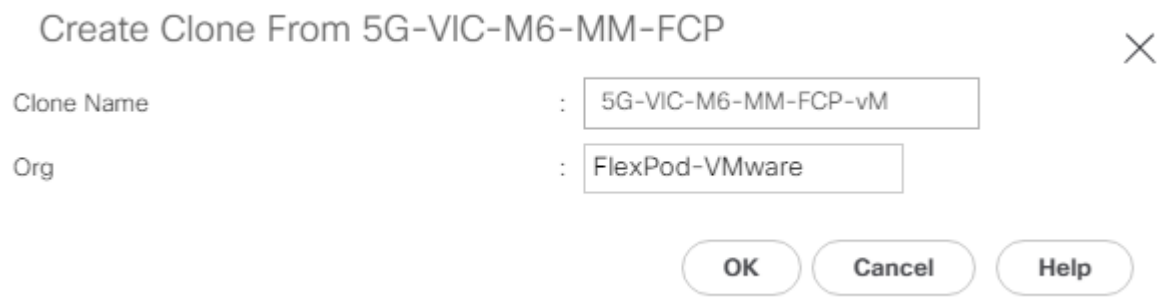


Step 5. Select the **Policies** tab. If the BIOS policy needs to be changed, expand **BIOS Policy,** and select the appropriate BIOS policy. If Intel Optane Persistent Memory is in use, expand **Persistent Memory Policy** and select the appropriate Persistent Memory Policy.

Step 6. If any changes were made to the cloned template, click **Save Changes,** and then click **OK**.

Step 7. To create the -vM (vMedia) version of the cloned template, right-click the cloned template and select **Create a Clone**.

Step 8. Use the same template name with -vM appended to the name. Click **OK** twice to create the clone.



Step 9. Select the newly created -vM clone and click the **vMedia Policy** tab.

Step 10. Click **Modify vMedia Policy**. Select the appropriate vMedia Policy and double-click **OK** to add the vMedia Policy to the template.

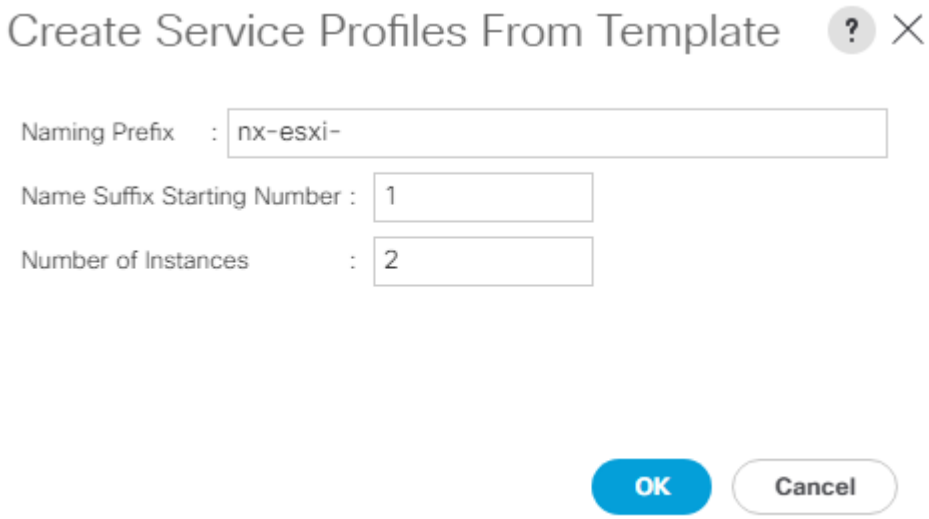
Step 11. Repeat this procedure to create any other needed cloned templates noting that if a 5G VIC LAN Connectivity policy is applied to a server with a 4G VIC, the process will fail because the 4G VIC does not support the 16K ring size used in the 5G VIC Ethernet Adapter policy.

Procedure 2. Create Service Profiles from Template

Step 1. In Cisco UCS Manager, go to **Servers** > **Service Profile Templates** > **root** > **Sub-Organizations** > **<FlexPod-Organization>**, and select the appropriate -vM Service Profile Template.

Step 2. Right-click the Service Profile Template and select **Create Service Profiles From Template**.

Step 3. Provide an appropriate Naming Prefix for the Service Profiles (it is recommended to use the server host names), a Name Suffix Starting Number, and the Number of Instances of Server Profiles. Click **OK**.



Step 4. If servers are available in the Server Pool attached to the template, servers will be selected from the pool and assigned to the Service Profiles. The Service Profiles will appear under Servers > Service Profiles > root > Sub-Organizations > <FlexPod-Organization>. Select each Service Profile created to monitor the server assignment status.

Step 5. Repeat this process to create all needed Service Profiles.

Note: The Service Profiles created here use the "-vM" Service Profile Templates, which have a vMedia policy mapping a VMware ESXi Installation ISO after the SAN Boot disks. Before an OS is installed on the server, the boot sequence will fall past the SAN Boot disks, since they are not yet bootable, and boot from the VMware ESXi Installation ISO. Once VMware ESXi is installed on the host servers, you can bind each server to the corresponding Service Profile Template without "-vM" to save resources.

Procedure 3. Claim Cisco UCS Domain into Intersight

Cisco Intersight can be used to monitor the FlexPod, install Cisco UCS Firmware, install OS software, and configure the FlexPod. The first step is to claim the Cisco UCS Domain into Intersight.

Step 1. If you have not already done so, go to **https://intersight.com** and click **Create an account**. If you already have an Intersight account, login and proceed with Step 17.

Step 2. Log in with either your Cisco ID or SSO ID.

Step 3. Select the appropriate Region and click **Next**.

Step 4. Read and accept the license agreement. Click **Next**.

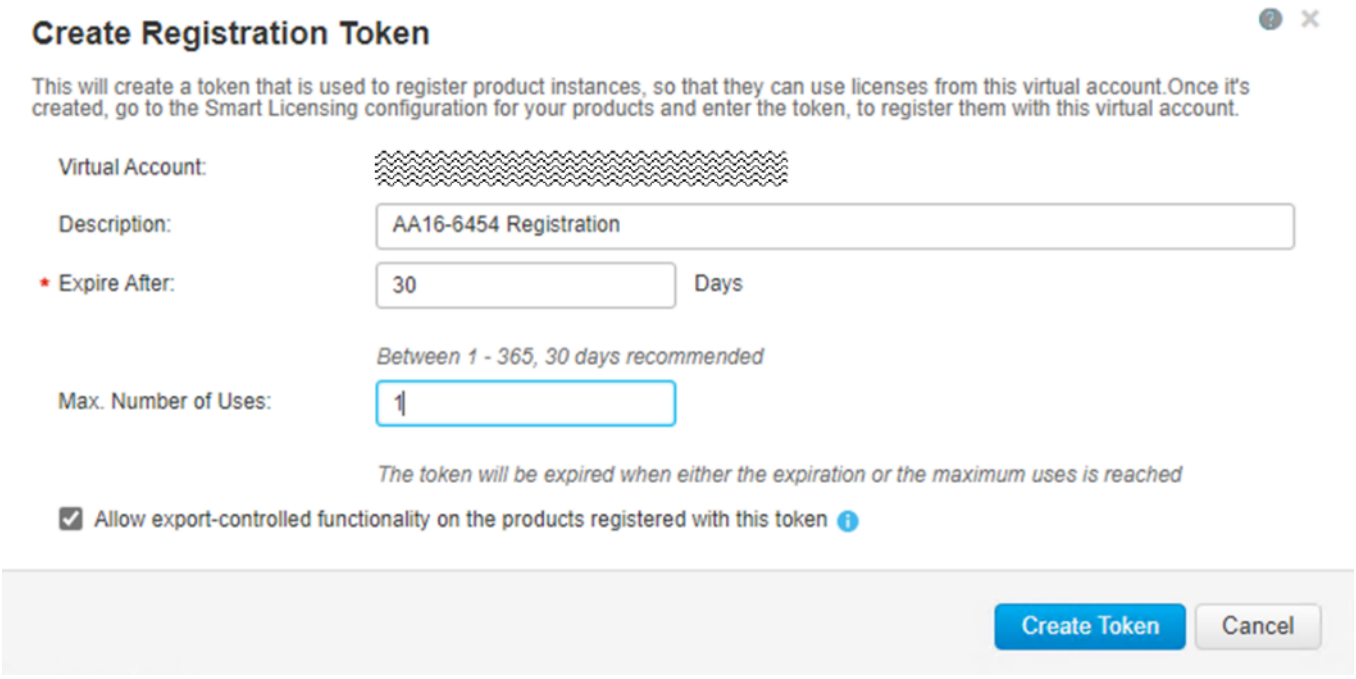
Step 5. Provide an Account Name and click **Create**.

Step 6. Either click **Start Trial** to setup a 90-day license trial or click **Register Smart Licensing** if you have purchased Intersight licenses and placed them in your Cisco Smart Account. This procedure will continue with Smart Licensing setup.

Step 7. In a separate browser window, log into the Cisco Smart Licensing portal: https://software.cisco.com/software/smart-licensing/inventory.

Step 8. Verify that the correct smart account and virtual account is selected.

Step 9. Under **Inventory** > **General**, generate a **New Token** for product registration. Click **Proceed**.



Step 10. Click **Create Token** to create the token.

Step 11. Copy this newly created token.

Step 12. From Cisco Intersight, paste the token under **Product Instance Registration Token**. Click **Next**.

Step 13. Optionally, leave Enable Subscription Information selected and click **Next**.

Step 14. Click **Allow** to enable subscription information.

Step 15. Select the products that you have purchased licenses for along with the appropriate tiers and click **Proceed**. Click **Confirm** to confirm these selections.

Step 16. Either step through Meet Intersight or click Skip.

Step 17. From the drop-down list, select **System**.

Step 18. Optionally, create a Resource Group for this FlexPod by clicking **Resource Groups** in the list under ACCESS @ PERMISSIONS. Click **Create Resource Group**. Provide a Name and optional Description. Leave Memberships at Custom. Click **Create** to create the Resource Group.

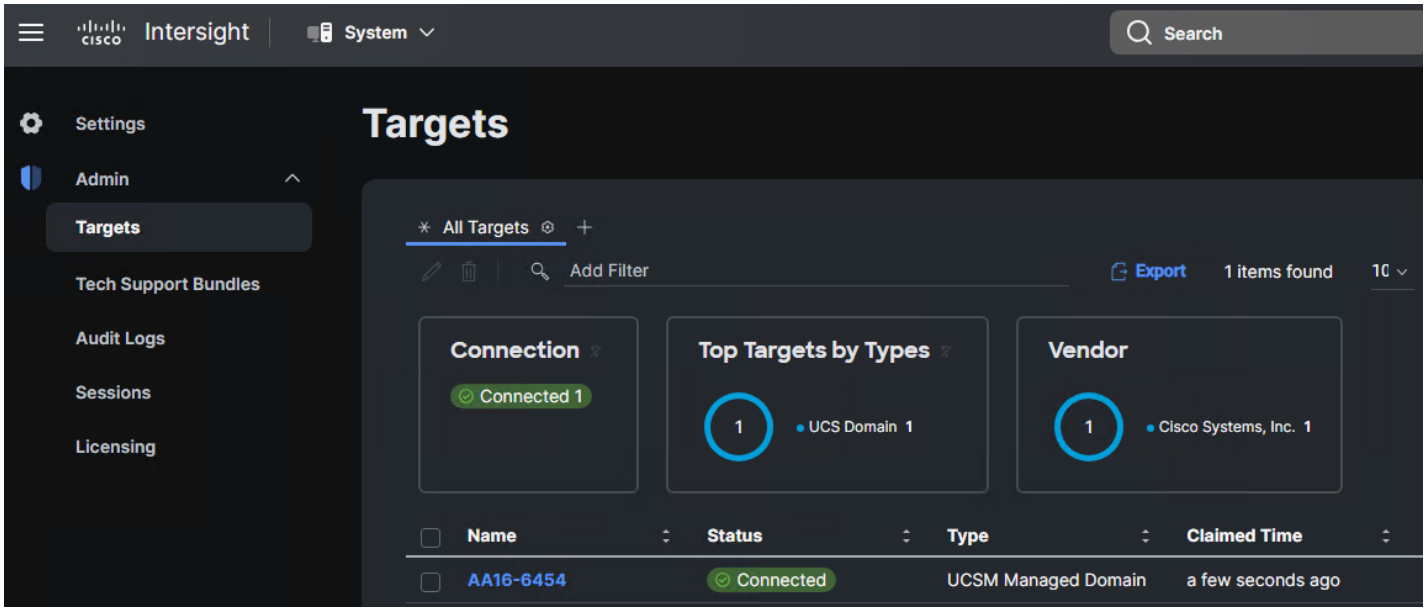
Step 19. If you created a Resource Group in the previous step, create an Organization for this FlexPod by clicking Organizations in the list under ACCESS @ PERMISSIONS. Click **Create Organization**. Provide a Name and

optional Description. Select the Resource Group created in the previous step. Click **Create** to create the Organization.

Step 20. Claim the UCS Manager UCS Domain Target. Select **Targets**. Click **Claim a New Target**.

Step 21. Click Cisco UCS Domain (UCSM Managed) and click Start.

Step 22. From Cisco UCS Manager, click **Admin** > **All** > **Device Connector**. Click the icon to the right of the Device ID to copy the Device ID to the clipboard. Paste the Device ID into the Device ID field in Intersight. Similarly, copy and paste the Claim Code into Intersight. If you created a Resource Group above, select that Resource Group and click **Claim** to claim the UCS Domain into Intersight.



SAN Switch Configuration

This chapter contains the following:

- Physical Connectivity
- FlexPod Cisco MDS Base

This chapter explains how to configure the Cisco MDS 9000s for use in a FlexPod environment. The configuration covered in this section is only needed when configuring Fibre Channel and FC-NVMe storage access.

Note: If FC connectivity is not required in the FlexPod deployment, this section can be skipped.

Note: If the Nexus 93180YC-FX switches are being used for SAN switching in this FlexPod Deployment, please refer to FlexPod with Cisco Nexus 93180YC-FX SAN Switching Configuration – Part 2 in the Appendix of this document.

Physical Connectivity

Follow the physical connectivity guidelines for FlexPod as explained in Physical Topology section.

FlexPod Cisco MDS Base

The following procedures describe how to configure the Cisco MDS switches for use in a base FlexPod environment. This procedure assumes you are using the Cisco MDS 9132T with NX-OS 9.3(2).

Procedure 1. Set up Cisco MDS 9132T A and 9132T B

Note: On initial boot and connection to the serial or console port of the switch, the NX-OS setup should automatically start and attempt to enter Power on Auto Provisioning. Enter y to get to the System Admin Account Setup.

Step 1. Configure the switch using the command line:

```
         ---- System Admin Account Setup ----


Do you want to enforce secure password standard (yes/no) [y]: Enter

Enter the password for "admin": <password>
Confirm the password for "admin": <password>

Would you like to enter the basic configuration dialog (yes/no): yes

Create another login account (yes/no) [n]: Enter

Configure read-only SNMP community string (yes/no) [n]: Enter

Configure read-write SNMP community string (yes/no) [n]: Enter

Enter the switch name : <mds-A-hostname>

Continue with Out-of-band (mgmt0) management configuration? (yes/no) [y]: Enter

Mgmt0 IPv4 address : <mds-A-mgmt0-ip>

Mgmt0 IPv4 netmask : <mds-A-mgmt0-netmask>

Configure the default gateway? (yes/no) [y]: Enter
```

```
IPv4 address of the default gateway : <mds-A-mgmt0-gw>

Configure advanced IP options? (yes/no) [n]: Enter

Enable the ssh service? (yes/no) [y]: Enter

Type of ssh key you would like to generate (dsa/rsa) [rsa]: Enter

Number of rsa key bits <1024-2048> [1024]: Enter

Enable the telnet service? (yes/no) [n]: Enter

Configure congestion/no_credit drop for fc interfaces? (yes/no)      [y]: Enter

Enter the type of drop to configure congestion/no_credit drop? (con/no) [c]: Enter

Enter milliseconds in multiples of 10 for congestion-drop for logical-type edge
in range (<200-500>/default), where default is 500.  [d]: Enter

Enable the http-server? (yes/no) [y]: Enter

Configure clock? (yes/no) [n]: Enter

Configure timezone? (yes/no) [n]: Enter

Configure summertime? (yes/no) [n]: Enter

Configure the ntp server? (yes/no) [n]: Enter

Configure default switchport interface state (shut/noshut) [shut]: Enter

Configure default switchport trunk mode (on/off/auto) [on]: auto

Configure default switchport port mode F (yes/no) [n]: y

Configure default zone policy (permit/deny) [deny]: Enter

Enable full zoneset distribution? (yes/no) [n]: y

Configure default zone mode (basic/enhanced) [basic]: Enter
```

Step 2. Review the configuration.

```
Would you like to edit the configuration? (yes/no) [n]: Enter
Use this configuration and save it? (yes/no) [y]: Enter
```

Step 3. To avoid possible timing errors with Ansible, perform a no shutdown on the FC interfaces connected to the Cisco UCS fabric interconnects.

```
config t
int fc1/5-6
no shutdown
copy r s
exit
```

Step 4. To set up the initial configuration of the Cisco MDS B switch, repeat steps 1-3 with appropriate host and IP address information.

Procedure 2. FlexPod Cisco MDS Switch Ansible Configuration

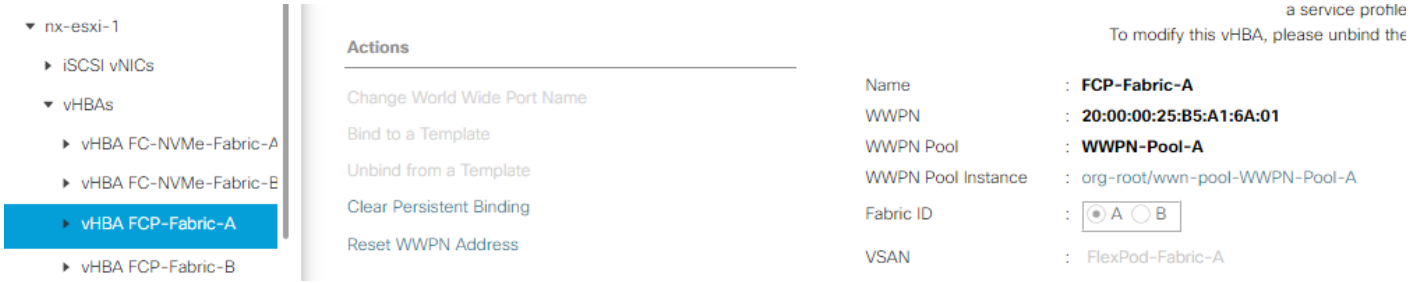
Step 1. Add MDS switch ssh keys to **/home/admin/.ssh/known_hosts**. Adjust known_hosts as necessary if errors occur.

```
ssh admin@<mds-A-mgmt0-ip>
exit
ssh admin@<mds-B-mgmt0-ip>
exit
```

Step 2. Edit the following variable files to ensure proper MDS variables are entered:

- FlexPod-UCSM-VMware/FlexPod-UCSM-VMware/inventory
- FlexPod-UCSM-VMware/FlexPod-UCSM-VMware/group_vars/all.yml
- FlexPod-UCSM-VMware/FlexPod-UCSM-VMware/host_vars/mdsA.yml
- FlexPod-UCSM-VMware/FlexPod-UCSM-VMware/host_vars/mdsB.yml
- FlexPod-UCSM-VMware/FlexPod-UCSM-VMware/roles/MDSconfig/defaults/main.yml

Note: The FC and FC-NVMe NetApp LIF WWPNs should have already been entered into the all.yml file so that MDS device aliases can be properly configured. The Cisco UCS server initiator WWPNs for both FC and FC-NVMe should also be entered into all.yml. To query these WWPNs, log into Cisco UCS Manager and select each of the server service profiles by going to Servers > Service Profiles > root > Sub-Organizations > <FlexPod-Organization> > <Service-Profile> > vHBAs. The needed WWPNs can be found under the vHBA Interfaces.



Step 3. From FlexPod-UCSM-VMware/FlexPod-UCSM-VMware, run the Setup_MDS.yml Ansible playbook.

```
ansible-playbook ./Setup_MDS.yml -i inventory
```

Step 4. Once the Ansible playbook has been run and configured both switches, it is important to configure the local time so that logging time alignment and any backup schedules are correct. For more information on configuring the timezone and daylight savings time or summertime, please see Cisco MDS 9000 Series Fundamentals Configuration Guide, Release 9.x. Sample clock commands for the United States Eastern timezone are:

```
clock timezone EST -5 0
clock summer-time EDT 2 Sunday March 02:00 1 Sunday November 02:00 60
copy running-config startup-config
```

Step 5. SSH into each switch and execute the following commands.

```
clock timezone <timezone> <hour-offset> <minute-offset>
clock summer-time <timezone> <start-week> <start-day> <start-month> <start-time> <end-week> <end-day> <end-month>
<end-time> <offset-minutes>
copy running-config startup-config
```

Step 6. Smart licensing should be setup in the MDS switches. For more information see Cisco MDS 9000 Series Licensing Guide, Release 9.x.

Storage Configuration – ONTAP Boot Storage Setup

This chapter contains the following:

This configuration requires information from both the UCS server profiles and NetApp storage system. After creating the boot LUNs, initiator groups, and appropriate mappings between the two, UCS server profiles will be able to see the boot disks hosted on NetApp controllers.

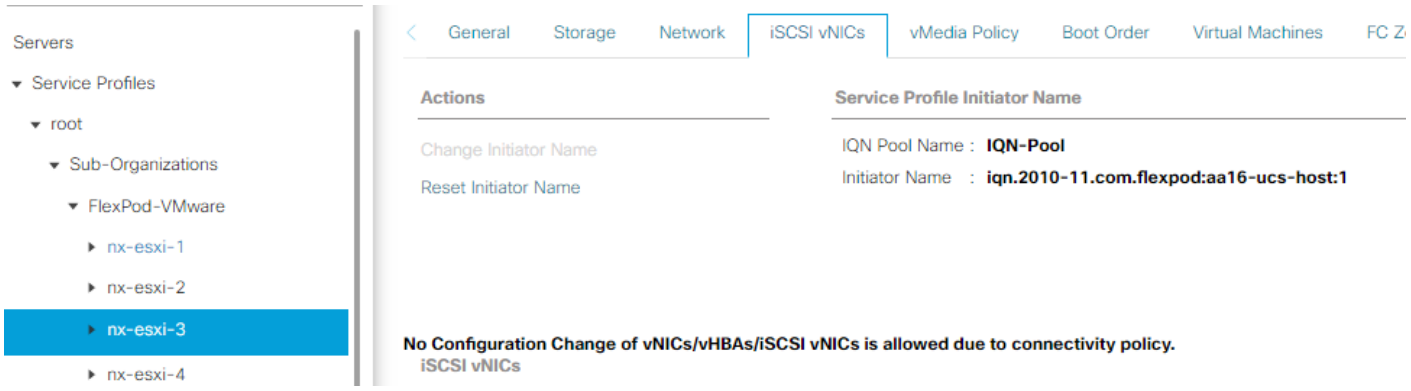
Ansible ONTAP Storage Configuration Part 2

Procedure 1. Obtain the WWPNs for UCS Server Profiles (required only for FC configuration)

Step 1. From the Cisco UCS Manager GUI, go to **Servers** > **Service Profiles** > **root** > **Sub-Organizations** > **<FlexPod-Organization>** > **<Service-Profile>** > **vHBAs**. Select each vHBA to find the WWPN information.

Procedure 2. Obtain the IQNs for UCS Server Profiles (required only for iSCSI configuration)

Step 1. From the UCS Manager GUI, go to **Servers** > **Service Profiles** > **root** > **Sub-Organizations** > **<FlexPod-Organization>** > **<Service-Profile>**. Click the **iSCSI vNICs** tab and you will find the IQN in the Initiator Name field.



Procedure 3. Configure ONTAP Boot Storage using Ansible

Step 1. Edit the following variable files to ensure the proper ONTAP Boot Storage variables are entered:

- FlexPod-UCSM-VMware/FlexPod-UCSM-VMware/group_vars/all.yml
- FlexPod-UCSM-VMware/FlexPod-UCSM-VMware/vars/ontap_main.yml

Step 2. Update the **boot_luns_iscsi** and **boot_luns_fcp** variables under vars/ontap_main.yml file for ISCSi and FCP boot storage configuration. Update the initiator **IQNs** and **WWPNs** related variables in group_vars/all.yml file. Initiator IQNs and WWPNs are for ISCSi and FCP igroups.

Step 3. From FlexPod-UCSM-VMware/FlexPod-UCSM-VMware, invoke the ansible scripts for this section using the following command:

```
ansible-playbook -i inventory Setup_ONTAP.yml -t ontap_config_part_2
```

VMware vSphere 8.0 Setup

This chapter contains the following:

VMware ESXi 8.0

This section provides detailed instructions for installing VMware ESXi 8.0 in a FlexPod environment. On successful completion of these steps, multiple ESXi hosts will be provisioned and ready to be added to VMware vCenter.

Several methods exist for installing ESXi in a VMware environment. These procedures focus on how to use the built-in keyboard, video, mouse (KVM) console and virtual media features in Cisco Intersight to map remote installation media to individual servers.

Download ESXi 8.0 from VMware

Procedure 1. Download VMware ESXi ISO (Optional)

Step 1. Click the following link: Cisco Custom Image for ESXi 8.0 Install CD.

Note: You will need a VMware user id and password on vmware.com to download this software.

Step 2. Download the **.iso** file.

Access Cisco UCS Manager and Launch KVM

The Cisco UCS Manager KVM enables the administrators to begin the installation of the operating system (OS) through vMedia connection to the Cisco Custom ISO.

Procedure 1. Log into Cisco UCS Manager and Launch KVM

In this procedure, the CIMC-mapped Cisco Custom ISO that mapped in the vMedia Policy in the Service Profile is being used to mount the Cisco Custom ISO and install VMware ESXi. An alternative method is to mount the ISO as a KVM-mounted ISO in the server console and install the OS from that ISO.

Step 1. Log into **Cisco UCS Manager**.

Step 2. Go to **Servers** > **Service Profiles** > **root** > **Sub-Organizations** > <**FlexPod-Organization**> > <**Service-Profile**>.

Step 3. Right-click the Service Profile and select **KVM Console**. Click **Load KVM Certificate**. Navigate the security prompts to launch the console.

Note: The use of a "-vM" Service Profile template, maps a copy of the Cisco Custom ISO Image to the server just after the SAN Boot disks. When you boot the server the first time, it will boot from this Cisco Custom ISO Image.

Step 4. Launch **KVM consoles** for all servers being provisioned.

Step 5. In each KVM console, select **Power** > **Power On System** and click **Confirm**.

Set up VMware ESXi Installation

Procedure 1. Prepare the Server for the OS Installation

Note: Follow these steps on **each** ESXi host.

Step 1. Monitor the server boot process in the KVM. The server should find the boot LUNs and begin to load the ESXi installer.

Note: If the ESXi installer fails to load because the software certificates cannot be validated, reset the server, and when prompted, press F2 to go into BIOS and set the system time and date to current. The ESXi installer should load properly.

Install VMware ESXi

Procedure 1. Install VMware ESXi onto the bootable LUN of the UCS Servers

Note: Follow these steps on **each** host.

Step 1. After the ESXi installer is finished loading (from the last step), press **Enter** to continue with the installation.

Step 2. Read and accept the end-user license agreement (EULA). Press **F11** to accept and continue.

Note: It may be necessary to map function keys as User Defined Macros under the Macros menu in the KVM console.

Step 3. Select the NetApp boot LUN that was previously set up as the installation disk for ESXi and press **Enter** to continue with the installation.

Step 4. Select the appropriate keyboard layout and press **Enter**.

Step 5. Enter and confirm the root password and press **Enter**.

Step 6. The installer issues a warning that the selected disk will be repartitioned. Press **F11** to continue with the installation.

Step 7. After the installation is complete, press **Enter** to reboot the server.

Set up Management Networking for ESXi Hosts

Procedure 1. Add the Management Network for each VMware Host

Note: This is required for managing the host. To configure ESXi host with access to the management network, follow these steps on **each** ESXi host.

Step 1. After the server has finished rebooting, in the UCS KVM console, press **F2** to customize VMware ESXi.

Step 2. Log in as root, enter the password set during installation, and press **Enter** to log in.

Step 3. Use the down arrow key to select **Troubleshooting Options** and press **Enter**.

Step 4. Select **Enable ESXi Shell** and press Enter.

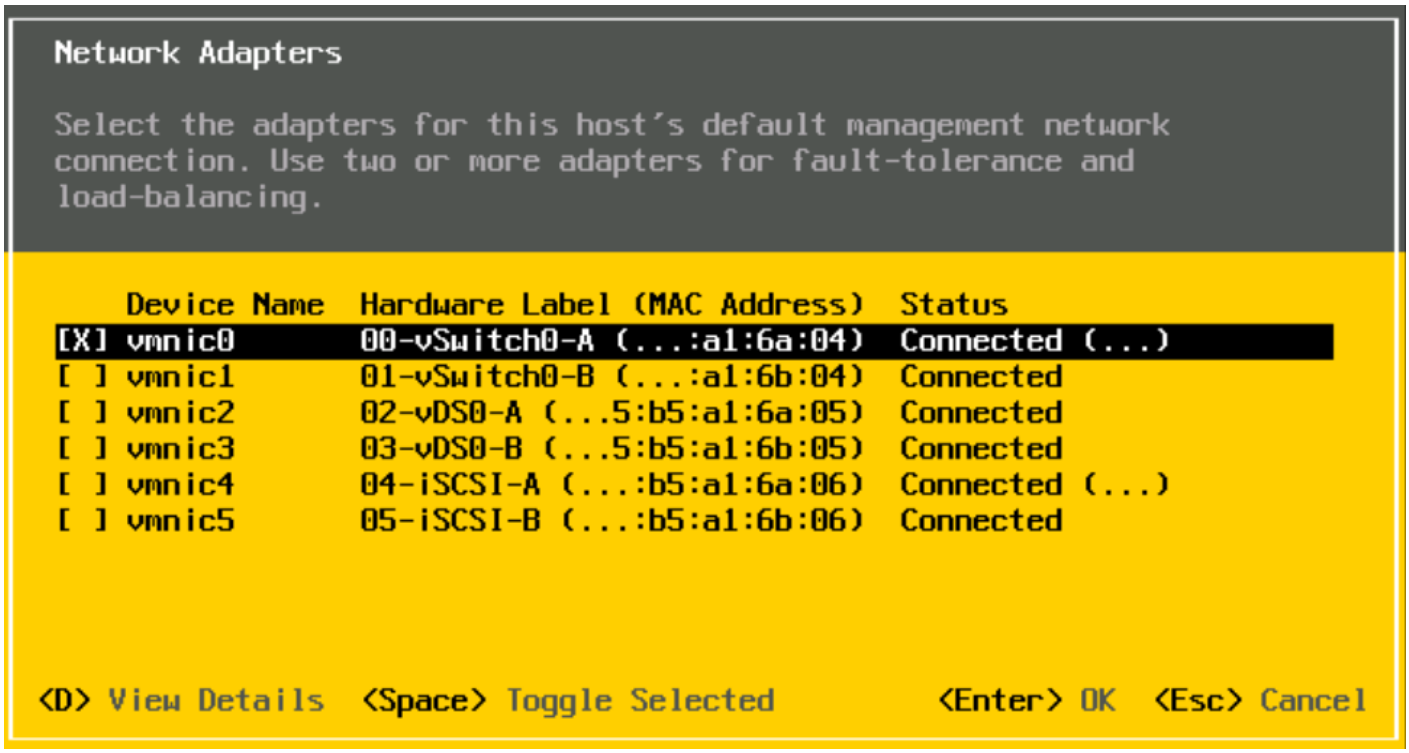
Step 5. Select **Enable SSH** and press **Enter**.

Step 6. Press **Esc** to exit the Troubleshooting Options menu.

Step 7. Select the Configure Management Network option and press Enter.

Step 8. Select Network Adapters and press **Enter**. Ensure the vmnic numbers align with the numbers under the Hardware Label (for example, vmnic0 and 00-vSwitch0-A). If these numbers do not align, note which vmnics are assigned to which vNICs (indicated under Hardware Label).

Note: In previous FlexPod CVDs, vmnic1 was selected at this stage as the second adapter in vSwitch0. It is important not to select vmnic1 at this stage. If using the Ansible configuration and vmnic1 is selected here, the Ansible playbook will fail.



Step 9. Press **Enter**.

Note: In the UCS Configuration portion of this document, the IB-MGMT VLAN was set as the native VLAN on the 00-vSwitch0-A and 01-vSwitch0-B vNICs. Because of this, the IB-MGMT VLAN should not be set here and should remain **Not set**.

Step 10. Select IPv4 Configuration and press Enter.

Note: When using DHCP to set the ESXi host networking configuration, setting up a manual IP address is not required.

Step 11. Select the **Set static IPv4 address and network configuration** option by using the arrow keys and space bar.

Step 12. Under **IPv4 Address**, enter the IP address for managing the ESXi host.

Step 13. Under **Subnet Mask**, enter the subnet mask.

Step 14. Under **Default Gateway**, enter the default gateway.

Step 15. Press **Enter** to accept the changes to the IP configuration.

Note: In previous versions of this CVD, IPv6 was disabled at this point. That is no longer necessary as the Ansible scripts will disable IPv6.

Step 16. Select the **DNS Configuration** option and press **Enter**.

Note: If the IP address is configured manually, the DNS information must be provided.

Step 17. Using the spacebar, select Use the following DNS server addresses and hostname.

Step 18. Under **Primary DNS Server**, enter the IP address of the primary DNS server.

Step 19. Optional: Under **Alternate DNS Server,** enter the IP address of the secondary DNS server.

Step 20. Under **Hostname**, enter the fully qualified domain name (FQDN) for the ESXi host.

Step 21. Press **Enter** to accept the changes to the DNS configuration.

Step 22. Press **Esc** to exit the Configure Management Network submenu.

Step 23. Press **Y** to confirm the changes and restart the management network.

Step 24. Back in the System Customization menu, use the arrow keys to select **Test Management Network** and press **Enter**.

Step 25. Press **Enter** to run the test.

Step 26. It is normal the first time the test is run for the first ping to fail. The test can be run again to see all fields pass, or if the remaining fields pass, press **Enter**.

Step 27. Press **Esc** to exit the System Customization menu.

Step 28. Repeat this procedure for all installed ESXi hosts.

Procedure 2. (Optional) Reset VMware ESXi Host VMkernel Port MAC Address

Note: By default, the MAC address of the management VMkernel port vmk0 is the same as the MAC address of the Ethernet port it is placed on. If the ESXi host's boot LUN is remapped to a different server Service Profile with different MAC addresses, a MAC address conflict will exist because vmk0 will retain the assigned MAC address unless the ESXi System Configuration is reset.

Step 1. From the ESXi console menu main screen, select **Macros** > **Static Macros** > **Ctrl + Alt + F** > **Ctrl + Alt + F1** to access the VMware console command line interface.

Step 2. Log in as **root**.

Step 3. Type "`esxcfg-vmknic -l`" to get a detailed listing of interface vmk0. vmk0 should be a part of the "Management Network" port group. Note the IP address and netmask of vmk0.

Step 4. To remove vmk0, type `esxcfg-vmknic -d "Management Network"`.

Step 5. To re-add vmk0 with a random MAC address, type `esxcfg-vmknic –a –i <vmk0-ip> -n <vmk0-netmask> “Management Network”`.

Step 6. Verify vmk0 has been re-added with a random MAC address by typing `esxcfg-vmknic –l`.

Step 7. Tag vmk0 as the management interface by typing `esxcli network ip interface tag add -i vmk0 -t Management`.

Step 8. When vmk0 was re-added, if a message pops up saying vmk1 was marked as the management interface, type `esxcli network ip interface tag remove -i vmk1 -t Management`.

Step 9. Press Ctrl-D to log out of the ESXi console.

Step 10. Select Macros > Static Macros > Ctrl + Alt + F’s > Ctrl + Alt + F2 to return to the VMware ESXi menu.

Cisco Intersight Hardware Compatibility List (HCL) Status

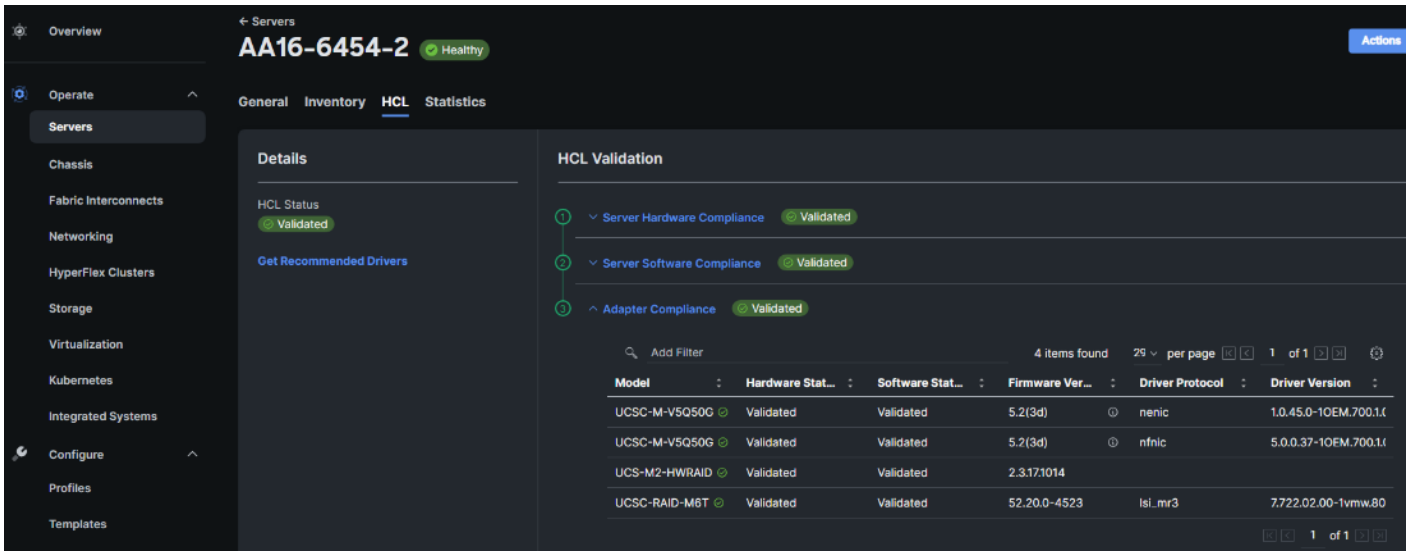
Cisco Intersight evaluates the compatibility your UCS system to check if the hardware and software have been tested and validated by Cisco or Cisco partners. Intersight reports validation issues after checking the compatibility of the server model, processor, firmware, adapters, operating system, and drivers, and displays the compliance status with the Hardware Compatibility List (HCL).

To determine HCL compatibility for VMware ESXi, Cisco Intersight uses Cisco UCS Tools. The Cisco UCS Tools is part of VMware ESXi Cisco custom ISO, and no additional configuration is required.

For more details on Cisco UCS Tools manual deployment and troubleshooting, refer to:
https://intersight.com/help/saas/resources/cisco_ucs_tools#about_cisco_ucs_tools

Procedure 1. View Compute Node Hardware Compatibility

Step 1. To find detailed information about the hardware compatibility of a compute node, in Cisco Intersight, click **Infrastructure Service** > **Operate** > **Servers**, click a server, select **HCL**.



Step 2. If any of the drivers do not show Validated under Software Status, use this information to properly fill in the FlexPod-UCSM-VMware/FlexPod-UCSM-VMware/roles/VMware/ESXIhosts/defaults/main.yml file below.

FlexPod VMware ESXi Ansible Configuration

Procedure 1. Use Ansible to Configure All VMware ESXi Hosts from the Management Workstation

Step 1. Edit the following variable files to ensure proper VMware variables are entered:

- FlexPod-UCSM-VMware/FlexPod-UCSM-VMware/inventory
- FlexPod-UCSM-VMware/FlexPod-UCSM-VMware/group_vars/all.yml
- FlexPod-UCSM-VMware/FlexPod-UCSM-VMware/roles/VMware/ESXIhosts/defaults/main.yml
- FlexPod-UCSM-VMware/FlexPod-UCSM-VMware/roles/VMware/ESXIiscsi/defaults/main.yml (If using iSCSI boot)

Step 2. From FlexPod-UCSM-VMware/FlexPod-UCSM-VMware, run the Setup_ESXi.yml Ansible playbook:

```
ansible-playbook ./Setup_ESXi.yml -i inventory
```

VMware vCenter 8.0

The procedures in the following sections provide detailed instructions for installing the VMware vCenter 7.0U3h Server Appliance in a FlexPod environment.

Procedure 1. Download vCenter 8.0 from VMware

Step 1. Click this link: https://customerconnect.vmware.com/downloads/details?downloadGroup=VC800C&productId=1345&rPId=108068 and download the VMware-VCSA-all-8.0.0-21457384.iso.

Note: You will need a VMware user id and password on vmware.com to download this software.

Procedure 2. Install the VMware vCenter Server Appliance

Note: The VCSA deployment consists of 2 stages: installation and configuration.

Step 1. Locate and copy the **VMware-VCSA-all-8.0.0-21457384.iso** file to the desktop of the management workstation. This ISO is for the VMware vSphere 8.0 vCenter Server Appliance.

Step 2. Mount the ISO image as a disk on the management workstation. For example, with the Mount command in Windows Server 2012 and above.

Step 3. In the mounted disk directory, navigate to the **vcsa-ui-installer > win32** directory and double-click `installer.exe`. The vCenter Server Appliance Installer wizard appears.

Step 4. Click **Install** to start the vCenter Server Appliance deployment wizard.

Step 5. Click **NEXT** in the Introduction section.

Step 6. Read and accept the license agreement and click **NEXT**.

Step 7. In the “vCenter Server deployment target” window, enter the FQDN or IP address of the destination host, User name (root) and Password. Click **NEXT**.

Note: Installation of vCenter on a separate existing management infrastructure vCenter is recommended. If a separate management infrastructure is not available, customers can choose the recently configured first ESXi host as an installation target. The recently configured ESXi host is used in this deployment.

Step 8. Click **YES** to accept the certificate.

Step 9. Enter the Appliance VM name and password details shown in the Set up vCenter Server VM section. Click **NEXT**.

Step 10. In the Select deployment size section, select the Deployment size and Storage size. For example, select “Small” and “Default.” Click **NEXT**.

Step 11. Select the datastore (for example, infra_datastore) for storage. Click **NEXT**.

Step 12. In the Network Settings section, configure the following settings:

a. Select a Network: (for example, **IB-MGMT Network**)

Note: When the vCenter is running on the FlexPod, it is important that the vCenter VM stay on the IB-MGMT Network on vSwitch0 and not moved to a vDS. If vCenter is moved to a vDS and the virtual environment is completely shut down and then brought back up, trying to bring up vCenter on a different host than the one it was running on before the shutdown will cause problems with the network connectivity. With the vDS, for a virtual machine to move from one host to another, vCenter must be up and running to coordinate the move of the virtual ports on the vDS. If vCenter is down, the port move on the vDS cannot occur correctly. Moving vCenter to a different host on vSwitch0 does not require vCenter to already be up and running. If this vCenter is running in a different management environment, it is fine to have its’ networking on a vDS.

b. IP version: **IPV4**

c. IP assignment: **static**

d. FQDN: <vcenter-fqdn>

e. IP address: <**vcenter-ip**>

f. Subnet mask or prefix length: <**vcenter-subnet-mask**>

g. Default gateway: <**vcenter-gateway**>

h. DNS Servers: <dns-server1>,<dns-server2>

Step 13. Click **NEXT**.

Step 14. Review all values and click **FINISH** to complete the installation.

Note: The vCenter Server appliance installation will take a few minutes to complete.

Step 15. When Stage 1, Deploy vCenter Server, is complete, Click **CONTINUE** to proceed with stage 2.

Step 16. Click **NEXT**.

Step 17. In the vCenter Server configuration window, configure these settings:

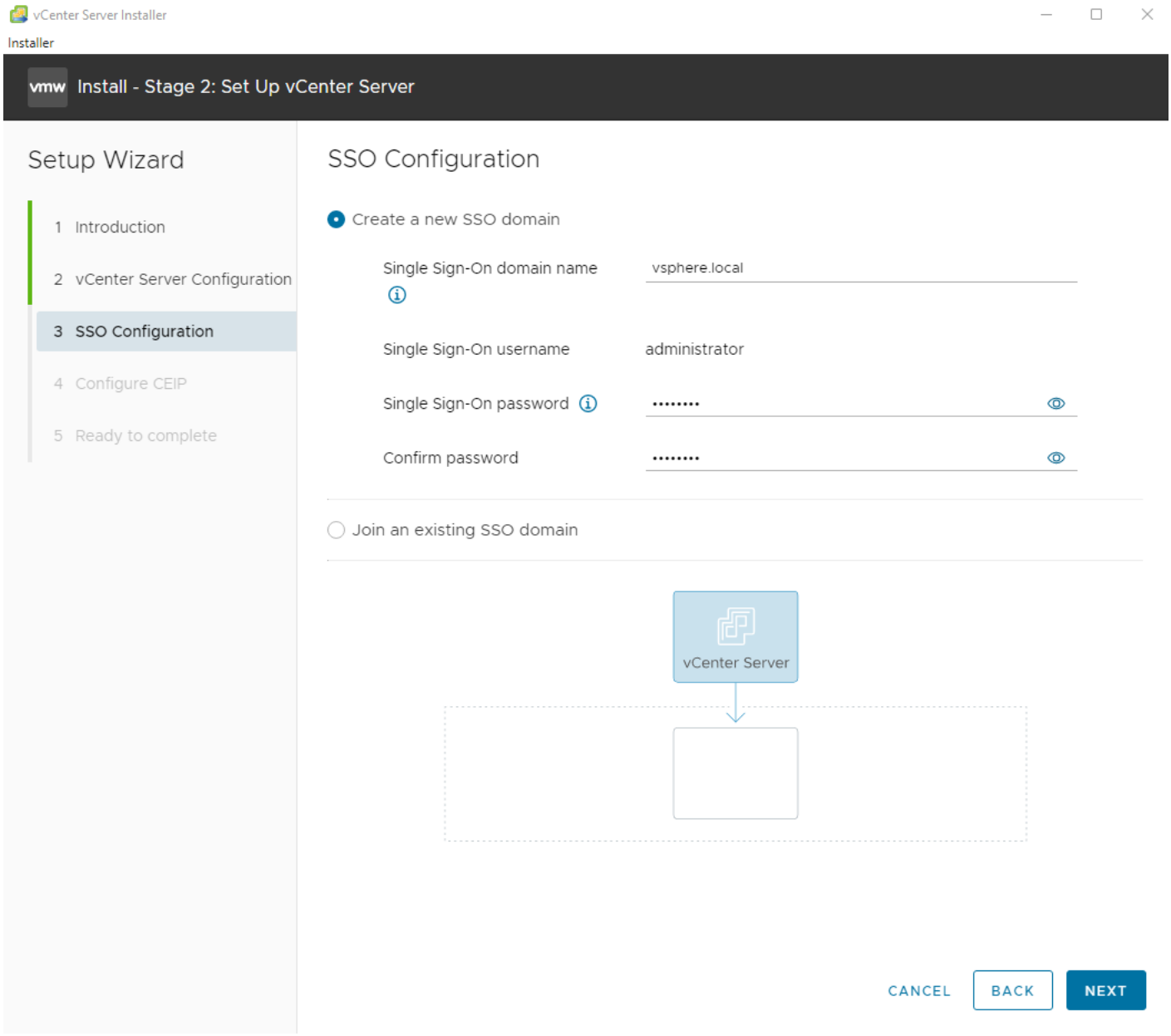
a. Time Synchronization Mode: Synchronize time with NTP servers.

b. NTP Servers: NTP server IP addresses from IB-MGMT VLAN

c. SSH access: Activated.

Step 18. Click **NEXT**.

Step 19. Complete the SSO configuration as shown below (or according to your organization's security policies):



Step 20. Click **NEXT**.

Step 21. Decide whether to join VMware's Customer Experience Improvement Program (CEIP).

Step 22. Click **NEXT**.

Step 23. Review the configuration and click **FINISH**.

Step 24. Click **OK**.

Note: vCenter Server setup will take a few minutes to complete and Install – Stage 2 with show Complete.

Step 25. Click **CLOSE**. Eject or unmount the VCSA installer ISO.

Procedure 3. Verify vCenter CPU Settings

Note: If a vCenter deployment size of Small or larger was selected in the vCenter setup, it is possible that the VCSA's CPU setup does not match the Cisco UCS server CPU hardware configuration. Cisco UCS C-Series M6 and B200 M6 servers are 2-socket servers. During this validation, the Small deployment size was selected and vCenter was setup for a 4-socket server. This setup can cause issues in the VMware ESXi cluster Admission Control.

Step 1. Open a web browser on the management workstation and navigate to the vCenter or ESXi server where the vCenter appliance was deployed and login.

Step 2. Click the **vCenter VM**, right-click and click **Edit settings**.

Step 3. In the **Edit settings** window, expand CPU and check the value of Sockets.

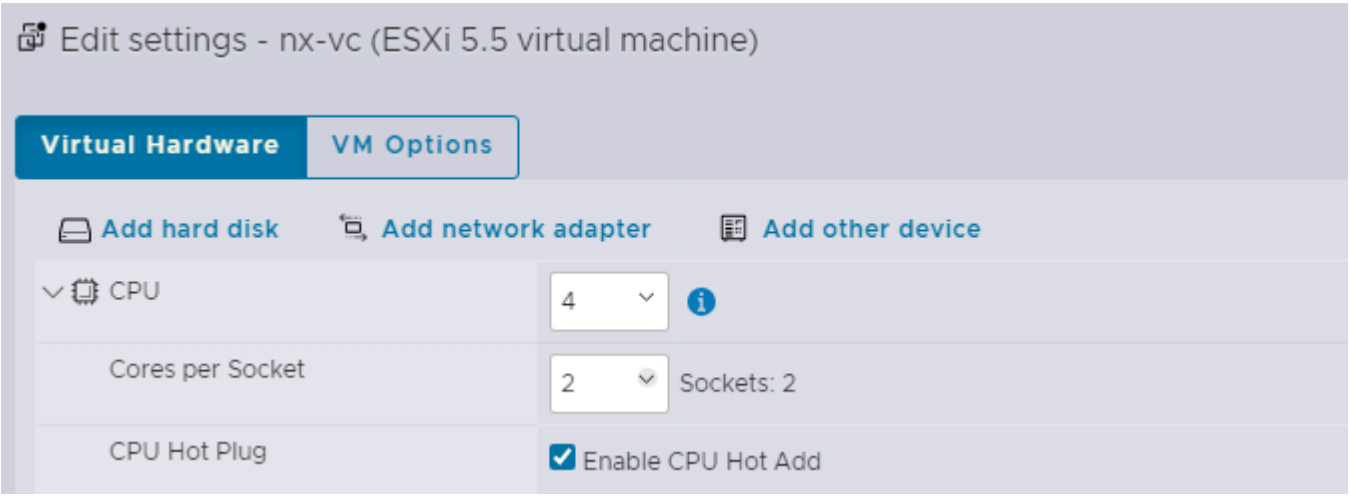
Step 4. If the number of Sockets match the server configuration, click **Cancel**.

Step 5. If the number of Sockets does not match the server configuration, it will need to be adjusted:

a. Right-click the vCenter VM and click **Guest OS** > **Shut down**. Click **Yes** on the confirmation.

b. When vCenter is shut down, right-click the vCenter VM and click **Edit settings**.

c. In the Edit settings window, expand CPU and change the Cores per Socket value to make the Sockets value equal to the server configuration.



Step 6. Click **SAVE.**

Step 7. Right-click the vCenter VM and click **Power** > **Power on**. Wait approximately 10 minutes for vCenter to come up.

Procedure 4. Setup VMware vCenter Server

Step 1. Using a web browser, navigate to **https://<vcenter-ip-address>:5480**. Navigate the security screens.

Step 2. Log into the **VMware vCenter Server Management** interface as **root** with the root password set in the vCenter installation.

Step 3. In the menu on the left, click **Time**.

Step 4. Click **EDIT** to the right of Time zone.

Step 5. Select the appropriate Time zone and click **SAVE**.

Step 6. In the menu on the left select **Administration**.

Step 7. According to your Security Policy, adjust the settings for the root user and password.

Step 8. In the menu on the left click **Update**.

Step 9. Follow the prompts to stage and install any available vCenter 8.0 (not 8.0U1) updates.

Step 10. In the upper right-hand corner of the screen, click **root > Logout** to logout of the Appliance Management interface.

Step 11. Using a web browser, navigate to https://<vcenter-fqdn> and navigate through security screens.

Note: With VMware vCenter 7.0 and above, you must use the vCenter FQDN.

Step 12. Select LAUNCH VSPHERE CLIENT.

Step 13. Log in using the Single Sign-On username (administrator@vsphere.local) and password created during the vCenter installation. Dismiss the Licensing warning.

Procedure 5. Add AD User Authentication to vCenter (Optional)

Step 1. In the **AD Infrastructure**, using the Active Directory Users and Computers tool, setup a Domain Administrator user with a user name such as flexadmin (FlexPod Admin).

Step 2. Connect to **https://<vcenter-fqdn>** and select **LAUNCH VSPHERE CLIENT**.

Step 3. Log in as **administrator@vsphere.local** (or the SSO user set up in vCenter installation) with the corresponding password.

Step 4. Under the top-level menu, click **Administration**. In the list on the left, under **Single Sign On**, select **Configuration.**

Step 5. In the center pane, under **Configuration**, select the **Identity Provider** tab.

Step 6. In the list under **Type**, select **Active Directory Domain**.

Step 7. Click **JOIN AD**.

Step 8. Fill in the AD domain name, the Administrator user, and the domain Administrator password. Do not fill in an Organizational unit. Click **JOIN**.

Step 9. Click Acknowledge.

Step 10. In the list on the left under **Deployment**, click **System Configuration**. Select the radio button to select the vCenter, then click **REBOOT NODE**.

Step 11. Input a reboot reason and click **REBOOT**. The reboot will take approximately 10 minutes for full vCenter initialization.

Step 12. Log back into the vCenter vSphere Client as Administrator@vsphere.local.

Step 13. Under the top-level menu, click **Administration**. In the list on the left, under **Single Sign On**, click **Configuration**.

Step 14. In the center pane, under **Configuration**, click **the Identity Provider** tab. Under **Type**, select **Identity Sources**. Click **ADD**.

Step 15. Make sure Active Directory (Integrated Windows Authentication) is selected, your Windows Domain name is listed, and Use machine account is selected. Click **ADD**.

Step 16. In the list select the **Active Directory (Integrated Windows Authentication)** Identity source type. If desired, select **SET AS DEFAULT** and click **OK**.

Step 17. On the left under Access Control, select **Global Permissions**.

Step 18. In the center pane, click **ADD** to add a Global Permission.

Step 19. In the **Add Permission** window, select your AD domain for the Domain.

Step 20. In the User/Group line, enter either the FlexPod Admin username or the Domain Admins group. Leave the Role set to Administrator. Check the box for **Propagate to children**.

Note: The FlexPod Admin user was created in the Domain Admins group. The selection here depends on whether the FlexPod Admin user will be the only user used in this FlexPod or if additional users will be added later. By selecting the Domain Admins group, any user placed in that AD Domain group will be able to login to vCenter as an Administrator.

Step 21. Click **OK** to add the selected User or Group. The user or group should now appear in the Global Permissions list with the Administrator role.

Step 22. Log out and log back into the vCenter HTML5 Client as the FlexPod Admin user. You will need to add the domain name to the user, for example, flexadmin@domain if you did not make your AD Domain the default domain.

vCenter and ESXi Ansible Setup

Procedure 1. Configure the VMware vCenter and the three management ESXi hosts

Step 1. Edit the following variable files to ensure proper VMware variables are entered:

- FlexPod-UCSM-VMware/FlexPod-UCSM-VMware/inventory
- FlexPod-UCSM-VMware/FlexPod-UCSM-VMware/group_vars/all.yml
- FlexPod-UCSM-VMware/FlexPod-UCSM-VMware/roles/VMware/ESXIpostvC/defaults/main.yml
- FlexPod-UCSM-VMware/FlexPod-UCSM-VMware/roles/VMware/ESXIpostvCiscsi/defaults/main.yml

Step 2. From FlexPod-UCSM-VMware/FlexPod-UCSM-VMware, run the Setup_vCenter.yml Ansible playbook:

```
ansible-playbook ./Setup_vCenter.yml -i inventory
```

Note: After the playbook run is complete, complete the following manual steps to complete vCenter setup.

Step 3. Right-click the Cluster that was created and select **Settings**.

Step 4. In the list in the center pane under **Configuration**, choose **General**.

Step 5. On the right, to the right of **General**, choose **EDIT**.

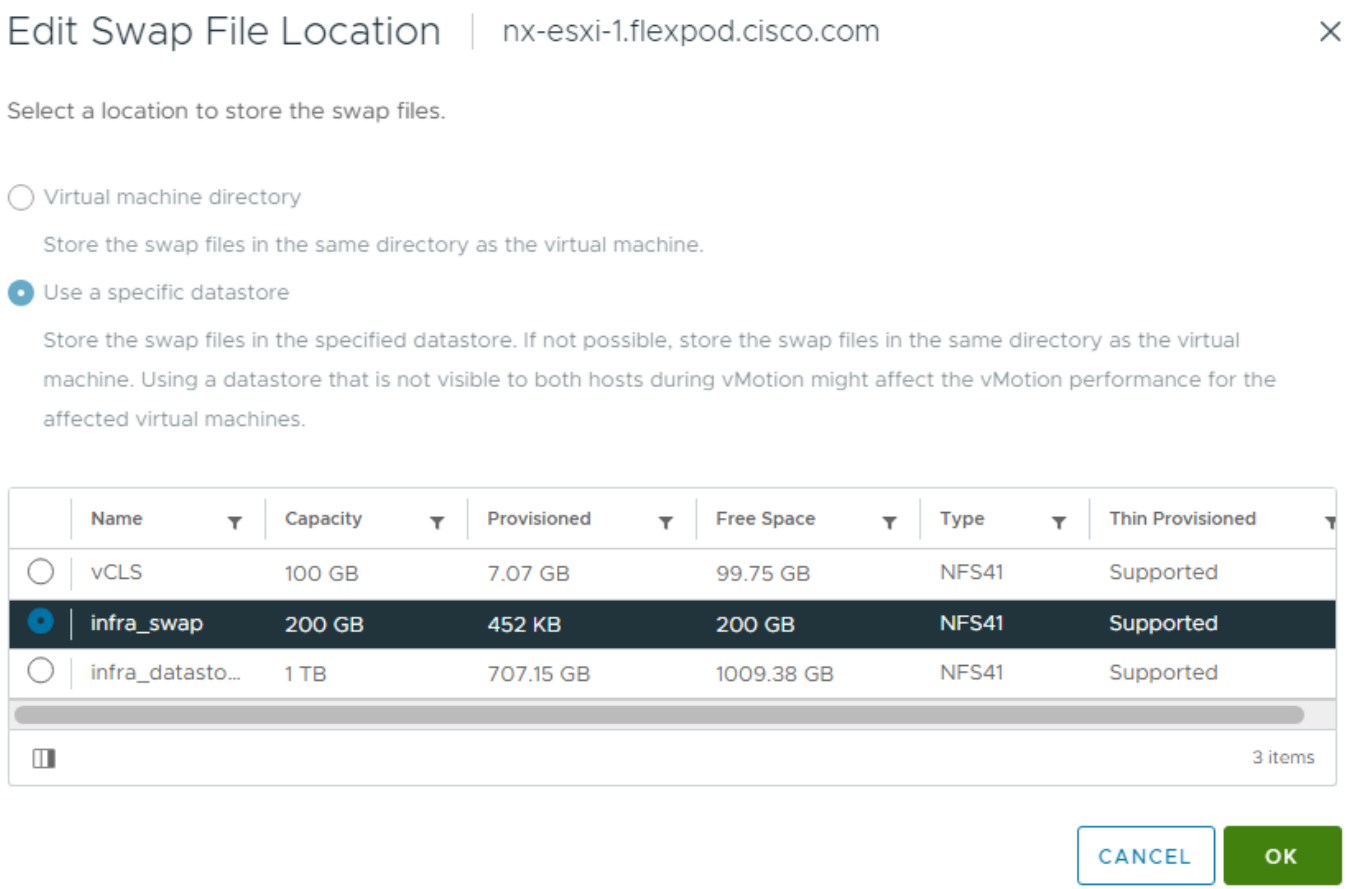
Step 6. Select Datastore specified by host and click OK.

Step 7. In the list on the left, select the first ESXi host. In the center pane, choose the **Configure** tab.

Step 8. In the center pane list under **Virtual Machines**, click **Swap File location**.

Step 9. On the right, click **EDIT**.

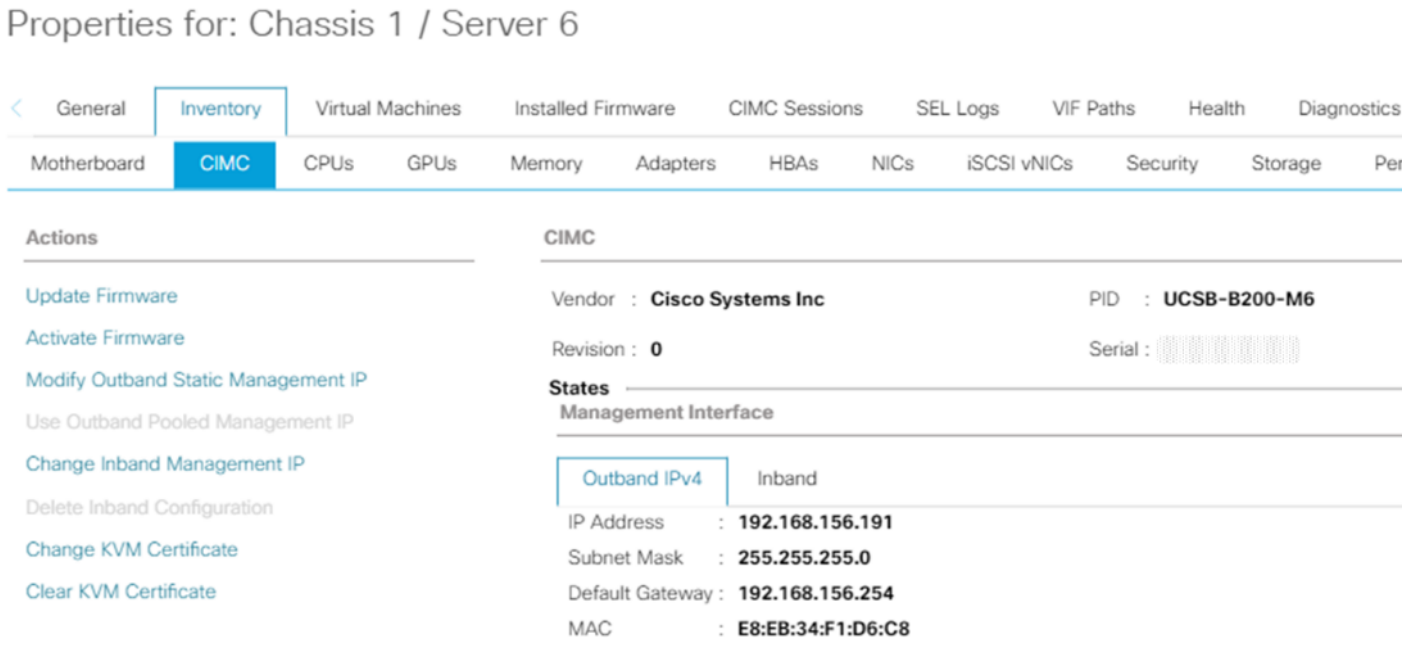
Step 10. Select infra_swap and click **OK**.

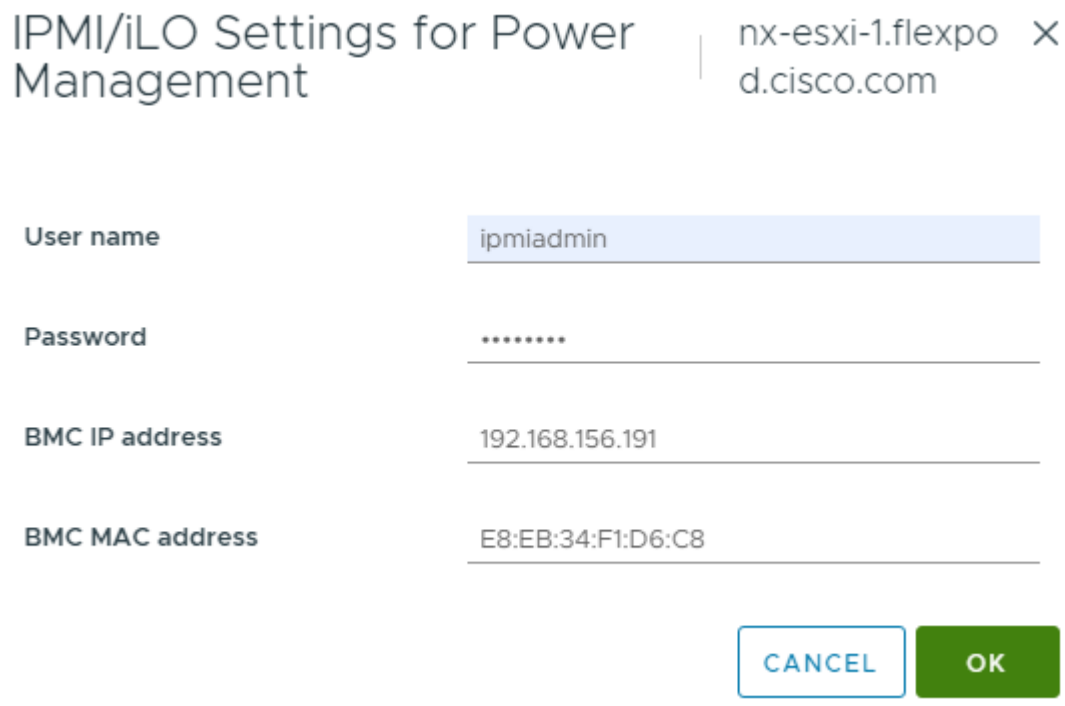


Step 11. Repeat steps 7-10 to set the swap file location for each ESXi host.

Step 12. Select each ESXi host and from the **Summary** tab, clear any alerts or alarms associated with the host.

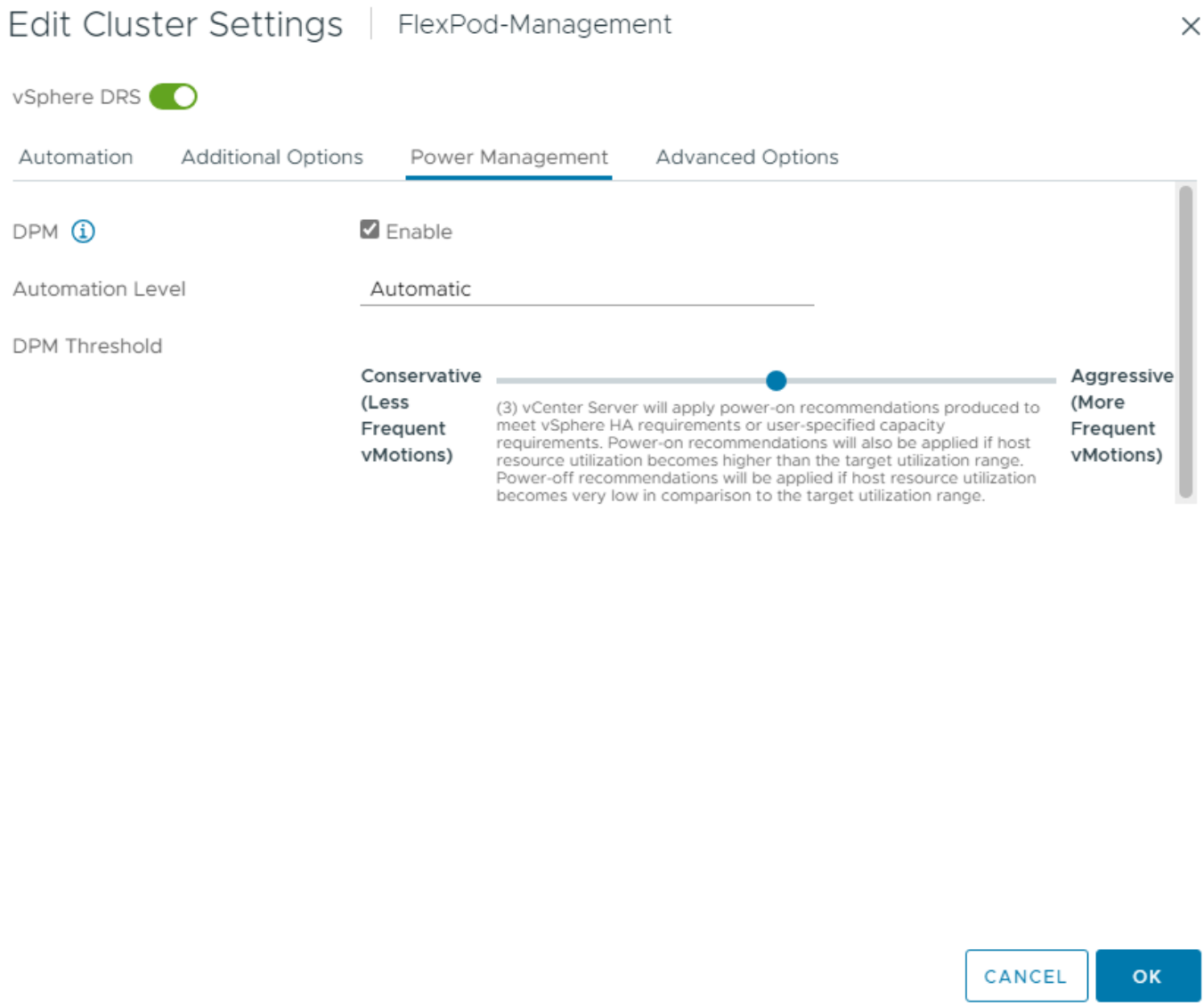
Step 13. Select the first ESXi host and under **Configure** > **System**, click **Power Management**. In the upper right corner, click **EDIT**. Fill in the User name (ipmiadmin) and associated password as configured in the Cisco UCS Manager IPMI/Redfish Profile. For Cisco UCS B-Series servers to get the BMC IP address and BMC MAC address, login to Cisco UCS Manager and click **Servers** > **Service Profiles** > **root** > **Sub-Organizations** > **<FlexPod Organization>** > **<Service Profile>**. In the center pane, click the link to the right of Associated Server to bring up the Properties for the server. Select **Inventory** > **CIMC**. The IP Address and MAC are shown in the center of the window. For Cisco UCS C-Series servers, if you get an error stating that the MAC address is incorrect, use ipmitool as shown in the next sentence. For both B- and C-Series, the MAC can also be obtained by using ipmitool on a Linux machine with the following query: "ipmitool -I lanplus -H <serverOOBMGMTIP> -U ipmiadmin -P <password> lan print". Once all fields are populated, click **OK**. VMware ESXi will launch an IPMI over LAN query to the server's CIMC and verify the BMC MAC address. This setup will allow the ESXi host to be powered on from vCenter. Repeat this step for all ESXi hosts.





Step 14. Optional. This step is optional and should only be done if you are not using Cisco Intersight Workload Optimizer (IWO) to suspend servers in an effort to lower power usage. In VMware vCenter, under Inventory, select the ESXi cluster. In the center pane, select **Configure** and then under Services select **vSphere**

DRS. On the right, click **EDIT** then select **Power Management**. Select the Enable checkbox to turn on DPM and select your desired Automation Level. Click **OK** to finalize this setting.

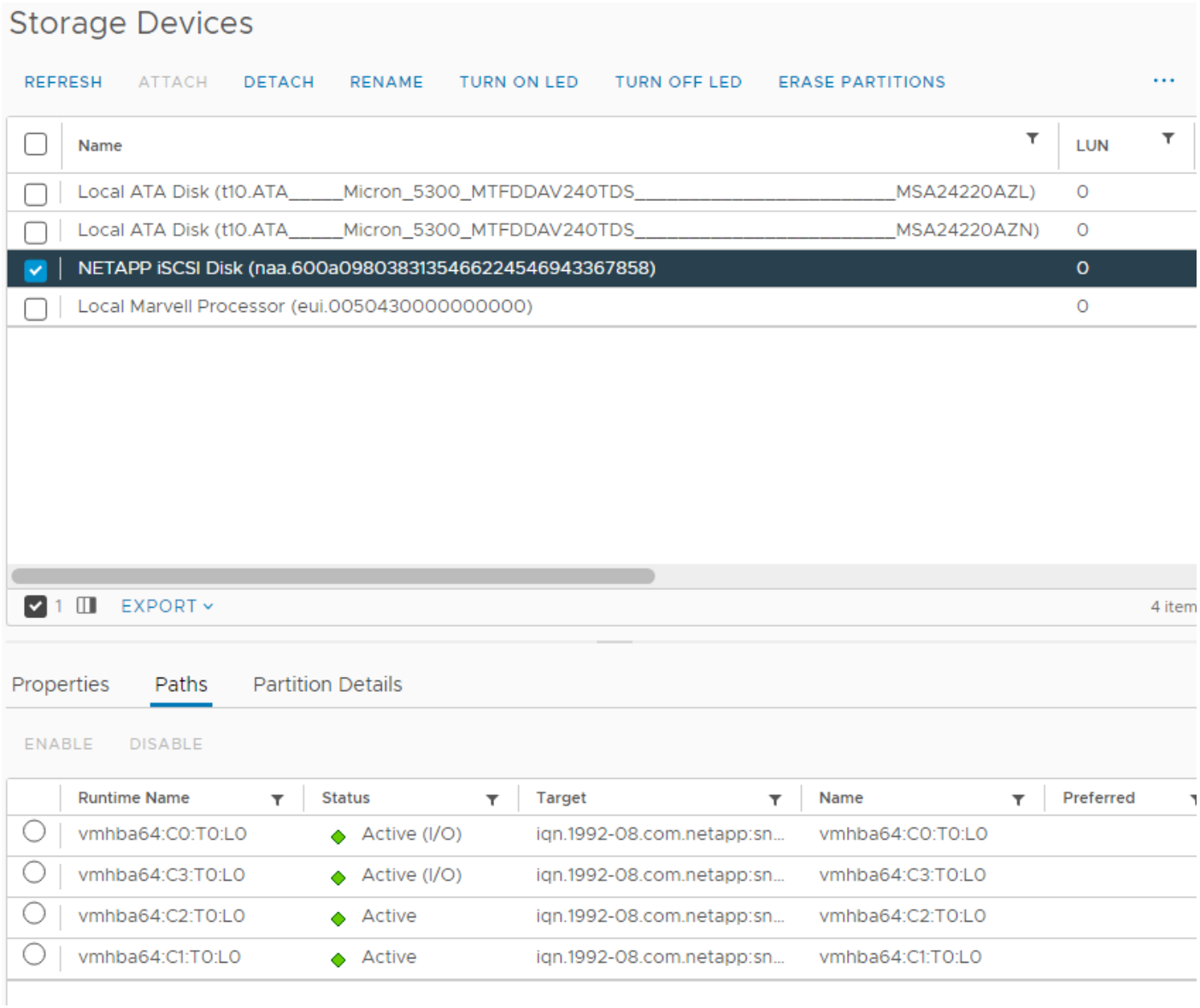


Note: It is recommended to cycle through the ESXi hosts testing whether the server can be powered on with IPMI over LAN before turning on DPM.

Step 15. Select the first ESXi host. In the center pane under **Configure** > **Storage**, click **Storage Devices**. Make sure the NETAPP Fibre Channel Disk LUN 0 or NETAPP iSCSI Disk LUN 0 is selected.

Step 16. Click the **Paths** tab.

Step 17. Ensure that 4 paths appear, two of which should have the status Active (I/O). The output below shows the paths for an iSCSI LUN.



Step 18. Repeat steps 15–17 for all ESXi hosts.

Procedure 2. VMware ESXi 8.0 TPM Attestation

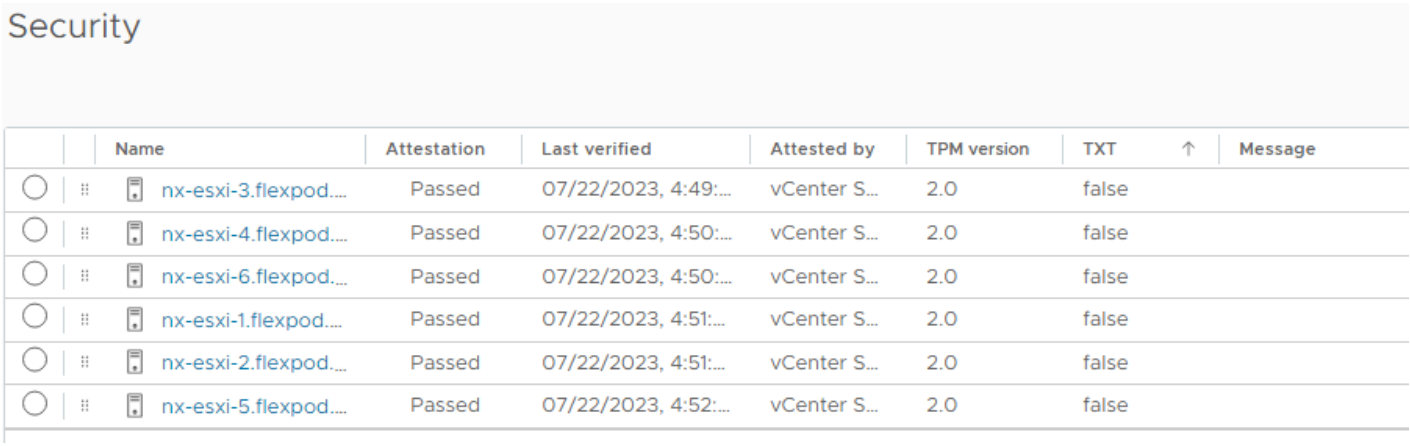
Note: If your Cisco UCS servers have Trusted Platform Module (TPM) 2.0 modules installed, the TPM can provide assurance that ESXi has booted with UEFI Secure Boot enabled and using only digitally signed code. In the Cisco UCS Configuration section of this document, UEFI secure boot was enabled in the boot order policy. A server can boot with UEFI Secure Boot with or without a TPM 2.0 module. If it has a TPM, VMware vCenter can attest that the server booted with UEFI Secure Boot.

Step 1. For Cisco UCS servers that have TPM 2.0 modules installed, TPM Attestation can be verified in the vSphere HTML5 Client.

Step 2. In the vCenter Interface, under **Inventory** select the cluster.

Step 3. In the center pane, click the **Monitor** tab.

Step 4. Click **Monitor > Security**. The Attestation status will show the status of the TPM:



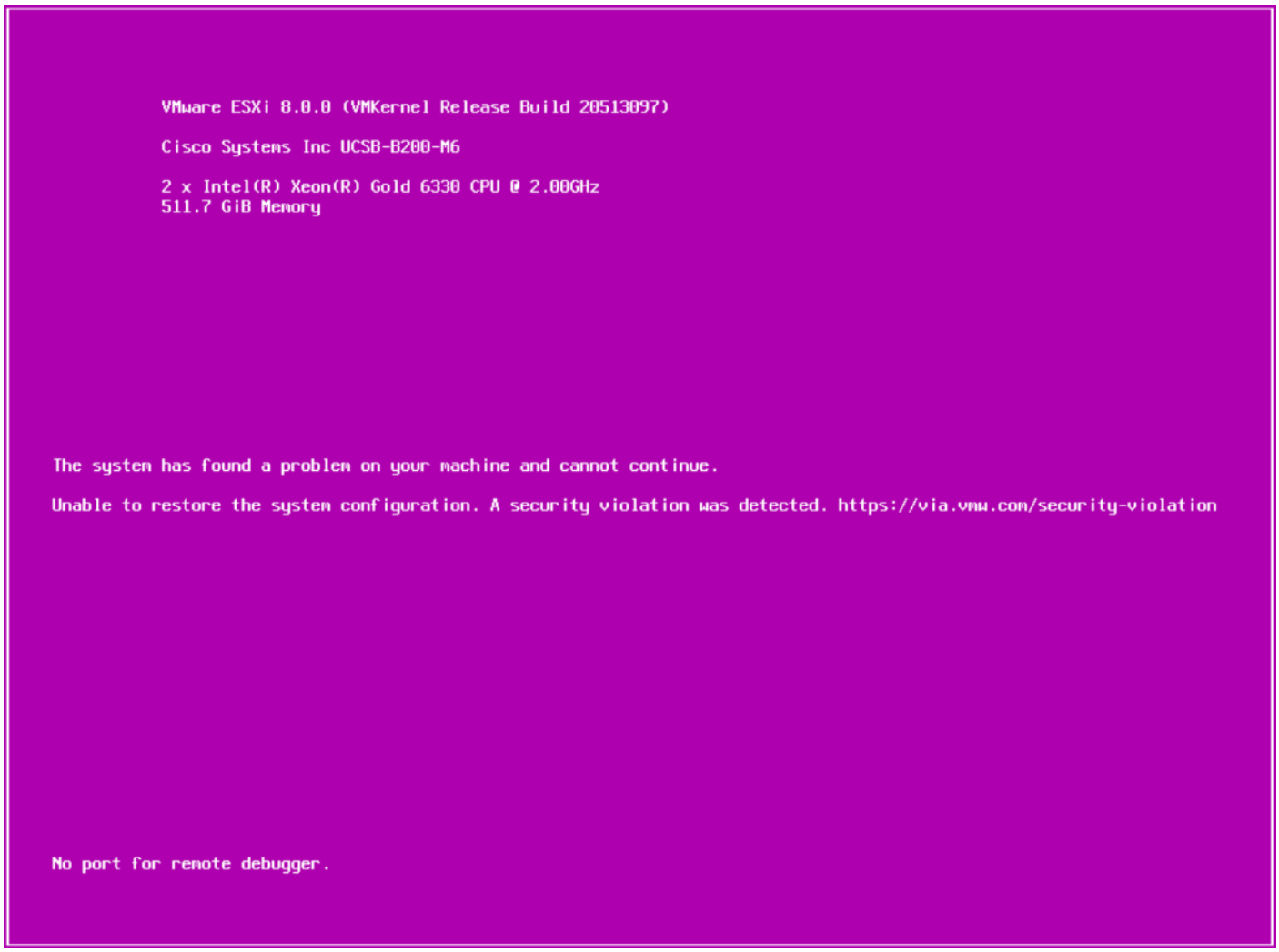
Note: It may be necessary to disconnect and reconnect or reboot a host from vCenter to get it to pass attestation the first time.

Procedure 3. Avoiding Boot Failure When UEFI Secure Booted Server Profiles are Moved

Typically, hosts in FlexPod Datacenter are configured for boot from SAN. Cisco UCS supports stateless compute where a server profile can be moved from one blade or compute node to another seamlessly.

When a server profile is moved from one blade to another blade server with the following conditions, the ESXi host runs into PSOD and ESXi will fail to boot:

- TPM present in the node (Cisco UCS M5 and M6 family servers)
- Host installed with ESXi 7.0 U2 or above
- Boot mode is UEFI Secure
- Error message: Unable to restore system configuration. A security violation was detected. https://via.vmw.com/security-violation.



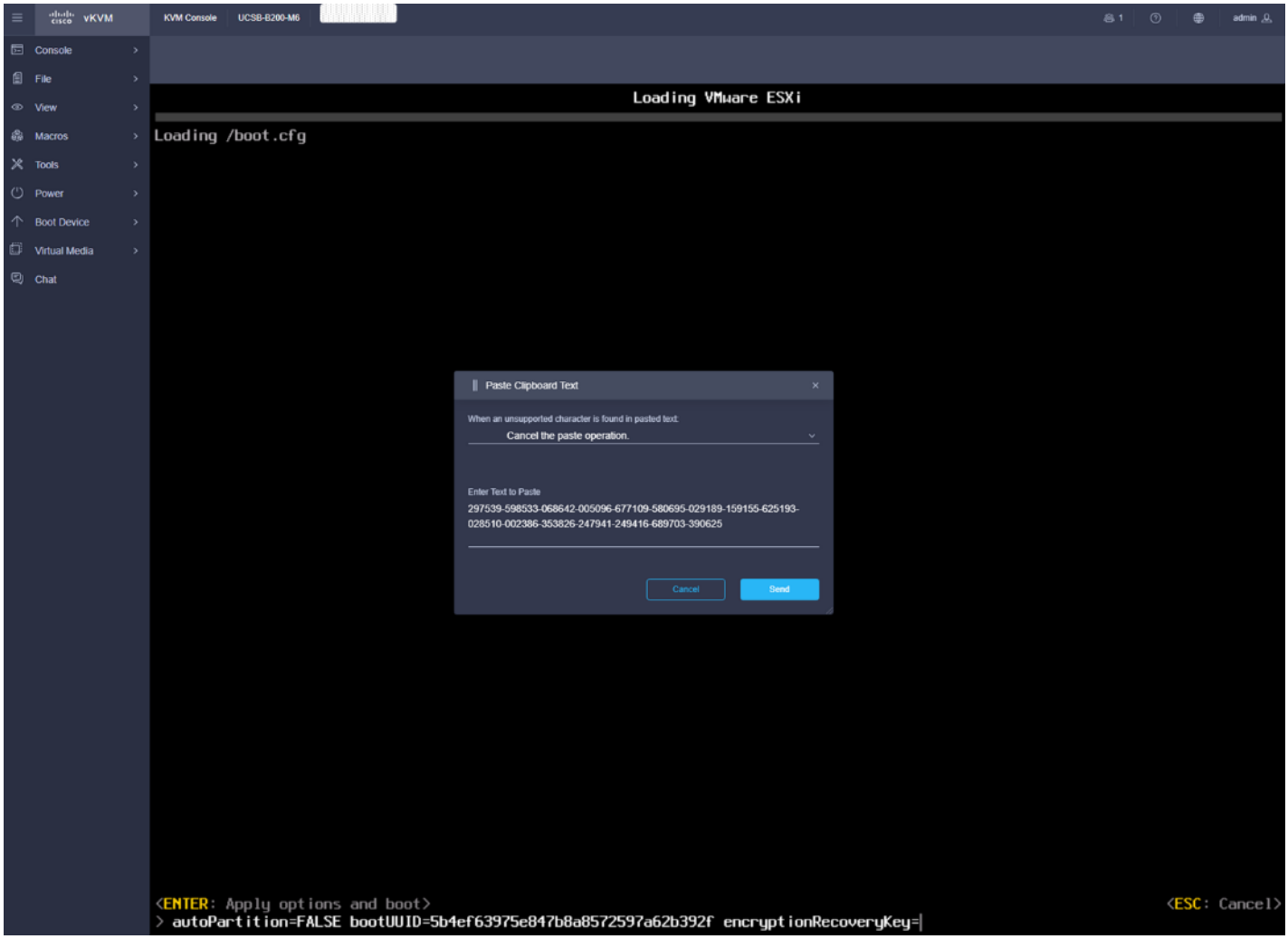
Step 1. Log into the host using **SSH**.

Step 2. Gather the recovery key using this command:

```
[root@nx-esxi-1:~] esxcli system settings encryption recovery list
Recovery ID                                  Key
-----------------------------------------  ---
{74AC4D68-FE47-491F-B529-6355D4AAF52C}
529012-402326-326163-088960-184364-097014-312164-590080-407316-660658-634787-601062-601426-263837-330828-197047
```

Step 3. Store the keys from all hosts in a safe location.

Step 4. After associating the Server Profile to the new compute-node or blade, stop the ESXi boot sequence by pressing **Shift + O** when the ESXi boot screen appears.



Step 5. Add the recovery key using following boot option: encryptionRecoveryKey=*recovery_key.* Use **File** > **Paste Clipboard Text** and **Send** to paste in the recovery key. Press Enter to continue the boot process.

Step 6. To persist the change, enter the following command at the VMware ESXi ssh command prompt:

```
/sbin/auto-backup.sh
```

Note: For more information, refer to: https://docs.vmware.com/en/VMware-vSphere/8.0/vsphere-security/GUID-30DA8CC1-5D9F-4025-B5DB-6D592B6BD9B4.html.

Storage Configuration – ONTAP NVMe Configuration and Finalizing ONTAP Storage

This chapter contains the following:

Ansible ONTAP Storage Configuration Part 3

Procedure 1. Configure the ONTAP NVMe setup and finalize ONTAP storage using Ansible

Step 1. Edit the following variable files to ensure proper variables are entered:

- FlexPod-UCSM-VMware/FlexPod-UCSM-VMware/group_vars/all.yml
- FlexPod-UCSM-VMware/FlexPod-UCSM-VMware/vars/ontap_main.yml

Note: Update the “nvme_namespaces” and “nvme_subsystem” variables in vars/ontap_main.yml file. Add the NQNs from each ESXi host to the corresponding variable “nvme_nqn” in group_vars/all.yml file. The NVMe namespace will be shared by all the hosts in the nvme subsystem in this solution

Note: The ONTAP NVMe setup is only required for FC-NVMe and NVMe/TCP configurations.

Step 2. From FlexPod-UCSM-VMware/FlexPod-UCSM-VMware, invoke the ansible scripts for this section using the following command:

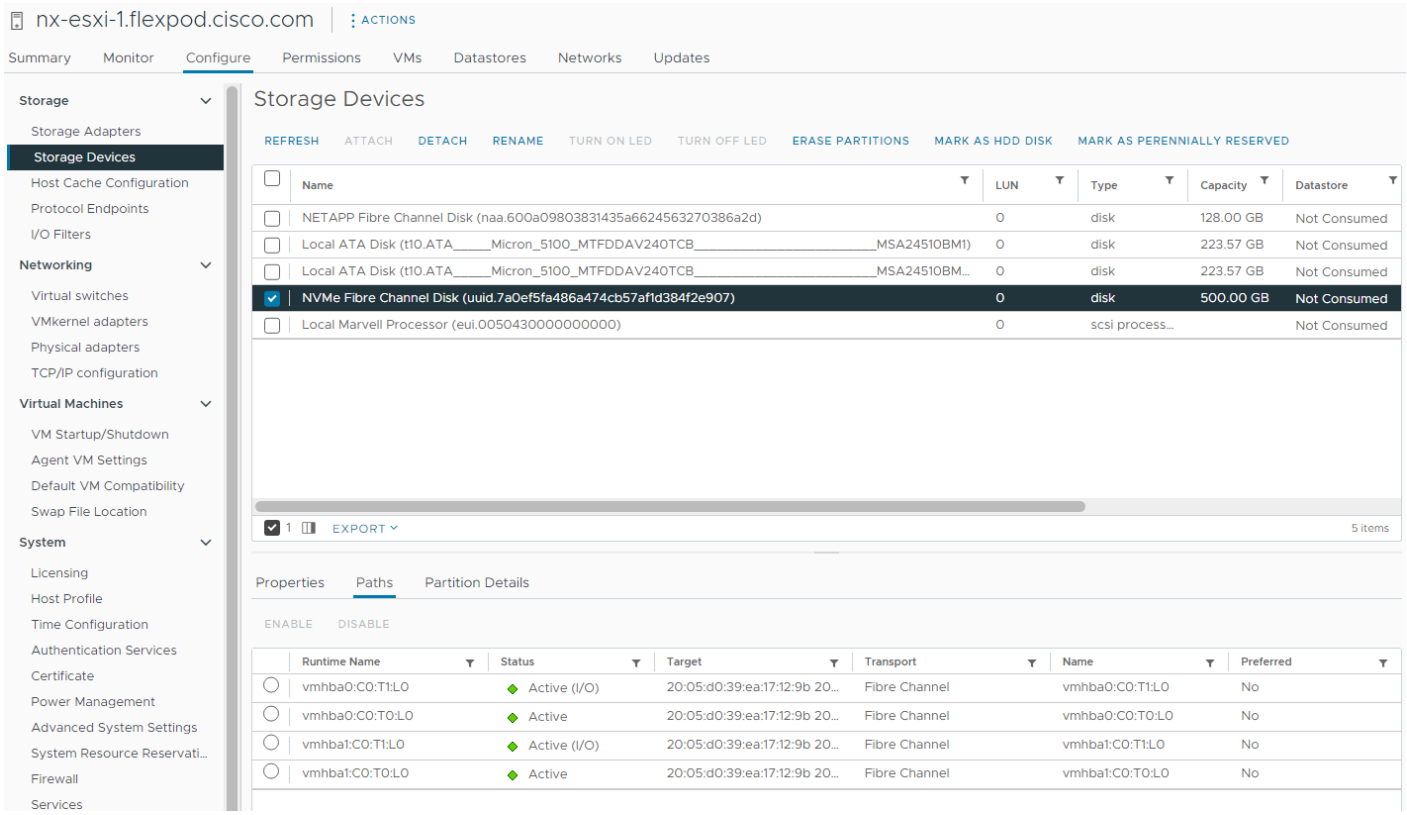
```
ansible-playbook -i inventory Setup_ONTAP.yml -t ontap_config_part_3
```

Procedure 2. Configure ESXi Host NVMe over FC and NVMe over TCP Datastore

Step 1. To verify that the NVMe Fibre Channel Disk is mounted on each ESXi host, log into the **VMware vCenter** using a web-browser.

Step 2. Under **Inventory** select an ESXi host running FC-NVMe. In the center pane, go to **Configure** > **Storage** > **Storage Devices**. The NVMe Fibre Channel Disk should be listed under Storage Devices.

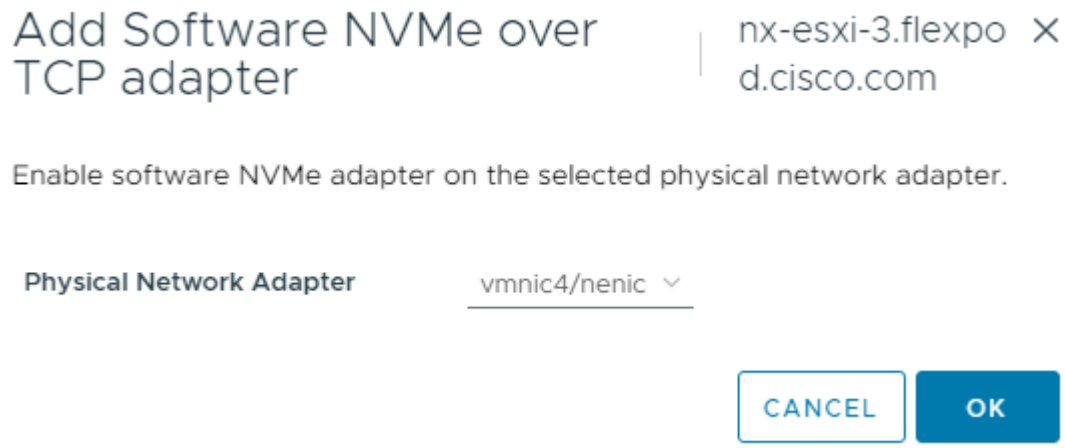
Step 3. Select the NVMe Fibre Channel Disk, then select **Paths** underneath. Verify 2 paths have a status of Active (I/O) and 2 paths have a status of Active.



Step 4. Repeat Step 3 for all the FC-NVMe hosts.

Step 5. Under **Inventory** select an ESXi host running NVMe-TCP. In the center pane, go to **Configure** > **Storage** > **Storage Adapters**.

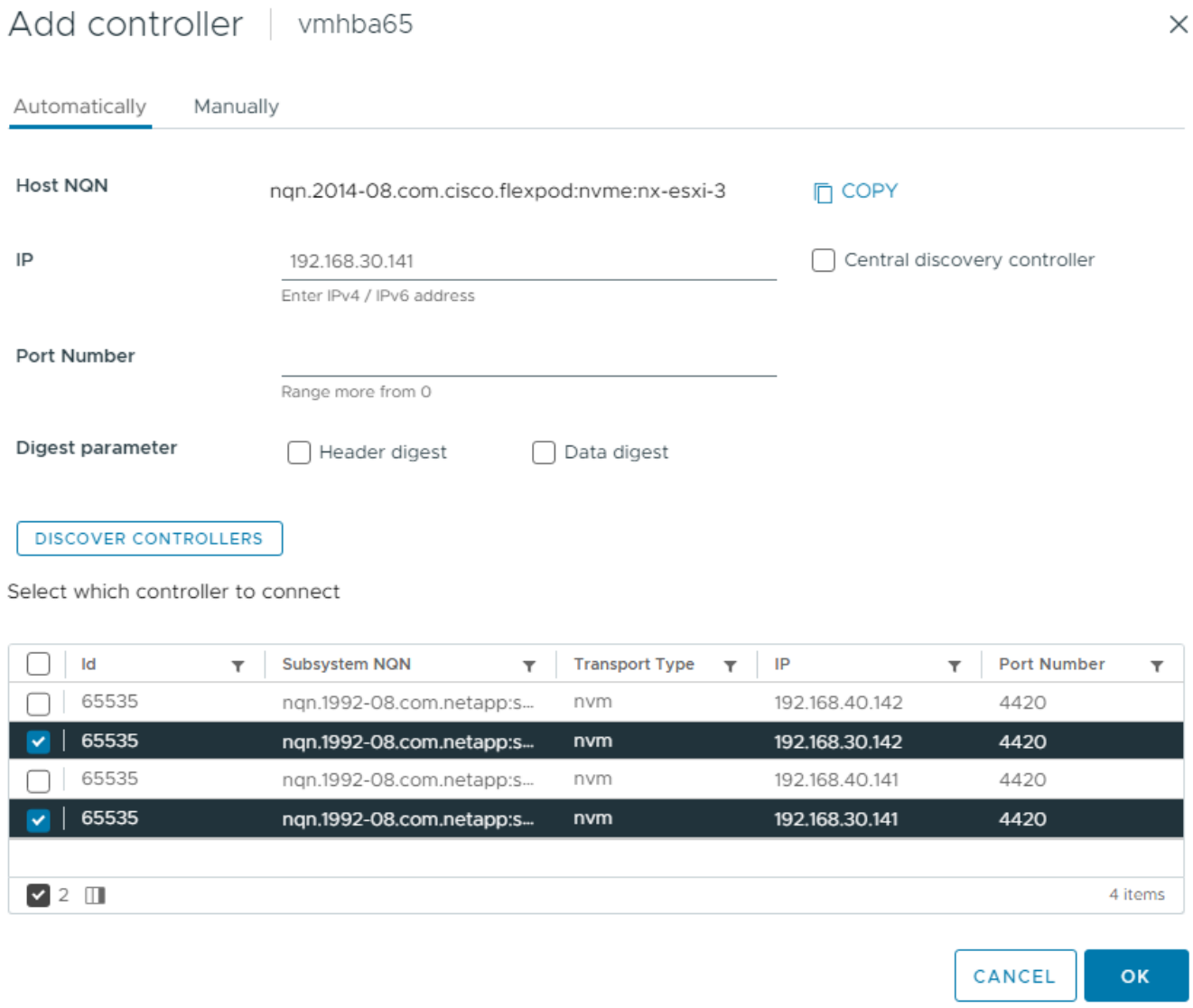
Step 6. Click **ADD SOFTWARE-ADAPTER** > **Add NVMe over TCP adapter**. From the drop-down list select **vmnic4/nenic** and click **OK**. A new vmhba should appear under Storage Adapters.



Step 7. Click **ADD SOFTWARE-ADAPTER** > **Add NVMe over TCP adapter** to add a second vmhba. Use the pulldown to select **vmnic5/nenic** and click **OK**. A new vmhba should appear under Storage Adapters.

Step 8. Select the first VMware NVMe over TCP Storage Adapter added (for example, vmhba65). In the middle of the window, select the **Controllers** tab. Click **ADD CONTROLLER**.

Step 9. Enter the IP address of nvme-tcp-lif-01a and click **DISCOVER CONTROLLERS**. Select the two controllers in the Infra-NVMe-TCP-A subnet and click **OK**. The two controllers should now appear under the Controllers tab after clicking **Refresh**.

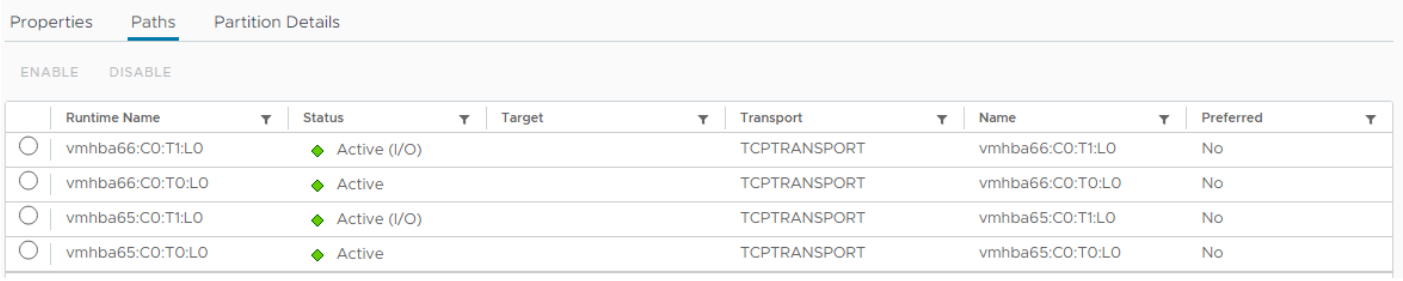


Step 10. Select the second VMware NVMe over TCP Storage Adapter added (for example, vmhba66). In the middle of the window, select the **Controllers** tab. Click **ADD CONTROLLER**.

Step 11. Enter the IP address of nvme-tcp-lif-02b and click **DISCOVER CONTROLLERS**. Select the two controllers in the Infra-NVMe-TCP-B subnet and click **OK**. The two controllers should now appear under the Controllers tab after clicking to Refresh.

Step 12. Repeat steps 5-11 for all ESXi hosts running NVMe-TCP.

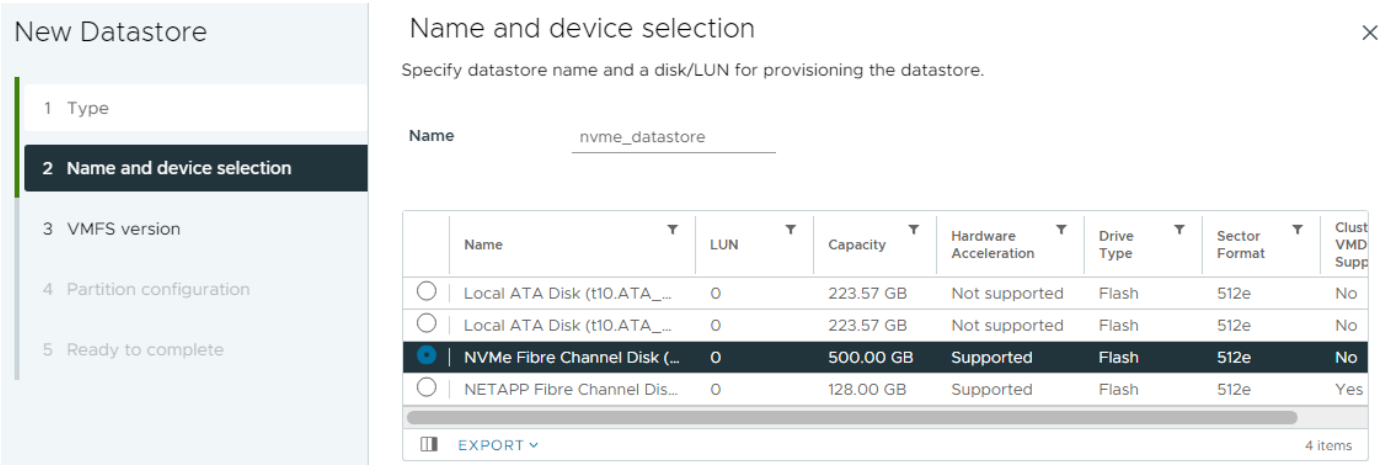
Step 13. For each of the hosts running NVMe-TCP, select **Configure** > **Storage** > **Storage Devices**, then select the NVMe Disk. Under the Paths tab, make sure that 4 paths are shown and that 2 of the paths have the Status **Active (I/O)**. Also, all paths should have the Transport **TCPTRANSPORT**.



Runtime Name	Status	Target	Transport	Name	Preferred
vmhba66:C0:T1:L0	Active (I/O)		TCPTRANSPORT	vmhba66:C0:T1:L0	No
vmhba66:C0:T0:L0	Active		TCPTRANSPORT	vmhba66:C0:T0:L0	No
vmhba65:C0:T1:L0	Active (I/O)		TCPTRANSPORT	vmhba65:C0:T1:L0	No
vmhba65:C0:T0:L0	Active		TCPTRANSPORT	vmhba65:C0:T0:L0	No

Step 14. For any one of these hosts, right-click the host under **Inventory** and select **Storage** > **New Datastore**. Leave VMFS selected and click **NEXT**.

Step 15. Name the datastore (for example, nvme_datastore) and select the **NVMe Disk**. Click **NEXT**.



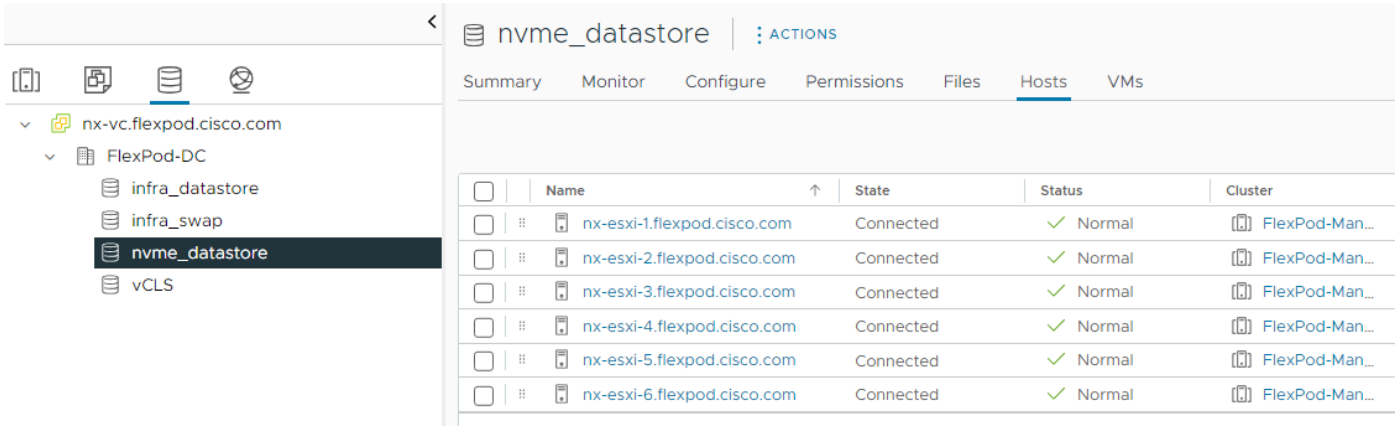
Name	LUN	Capacity	Hardware Acceleration	Drive Type	Sector Format	Clust VMD Supp
Local ATA Disk (t10.ATA_...	0	223.57 GB	Not supported	Flash	512e	No
Local ATA Disk (t10.ATA_...	0	223.57 GB	Not supported	Flash	512e	No
NVMe Fibre Channel Disk (...	0	500.00 GB	Supported	Flash	512e	No
NETAPP Fibre Channel Dis...	0	128.00 GB	Supported	Flash	512e	Yes

Step 16. Leave VMFS 6 selected and click **NEXT**.

Step 17. Leave all Partition configuration values at the default values and click **NEXT**.

Step 18. Review the information and click **FINISH**.

Step 19. Select **Storage**, expand the vCenter and Datacenter, and select the new NVMe datastore. In the center pane, select **Hosts**. Ensure all the NVMe hosts have mounted the datastore.



Note: If any hosts are missing from the list, it may be necessary to put the host in Maintenance Mode and reboot the host. If you happen to have hosts with both FC-boot and iSCSI-boot and are running both FC-NVMe and NVMe-TCP, notice that the same datastore is mounted on both types of hosts and that the only difference in the storage configuration is what LIF the traffic is coming in on.

FlexPod Management Tools Setup

This chapter contains the following:

Cisco Intersight Hardware Compatibility List (HCL) Status

Cisco Intersight evaluates the compatibility of customer's UCS system to check if the hardware and software have been tested and validated by Cisco or Cisco partners. Intersight reports validation issues after checking the compatibility of the server model, processor, firmware, adapters, operating system, and drivers, and displays the compliance status with the Hardware Compatibility List (HCL).

To determine HCL compatibility for VMware ESXi, Cisco Intersight uses Cisco UCS Tools. The Cisco UCS Tools is part of VMware ESXi Cisco custom ISO, and no additional configuration is required.

For more information on Cisco UCS Tools manual deployment and troubleshooting, refer to:
https://intersight.com/help/saas/resources/cisco_ucs_tools#about_cisco_ucs_tools

NetApp ONTAP Tools 9.12 Deployment

The ONTAP tools for VMware vSphere provide end-to-end life cycle management for virtual machines in VMware environments that use NetApp storage systems. It simplifies storage and data management for VMware environments by enabling administrators to directly manage storage within the vCenter Server. This topic describes the deployment procedures for the NetApp ONTAP Tools for VMware vSphere.

NetApp ONTAP Tools for VMware vSphere 9.12 Pre-installation Considerations

The following licenses are required for ONTAP Tools on storage systems that run ONTAP 9.8 or above:

- Protocol licenses (NFS, FCP, and/or iSCSI)
- NetApp FlexClone ((optional) Required for performing test failover operations for SRA and for vVols operations of VASA Provider
- NetApp SnapRestore (for backup and recovery)
- The NetApp SnapManager Suite
- NetApp SnapMirror or NetApp SnapVault (Optional – required for performing failover operations for SRA and VASA Provider when using vVols replication)

The Backup and Recovery capability has been integrated with SnapCenter and requires additional licenses for SnapCenter to perform backup and recovery of virtual machines and applications.

Note: Beginning with ONTAP 9.10.1, all licenses are delivered as NLFs (NetApp License File). NLF licenses can enable one or more ONTAP features, depending on your purchase. ONTAP 9.10.1 also supports 28-character license keys using System Manager or the CLI. However, if an NLF license is installed for a feature, you cannot install a 28-character license key over the NLF license for the same feature.

Table 6. Port Requirements for NetApp ONTAP Tools

TCP Port	Requirement
443 (HTTPS)	Secure communications between VMware vCenter Server and the storage systems
8143 (HTTPS)	ONTAP Tools listens for secure communications
9083 (HTTPS)	VASA Provider uses this port to communicate with the vCenter Server and obtain TCP/IP settings
7	ONTAP tools sends an echo request to ONTAP to verify reachability and is required only when adding storage system and can be disabled later.

Note: The requirements for deploying NetApp ONTAP Tools are listed here.

Procedure 1. Install NetApp ONTAP Tools for VMware vSphere via Ansible

Step 1. Clone the repository from https://github.com/NetApp-Automation/ONTAP-Tools-for-VMware-vSphere.

Step 2. Follow the instructions in the README file in the repository to ensure the Ansible environment is configured properly.

Step 3. Update the following variable files:

```
hosts
group_vars/vcenter
vars/ontap_tools_main.yml
```

Step 4. To invoke the ansible scripts, use the following command:

```
ansible-playbook -i hosts Setup_ONTAP_tools.yml
```

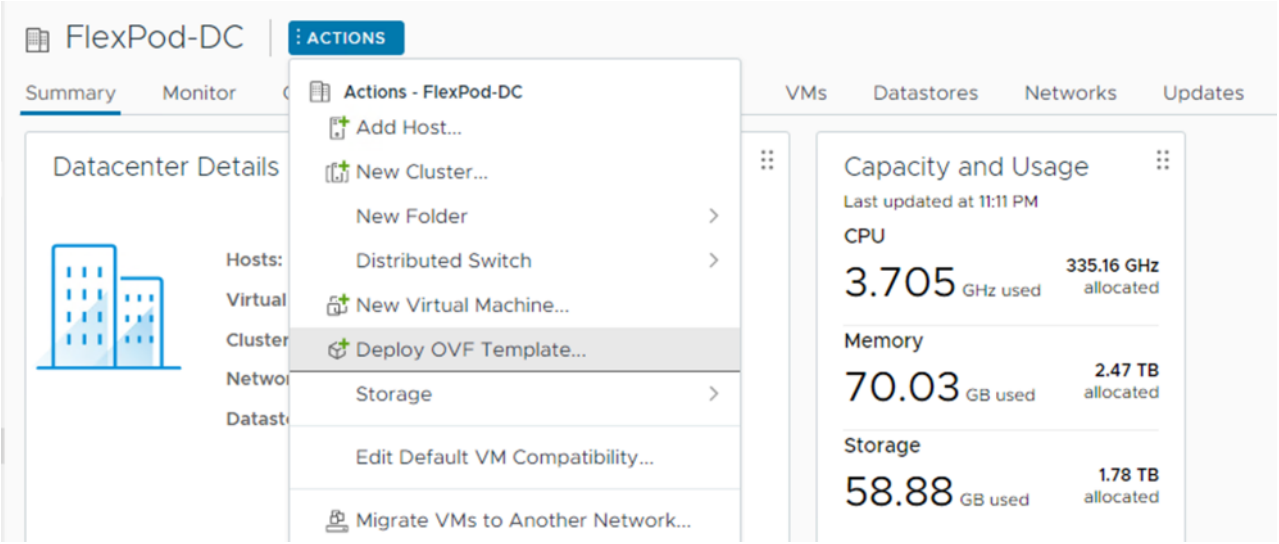
Note: The above playbook installs NetApp ONTAP Tools for VMware vSphere and registers it with VMWare vCenter. It also adds the ONTAP Storage System to ONTAP tools.

Procedure 2. Install NetApp ONTAP Tools for VMware vSphere Manually

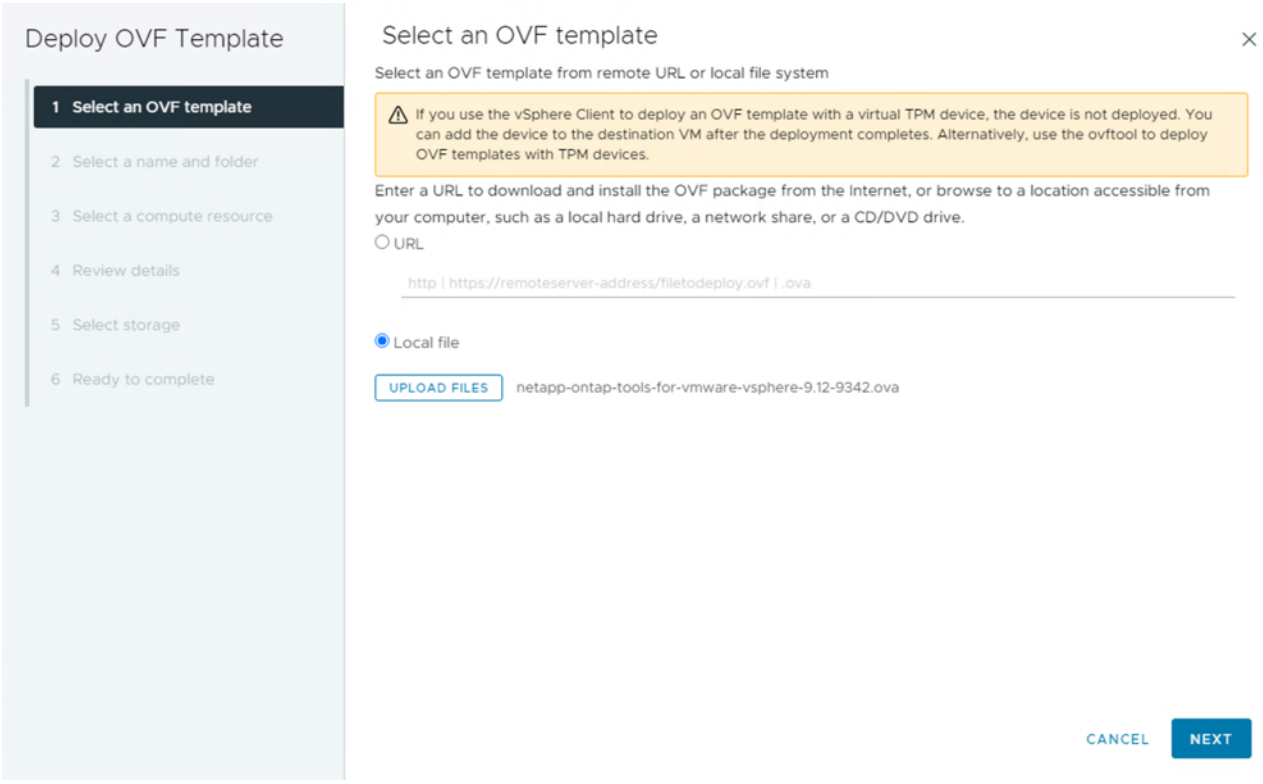
Use the following steps to manually install NetApp ONTAP Tools for VMware vSphere if desirable, or if there is a problem with running Ansible automation for it.

Step 1. Launch the **vSphere Web Client** and navigate to **Hosts** and **Clusters**.

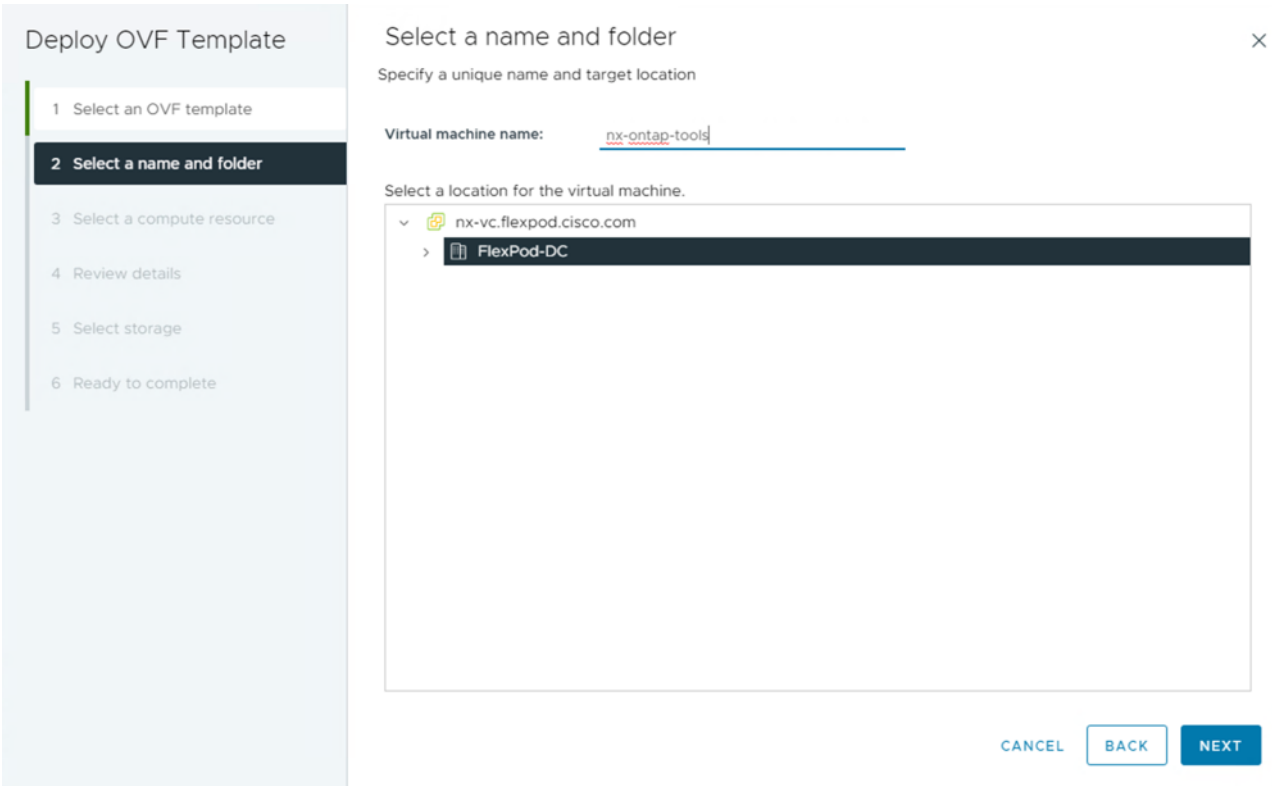
Step 2. Select **ACTIONS** for the FlexPod-DC datacenter and select **Deploy OVF Template**.



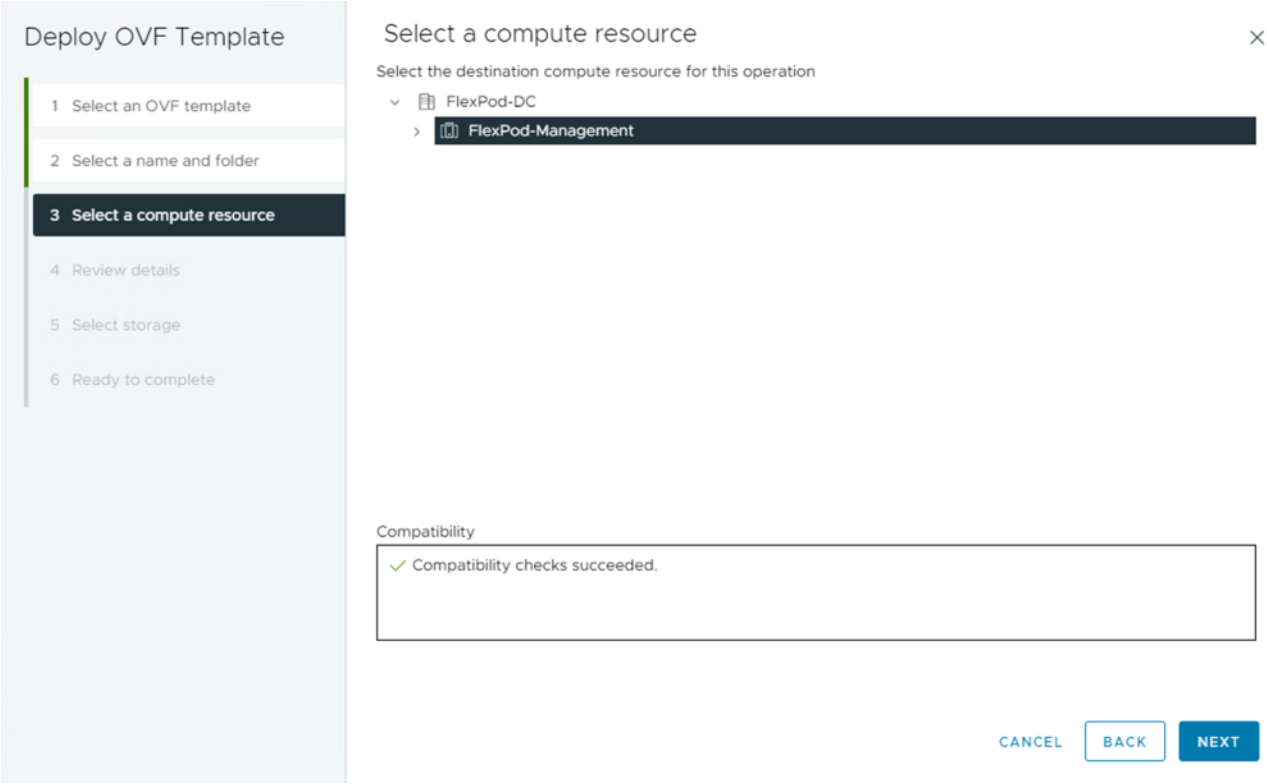
Step 3. Select an OVF template from remote URL or local file system and click **NEXT**.



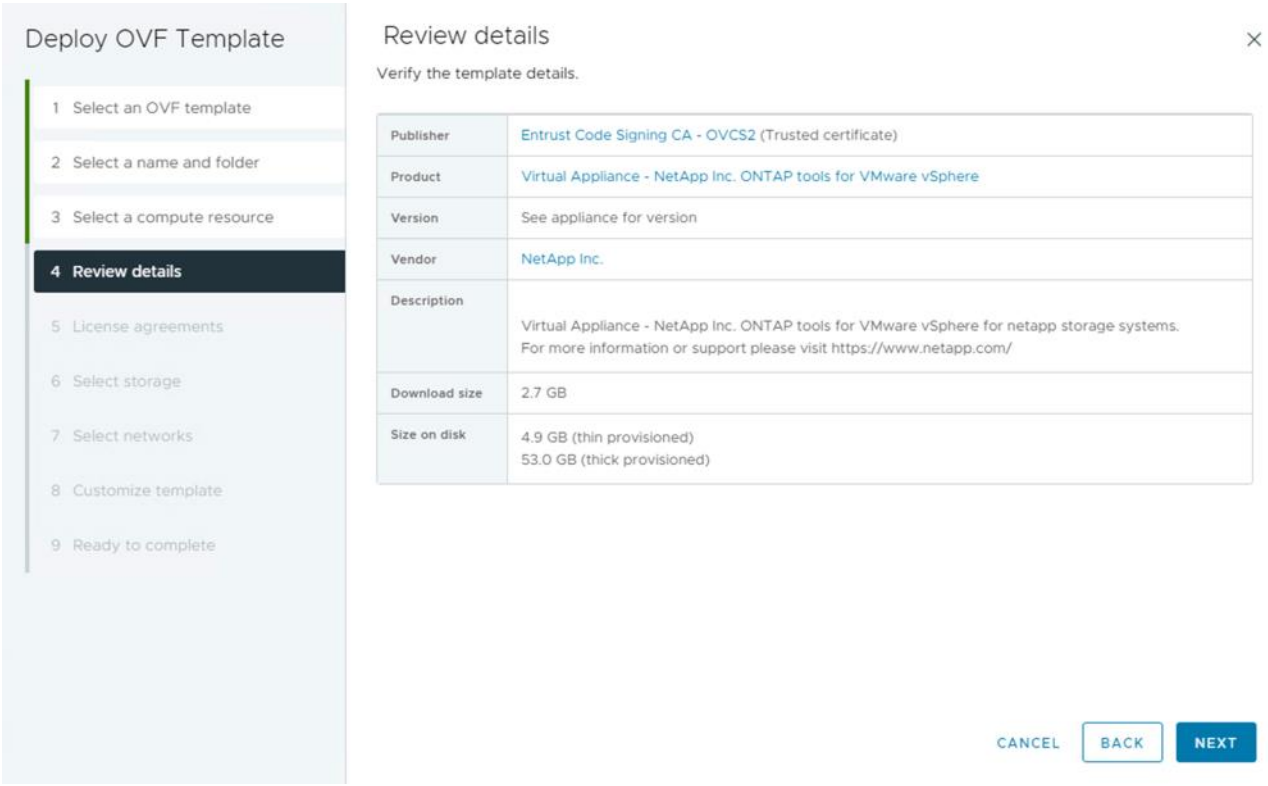
Step 4. Enter the **VM name**, select a **location** for the VM and click **NEXT**.



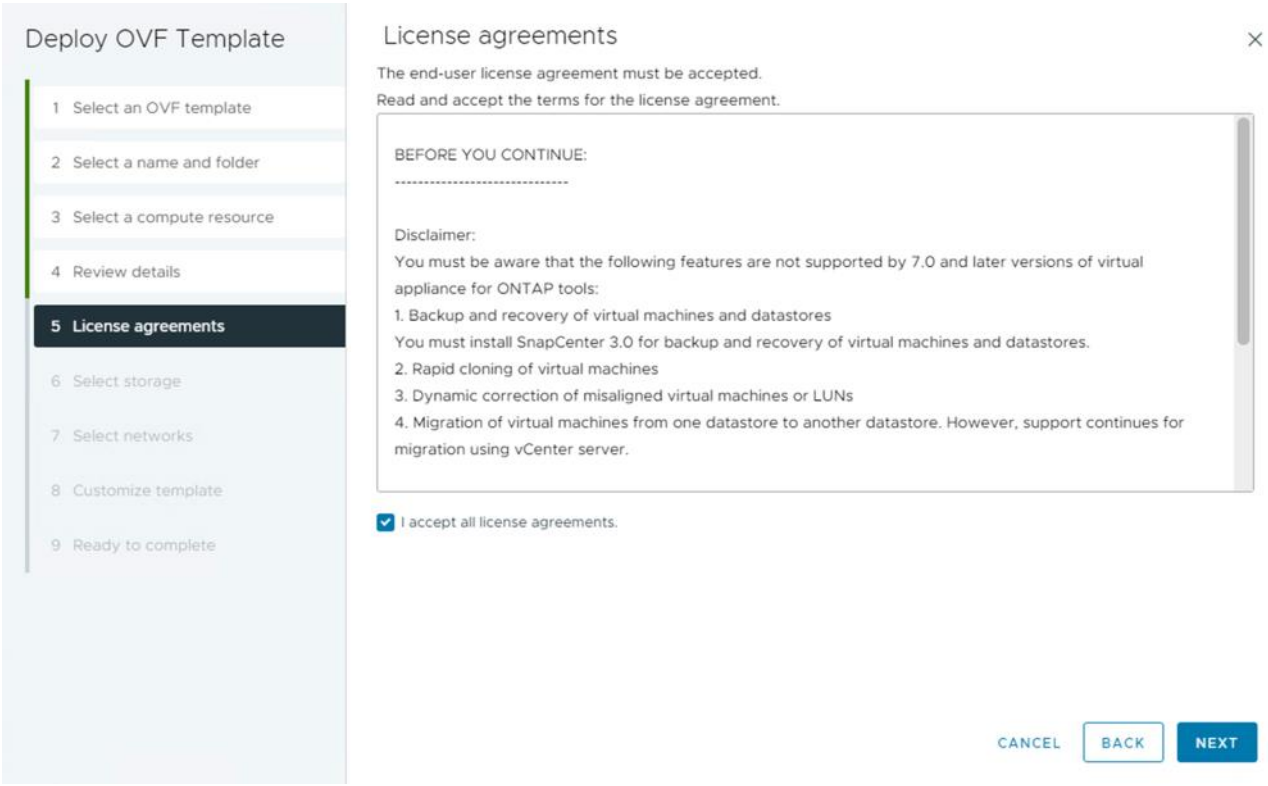
Step 5. Select a host cluster resource in which to deploy OVA and click **NEXT**.



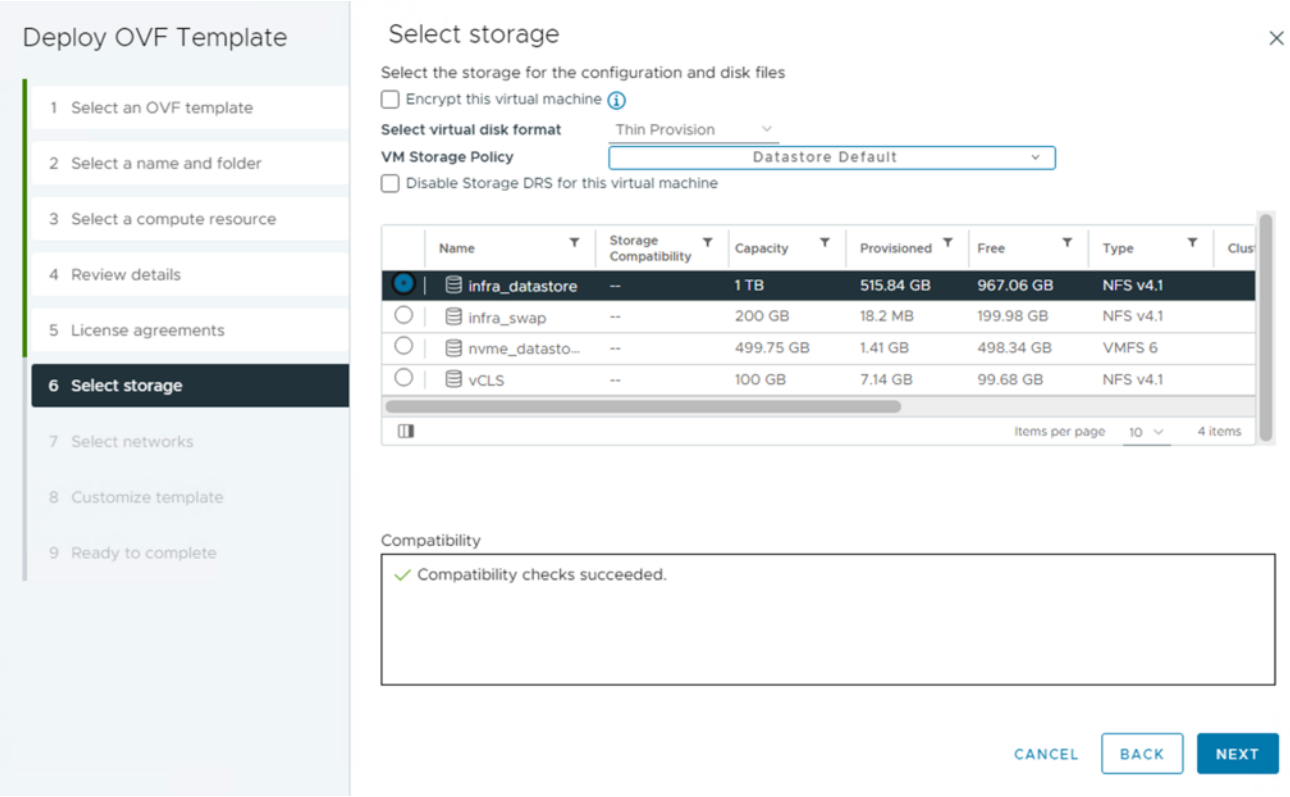
Step 6. Verify the template details and click **Next**.



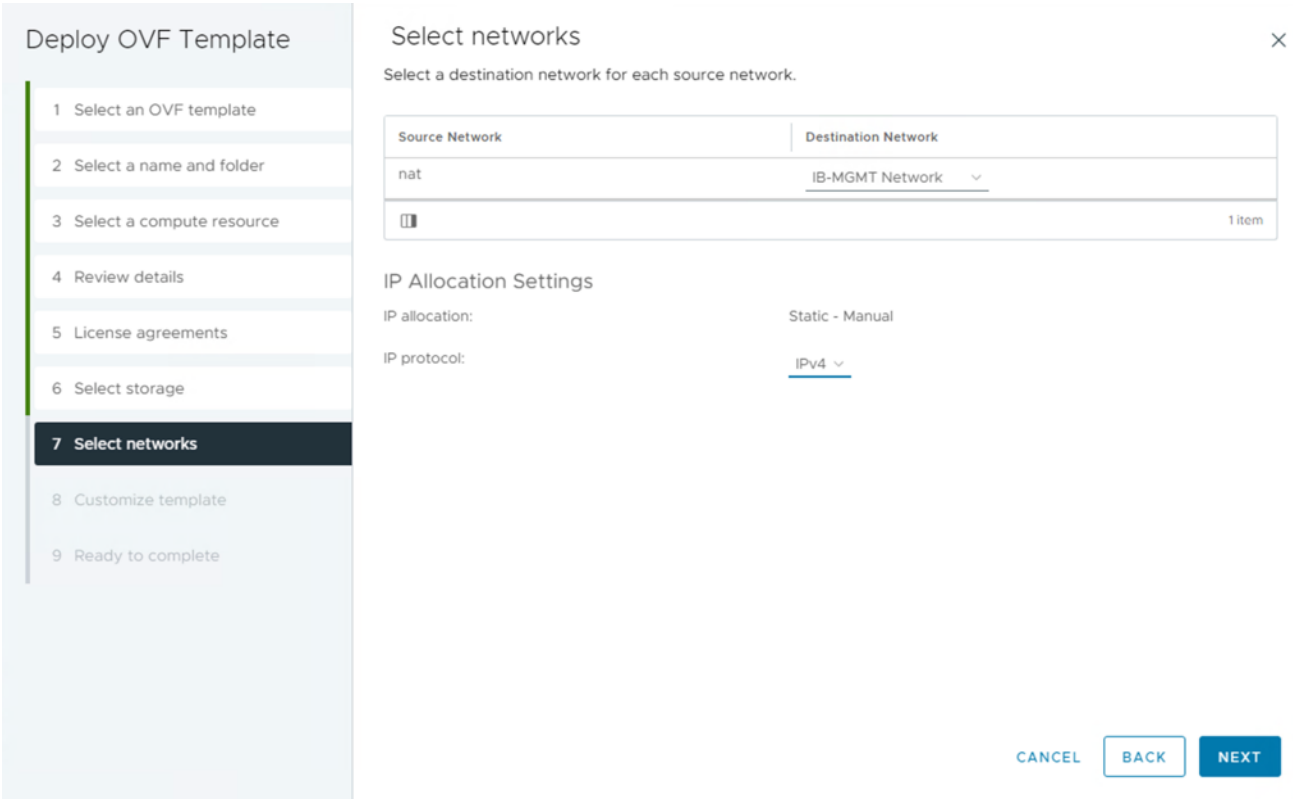
Step 7. Read and accept the license agreement and click **Next**.



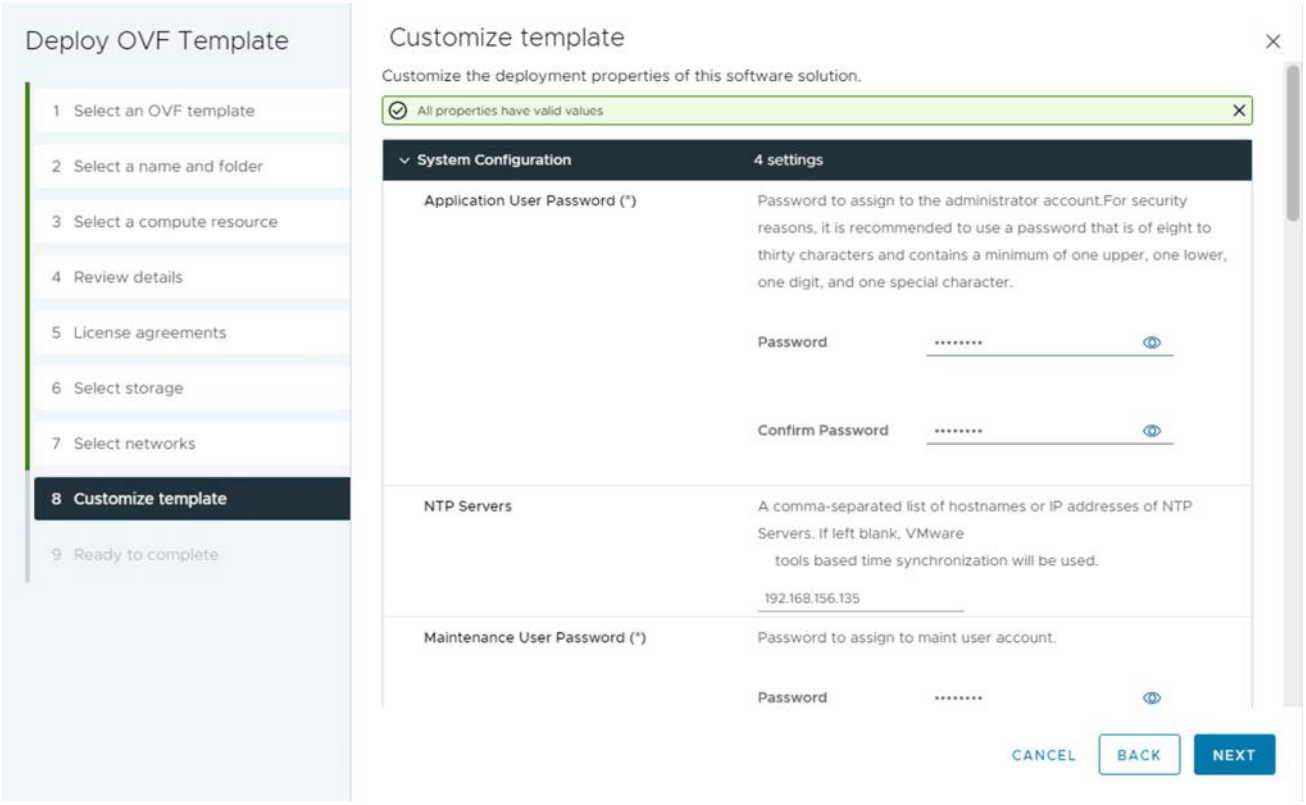
Step 8. Select the **Thin Provision** option for the virtual disk format, select **infra_datastore** for storage and click **Next**.



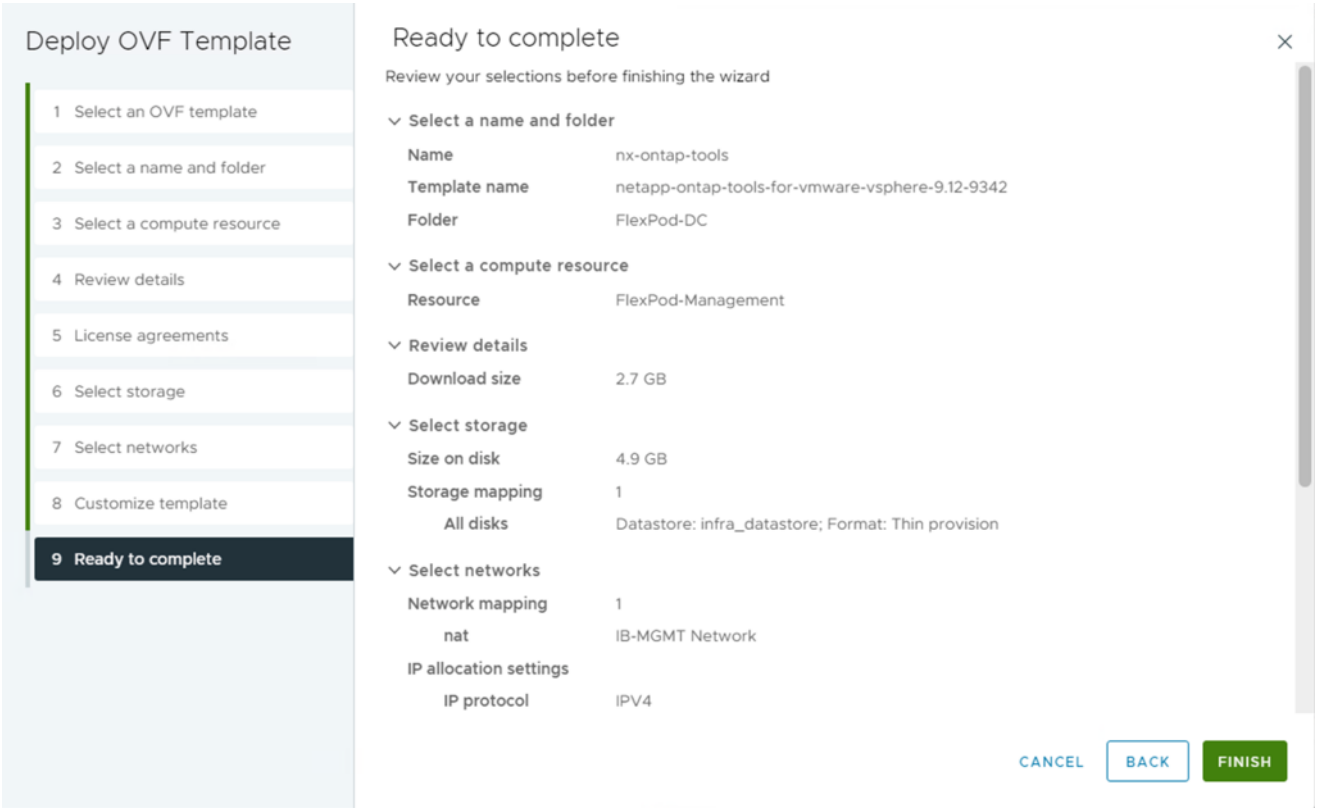
Step 9. Select a **destination network**, **IP protocol**, and click **Next**.



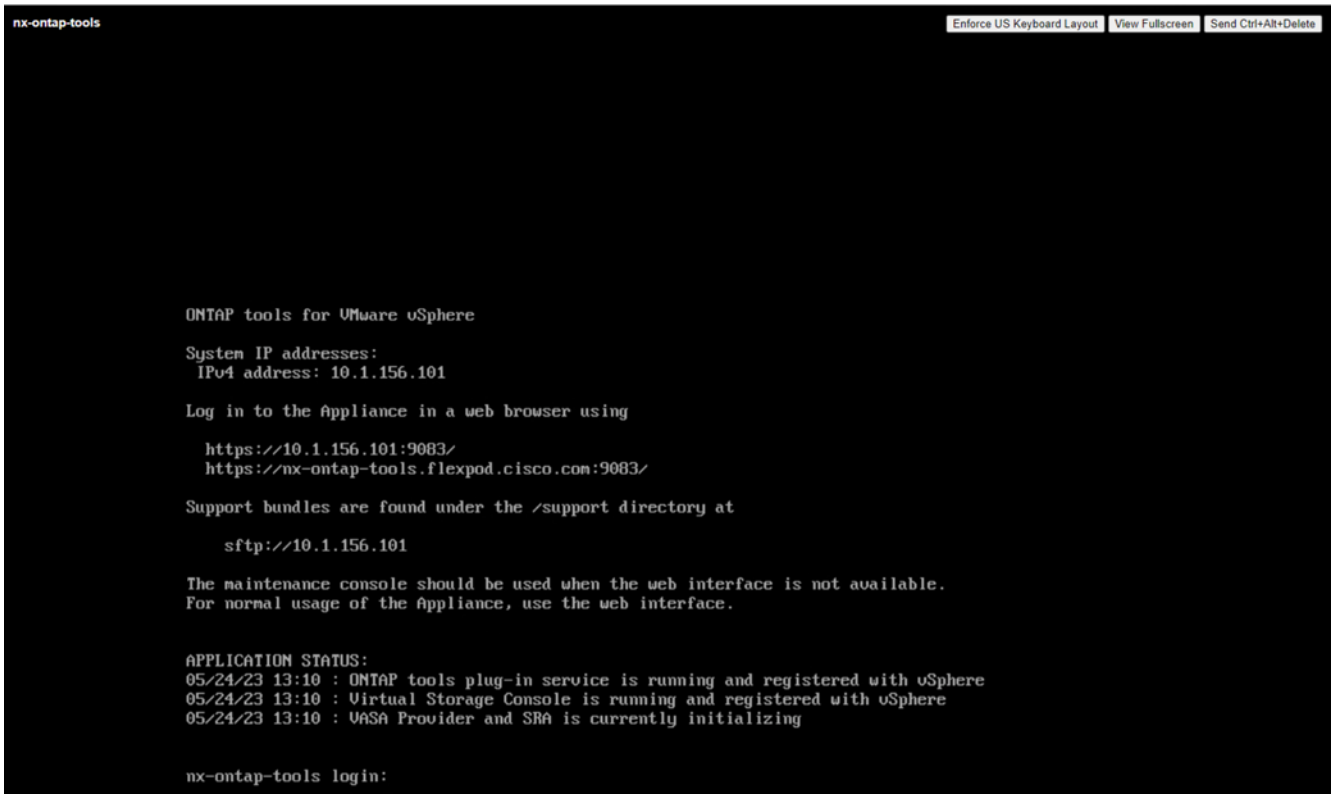
Step 10. From Customize Template, enter the ONTAP tools system configurations, vCenter name or IP address and other network property details and click **NEXT**.



Step 11. Review the configuration details entered and click **FINISH** to complete the deployment of ONTAP tools VM.

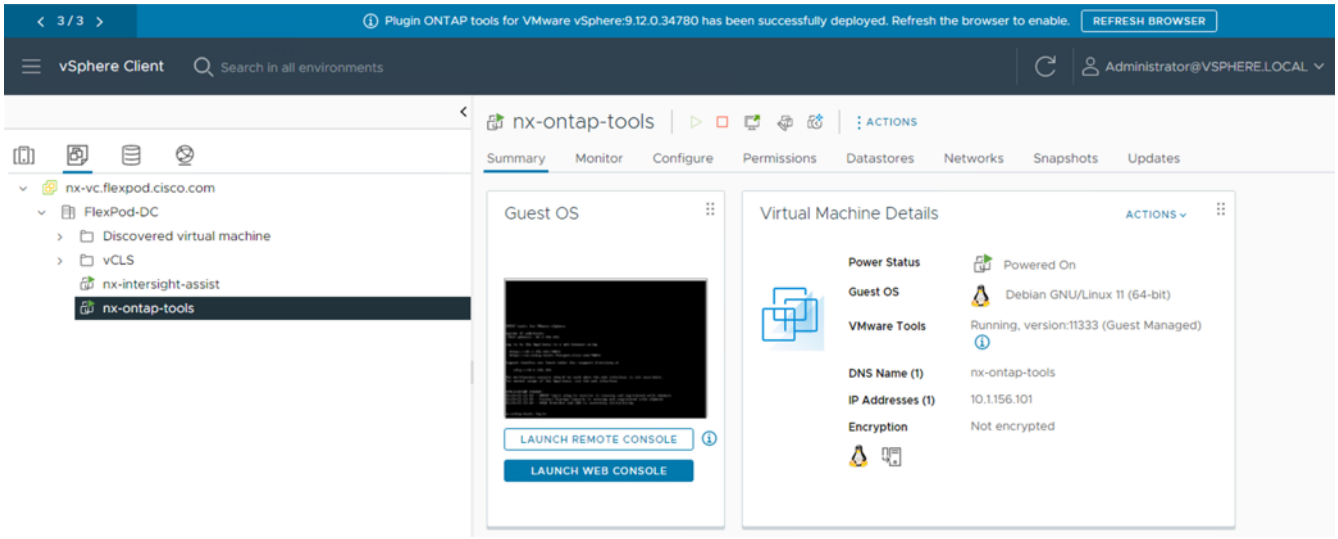


Step 12. Power on the **ONTAP tools VM** and open the **VM console** to monitor the boot up process and the information provided to confim that the tool is registered with vCenter and the Virtual Storage Console (VSC) is running.

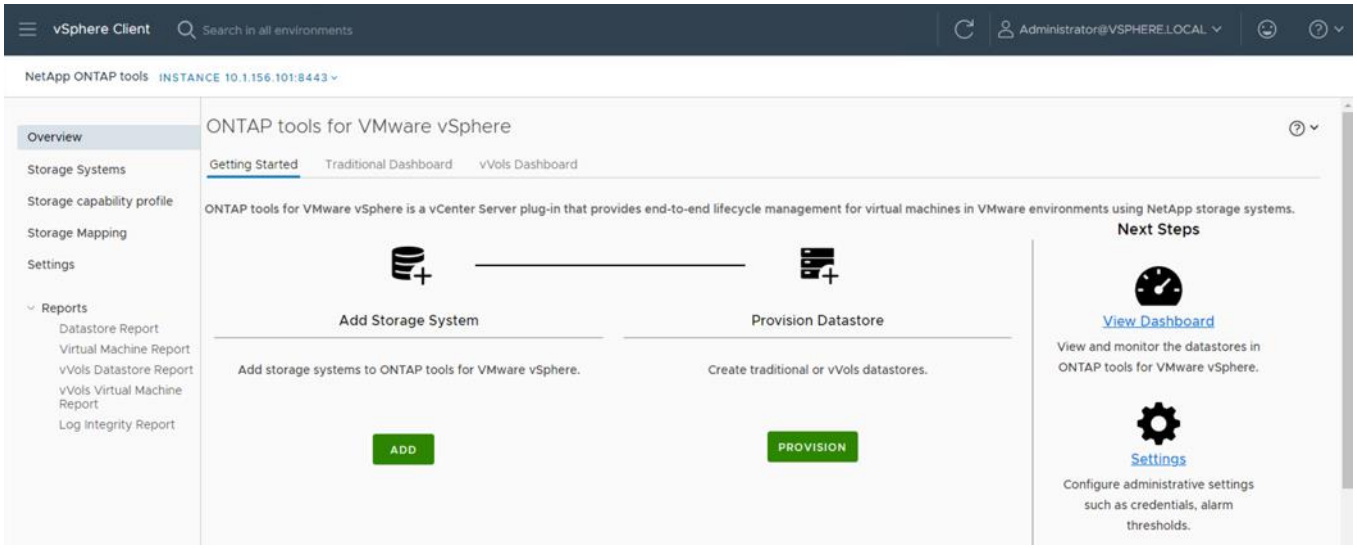


Note: If ONTAP tools is not registered with any vCenter Server, go to https://appliance_ip:8143/Register.html to register the VSC instance. The Register.html redirects you to the swagger page. From ONTAP tools 9.12 onwards the registration of ONTAP tools with vCenter happens from the swagger page.

Step 13. Click the notification on top of the vSphere Client GUI to see the notification that the ONTAP tools plugin has been deployed and click **REFRESH BROWSER** to enable it.



Step 14. From the **vSphere Client GUI menu**, open the **NetApp ONTAP tools plugin** to view the plugin information, add storage system, and provision datastores.

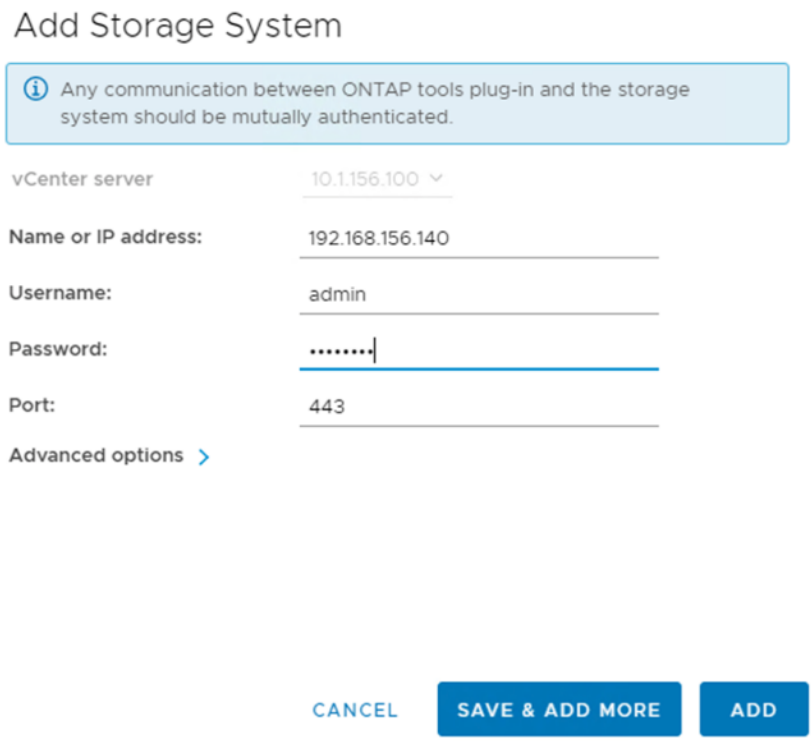


Procedure 3. Add ONTAP Cluster to ONTAP tools manually

Step 1. From the **vSphere Client GUI Menu**, open the **NetApp ONTAP tools plugin**.

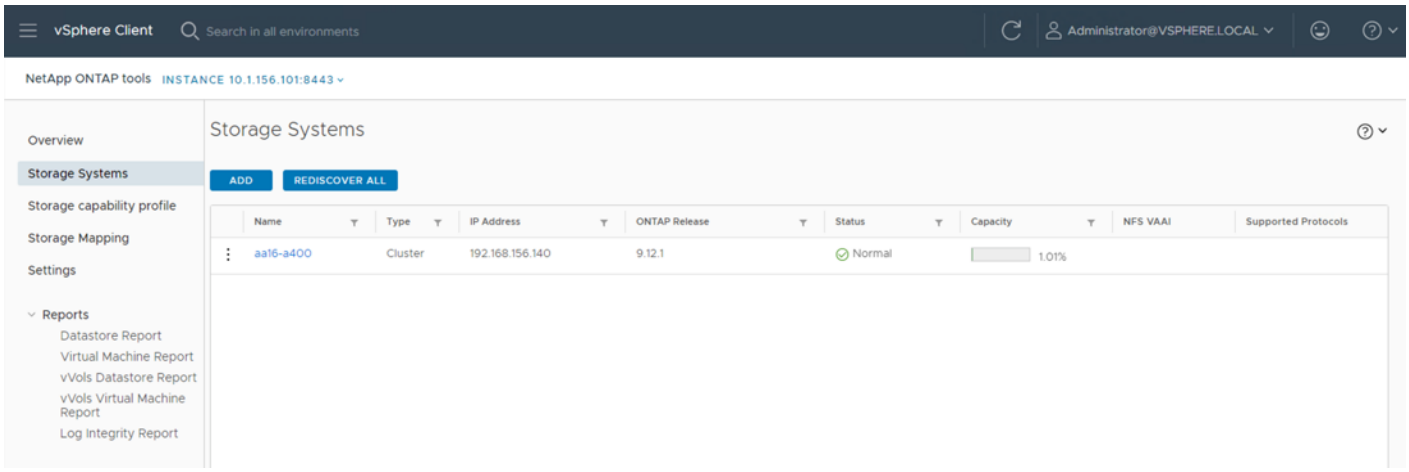
Step 2. On the Getting Started tab, add storage system to ONTAP tools by clicking **ADD**.

Step 3. Provide the storage system information and login credential and click **ADD**.



Step 4. Click **YES** when prompted to authorize the ONTAP Cluster certificate.

Step 5. Go to the **Storage System menu** to see the newly added ONTAP cluster information.



Procedure 4. Download and Install the NetApp NFS Plug-in for VMware VAAI

Step 1. Download the Netapp NFS Plug-in 2.0.1 for VMware VAAI file from: https://mysupport.netapp.com/site/products/all/details/nfsplugin-vmware-vaai/downloads-tab

Step 2. Go to **vib20** > **NetAppNasPlugin** and unzip the file and extract **NetApp_bootbank_NetAppNasPlugin_2.0.1-16.vib.**

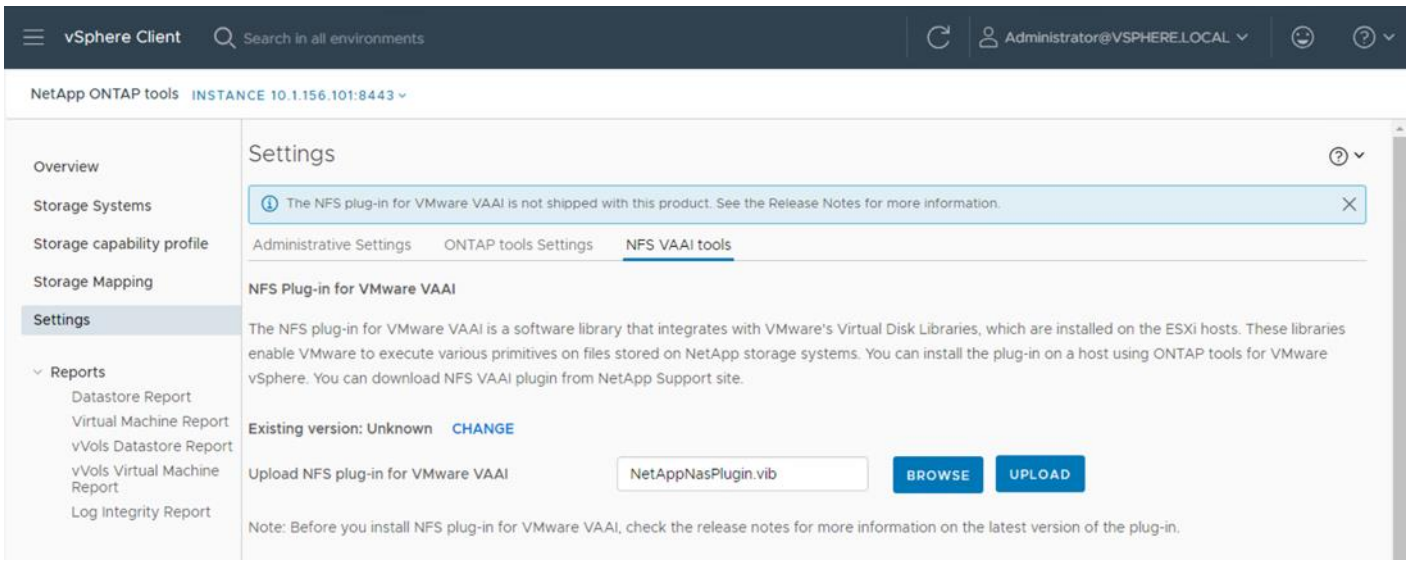
Step 3. Rename the .vib file to **NetAppNasPlugin.vib** to match the predefined name that ONTAP tools uses.

Step 4. Click **Settings** in the ONTAP tool Getting Started page.

Step 5. Click **NFS VAAI Tools** tab.

Step 6. Click **Change** in the Existing version section.

Step 7. Browse and select the renamed .vib file, and then click **Upload** to upload the file to the virtual appliance



Note: The next step is only required on the hosts where NetApp VAAI plug-in was not installed alongside Cisco VIC driver installation.

Step 8. In the Install on ESXi Hosts section, select the ESXi host where the NFS Plug-in for VAAI is to be installed, and then click **Install**.

Step 9. **Reboot** the ESXi host after the installation finishes.

Procedure 5. Verify the VASA Provider

Note: The VASA provider for ONTAP is enabled by default during the installation of the NetApp ONTAP tools.

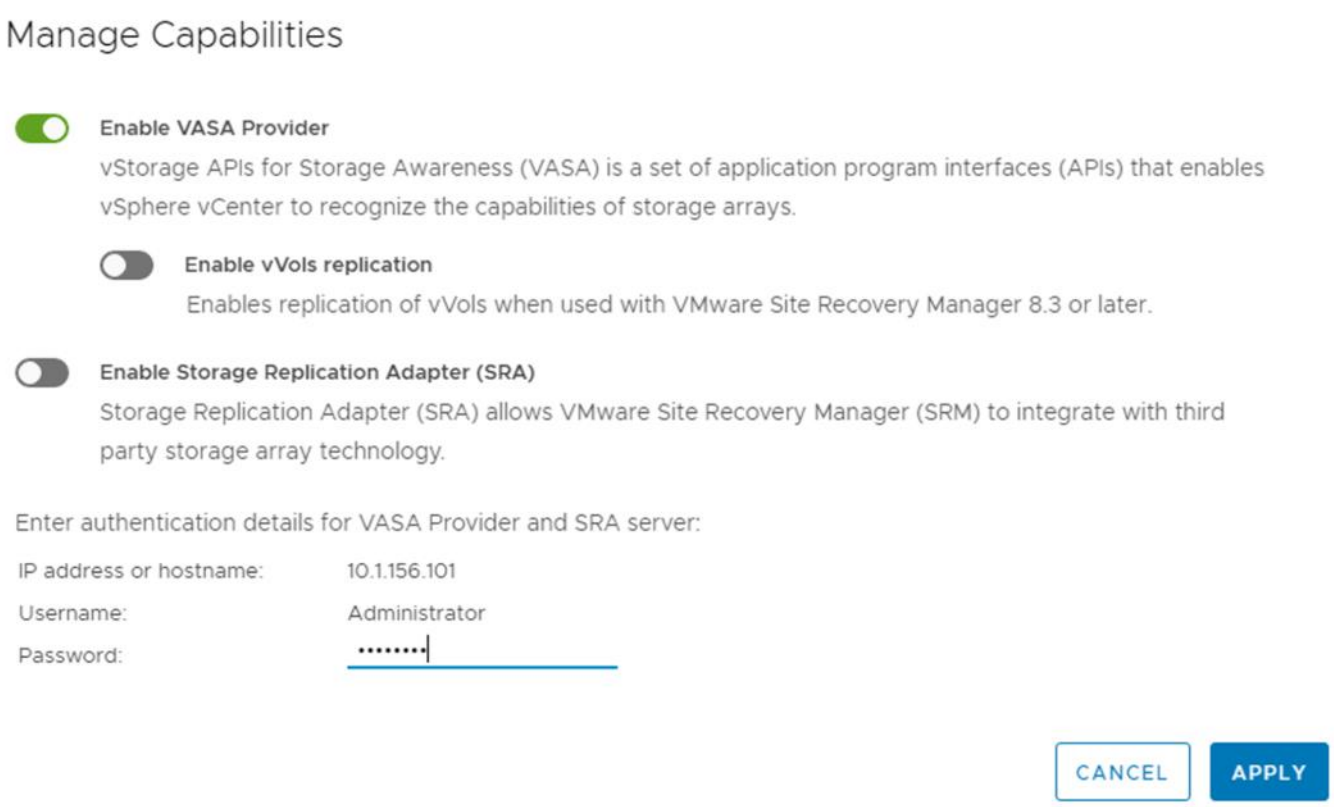
Step 1. From the vSphere Client, click **Menu** > **NetApp ONTAP tools**.

Step 2. Click **Settings**.

Step 3. From the Administrative Settings tab, click **Manage Capabilities** .

Step 4. In the Manage Capabilities dialog box, click **Enable VASA Provider** if it was not pre-enabled.

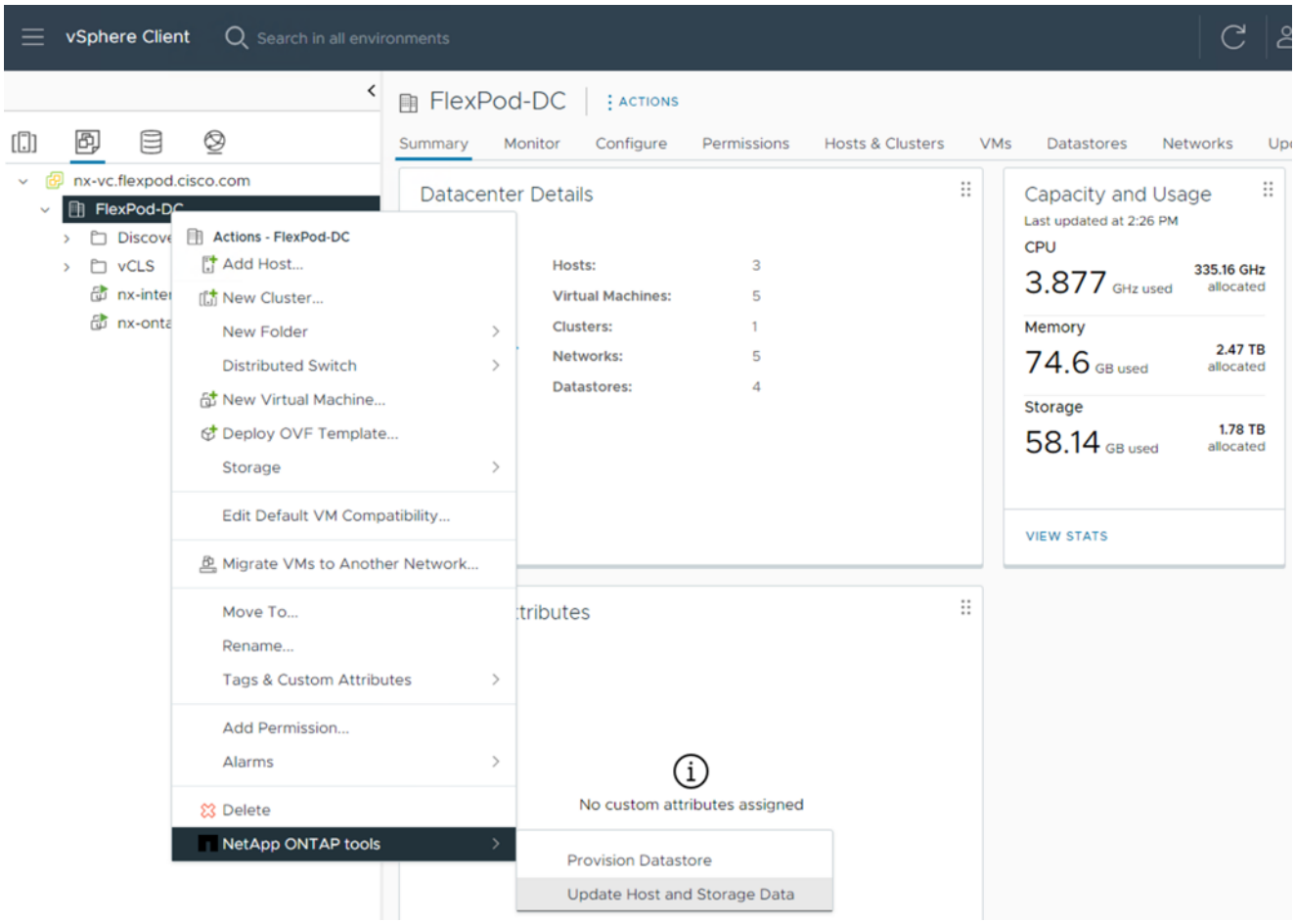
Step 5. Enter the IP address of the virtual appliance for ONTAP tools, VASA Provider, and VMware Storage Replication Adapter (SRA) and the administrator password, and then click **Apply if changes to capabilities were made**.



Procedure 6. Update Host and Storage Data

Step 1. From the **vSphere Client Home Page**, click **Hosts and Clusters**.

Step 2. Right-click the **FlexPod-DC datacenter**, click **NetApp ONTAP tools** > **Update Host and Storage Data**.



Step 3. On the Confirmation dialog box, click **YES**. It might take a few minutes to update the data.

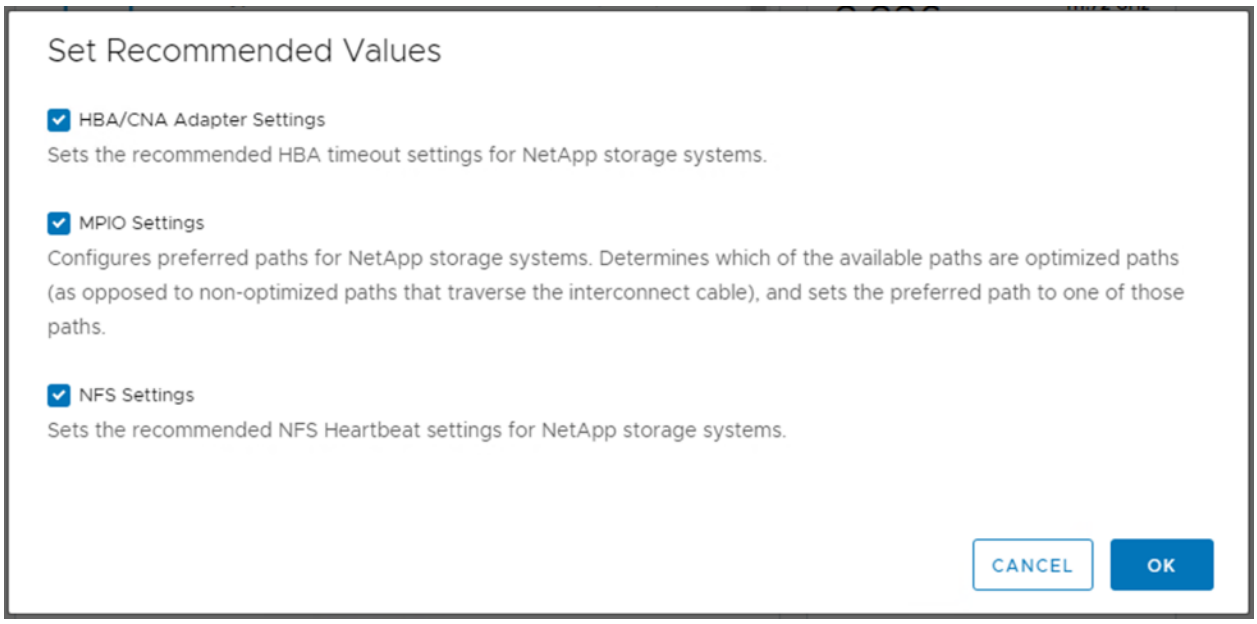
Procedure 7. Optimal Storage Settings for ESXi Hosts

Note: ONTAP tools enables the automated configuration of storage-related settings for all ESXi hosts that are connected to NetApp storage controllers.

Step 1. From the **VMware vSphere Web Client Home page**, click **vCenter** > **Hosts and Clusters**.

Step 2. Select a **host** and then click **Actions** > **NetApp ONTAP tools** > **Set Recommended Values**.

Step 3. In the **NetApp Recommended Settings** dialog box, select all the applicable **values** for the ESXi host.



Note: This functionality sets values for HBAs and converged network adapters (CNAs), sets appropriate paths and path-selection plug-ins, and verifies appropriate settings for NFS I/O. A vSphere host reboot may be required after applying the settings.

Step 4. Click **OK**.

Provision Datastores using ONTAP Tools (Optional)

Using ONTAP tools, the administrator can provision an NFS, FC, FC-NVMe or iSCSI datastore and attach it to a single or multiple hosts in the cluster. The following steps describe provisioning a datastore and attaching it to the cluster.

Note: It is a NetApp best practice to use ONTAP tools to provision any additional datastores for the FlexPod infrastructure. When using VSC to create vSphere datastores, all NetApp storage best practices are implemented during volume creation and no additional configuration is needed to optimize performance of the datastore volumes.

Storage Capabilities

A storage capability is a set of storage system attributes that identifies a specific level of storage performance (storage service level), storage efficiency, and other capabilities such as encryption for the storage object that is associated with the storage capability.

Create the Storage Capability Profile

In order to leverage the automation features of VASA two primary components must first be configured. The Storage Capability Profile (SCP) and the VM Storage Policy. The Storage Capability Profile expresses a specific set of storage characteristics into one or more profiles used to provision a Virtual Machine. The SCP is specified as part of VM Storage Policy. NetApp ONTAP tools comes with several pre-configured SCPs such as Platinum, Bronze, and so on.

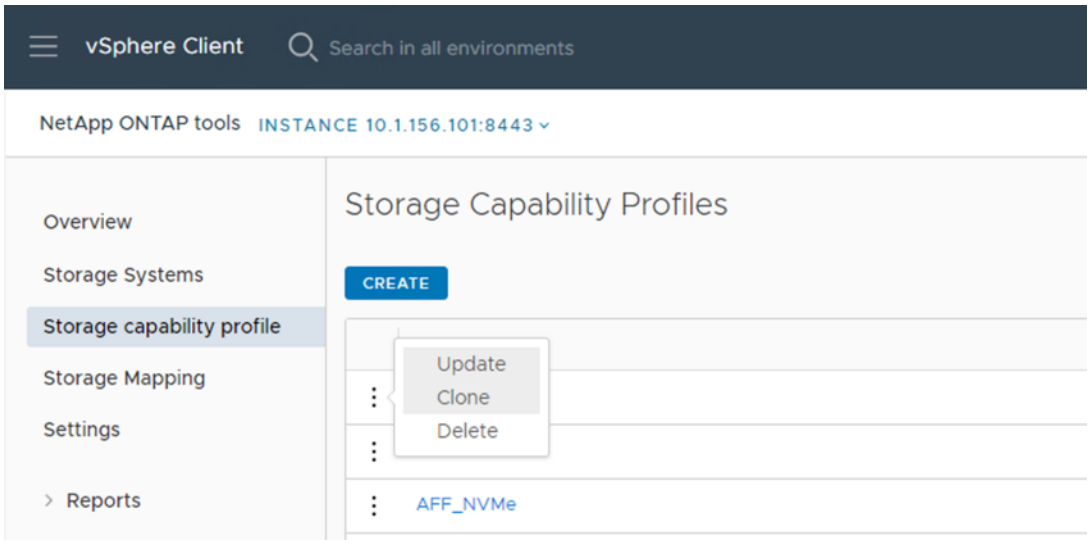
Note: The ONTAP tools for VMware vSphere plug-in also allows you to set Quality of Service (QoS) rule using a combination of maximum and/or minimum IOPs.

Procedure 1. Review or Edit the Built-In Profiles Pre-Configured with ONTAP Tools

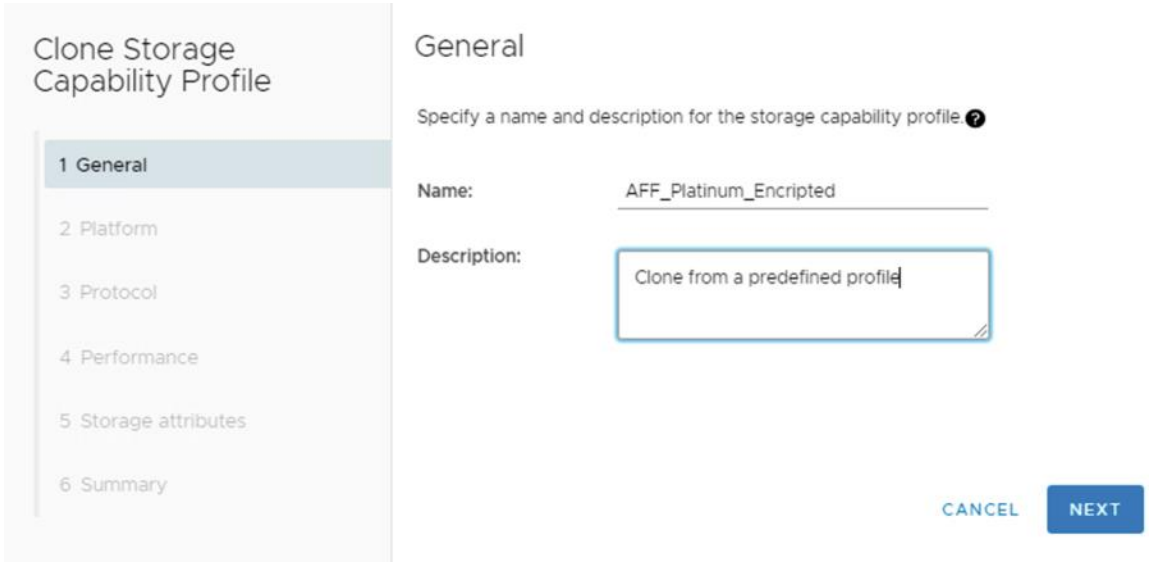
Step 1. From the vCenter console, click **Menu** > **NetApp ONTAP tools**.

Step 2. In the NetApp ONTAP tools click **Storage Capability Profiles**.

Step 3. Select the **Platinum** Storage Capability Profile and select **Clone** from the toolbar.



Step 4. Enter a name for the cloned SCP (for example, AFF_Platinum_Encrypted) and add a description if desired. Click **NEXT**.

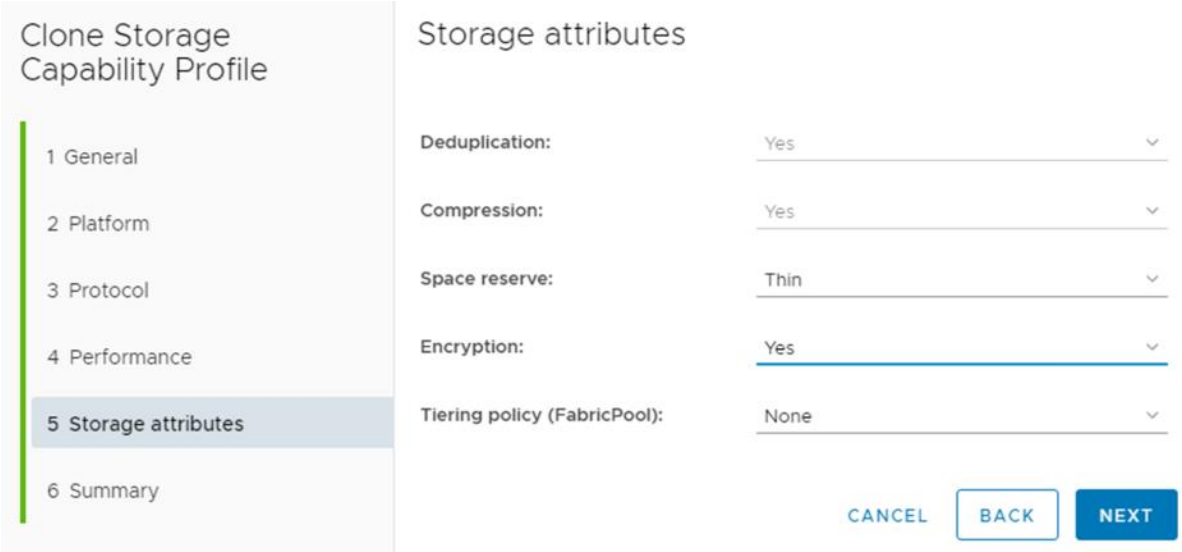


Step 5. Select **All Flash FAS(AFF)** for the storage platform and click **NEXT**.

Step 6. Select **Any** for the Protocol and click **NEXT**.

Step 7. Select **None** to allow unlimited performance or set a the desired minimum and maximum IOPS for the QoS policy group. Click **NEXT**.

Step 8. On the Storage attributes page, change the Encryption and Tiering policy to the desired settings and click **NEXT**. In the example below, Encryption was enabled.



Step 9. Review the summary page and click **FINISH** to create the storage capability profile.

Note: It is recommended to Clone the Storage Capability Profile if you wish to make any changes to the predefined profiles rather than editing the built-in profile.

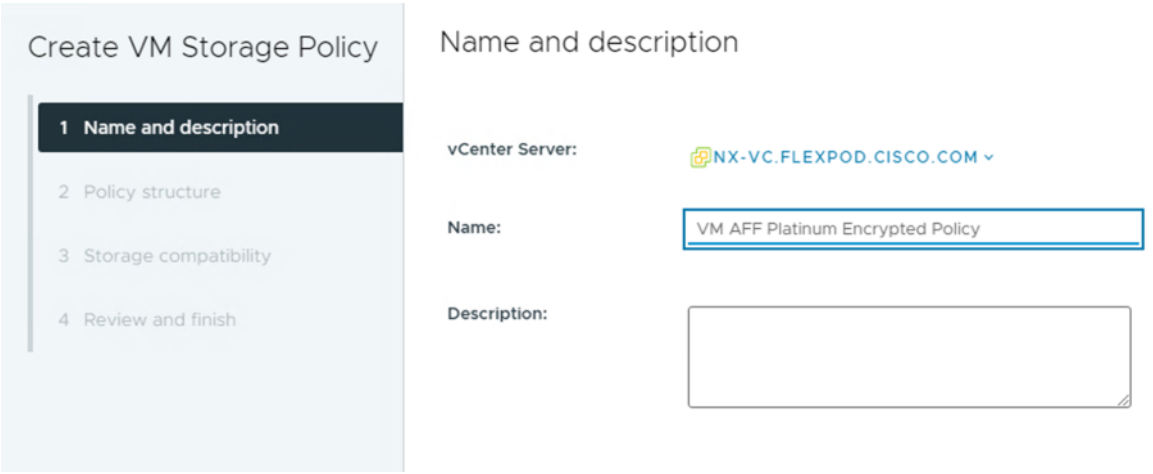
Procedure 2. Create a VM Storage Policy

Note: You must create a VM storage policy and associate SCP to the datastore that meets the requirements defined in the SCP.

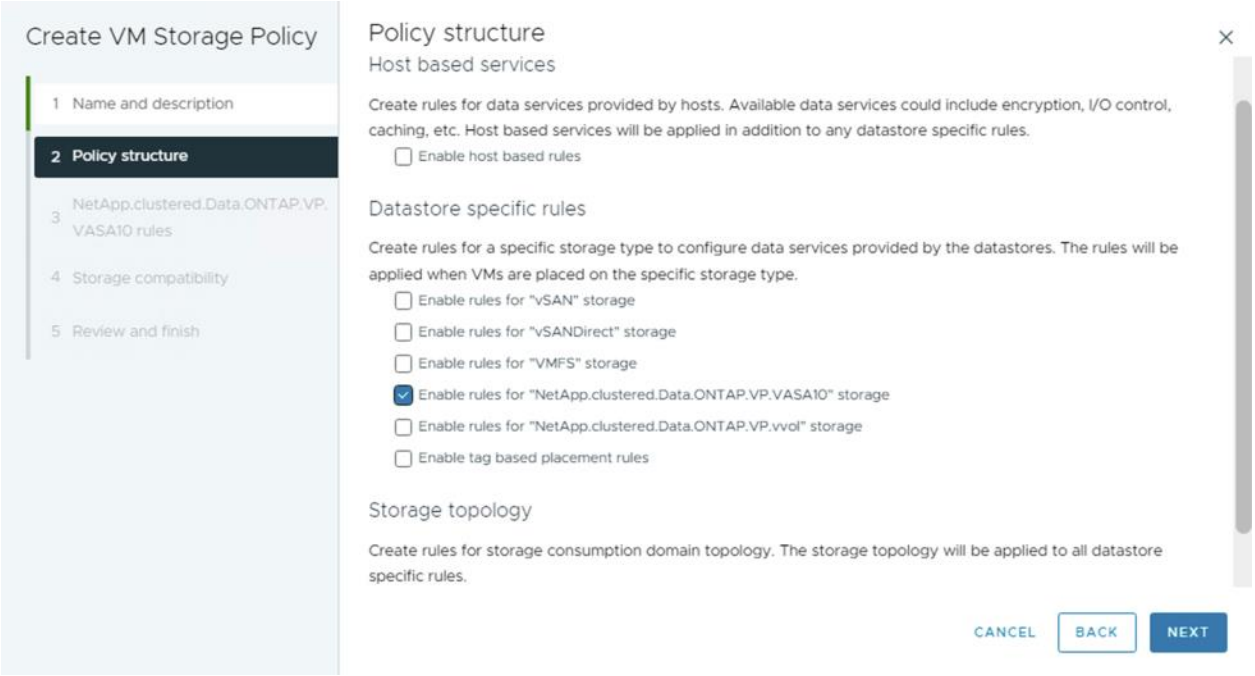
Step 1. From the vCenter console, click **Menu** > **Policies and Profiles**.

Step 2. Select **VM Storage Policies** and click **CREATE**.

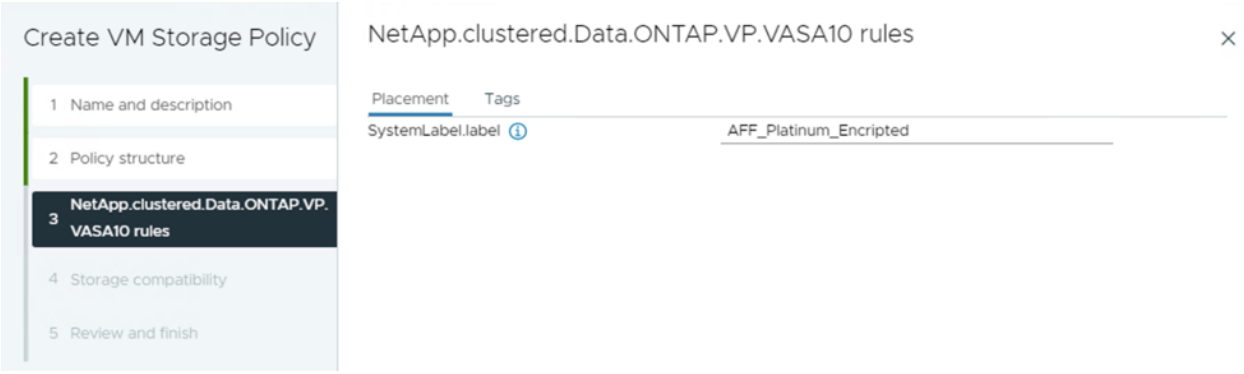
Step 3. Create a name for the VM storage policy and enter a description if desired and click **NEXT**.



Step 4. Select **Enable rules for NetApp.clustered.Data.ONTAP.VP.VASA10 storage** located under the Datastore specific rules section and click **NEXT**.



Step 5. From the Placement tab select the SCP created in the previous step and click **NEXT**.



Step 6. All the datastores with matching capabilities are displayed, click **NEXT**.

Step 7. Review the policy summary and click **FINISH**.

Procedure 3. Provision NFS Datastore

Step 1. From the vCenter console, click **Menu > NetApp ONTAP tools**.

Step 2. From the ONTAP tools Home page, click **Overview**.

Step 3. From the Getting Started tab, click **Provision**.

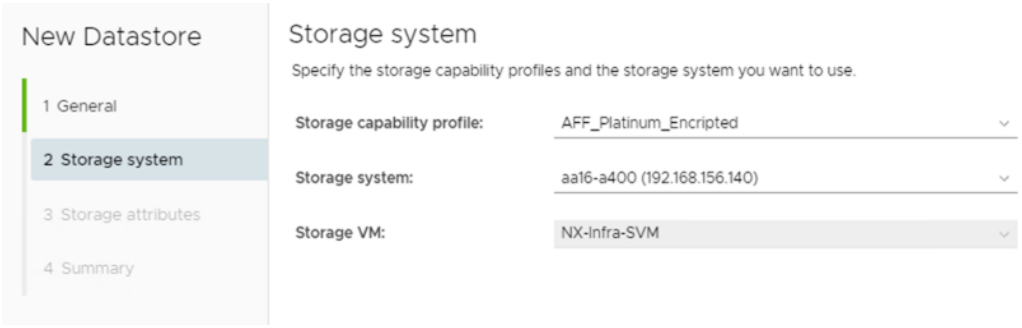
Step 4. Click **Browse** to select the destination to provision the datastore.

Step 5. Select the type as **NFS** and Enter the datastore name (for example, NFS_DS_1).

Step 6. Provide the size of the datastore and the NFS Protocol.

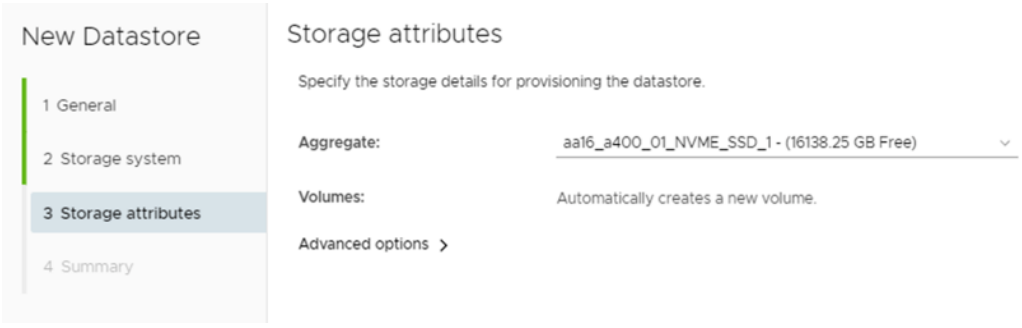
Step 7. Check the storage capability profile and click **NEXT**.

Step 8. Select the desired Storage Capability Profile, cluster name and the desired SVM to create the datastore. In this example, the Infra-SVM is selected.

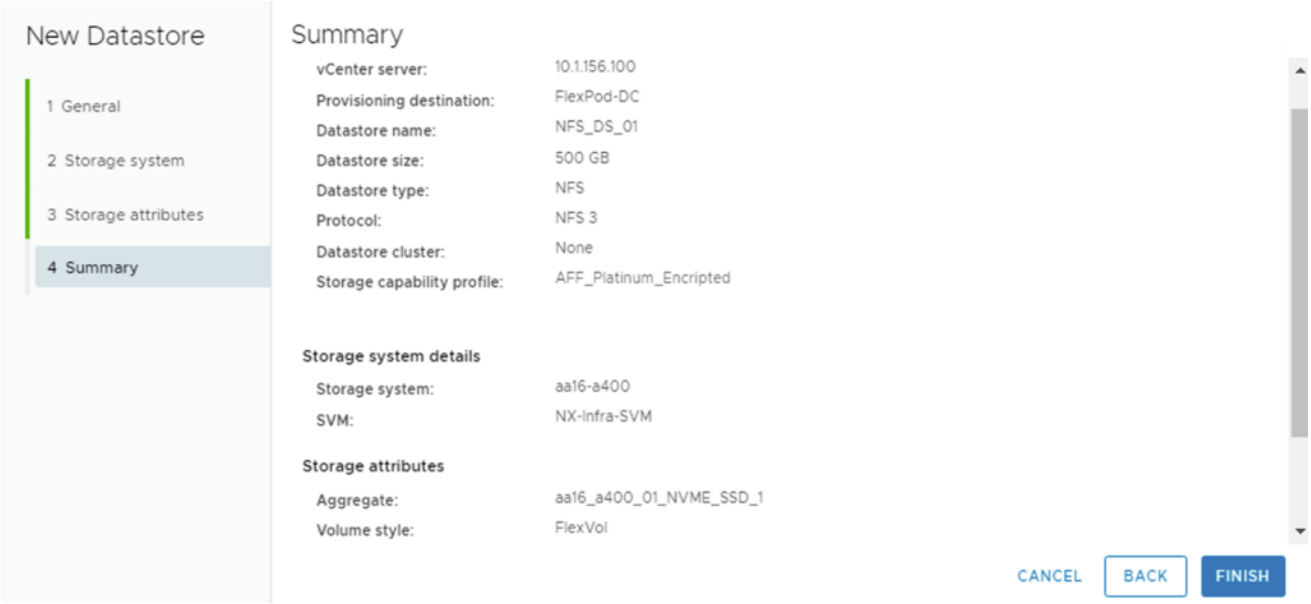


Step 9. Click **NEXT**.

Step 10. Select the aggregate name and click **NEXT**.



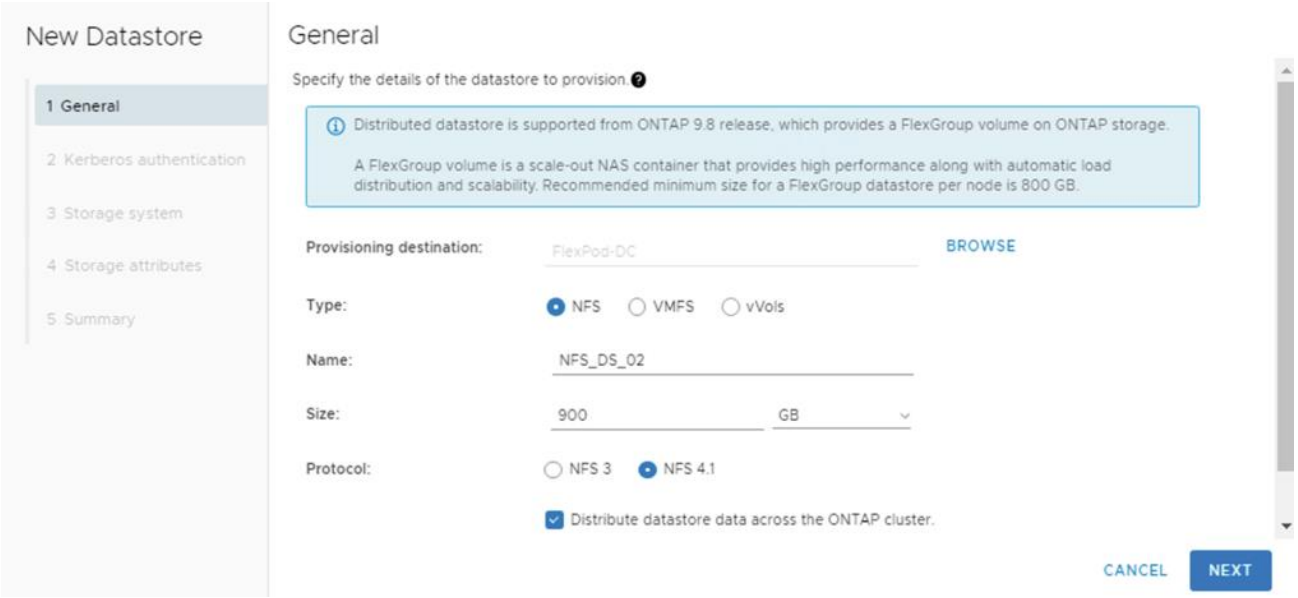
Step 11. Review the Summary and click **FINISH**.



Step 12. The datastore is created and mounted on the hosts in the cluster. Click **Refresh** from the vSphere Web Client to see the newly created datastore.

Note: Before provision a datastore with encryption, be sure to enable storage cluster onboard key manager using the "security key-manager onboard enable" command or provide an external key manager with the "security key-manager external" command with additional information for the external key manager.

Note: Distributed datastore is supported from ONTAP 9.8, which provides FlexGroup volume on ONTAP storage. To create a Distributed Datastore across the ONTAP Cluster select NFS 4.1 and check the box for Distributed datastore data across the ONTAP Cluster as shown in the example below.



Procedure 4. Provision FC Datastore

Step 1. From the vCenter console, click **Menu** > **ONTAP tools**.

Step 2. From the ONTAP tools Home page, click **Overview**.

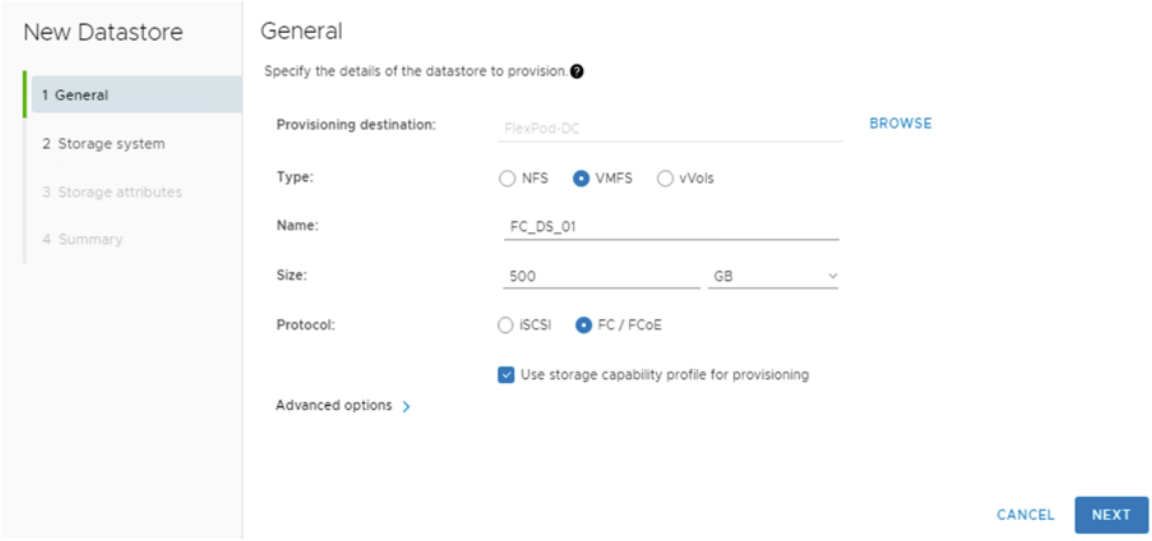
Step 3. From the Getting Started tab, click **Provision**.

Step 4. Click **Browse** to select the destination to provision the datastore.

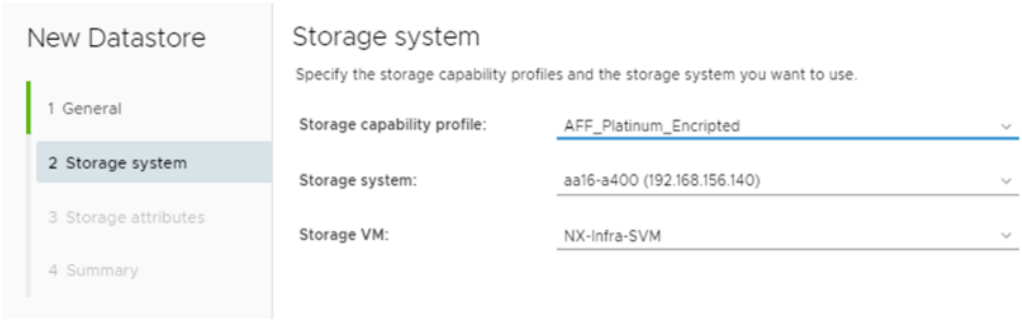
Step 5. Select the type as **VMFS** and Enter the datastore name.

Step 6. Provide the size of the datastore and the FC Protocol.

Step 7. Check the Use storage capability profile and click **NEXT**.

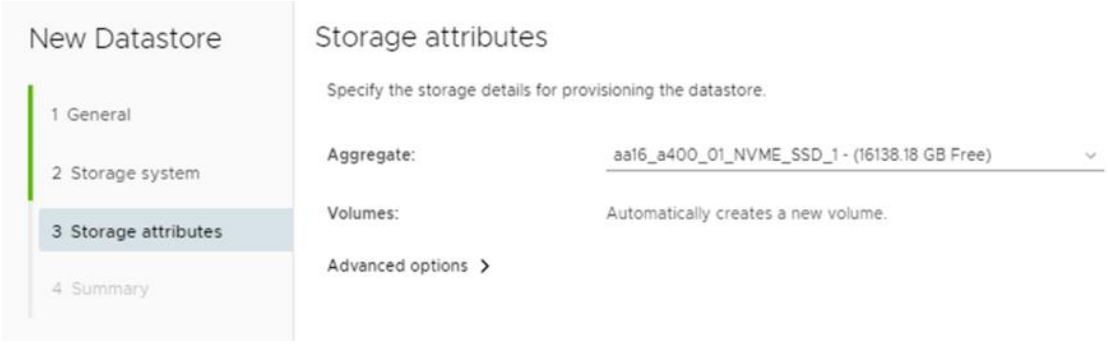


Step 8. Select the **Storage Capability Profile**, **Storage System,** and the desired **Storage VM** to create the datastore.

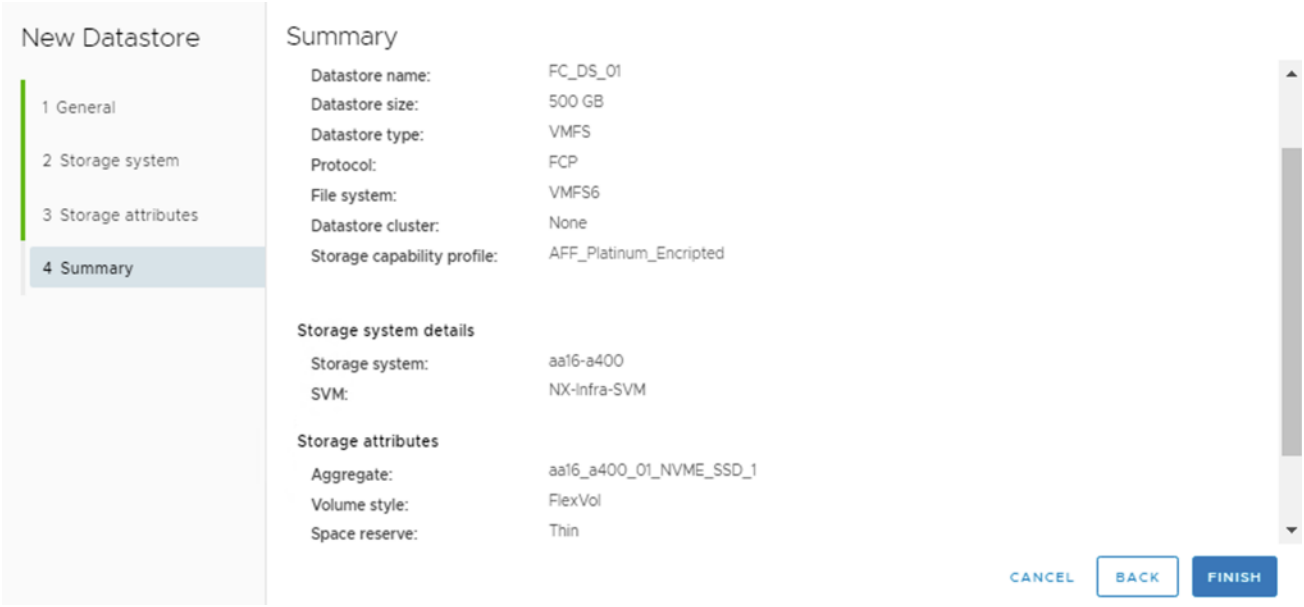


Step 9. Click **NEXT**.

Step 10. Select the aggregate name and click **NEXT**.



Step 11. Review the Summary and click **FINISH**.



Step 12. The datastore is created and mounted on all the hosts in the cluster. Click Refresh from the vSphere Web Client to see the newly created datastore.

Procedure 5. Create Virtual Machine with Assigned VM Storage Policy

Step 1. Log into vCenter and navigate to the **VMs and Templates** tab and click to select the datacenter (for example, FlexPod-DC).

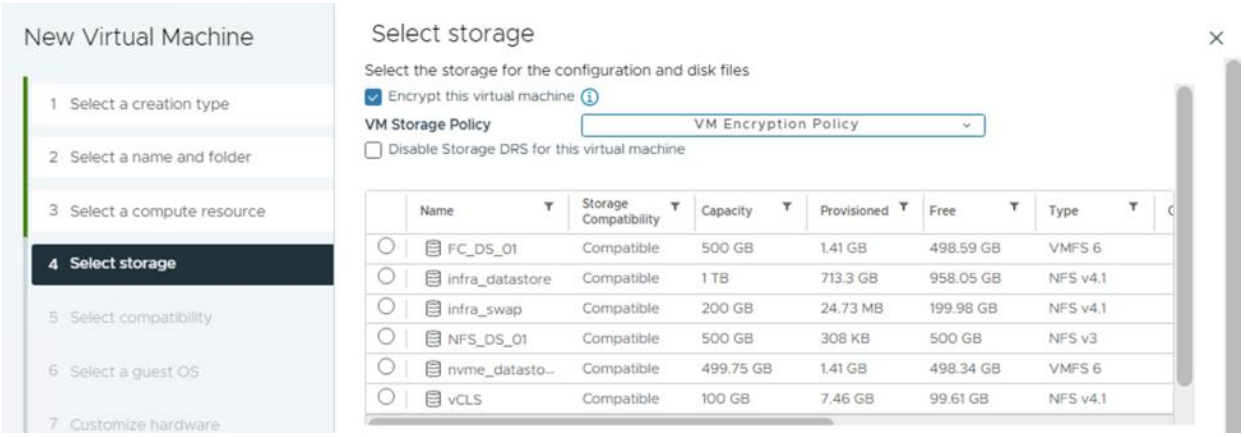
Step 2. Click **Actions** and click **New Virtual Machine**.

Step 3. Click **Create a new virtual machine** and click **NEXT**.

Step 4. Enter a name for the VM and select the datacenter (for example, FlexPod-DC).

Step 5. Select the cluster (for example, FlexPod-Management) and click **NEXT**.

Step 6. Select the VM storage policy from the selections and select a compatible datastore. Click **NEXT**.



Step 7. Select Compatibility (for example, ESXi 8.0 or later) and click **NEXT**.

Step 8. Select the Guest OS and click **NEXT**.

Step 9. Customize the hardware for the VM and click **NEXT**.

Step 10. Review the details and click **FINISH**.

Note: By selecting the VM storage policy in Step 6, the VM will be deployed on the compatible datastores.

Virtual Volumes – vVol (Optional)

NetApp VASA Provider enables customers to create and manage VMware virtual volumes (vVols). A vVols datastore consists of one or more FlexVol volumes within a storage container (also called "backing storage"). A virtual machine can be spread across one vVols datastore or multiple vVols datastores. All of the FlexVol volumes within the storage container must use the same protocol (NFS, iSCSI, or FCP) and the same SVMs.

For more information on vVOL datastore configuration, see:
https://www.cisco.com/c/en/us/td/docs/unified_computing/ucs/UCS_CVDs/flexpod_xseries_vmware_7u2.html#VirtualVolumesvVolOptional

NetApp SnapCenter Plug-in 4.8 Installation

SnapCenter Software is a centralized and scalable platform that provides application-consistent data protection for applications, databases, host file systems, and VMs running on ONTAP systems anywhere in the Hybrid Cloud.

NetApp SnapCenter Architecture

The SnapCenter platform is based on a multitier architecture that includes a centralized management server (SnapCenter Server) and a SnapCenter host agent. The host agent that performs virtual machine and datastore backups for VMware vSphere is the SnapCenter Plug-in for VMware vSphere. It is packaged as a Linux appliance (Debian-based Open Virtual Appliance format) and is no longer part of the SnapCenter Plug-ins Package for Windows. Additional information on deploying SnapCenter server for application backups can be found in the documentation listed below.

This guide focuses on deploying and configuring the SnapCenter plug-in for VMware vSphere to protect virtual machines and VM datastores.

Note: You must install SnapCenter Server and the necessary plug-ins to support application-consistent backups for Microsoft SQL, Microsoft Exchange, Oracle databases and SAP HANA. Application-level protection is beyond the scope of this deployment guide.

Note: Refer to the SnapCenter documentation for more information or the application specific CVD's and technical reports for detailed information on how to deploy SnapCenter for a specific application configuration:

- SnapCenter Documentation: https://docs.netapp.com/us-en/snapcenter/index.html
- Deploy FlexPod Datacenter for Microsoft SQL Server 2019 with VMware 7.0 on Cisco UCS B200 M6 and NetApp ONTAP 9.8: https://www.cisco.com/c/en/us/products/collateral/servers-unified-computing/ucs-b-series-blade-servers/flexpod-sql-2019-vmware-on-ucs-netapp-ontap-wp.html
- SnapCenter Plug-in for VMware vSphere Documentation: SnapCenter Plug-in for VMware vSphere documentation (netapp.com)

Host and Privilege Requirements for the SnapCenter Plug-In for VMware vSphere

Review the following requirements before installing the SnapCenter Plug-in for VMware vSphere virtual appliance:

- SnapCenter Plug-in for VMware vSphere is deployed as a Linux based virtual appliance.
- Virtual appliance must not be deployed in a folder name with special characters.
- A separate, unique instance of the virtual appliance must be deployed for each vCenter Server.

Table 7. Port Requirements

Port	Requirement
8080(HTTPS) bidirectional	This port is used to manage the virtual appliance
8144(HTTPs) bidirectional	Communication between SnapCenter Plug-in for VMware vSphere and vCenter
443 (HTTPS)	Communication between SnapCenter Plug-in for VMware vSphere and vCenter

License Requirements for SnapCenter Plug-In for VMware vSphere

The licenses listed in Table 8 are required on the ONTAP storage system to backup and restore VM's in the virtual infrastructure:

Table 8. SnapCenter Plug-in for VMware vSphere License Requirements

Product	License Requirements
ONTAP	**SnapManager Suite:** Used for backup operations One of these: SnapMirror or SnapVault (for secondary data protection regardless of the type of relationship)

Product	License Requirements
ONTAP Primary Destinations	To perform protection of VMware VMs and datastores the following licenses should be installed: **SnapRestore**: used for restoring operations **FlexClone**: used for mount and attach operations
ONTAP Secondary Destinations	To perform protection of VMware VMs and datastores only: **FlexClone**: used for mount and attach operations
VMware	**vSphere Standard, Enterprise, or Enterprise Plus** A vSphere license is required to perform restore operations, which use Storage vMotion. vSphere Essentials or Essentials Plus licenses do not include Storage vMotion.

Note: It is recommended (but not required) to add SnapCenter Standard licenses to secondary destinations. If SnapCenter Standard licenses are not enabled on secondary systems, SnapCenter cannot be used after a failover operation. A FlexClone license on secondary storage is required to perform mount and attach operations. A SnapRestore license is required to perform restore operations.

Procedure 1. Deploy the SnapCenter Plug-In for VMware vSphere 4.8 using Ansible

Step 1. Clone the repository from https://github.com/NetApp-Automation/SnapCenter-Plug-in-for-VMware-vSphere.

Step 2. Follow the instructions in the README file in the repository to ensure the Ansible environment is configured properly.

Step 3. Update the following variable files:

```
hosts
group_vars/vcenter
vars/snapcenter_vmware_plugin_main.yml
```

Step 4. To invoke the ansible scripts, use the following command:

```
ansible-playbook -i hosts Setup_SnapCenter_VMware_Plugin.yml
```

Note: The above ansible playbook will install the SnapCenter Plug-in in vCenter and will also add ONTAP Storage System.

NetApp SnapCenter Plug-in 4.8 Configuration

Procedure 1. SnapCenter Plug-In for VMware vSphere in vCenter Server

Step 1. Navigate to VMware vSphere Web Client URL **https://<vCenter Server>.**

Note: If you're currently logged into vCenter, logoff, close the open tab and sign-on again to access the newly installed SnapCenter Plug-in for VMware vSphere.

Step 2. After logging on, a blue banner will be displayed indicating the SnapCenter plug-in was successfully deployed. Click **Refresh** to activate the plug-in.

Step 3. On the VMware vSphere Web Client page, select **Menu** > **SnapCenter Plug-in for VMware vSphere** to launch the SnapCenter Plug-in for VMware GUI.

Step 4. When the storage system is added, you can create backup policies and take scheduled backup of VMs and datastores. The SnapCenter plug-in for VMware vSphere allows backup, restore and on-demand backups.

For more information on backup policy configuration, refer to this CVD:
https://www.cisco.com/c/en/us/td/docs/unified_computing/ucs/UCS_CVDs/flexpod_xseries_vmware_7u2.html#FlexPodManagementToolsSetup

Active IQ Unified Manager 9.12 Installation

Active IQ Unified Manager enables you to monitor and manage the health and performance of ONTAP storage systems and virtual infrastructure from a single interface. Unified Manager provides a graphical interface that displays the capacity, availability, protection, and performance status of the monitored storage systems. Active IQ Unified Manager is required to integrate NetApp storage with Cisco Intersight.

This subject describes the procedure to deploy NetApp Active IQ Unified Manager 9.12 as a virtual appliance. Table 9 lists the recommended configuration for the VM.

Table 9. Virtual Machine Configuration

Hardware Configuration	Recommended Settings
RAM	12 GB
Processors	4 CPUs
CPU Cycle Capacity	9572 MHz total
Free Disk Space/virtual disk size	5 GB - Thin provisioned 152 GB – Thick provisioned

Note: There is a limit to the number of nodes that a single instance of Active IQ Unified Manager can monitor before a second instance of Active IQ Unified Manager is needed. See the Unified Manager Best Practices Guide (TR-4621) for more details.

Procedure 1. Install NetApp Active IQ Unified Manager 9.12 using Ansible

Step 1. Clone the repository from https://github.com/NetApp-Automation/Active-IQ-Unified-Manager.

Step 2. Follow the instructions in the README file in the repository to ensure the Ansible environment is configured properly.

Step 3. Update the variable files as mentioned in the README document in the repository.

Step 4. To install AIQUM and add an ONTAP cluster, invoke the below ansible playbook:

```
ansible-playbook aiqum.yml -t aiqum_setup
```

Configure Active IQ Unified Manager

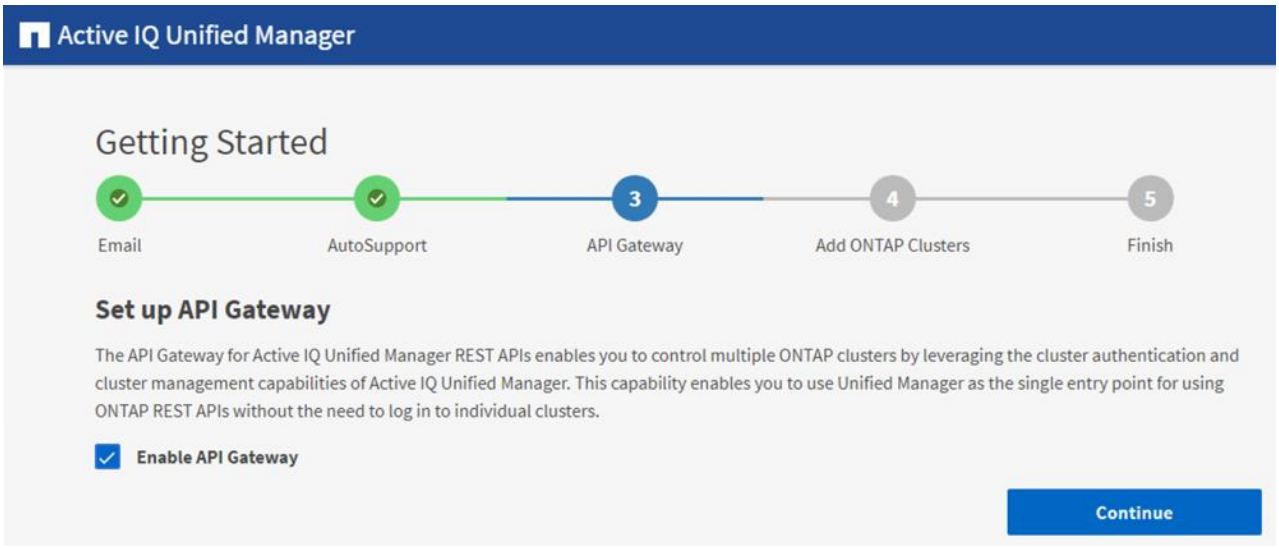
Procedure 1. Initial Setup

Step 1. Launch a web browser and log into Active IQ Unified Manger using the URL shown in the VM console and log in with the admin user.

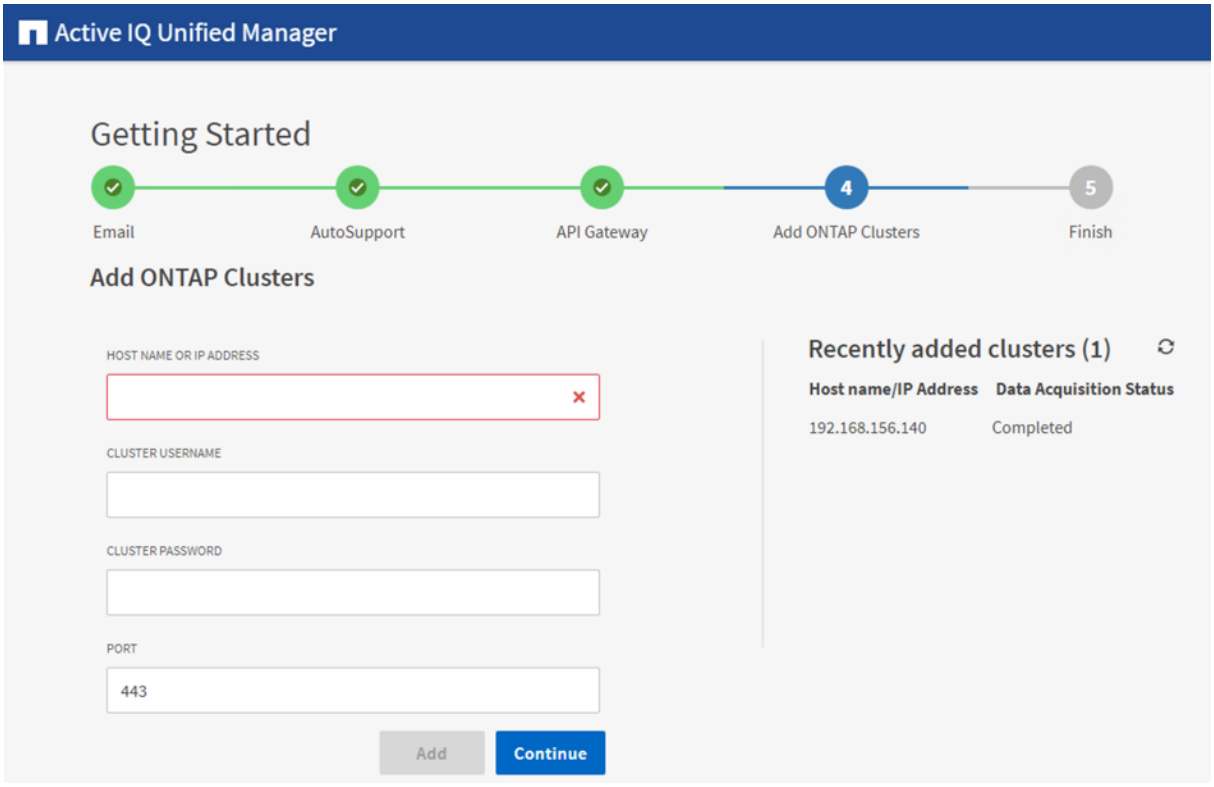
Step 2. Enter the email address that Unified Manager will use to send alerts and the mail server configuration. Click **Continue**.

Step 3. Select **Agree and Continue** on the Set up AutoSupport configuration.

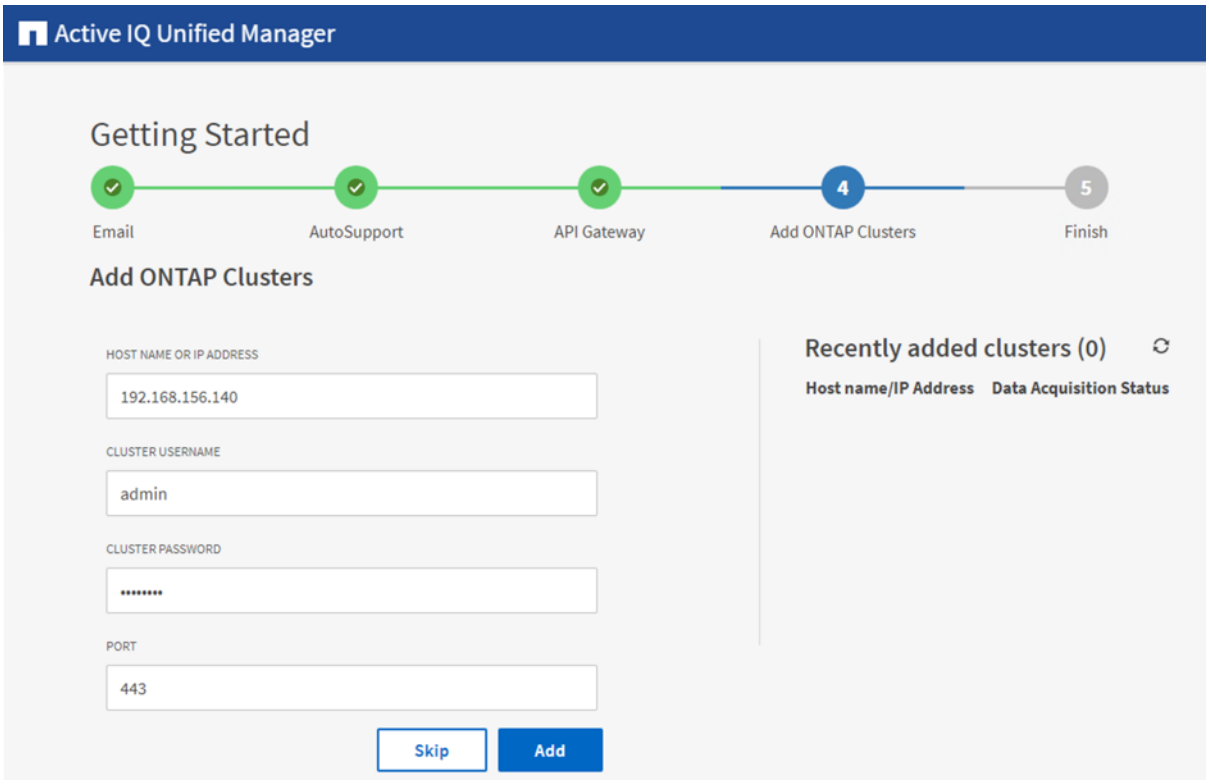
Step 4. Check the box for **Enable API Gateway** and click **Continue.**



Step 5. Skip the following steps if the ONTAP cluster has already been added by the Ansible automation for deploying the AIQUM as shown in the recently added cluster below.



Step 6. Add the ONTAP cluster if needed by entering the ONTAP cluster hostname or IP address and the admin login credentials.



Step 7. Click **Add**.

Step 8. Click **Yes** to trust the self-signed cluster certificate and finish adding the storage system.

Note: The initial discovery process can take up to 15 minutes to complete.

Step 9. Click **Finish** to complete initial AIQUM setup.

Procedure 2. Review Security Compliance with Active IQ Unified Manager

Active IQ Unified Manager identifies issues and makes recommendations to improve the security posture of ONTAP. Active IQ Unified Manager evaluates ONTAP storage based on recommendations made in the Security Hardening Guide for ONTAP 9. Items are identified according to their level of compliance with the recommendations. Review the Security Hardening Guide for NetApp ONTAP 9 (TR-4569) for additional information and recommendations for securing ONTAP 9.

Note: All events identified do not inherently apply to all environments, for example, FIPS compliance.

The status icons in the security cards have the following meanings in relation to their compliance:

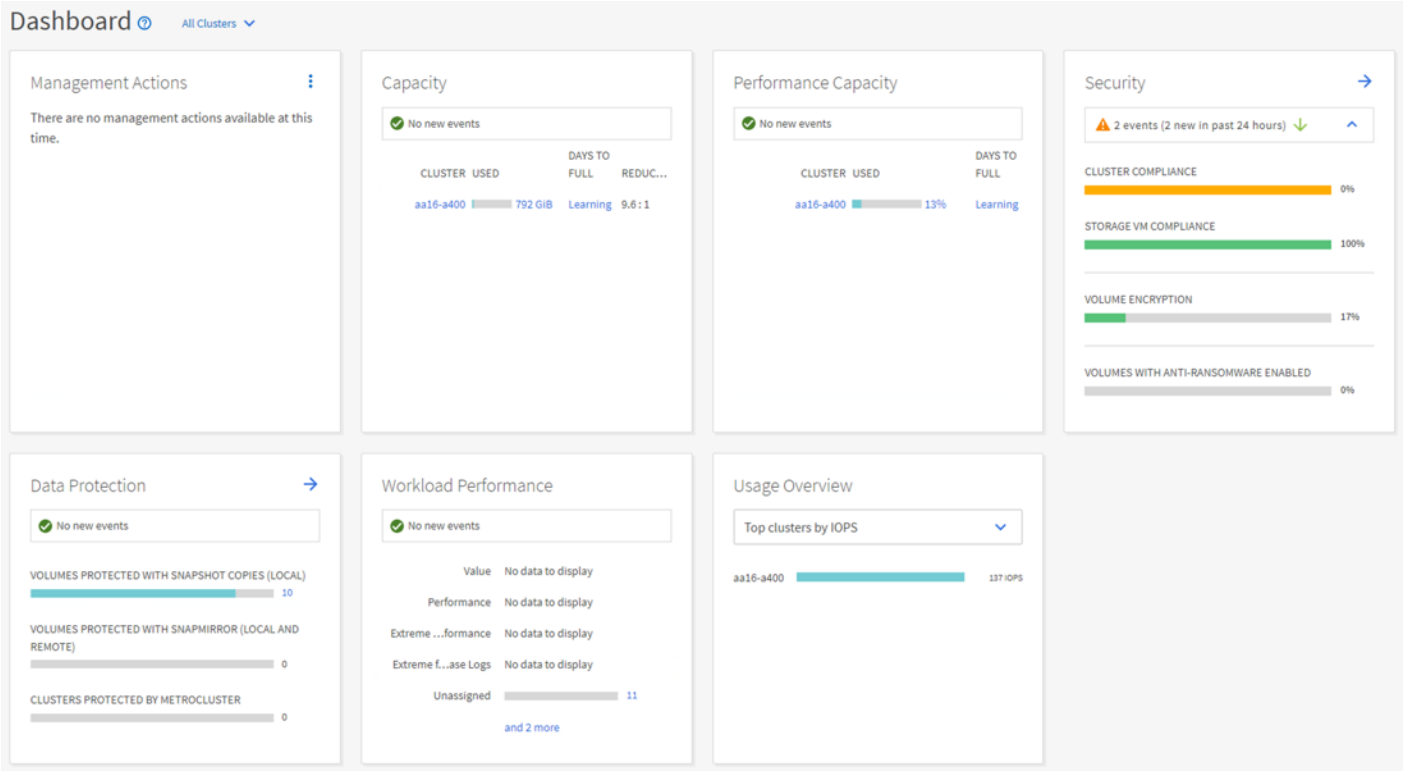
- - The parameter is configured as recommended.
- - The parameter is not configured as recommended.
- - Either the functionality is not enabled on the cluster, or the parameter is not configured as recommended, but this parameter does not contribute to the compliance of the object.

Note that volume encryption status does not contribute to whether the cluster or SVM are considered compliant.

Step 1. Navigate to the URL of the Active IQ Unified Manager and **login**.

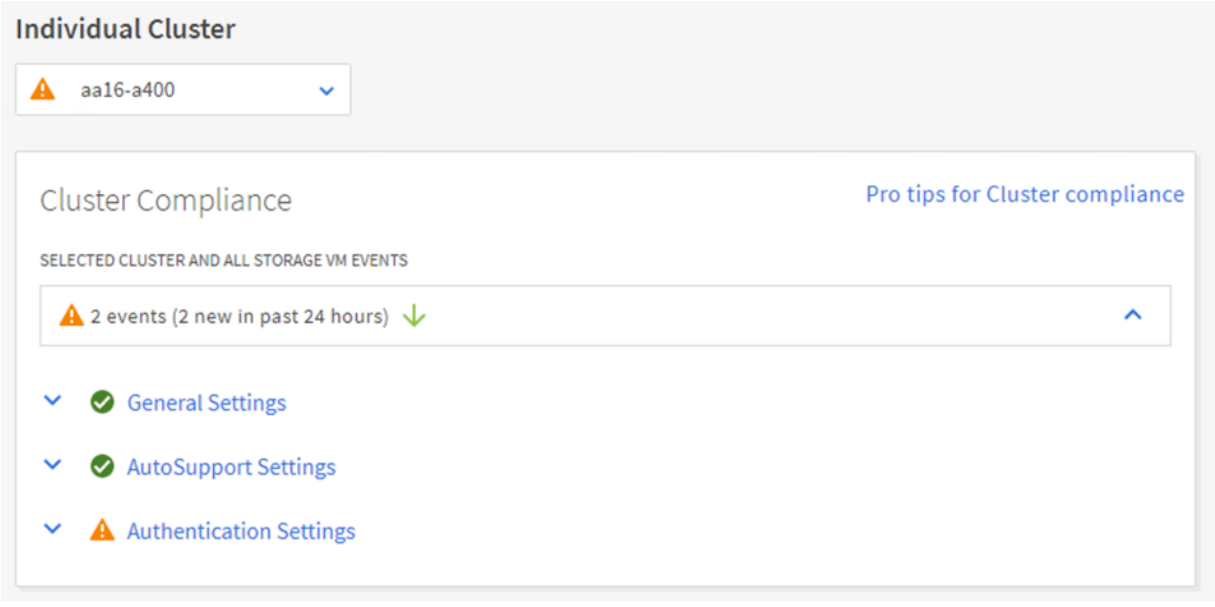
Step 2. Select the **Dashboard** from the left menu bar in Active IQ Unified Manager.

Step 3. Locate the **Security** card and note the compliance level of the cluster and SVM.

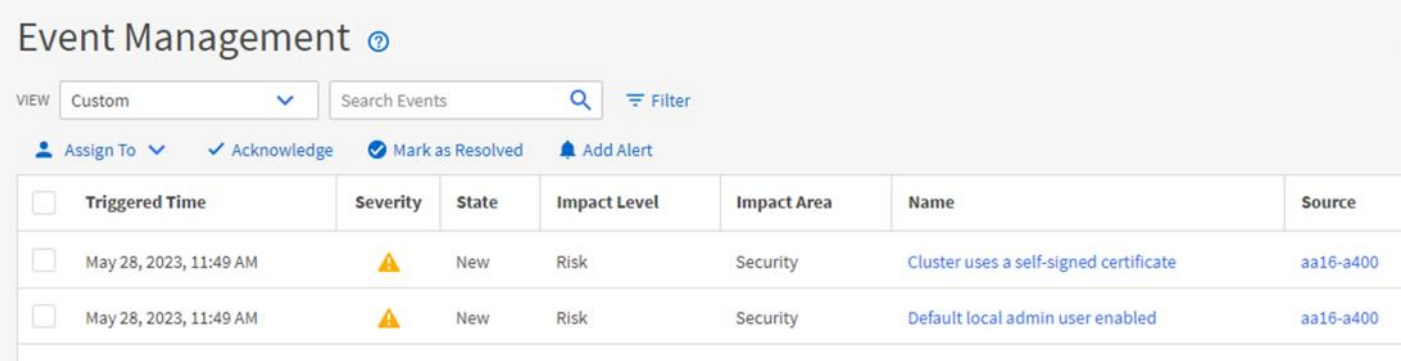


Step 4. Click the blue arrow to expand the findings.

Step 5. Locate Individual Cluster section and the Cluster Compliance card. From the drop-down list select **View All**.



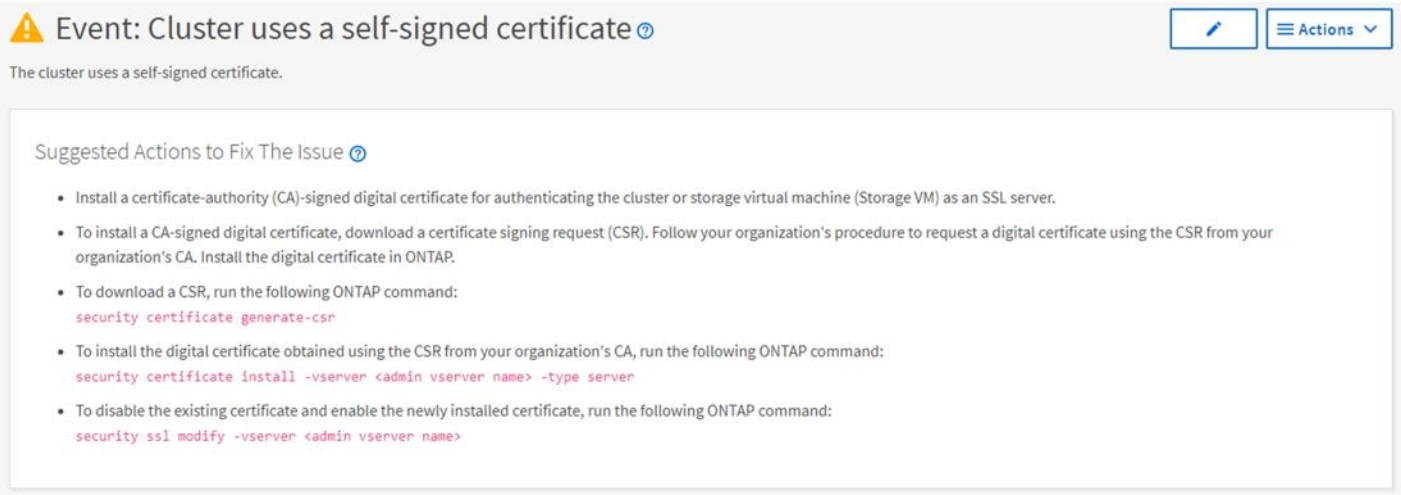
Step 6. Select an event from the list and click the name of the event to view the remediation steps.



Step 7. Remediate the risk if applicable to current environment and perform the suggested actions to fix the issue.

Remediate Security Compliance Findings

Note: Active IQ identifies several security compliance risks after installation that can be immediately corrected to improve the security posture of ONTAP. Click on the event name to get more information and suggested actions to fix the issue.

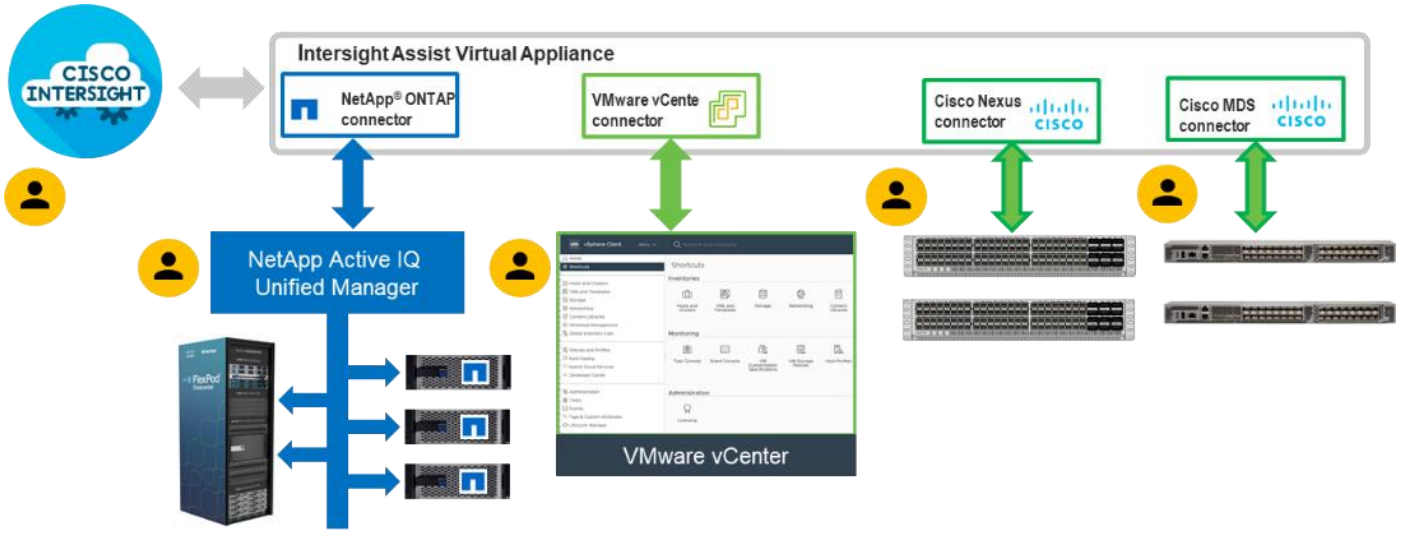


Deploy Cisco Intersight Assist Appliance

Cisco Intersight works with NetApp's ONTAP storage and VMware vCenter using third-party device connectors and Cisco Nexus and MDS switches using Cisco device connectors. Since third-party infrastructure and Cisco switches do not contain any usable built-in Intersight device connector, Cisco Intersight Assist virtual appliance enables Cisco Intersight to communicate with these devices.

Note: A single Cisco Intersight Assist virtual appliance can support both NetApp ONTAP storage, VMware vCenter, and Cisco Nexus and MDS switches.

Figure 6. Managing NetApp and VMware vCenter through Cisco Intersight using Cisco Intersight Assist



Procedure 1. Install Cisco Intersight Assist

Step 1. To install Cisco Intersight Assist from an Open Virtual Appliance (OVA), download the latest release of the Cisco Intersight Virtual Appliance for vSphere from https://software.cisco.com/download/home/286319499/type/286323047/release/1.0.9-588.

Note: Download the Latest Release.

Procedure 2. Set up DNS entries

Step 1. Setting up Cisco Intersight Virtual Appliance requires an IP address and 2 hostnames for that IP address. The hostnames must be in the following formats:

- **myhost.mydomain.com**: A hostname in this format is used to access the GUI. This must be defined as an A record and PTR record in DNS. The PTR record is required for reverse lookup of the IP address. If an IP address resolves to multiple hostnames, the first one in the list is used.
- **dc-myhost.mydomain.com:** The dc- must be prepended to your hostname. This hostname must be defined as the CNAME of myhost.mydomain.com. Hostnames in this format are used internally by the appliance to manage device connections.

Step 2. In this lab deployment the following information was used to deploy a Cisco Intersight Assist VM:

- **Hostname:** nx-intersight-assist.flexpod.cisco.com
- **IP address**: 10.1.156.107
- **DNS Entries** (Windows AD/DNS):
  - A Record
  - nx-intersight-assist Host (A) 10.1.156.107 static
  - CNAME:
    dc-nx-intersight-assist Alias (CNAME) nx-intersight-assist.flexpo... static
  - PTR (reverse lookup):

For more information, go to: https://www.cisco.com/c/en/us/td/docs/unified_computing/Intersight/b_Cisco_Intersight_Appliance_Getting_Started_Guide/b_Cisco_Intersight_Appliance_Install_and_Upgrade_Guide_chapter_00.html.

Procedure 3. Deploy Cisco Intersight OVA

Note: Ensure that the appropriate entries of type A, CNAME, and PTR records exist in the DNS, as explained in the previous section.

Step 1. Log into the vSphere Client and select **Inventory.**

Step 2. In the Inventory list, right-click the cluster and click **Deploy OVF Template**.

Step 3. Select Local file and click **UPLOAD FILES**. Browse to and select the intersight-appliance-installer-vsphere-1.0.9-588.ova or the latest release file and click **Open**. Click **NEXT**.

Step 4. Name the Intersight Assist VM and select the location. Click **NEXT**.

Step 5. Select the cluster and click **NEXT**.

Step 6. Review details, click **Ignore**, and click **NEXT**.

Step 7. Select the **Assist** deployment configuration. Click **NEXT**.

Step 8. Select the appropriate datastore (for example, infra_datastore) for storage and select the **Thin Provision** virtual disk format. Click **NEXT**.

Step 9. Using the pulldown, select the appropriate management network (for example, IB-MGMT Network) for the OVA and click **OK**. Click **NEXT**.

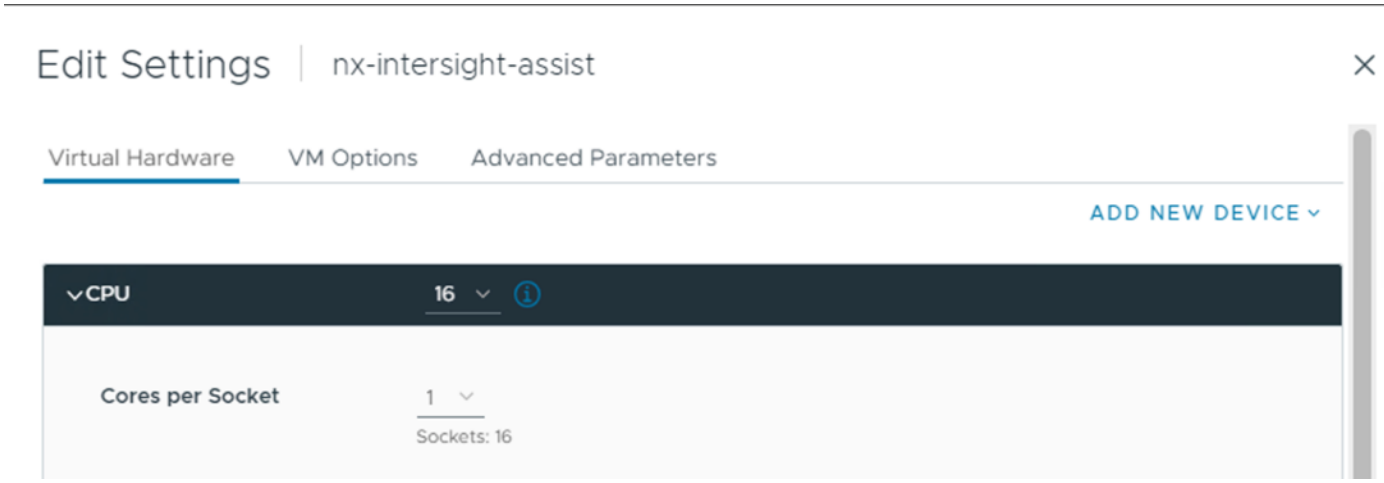
Note: The Cisco Intersight Assist VM must be able to access both the IB-MGMT network on FlexPod and Intersight.com. Select and configure the management network appropriately. If selecting IB-MGMT network on FlexPod, make sure the routing and firewall is setup correctly to access the Internet.

Step 10. Fill in all values to customize the template. Click **NEXT**.

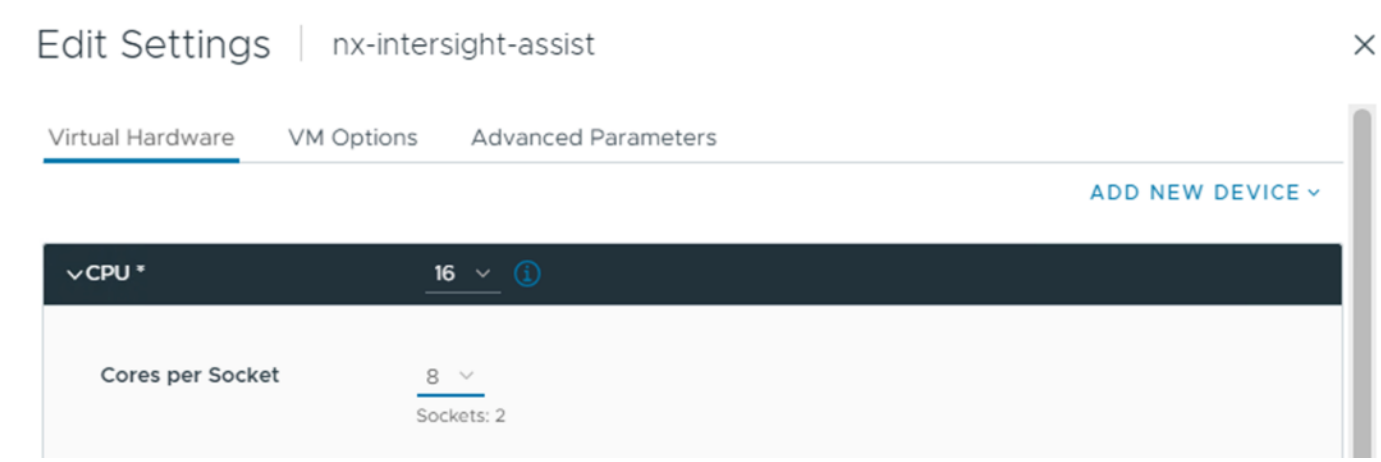
Step 11. Review the deployment information and click **FINISH** to deploy the appliance.

Step 12. When the OVA deployment is complete, right-click the Intersight Assist VM and click **Edit Settings**.

Step 13. Expand CPU and verify the socket configuration. For example, in the following deployment, on a 2-socket system, the VM was configured for 16 sockets:



Step 14. Adjust the Cores per Socket so that the number of Sockets matches the server CPU configuration (2 sockets in this deployment):



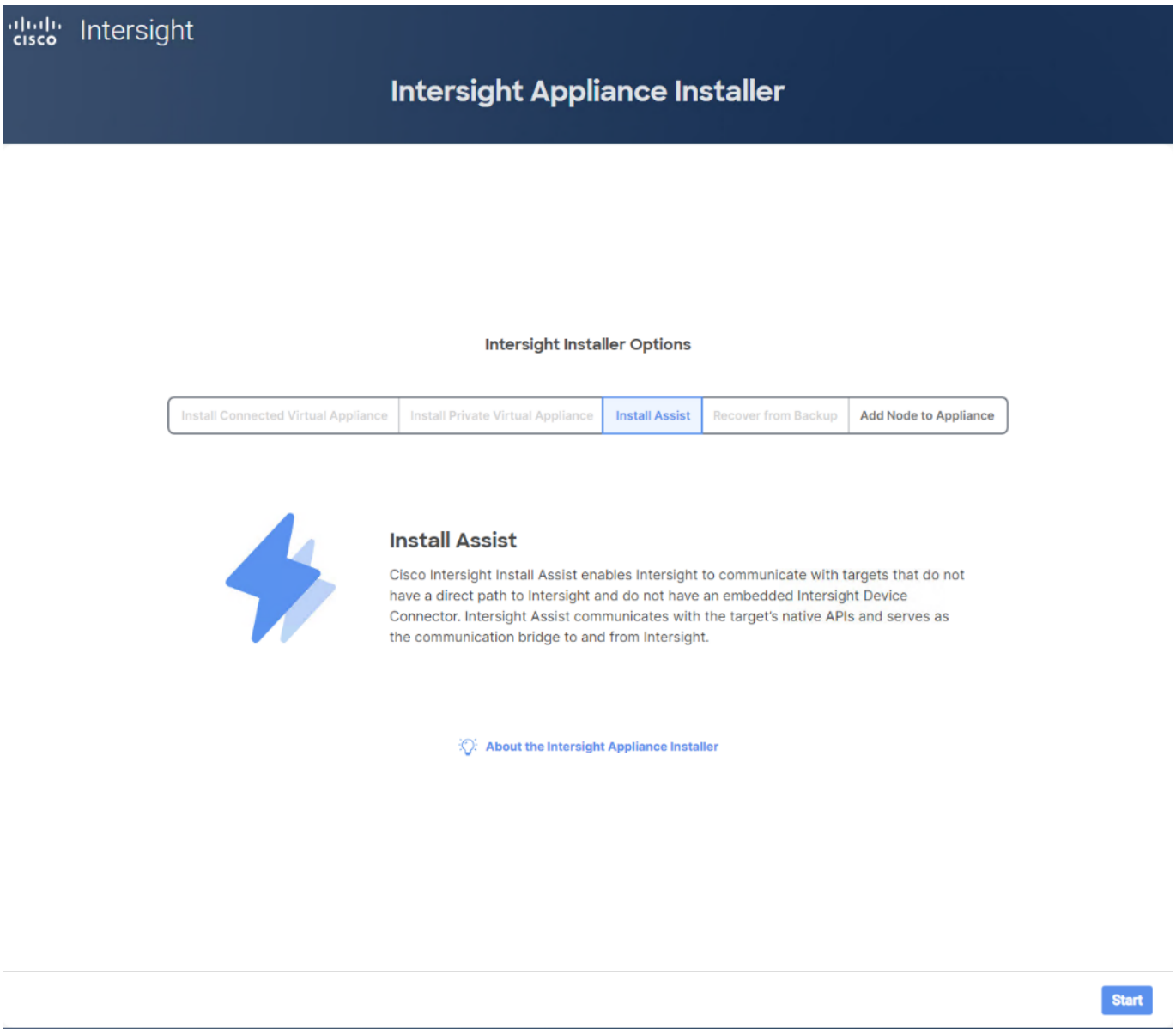
Step 15. Click **OK**.

Step 16. Right-click the Intersight Assist VM and select **Power** > **Power On**.

Step 17. When the VM powers on and login prompt is visible (use remote console), connect to https://intersight-assist-fqdn.

Note: It may take a few minutes for https://intersight-assist-fqdn to respond.

Step 18. Navigate the security prompts and select **Install Assist**. Click **Start**.



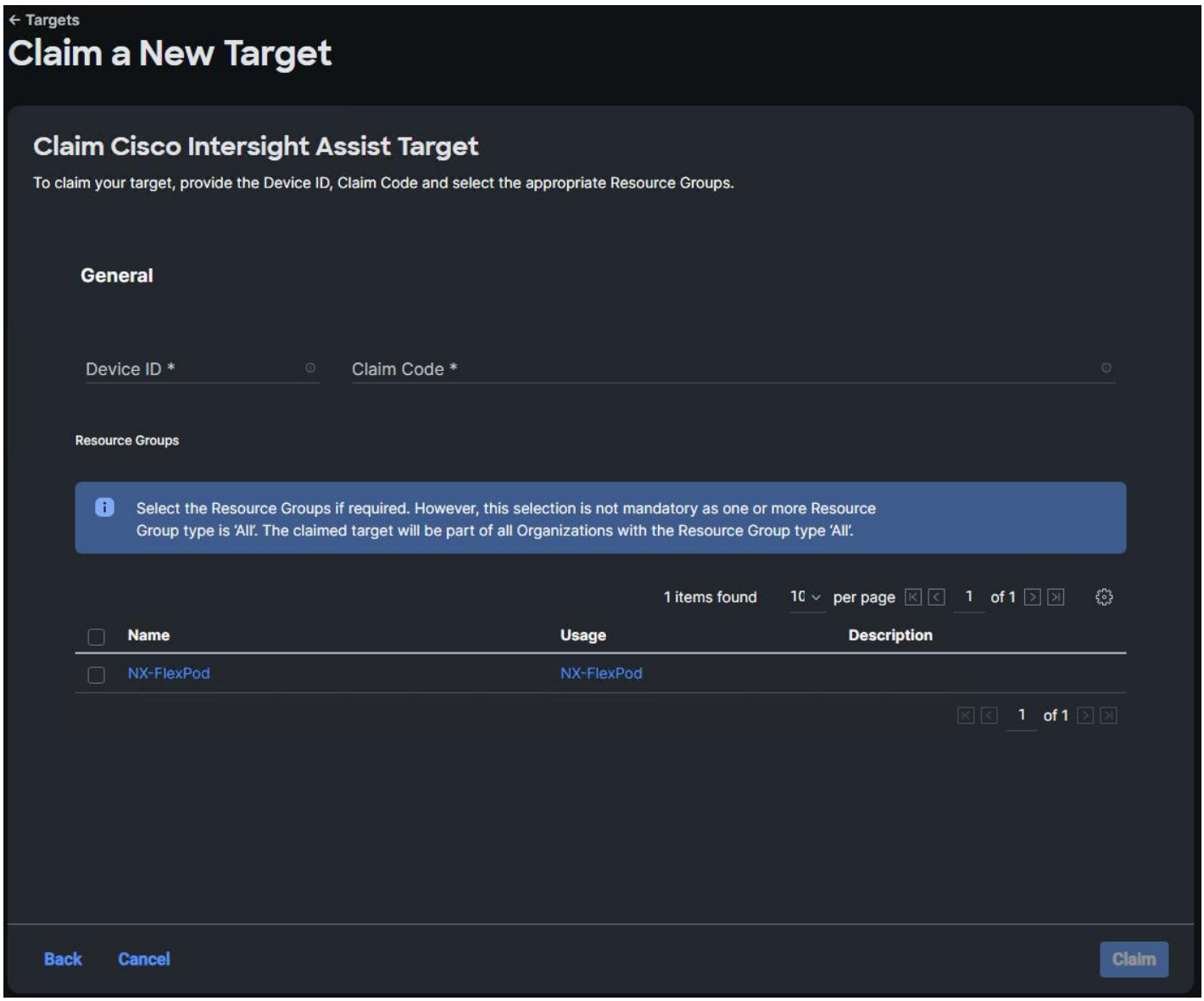
Note: The Cisco Intersight Assist VM needs to be claimed in Cisco Intersight using the Device ID and Claim Code information visible in the GUI.

Step 19. Log into **Cisco Intersight** and connect to the appropriate account.

Step 20. From Cisco Intersight, select **System**, then click **Admin** > **Targets**.

Step 21. Click **Claim a New Target**. Select Cisco Intersight Assist and click **Start**. Click **OK** to acknowledge the information about Cisco Intersight Workload Optimizer.

Step 22. Copy and paste the Device ID and Claim Code shown in the Intersight Assist web interface to the Cisco Intersight Device Claim window.



Step 23. Select the **Resource Group** and click **Claim**. Intersight Assist will now appear as a claimed device.

Step 24. In the Intersight Assist web interface, verify that Intersight Assist is Claimed Successfully, and click **Continue**.

Step 25. Verify success of the DNS Test and click **Next**.

Step 26. Accept the default Internal Network IP and click **Next**.

Note: The Cisco Intersight Assist software will now be downloaded and installed into the Intersight Assist VM. This can take up to an hour to complete.

Note: The Cisco Intersight Assist VM will reboot during the software download process. It will be necessary to refresh the Web Browser after the reboot is complete to follow the status of the download process.

Step 27. When the software download is complete, an Intersight Assist login screen will appear.

Step 28. Log into Intersight Assist with the admin user and the password supplied in the OVA installation. Check the Intersight Assist status and **log out** of Intersight Assist.

Claim VMware vCenter using Cisco Intersight Assist Appliance

Procedure 1. Claim the vCenter from Cisco Intersight

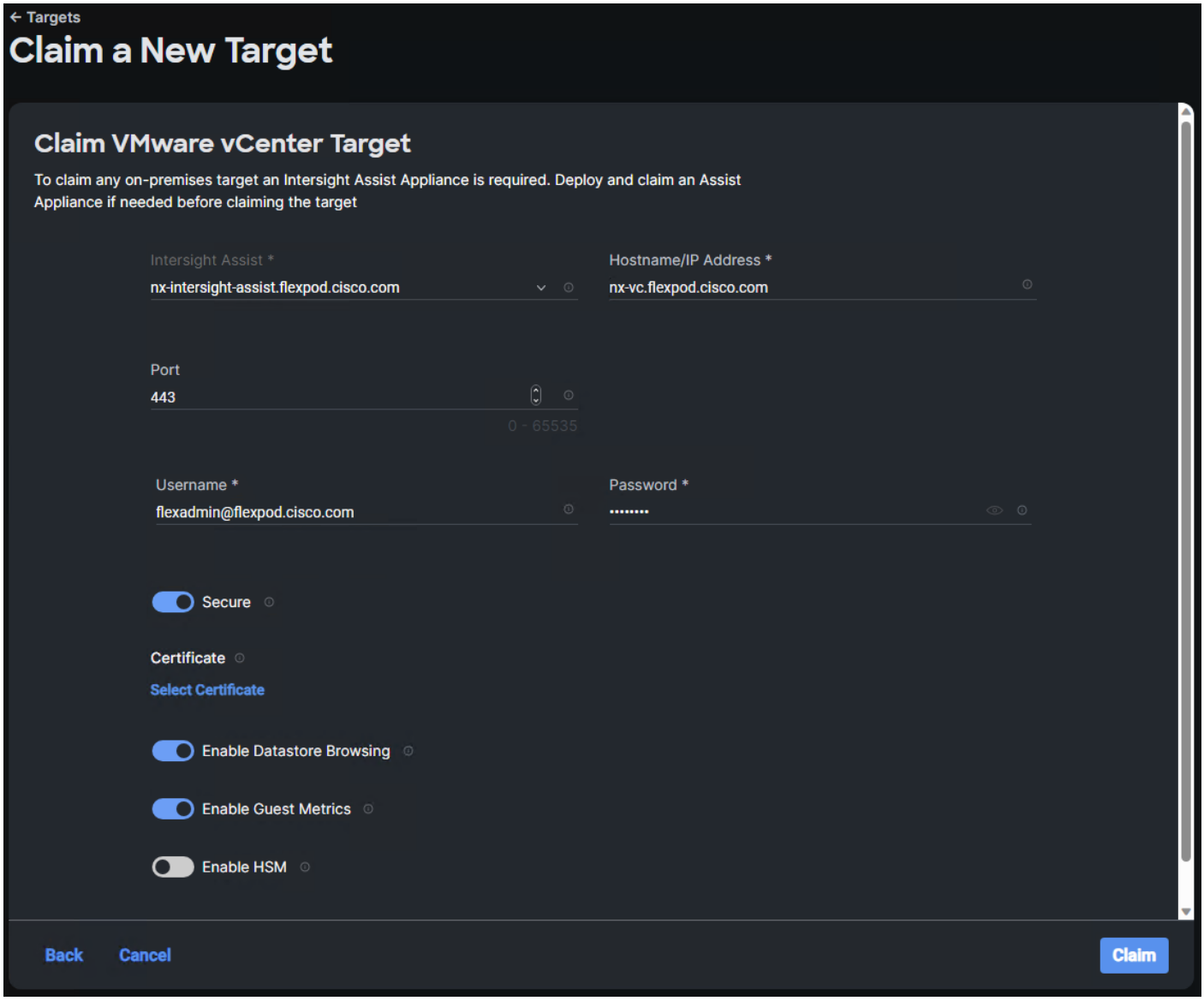
Step 1. Log into **Cisco Intersight** and connect to the account for this FlexPod.

Step 2. Go to **System** > **Admin** > **Targets** and click **Claim a New Target**.

Step 3. Under Select Target Type, select **VMware vCenter** under Hypervisor and click **Start**.

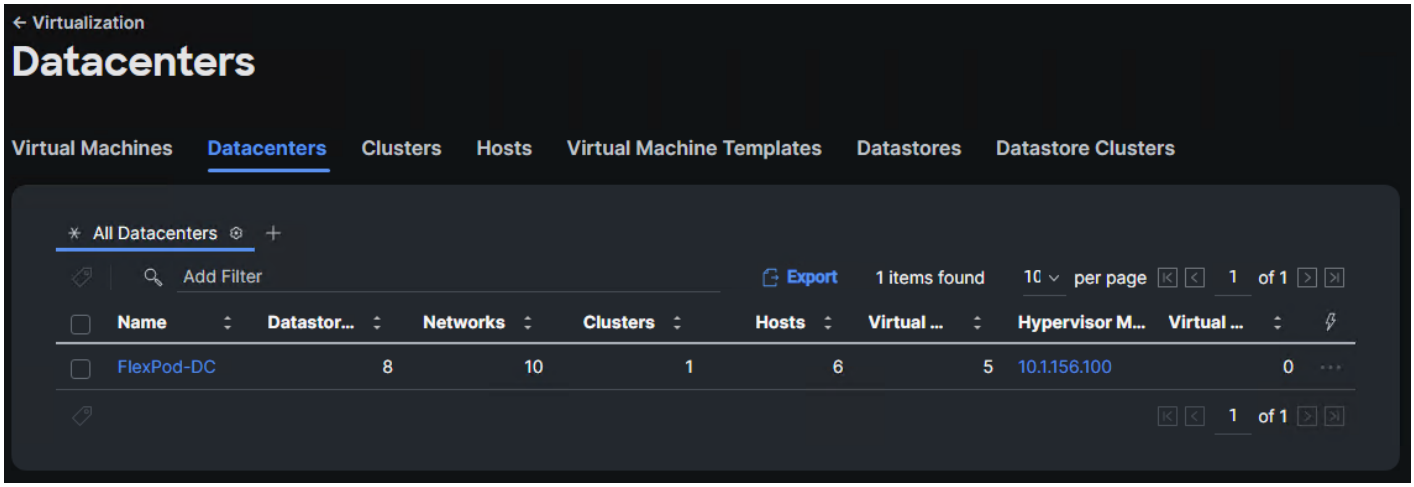
Step 4. In the **VMware vCenter** window, verify the correct Intersight Assist is selected.

Step 5. Fill in the vCenter information. It is recommended to use a user other than administrator@vsphere.local for this connection to remove visibility to the vCLS VMs. If Intersight Workflow Optimizer (IWO) will be used, turn on Datastore Browsing Enabled and Guest Metrics Enabled. Do not Enable HSM. Click **Claim**.



Step 6. After a few minutes, the VMware vCenter will show Connected in the Targets list and will also appear under **Infrastructure Service** > **Operate** > **Virtualization**.

Step 7. Detailed information obtained from the vCenter can now be viewed by clicking **Infrastructure Service** > **Operate** > **Virtualization** and selecting the Datacenters tab. Other VMware vCenter information can be obtained by navigating through the Virtualization tabs.



Procedure 2. Interact with Virtual Machines

VMware vCenter integration with Cisco Intersight allows you to directly interact with the virtual machines (VMs) from the Cisco Intersight dashboard. In addition to obtaining in-depth information about a VM, including the operating system, CPU, memory, host name, and IP addresses assigned to the virtual machines, you can use Cisco Intersight to perform the following actions on the virtual machines:

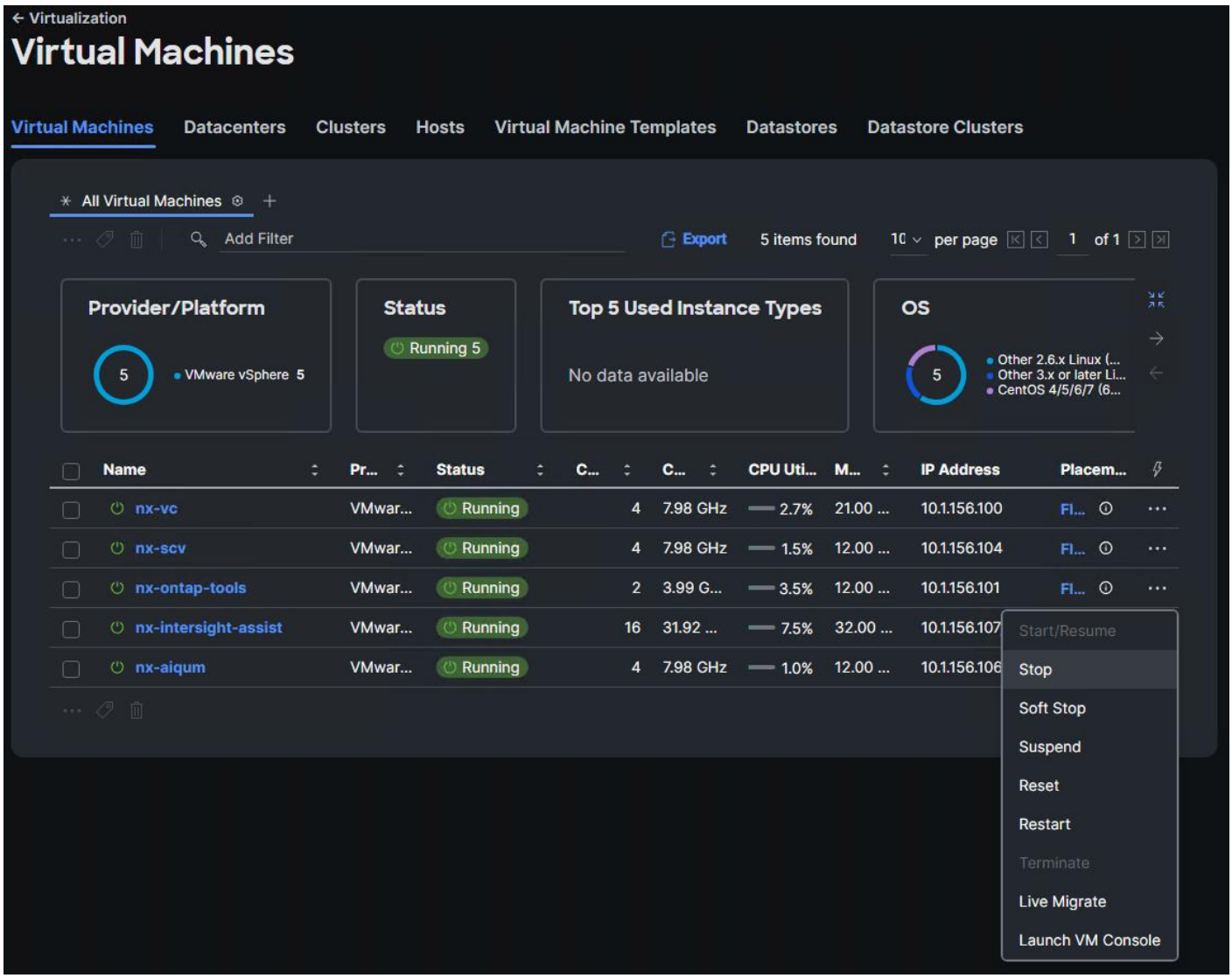
- Start/Resume
- Stop
- Soft Stop
- Suspend
- Reset
- Launch VM Console

Step 1. Log into **Cisco Intersight** and connect to the account for this FlexPod.

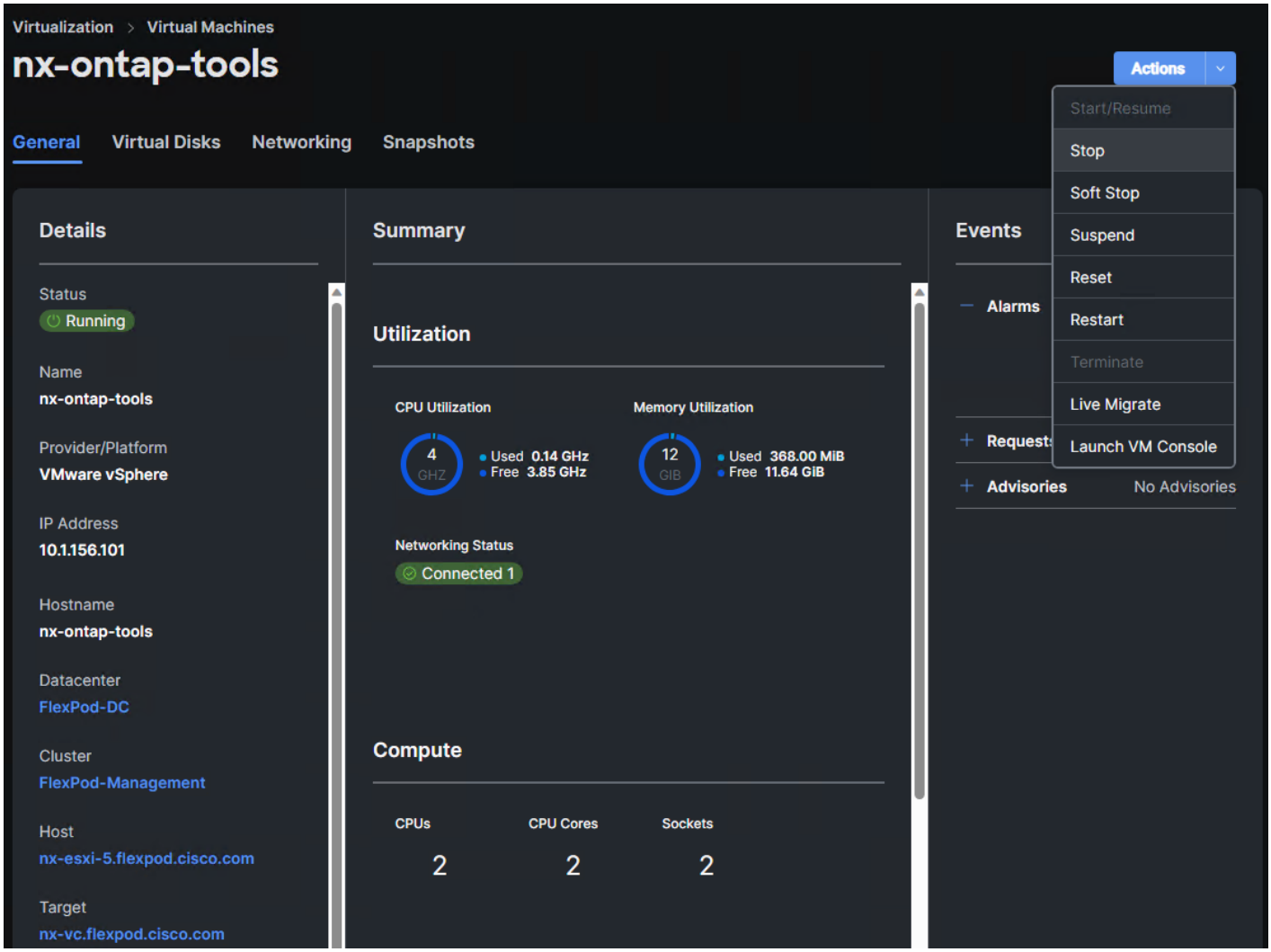
Step 2. Go to **Infrastructure Service** > **Operate** > **Virtualization**.

Step 3. Click the **Virtual Machines** tab.

Step 4. Click "**...**" to the right of a VM and interact with various VM options.



Step 5. To gather more information about a VM, click a VM name. The same interactive options are available under **Actions**.



Claim NetApp Active IQ Manager using Cisco Intersight Assist Appliance

Procedure 1. Claim the NetApp Active IQ Unified Manager into Cisco Intersight

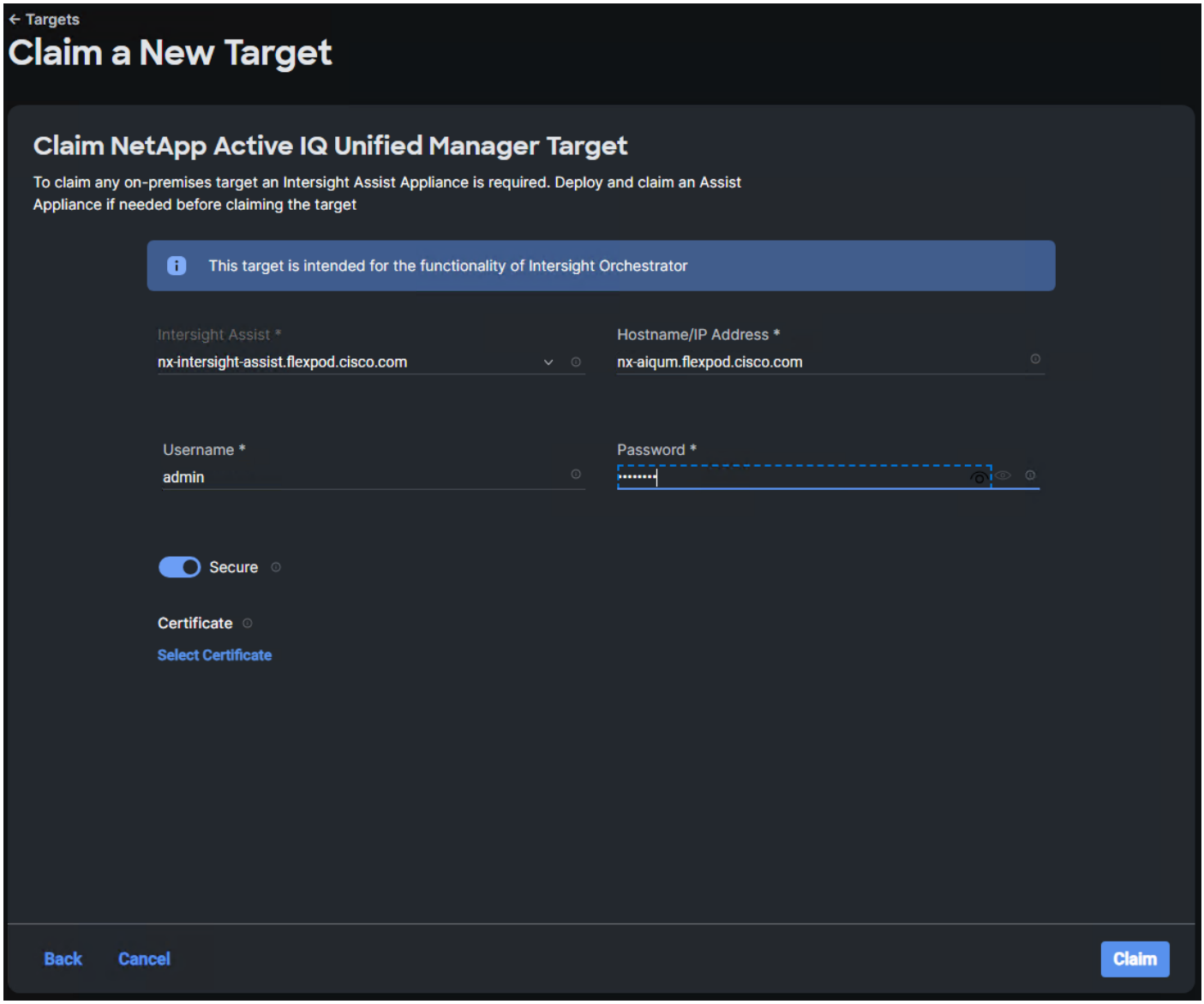
Step 1. Log into **Cisco Intersight** and connect to the account for this FlexPod.

Step 2. From Cisco Intersight, click **System** > **Admin** > **Targets**.

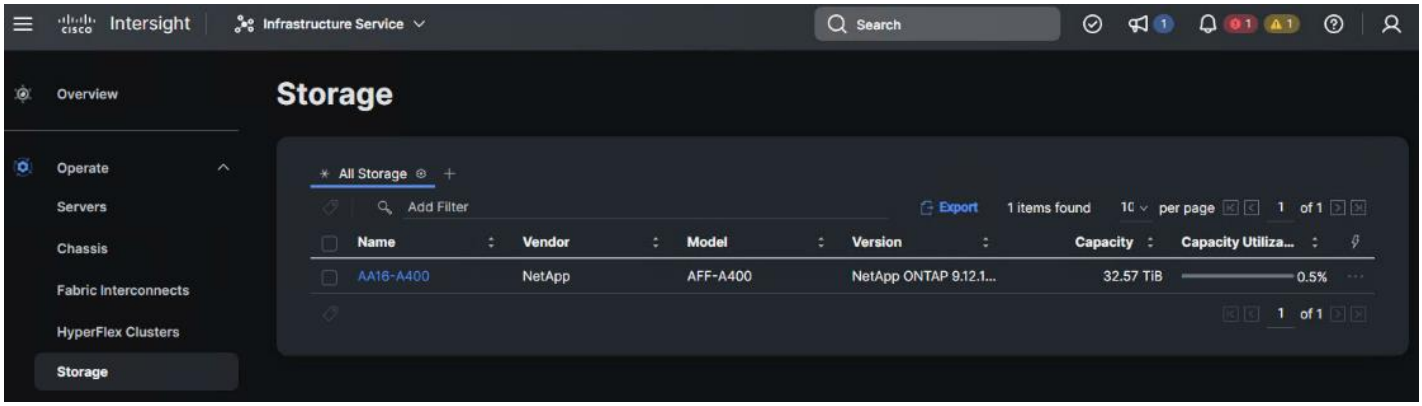
Step 3. Click **Claim a New Target**. In the Select Target Type window, select **NetApp Active IQ Unified Manager** under Storage and click **Start**.

Step 4. In the Claim NetApp Active IQ Unified Manager Target window, verify the correct Intersight Assist is selected.

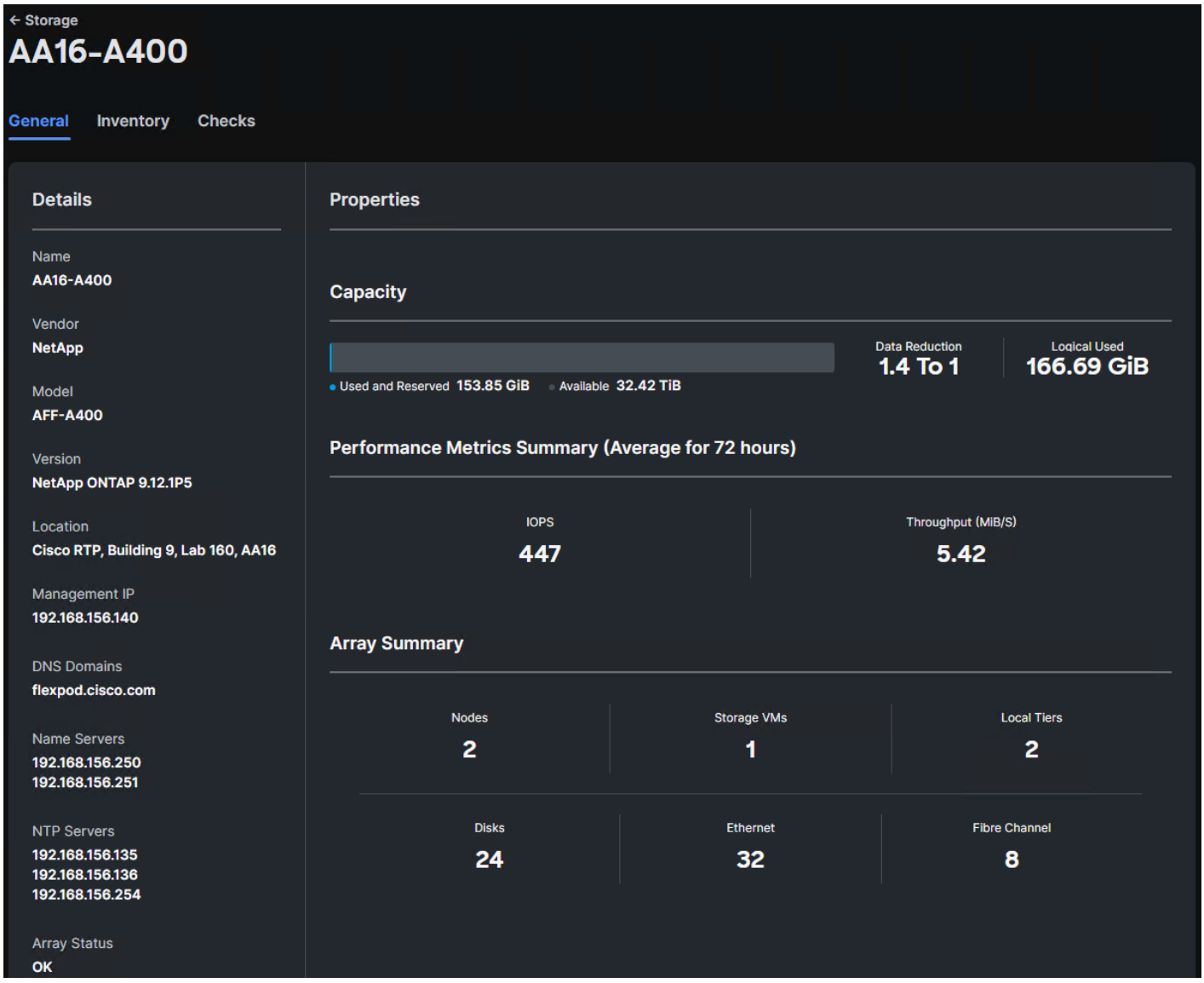
Step 5. Fill in the NetApp Active IQ Unified Manager information and click **Claim**.



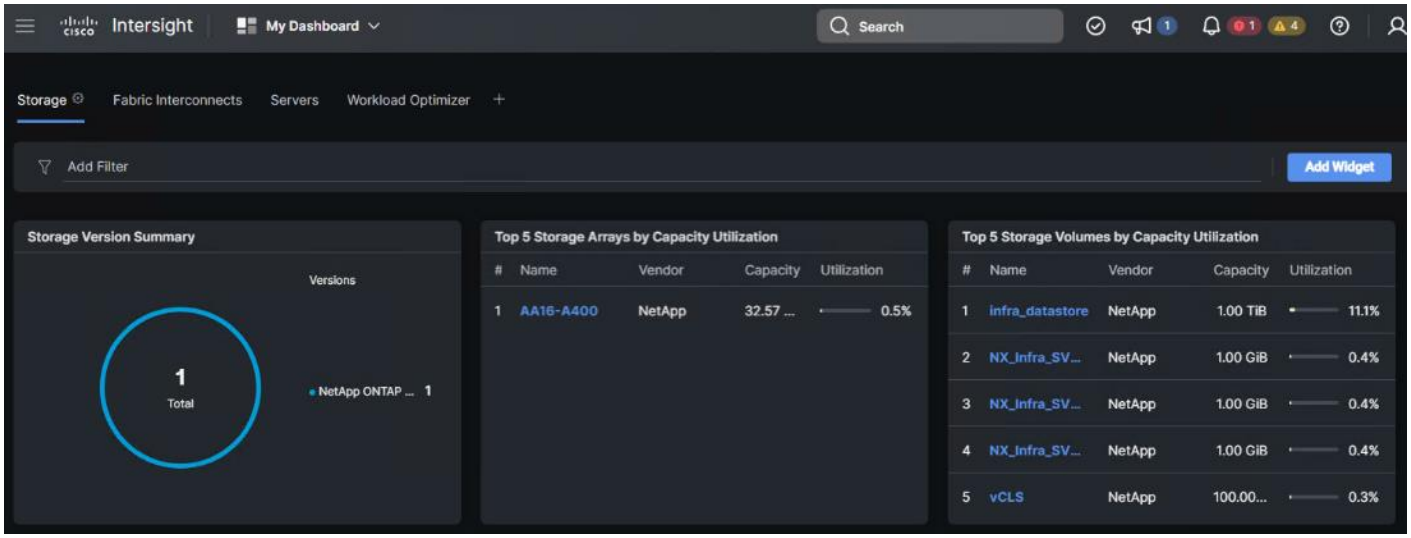
Step 6. After a few minutes, the NetApp ONTAP Storage configured in the Active IQ Unified Manager will appear under **Infrastructure Service** > **Operate** > **Storage** tab.



Step 7. Click the storage cluster name to see detailed General, Inventory, and Checks information on the storage.



Step 8. Click **My Dashboard** > **Storage** to see storage monitoring widgets.



Claim Cisco Nexus Switches using Cisco Intersight Assist Appliance

Procedure 1. Claim Cisco Nexus Switches

Step 1. Log into **Cisco Intersight** and connect to the account for this FlexPod.

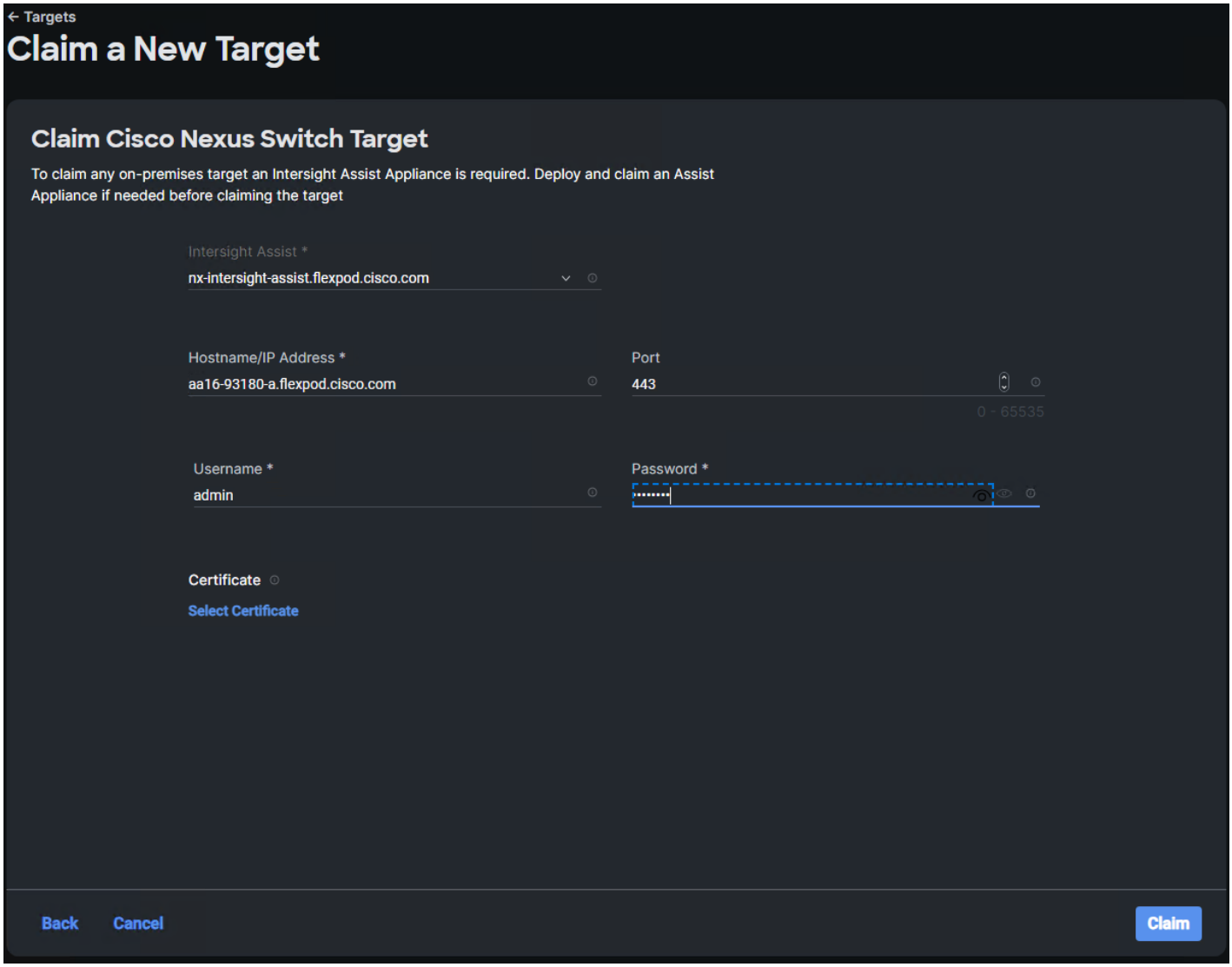
Step 2. From Cisco Intersight, click **System** > **Admin** > **Targets**.

Step 3. Click **Claim a New Target**. In the Select Target Type window, select Cisco Nexus Switch under Network and click **Start**.

Step 4. In the Claim Cisco Nexus Switch Target window, verify the correct Intersight Assist is selected.

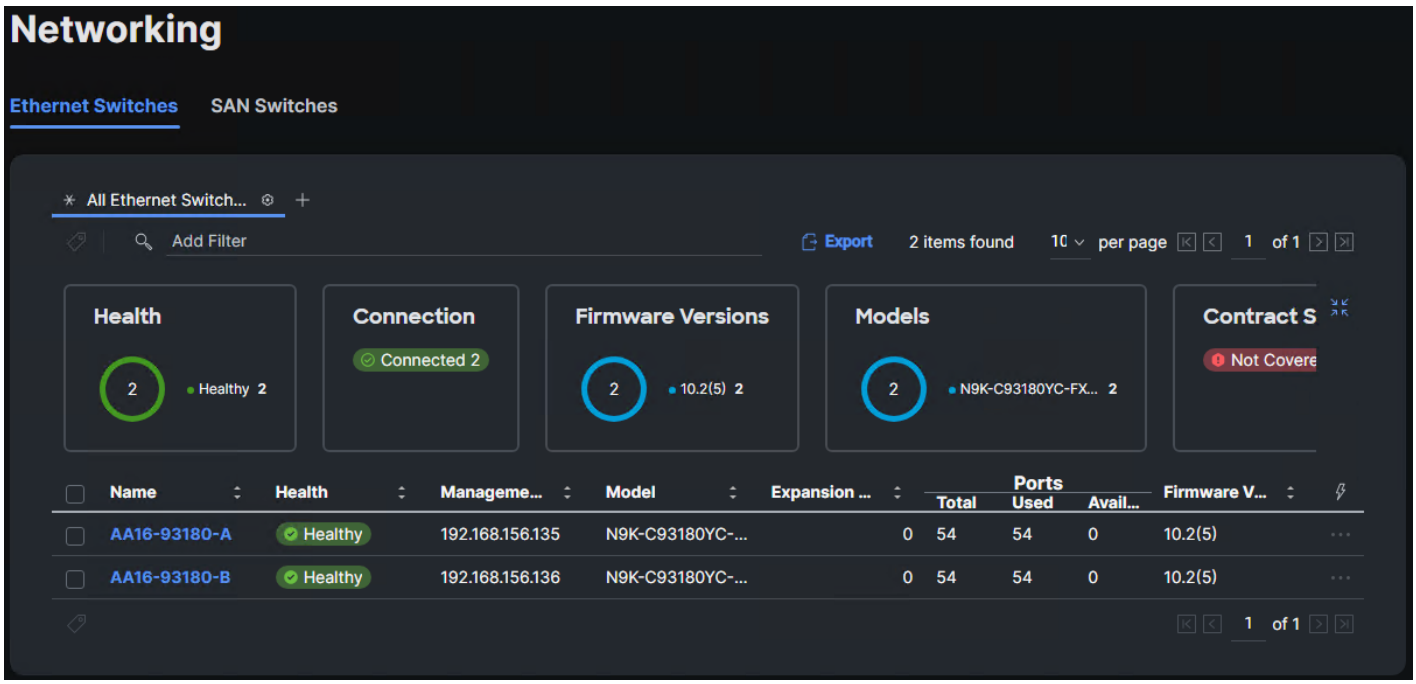
Step 5. Fill in the Cisco Nexus Switch information and click **Claim**.

Note: You can use the admin user on the switch.



Step 6. Repeat steps 1 – 5 to add the second Cisco Nexus Switch.

Step 7. After a few minutes, the two switches will appear under **Infrastructure Service** > **Operate** > **Networking** > **Ethernet Switches**.



Step 8. Click one of the switch names to get detailed General and Inventory information on the switch.

Claim Cisco MDS Switches using Cisco Intersight Assist Appliance

Procedure 1. Claim Cisco MDS Switches (if they are part of the FlexPod)

Step 1. Log into **Cisco Intersight** and connect to the account for this FlexPod.

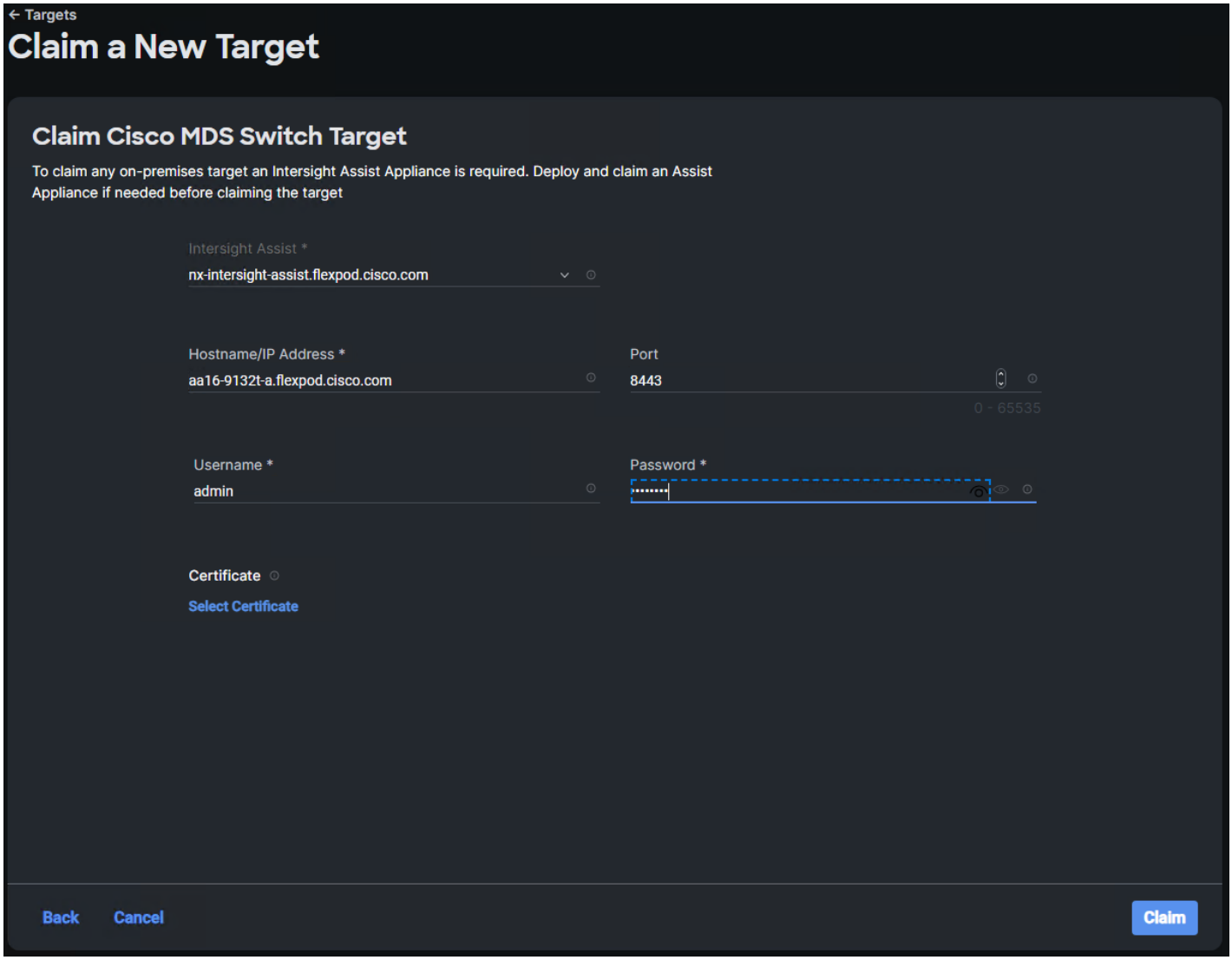
Step 2. From Cisco Intersight, click **System > Admin > Targets**.

Step 3. Click **Claim a New Target**. In the Select Target Type window, select Cisco MDS Switch under Network and click **Start**.

Step 4. In the Claim Cisco MDS Switch Target window, verify the correct Intersight Assist is selected.

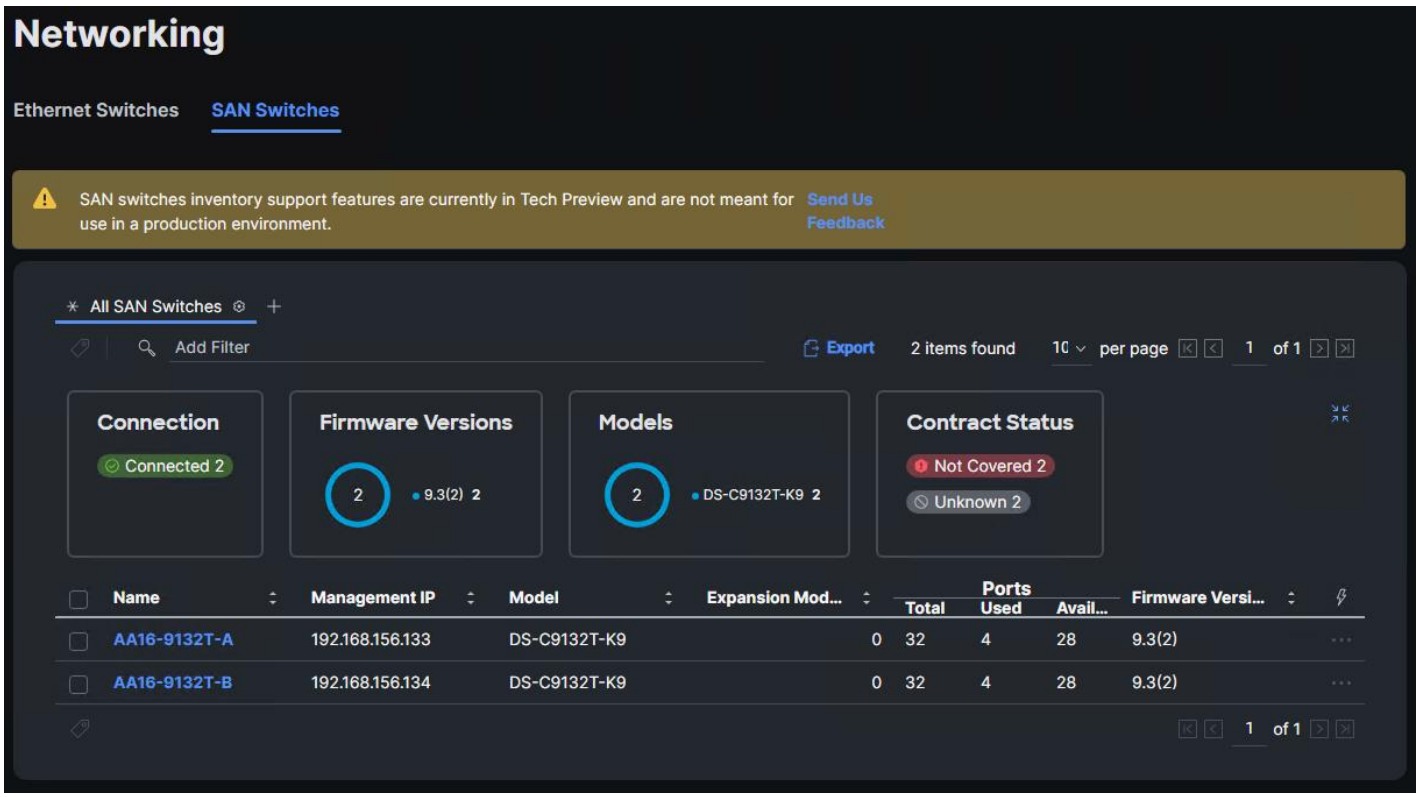
Step 5. Fill in the Cisco MDS Switch information including use of Port 8443 and click **Claim**.

Note: You can use the admin user on the switch.



Step 6. Repeat the steps in this procedure to add the second Cisco MDS Switch.

Step 7. After a few minutes, the two switches will appear under **Infrastructure Service** > **Operate** > **Networking** > **SAN Switches**.



Note: Cisco MDS switches are still under Tech Preview in Intersight. Viewing information about the switches is fine, but if this is a production FlexPod, Intersight Cloud Orchestrator tasks and workflows should not be executed against these switches.

Step 8. Click one of the switch names to get detailed General and Inventory information on the switch.

Create a FlexPod Integrated System

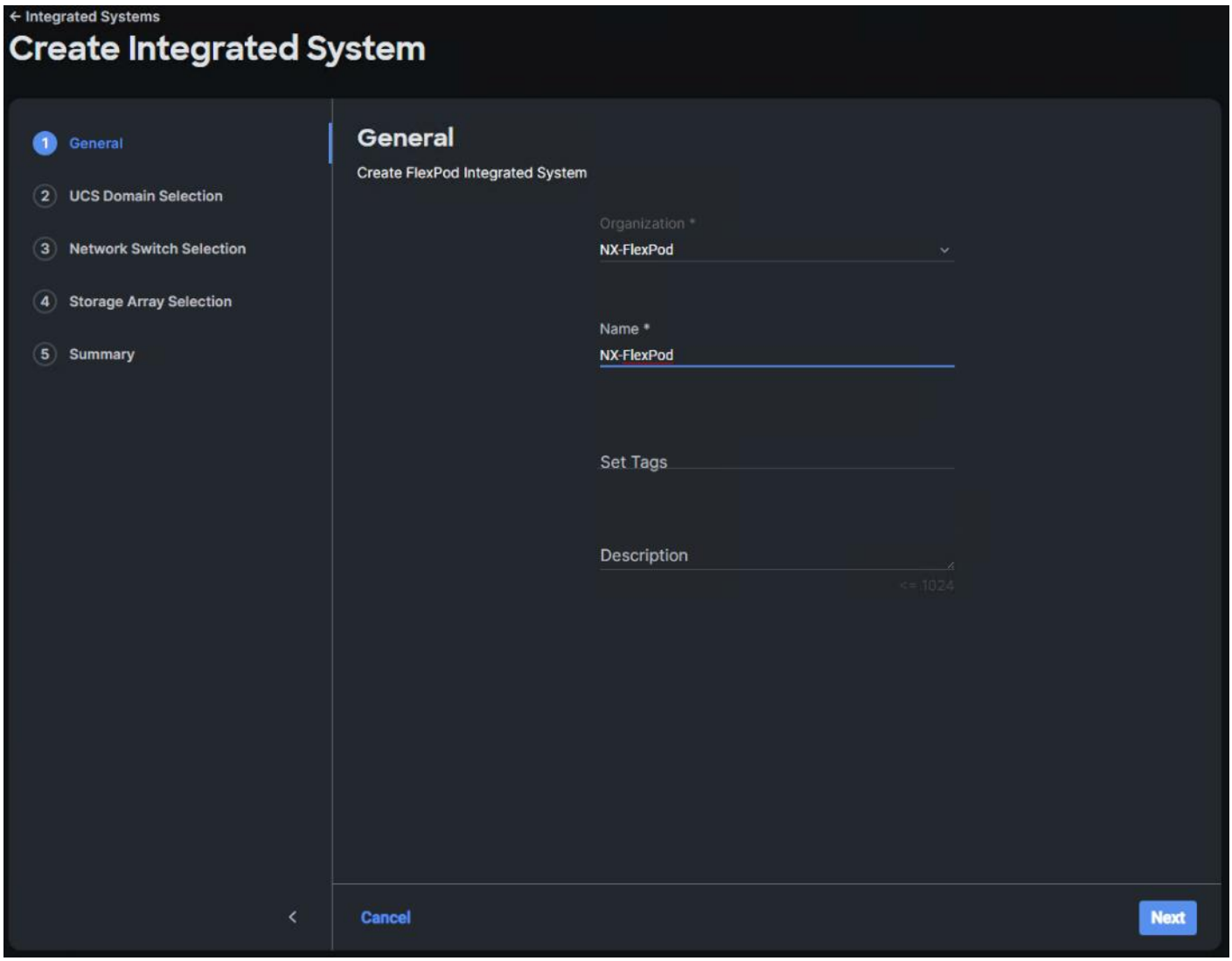
Procedure 1. Creating a FlexPod Integrated System

Step 1. Log into **Cisco Intersight** and connect to the account for this FlexPod.

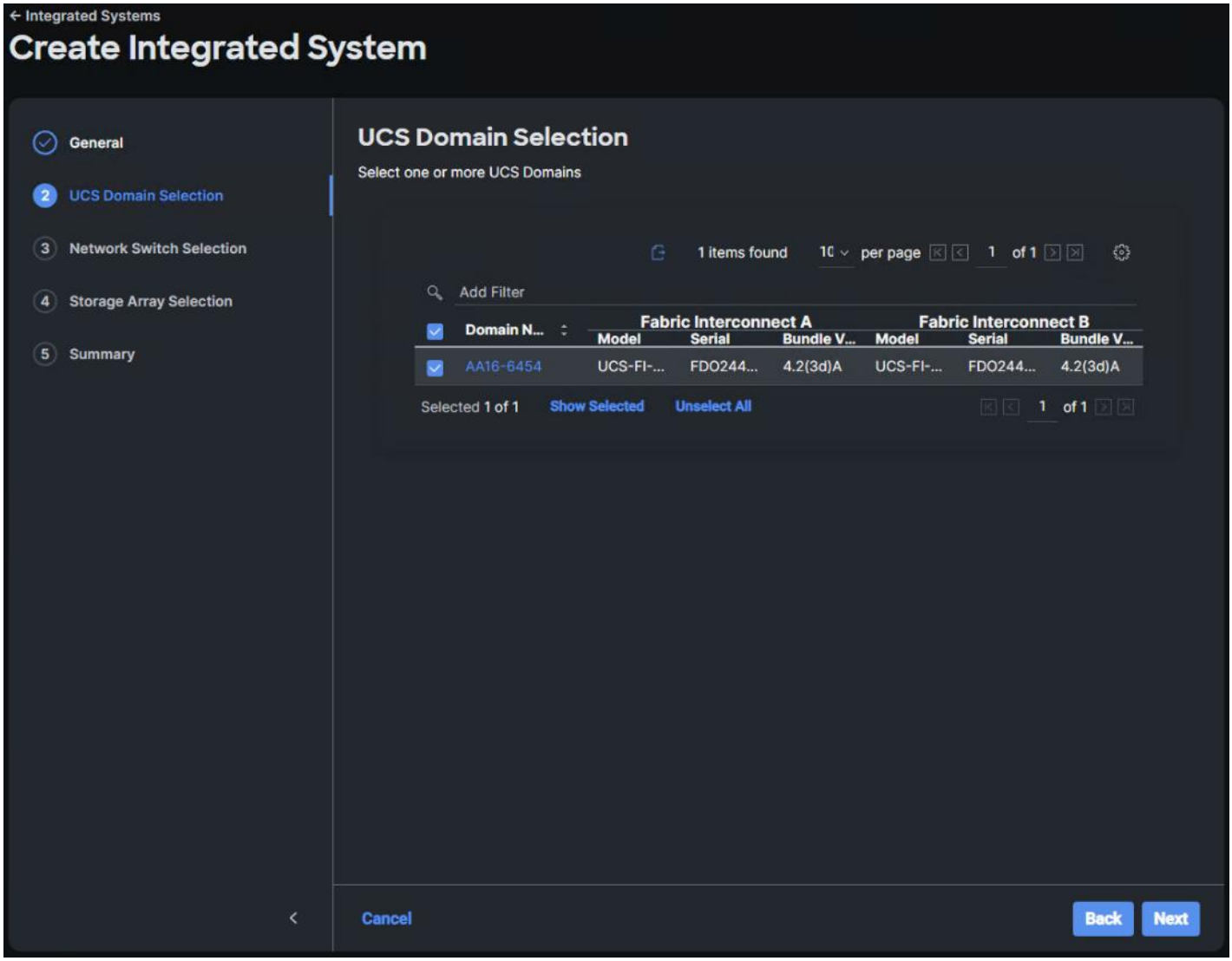
Step 2. From Cisco Intersight, click **Infrastructure Service** > **Operate** > **Integrated Systems**.

Step 3. Click **Create Integrated System**. In the center pane, select **FlexPod** and click **Start**.

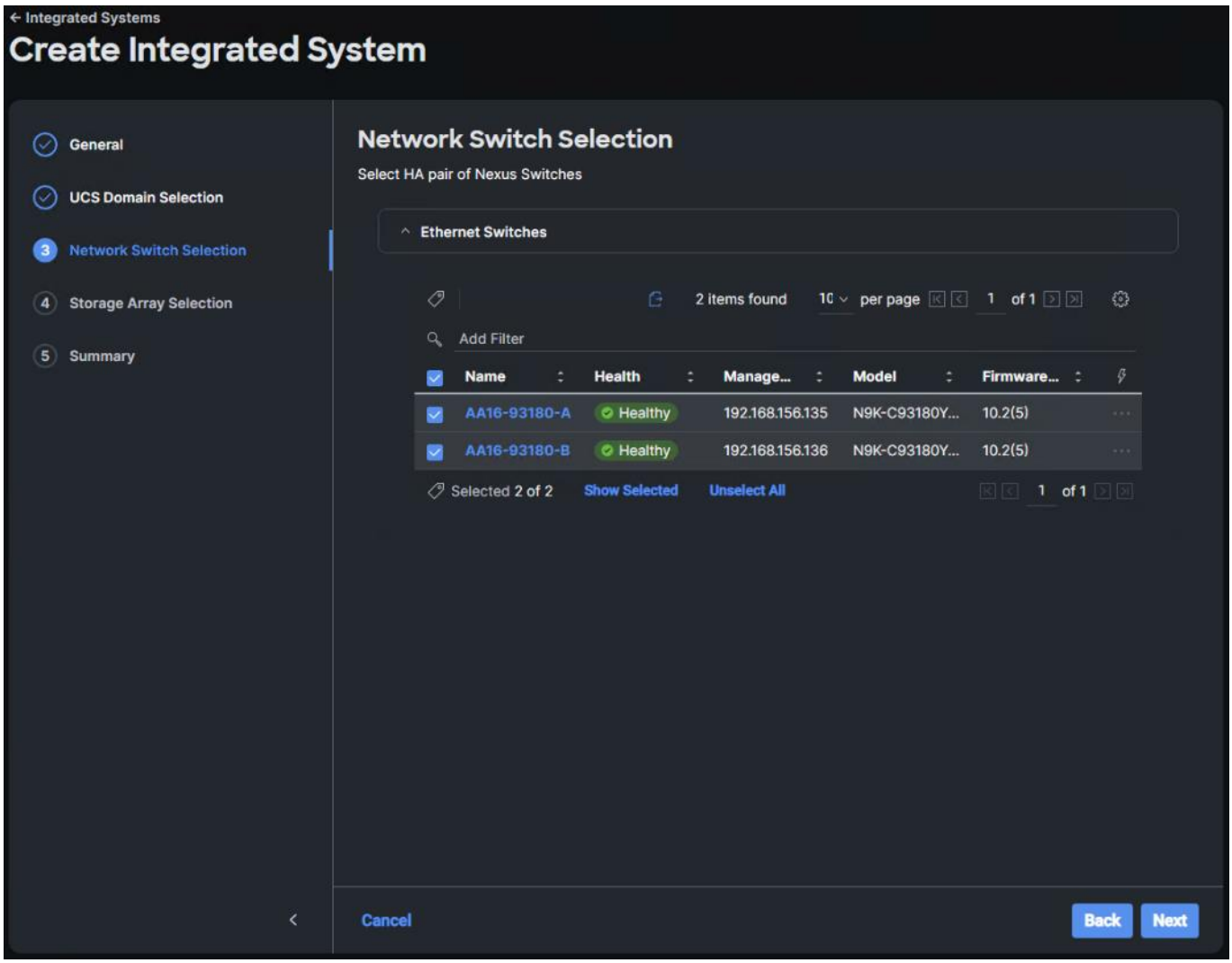
Step 4. Select the correct Organization, provide a suitable name, and optionally any Tags or a Description and click **Next**.



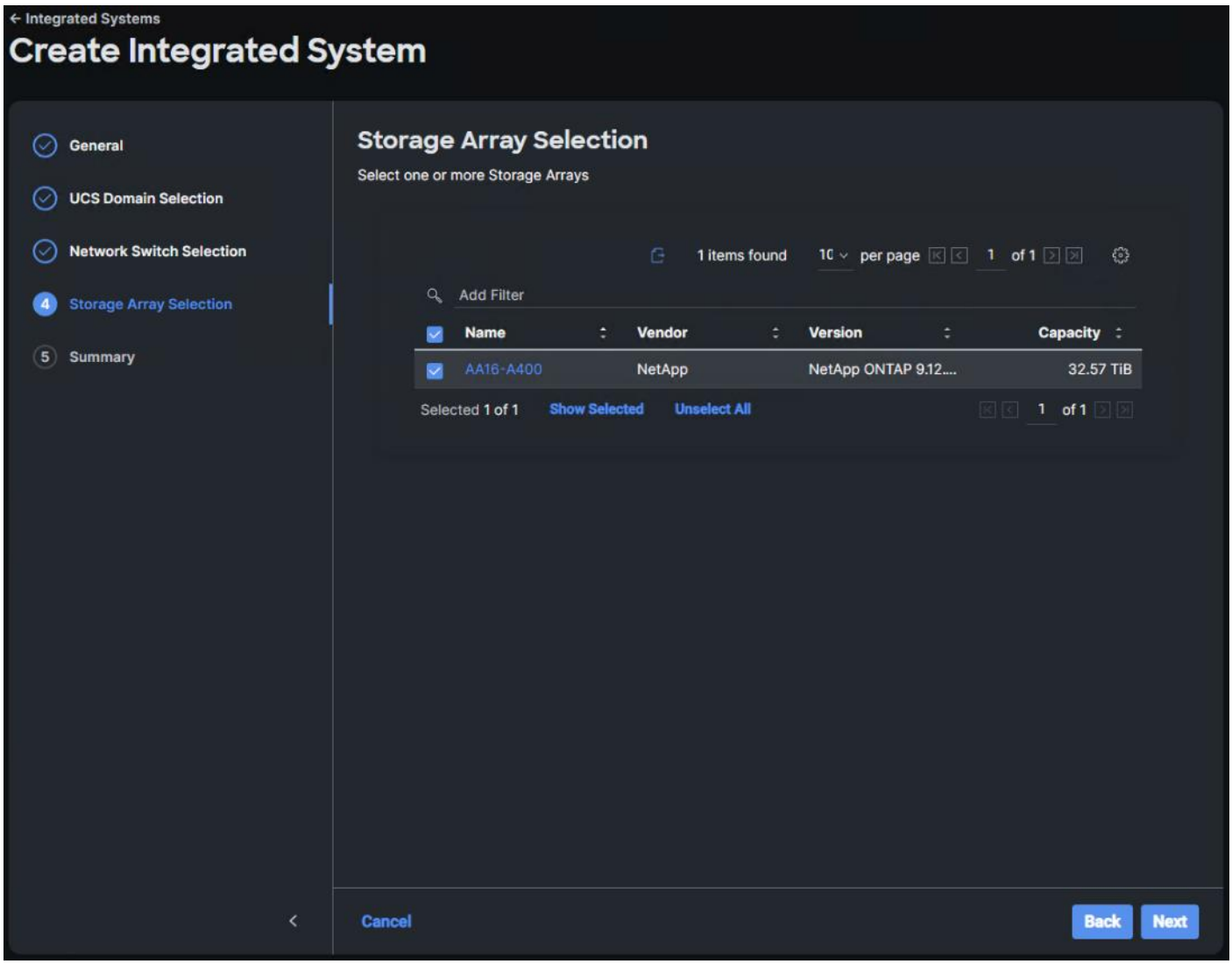
Step 5. Select the UCS Domain used in this FlexPod and click **Next**.



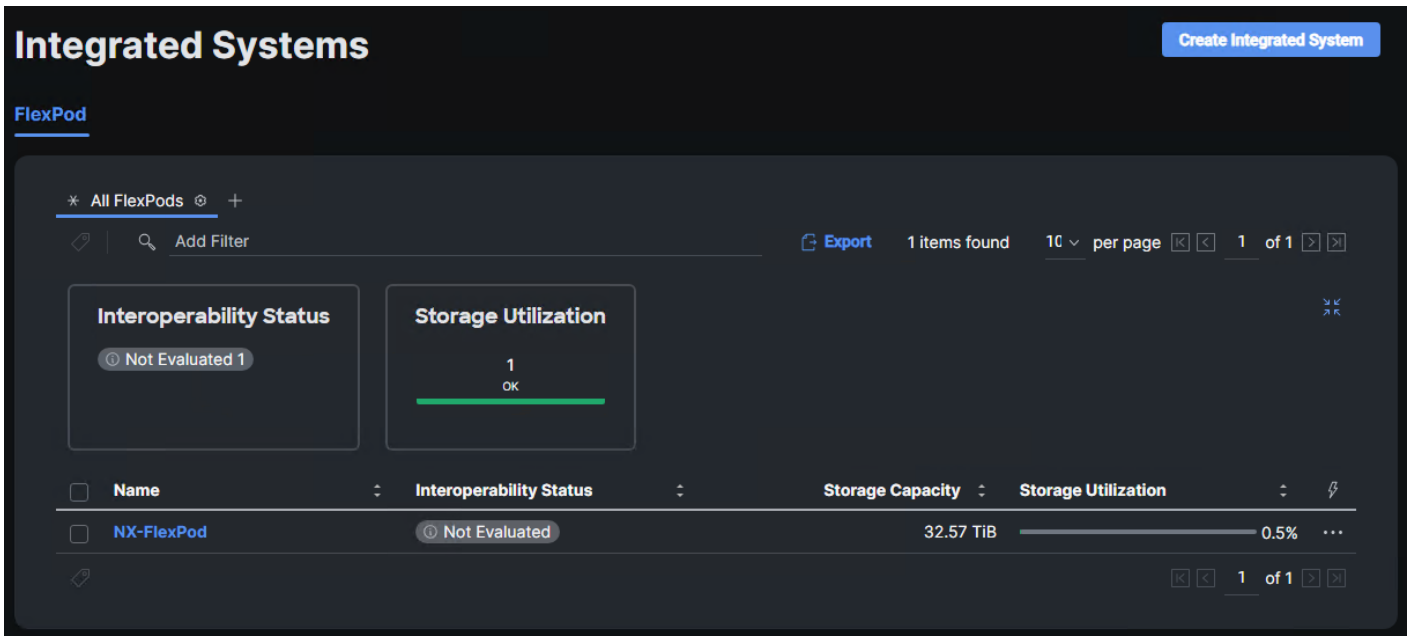
Step 6. Select the two Cisco Nexus switches used in this FlexPod and click **Next**.



Step 7. Select all NetApp storage used in this FlexPod and click **Next**.

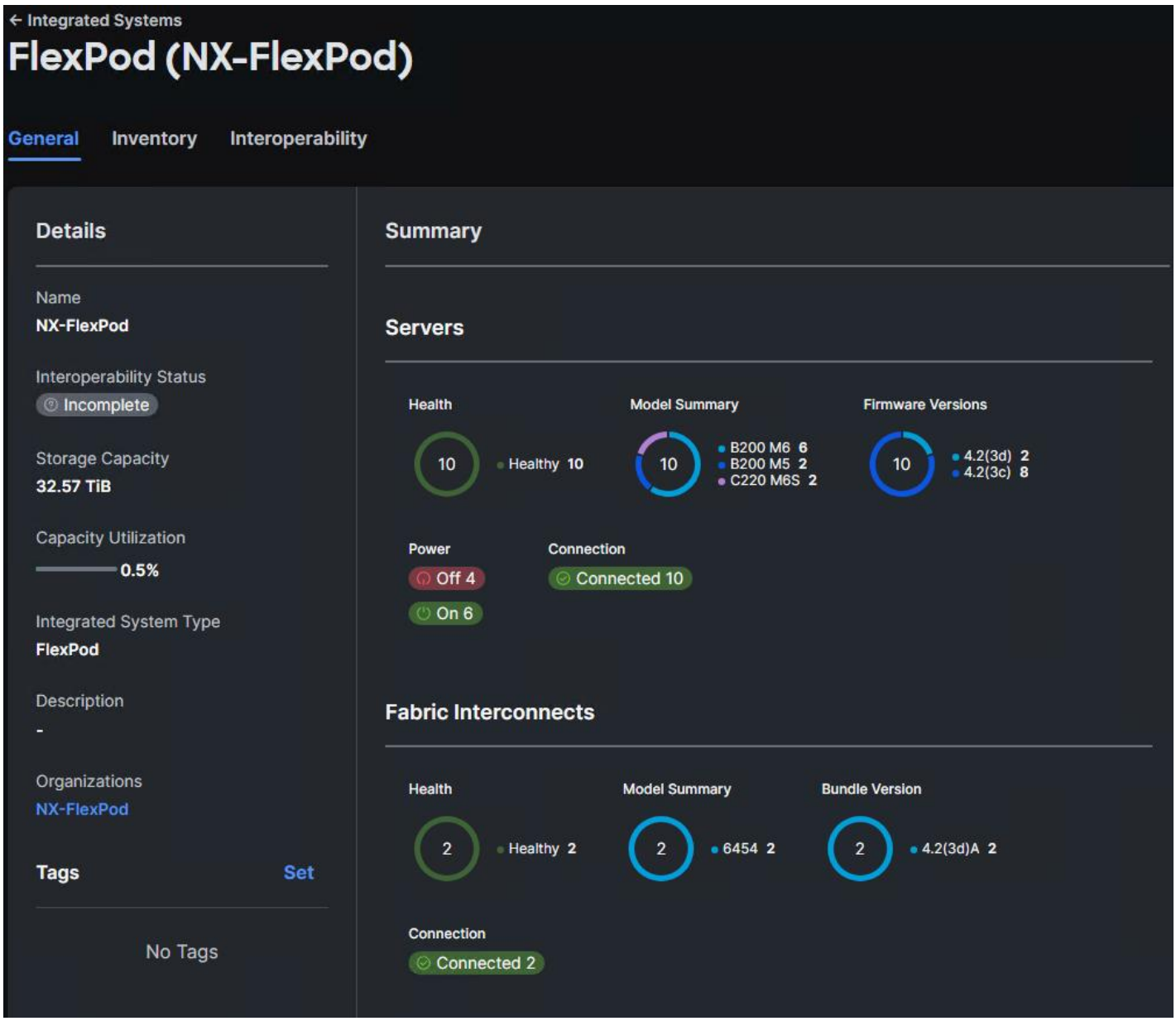


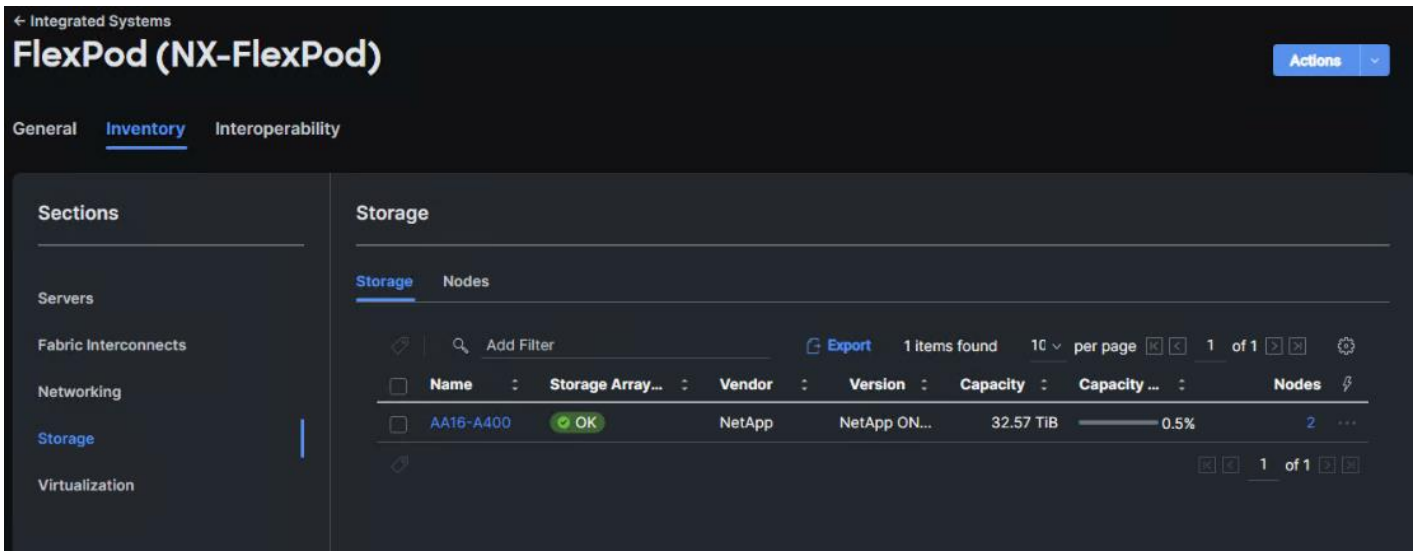
Step 8. Review the Summary information and click **Create**. After a few minutes, the FlexPod Integrated System will appear under Integrated Systems.

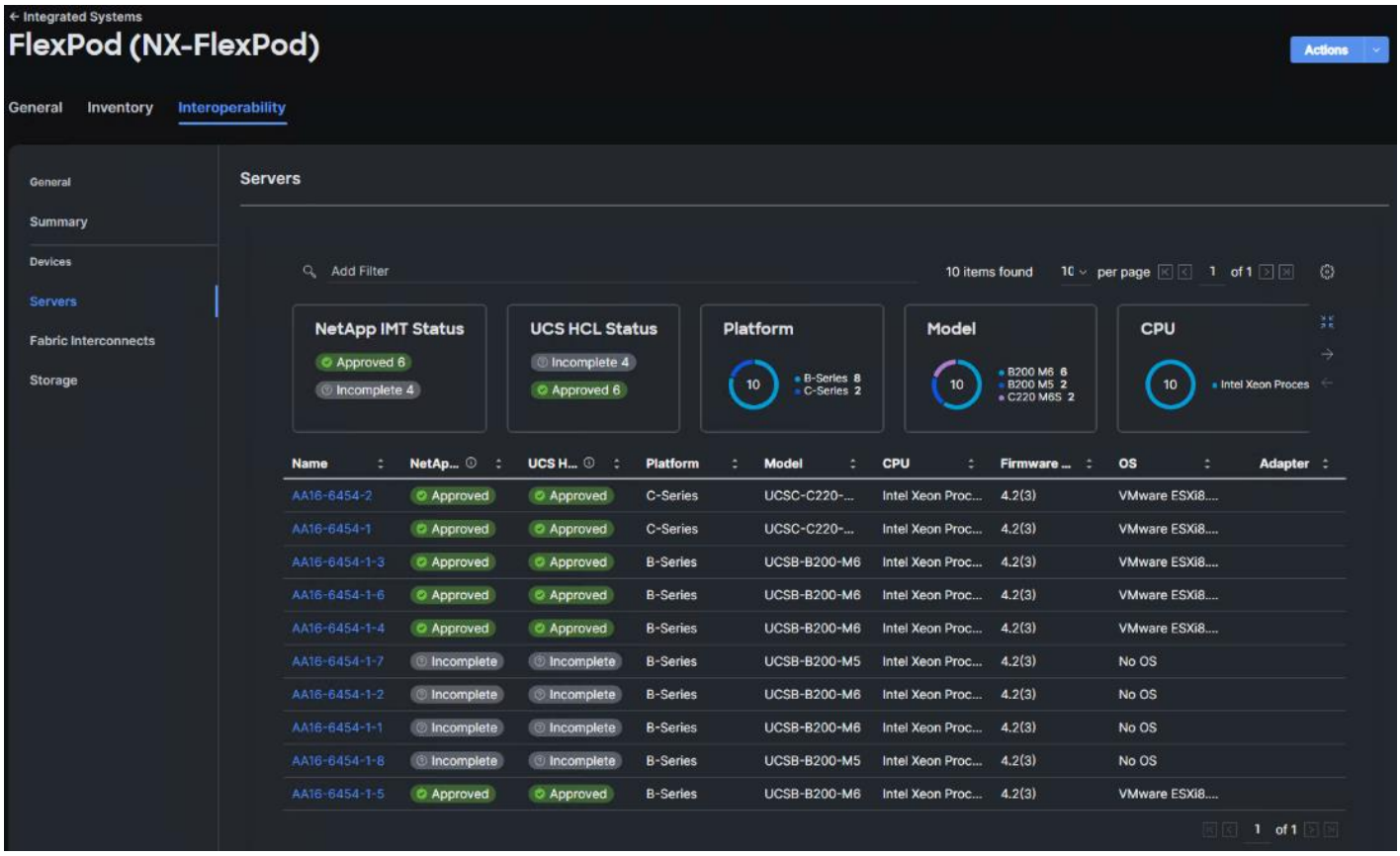


Note: You can click the "**...**" to the right of the FlexPod name and run an Interoperability check on the FlexPod. This check will take information on the FlexPod already checked against the Cisco UCS Hardware Compatibility List (HCL) and also check this information against the NetApp Interoperability Matrix Tool (IMT).

Step 9. Click the FlexPod name to see detailed General, Inventory, and Interoperability data on the FlexPod Integrated System.


← Integrated Systems
FlexPod (NX-FlexPod)
General
Inventory
Interoperability
Details
Name
NX-FlexPod
Interoperability Status
Incomplete
Storage Capacity
32.57 TiB
Capacity Utilization
0.5%
Integrated System Type
FlexPod
Description
-
Organizations
NX-FlexPod
Tags
Set
No Tags
Summary
Servers
Health
10
Healthy 10
Model Summary
10
B200 M6 6
B200 M5 2
C220 M6S 2
Firmware Versions
10
4.2(3d) 2
4.2(3c) 8
Power
Off 4
On 6
Connection
Connected 10
Fabric Interconnects
Health
2
Healthy 2
Model Summary
2
6454 2
Bundle Version
2
4.2(3d)A 2
Connection
Connected 2





Note: The servers that were not powered on during Run Interoperability Check were categorized as Incomplete Devices in the Interoperability Summary view.

Cisco Nexus Dashboard Fabric Controller (NDFC)-SAN

If you have fibre-channel SAN in your FlexPod, Cisco NDFC-SAN can be used to monitor, configure, and analyze Cisco fibre channel fabrics. This configuration will setup a single-node Nexus Dashboard on a Cisco UCS server

and then deploy NDFC-SAN. SAN Analytics can be added to provide insights into your fabric by allowing you to monitor, analyze, identify, and troubleshoot performance issues.

Prerequisites

The following prerequisites need to be configured:

- Licensing. Cisco NDFC-SAN includes a 60-day server-based trial license that can be used to monitor and configure Cisco MDS Fibre Channel switches and Cisco Nexus switches utilizing Nexus SAN switching. Both NDFC or DCNM server-based and switch-based licenses can be purchased. Additionally, SAN Insights and SAN Analytics requires an additional switch-based license on each switch. Cisco MDS 32Gbps Fibre Channel switches provide a 120-day grace period to trial SAN Analytics.

Note: If using Cisco Nexus 93180YC-FX, 93360YC-FX2, or 9336C-FX2-E for SAN switching, the Nexus switch does not support SAN Analytics.

- Passwords. Cisco NDFC-SAN passwords should adhere to the following password requirements:
  - It must be at least eight characters long and contain at least one alphabet and one numeral.
  - It can contain a combination of alphabets, numerals, and special characters.
  - Do not use any of these special characters in the DCNM password for all platforms: <SPACE> " & $ % ' ^ = < > ; : ` \ | / , .*
- NDFC SNMPv3 user on switches. Each switch (both Cisco MDS and Nexus) needs an SNMPv3 user added for NDFC to use to query and configure the switch. On each switch, enter the following command in configure terminal mode (in the example, the userid is snmpuser):

```
snmp-server user snmpadmin network-admin auth sha <password> priv aes-128 <privacy-password>
```

- On Cisco MDS switches, type show run. If snmpadmin passphrase lifetime 0 is present, enter username snm-padmin passphrase lifetime 99999 warntime 14 gracetime 3.

Note: It is important to use auth type sha and privacy auth aes-128 for both the switch and UCS snmpadmin users.

- Type "**copy run start**" on all switches to save the running configuration to the startup configuration.
- In Cisco UCS Manager, select **Admin** > **Communication Management** > **Communication Services**. Set the SNMP Admin State to **Enabled**. Under SNMP Users, add the same snmpadmin user with SHA and AES-128 with the same passwords set in the switches. Click **Save Changes** and then click **OK** to confirm this.

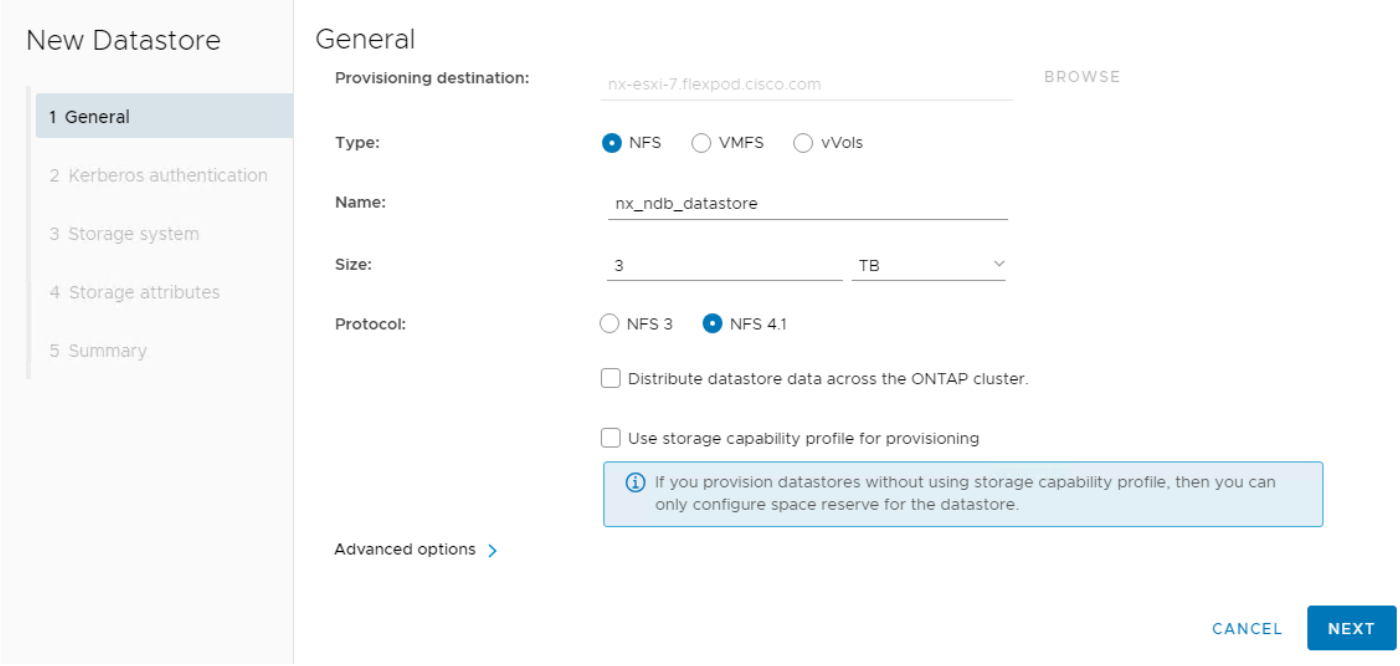
Procedure 1. Deploy the Cisco Nexus Dashboard OVA and then NDFC-SAN

Step 1. Download the Cisco Nexus Dashboard VM Image 2.3(2d) from https://software.cisco.com/download/home/281722751/type/282088134/release/12.1.2e.

Step 2. The single-node Nexus Dashboard should be installed on a server that is not part of a cluster since Nexus Dashboard does not support vMotion or VMware DRS. If an extra server was provisioned for this purpose, move it out to the Datacenter level in vCenter. Otherwise, follow the procedures in this document to provision a server at the Datacenter level. Make sure that it has a VMkernel port in the Infra-NFS subnet. For manual configuration of an ESXi host in a FlexPod, you can refer to https://www.cisco.com/c/en/us/td/docs/unified_computing/ucs/UCS_CVDs/flexpod_ucs_xseries_e2e_ontap_manual_deploy.html for everything except provisioning a Service Profile from template.

Step 3. Since Nexus Dashboard requires 3TB of disk space, it is recommended to place it in a separate datastore. Create a 3TB NFS datastore by right-clicking the Nexus Dashboard ESXi host and selecting **NetApp ONTAP Tools** > **Provision Datastore**.

Step 4. Name the datastore and set the size to 3TB. Select the NFS protocol in use in your environment and uncheck **Use storage capability profile for provisioning**. Click **NEXT**.



Step 5. If using NFS 4.1, leave “Don’t use Kerberos authentication” selected and click **NEXT**.

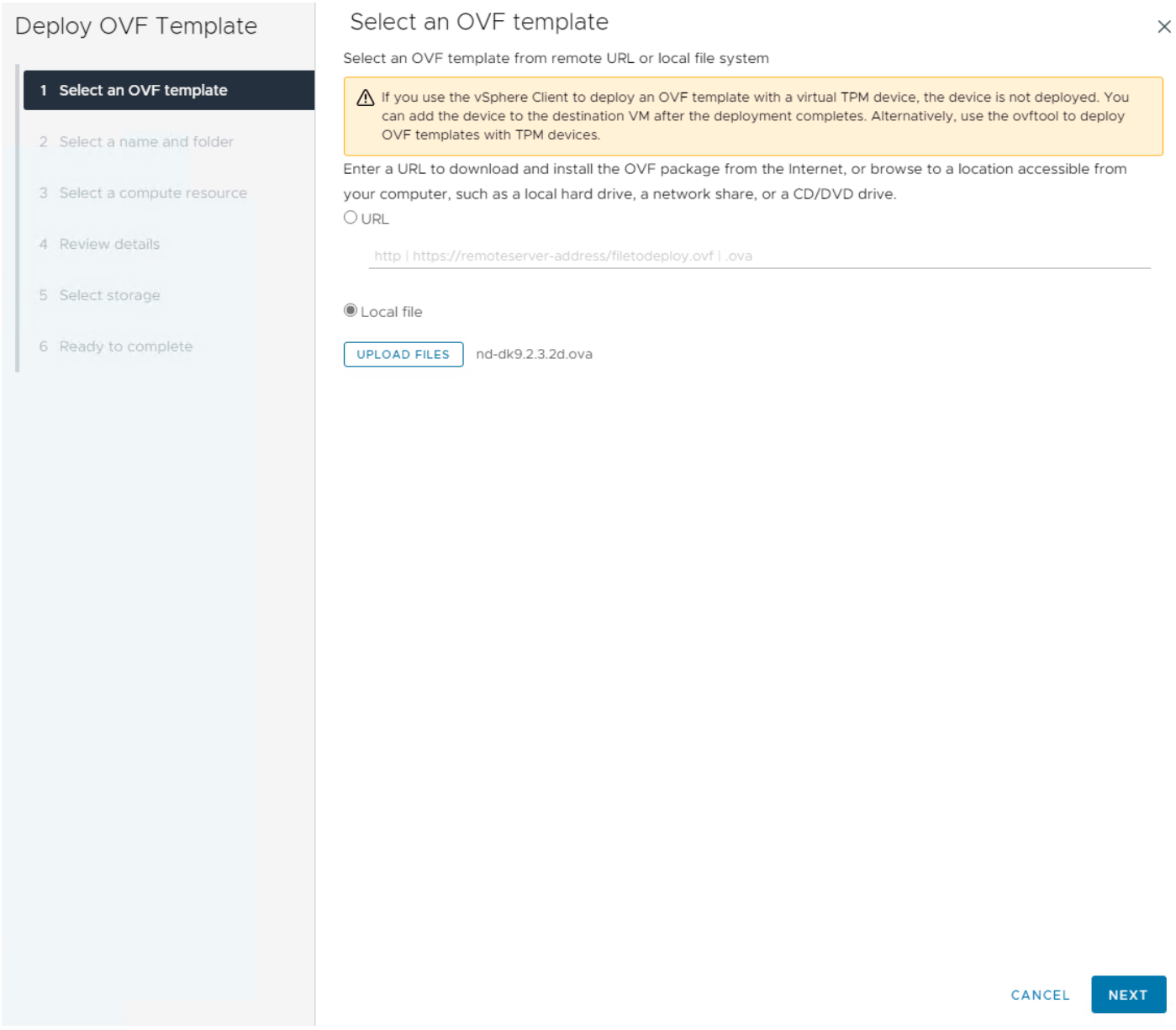
Step 6. Select the storage controller for this FlexPod and the Infra-SVM and click **NEXT**.

Step 7. Select the aggregate with the freest space. Expand Advanced options and make sure Space reserve is set to Thin. Click **NEXT**.

Step 8. Review the Summary and click **FINISH** and **OK**. ONTAP Tools will provision and mount the datastore on the Nexus Dashboard ESXi host.

Step 9. Right-click the Nexus Dashboard ESXi host and select **Deploy OVF Template**.

Step 10. Select Local file then click **UPLOAD FILES**. Navigate to select nd-dk9.2.3.2d.ova and click **Open**. Click **NEXT**.



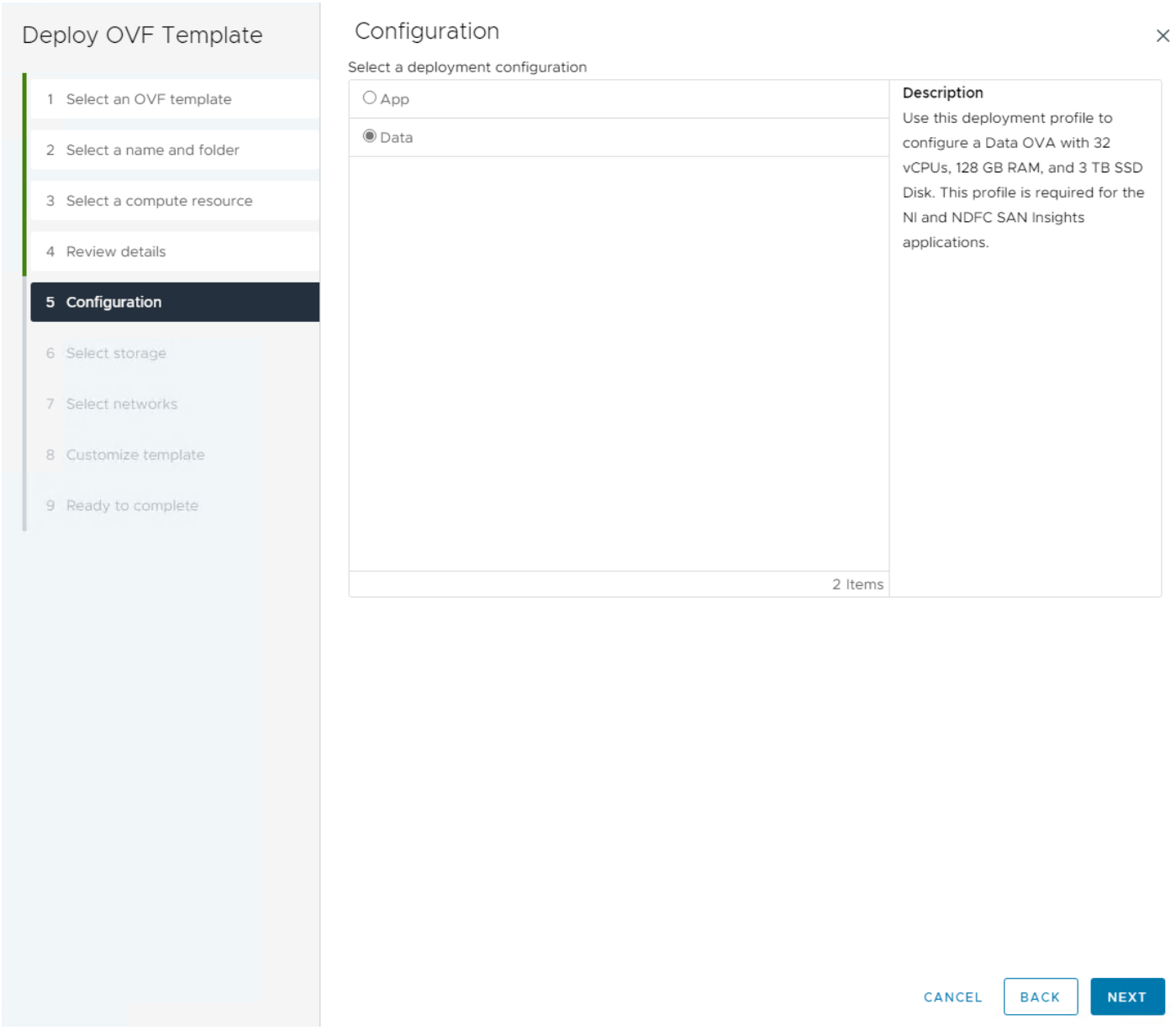
Step 11. Name the virtual machine and select the FlexPod-DC datacenter. Click **NEXT**.

Step 12. Select the Nexus Dashboard ESXi host and click **NEXT**.

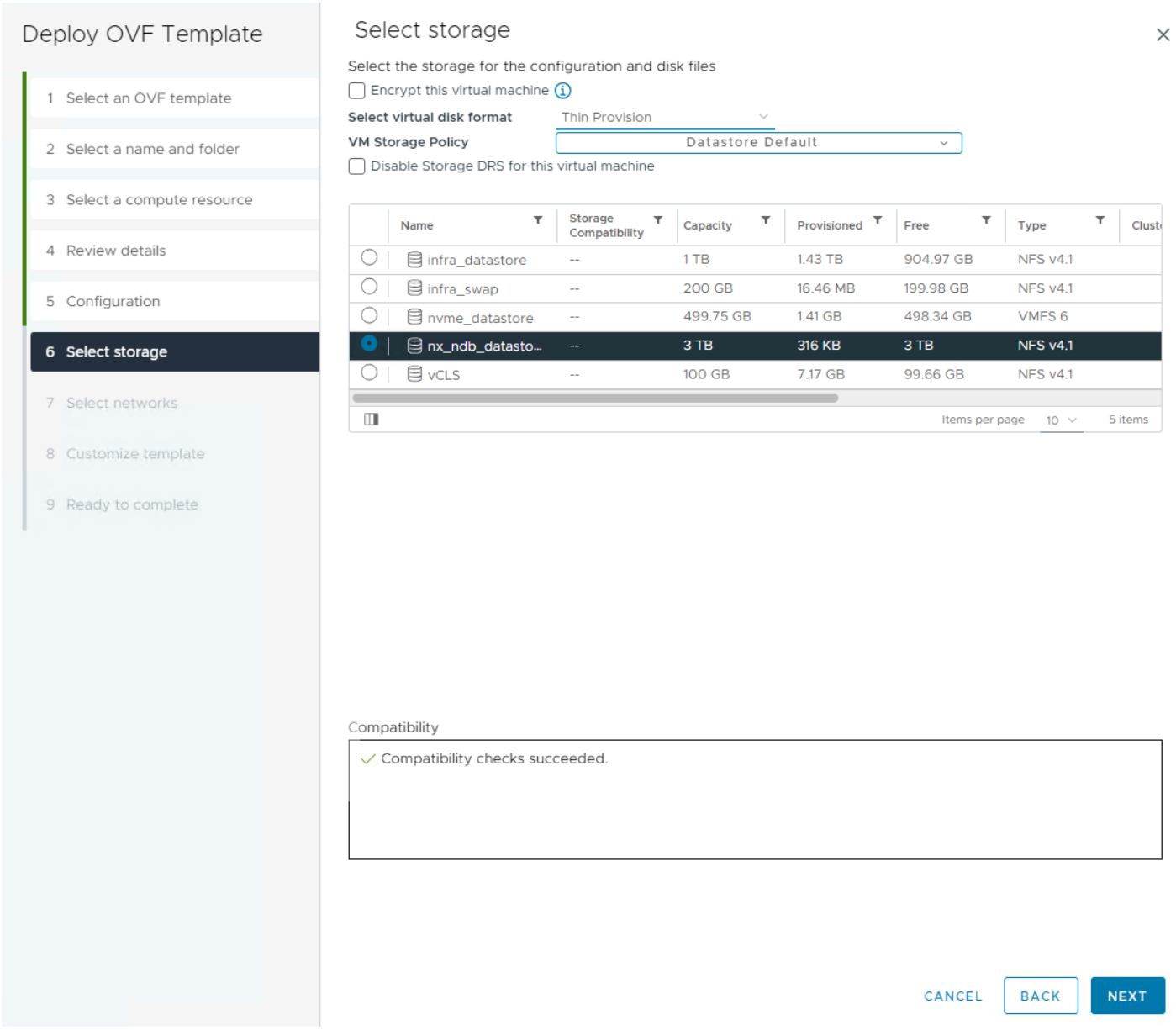
Step 13. Review the details and click **NEXT**.

Step 14. Select the appropriate deployment configuration size and click **NEXT**.

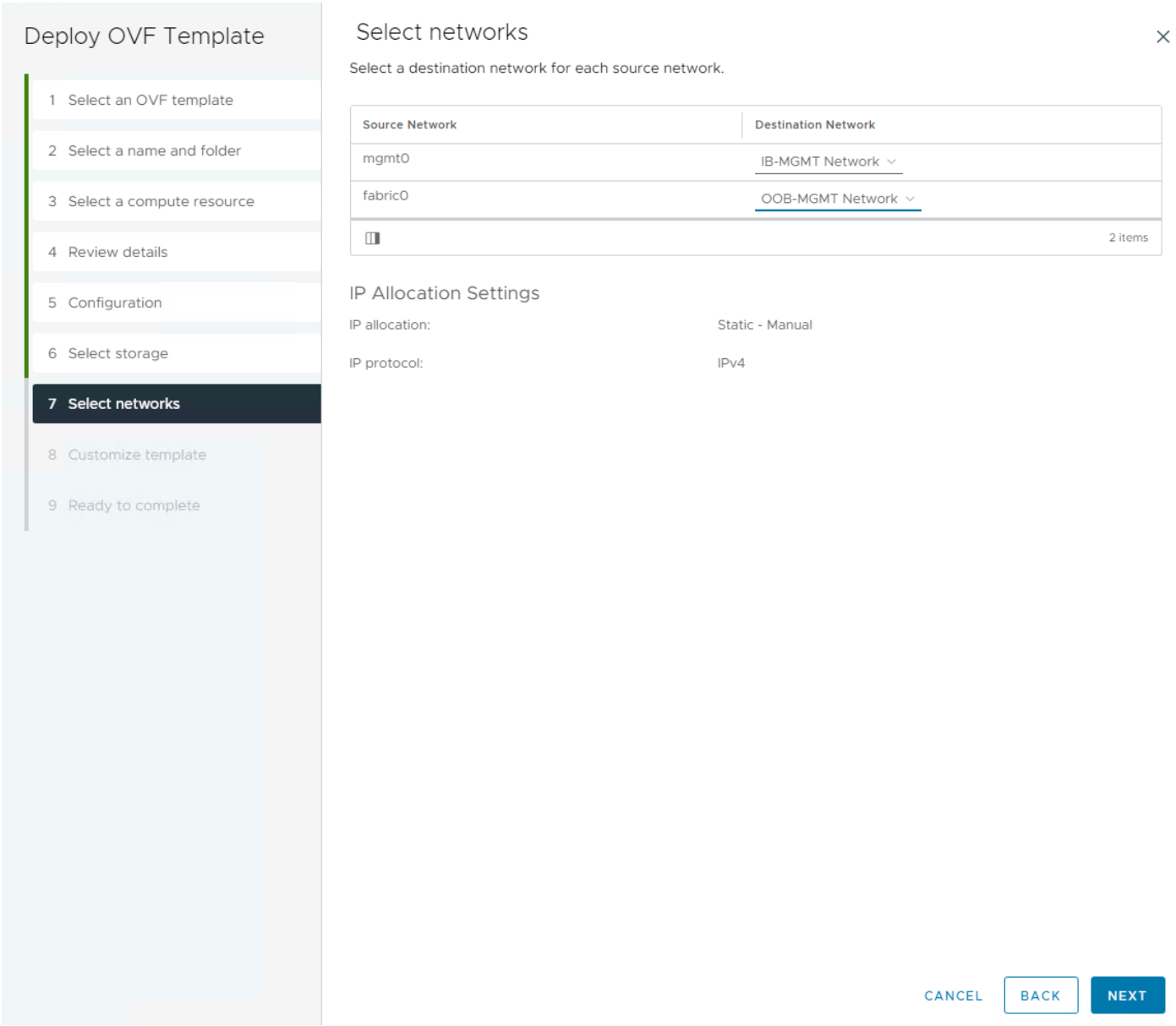
Note: If using the SAN Insights and SAN Analytics feature, it is recommended to use the Data deployment.



Step 15. Select the datastore previously configured and the Thin Provision virtual disk format. Click **NEXT**.

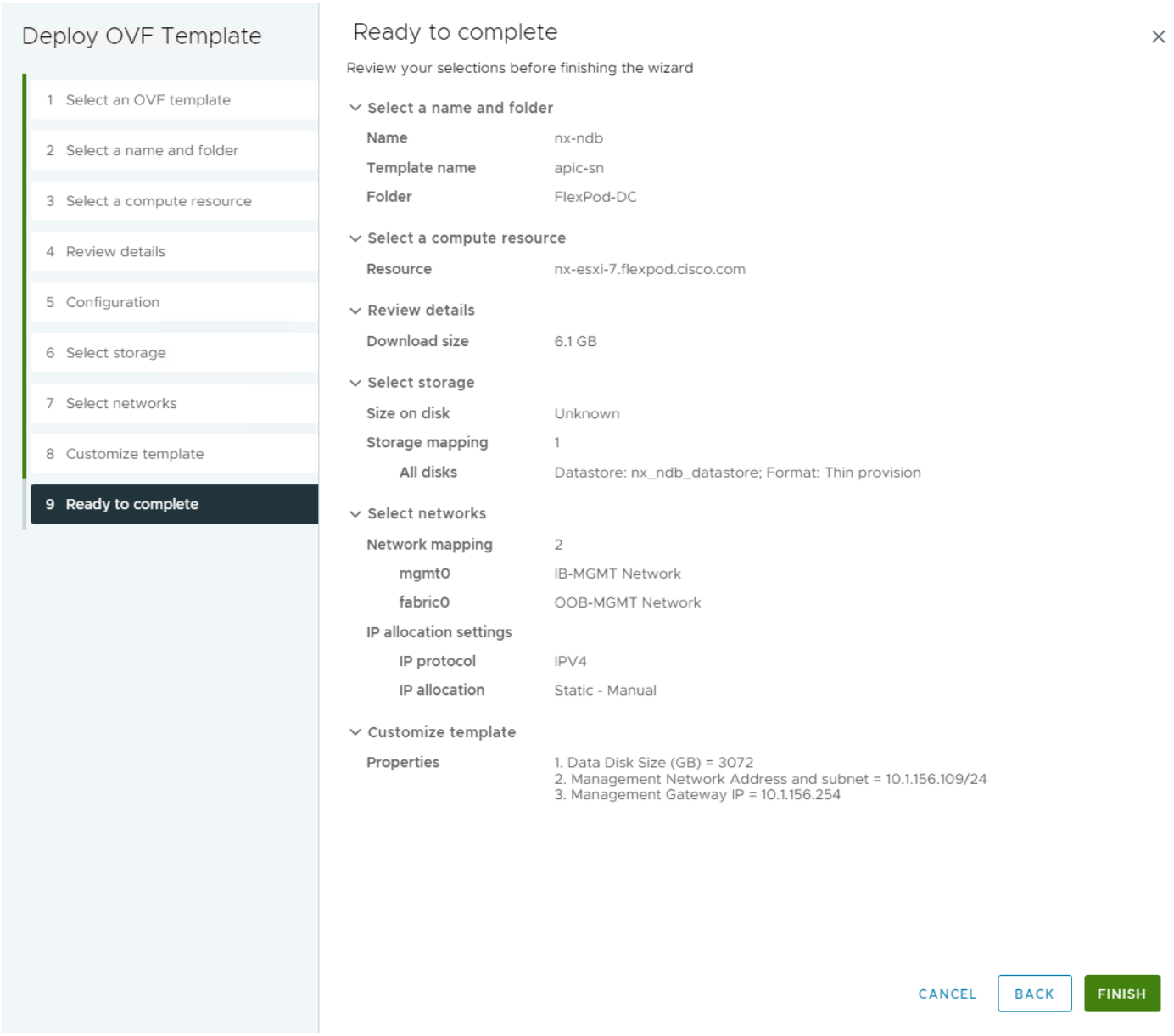


Step 16. Select **IB-MGMT Network** for the mgmt0 Source Network. Select **OOB-MGMT Network** for the fabric0 Source Network. Click **NEXT**.

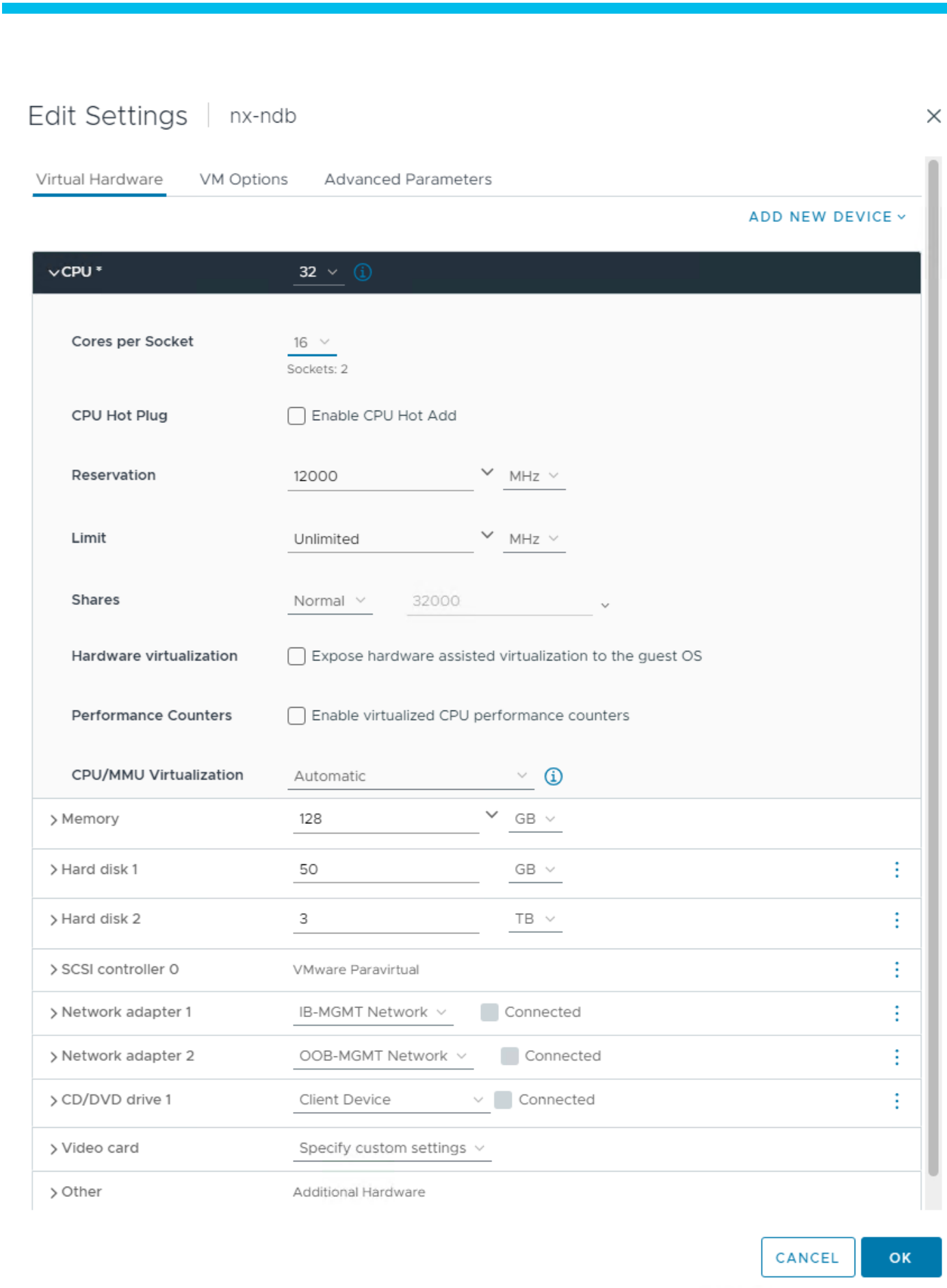


Step 17. Leave the Data Disk Size set to **3072**. Fill in the rescue-user password, the management network address and subnet, and the management network gateway. Click **NEXT**.

Step 18. Review the settings and click **FINISH** to deploy the OVA.



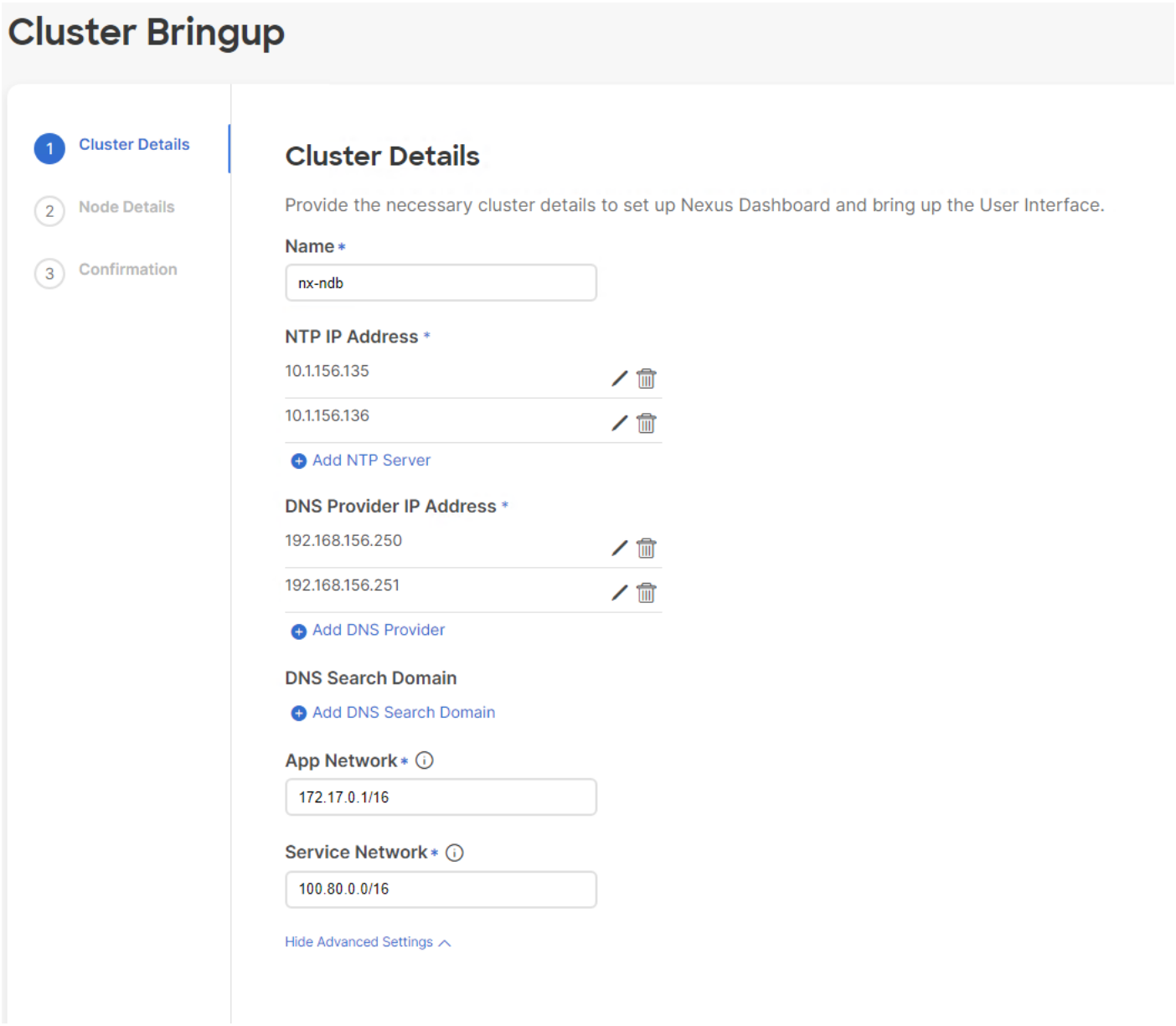
Step 19. After deployment is complete, right-click the newly deployed Nexus Dashboard VM and click **Edit Settings**. Expand CPU and adjust the Cores per Socket setting until the number of Sockets is set to match the number of CPUs in the UCS servers used in this deployment. The following example shows 2 sockets. Click **OK**.


Edit Settings
nx-ndb
Virtual Hardware
VM Options
Advanced Parameters
ADD NEW DEVICE
CPU *
32
Cores per Socket
16
Sockets: 2
CPU Hot Plug
Enable CPU Hot Add
Reservation
12000
MHz
Limit
Unlimited
MHz
Shares
Normal
32000
Hardware virtualization
Expose hardware assisted virtualization to the guest OS
Performance Counters
Enable virtualized CPU performance counters
CPU/MMU Virtualization
Automatic
Memory
128
GB
Hard disk 1
50
GB
Hard disk 2
3
TB
SCSI controller 0
VMware Paravirtual
Network adapter 1
IB-MGMT Network
Connected
Network adapter 2
OOB-MGMT Network
Connected
CD/DVD drive 1
Client Device
Connected
Video card
Specify custom settings
Other
Additional Hardware
CANCEL
OK

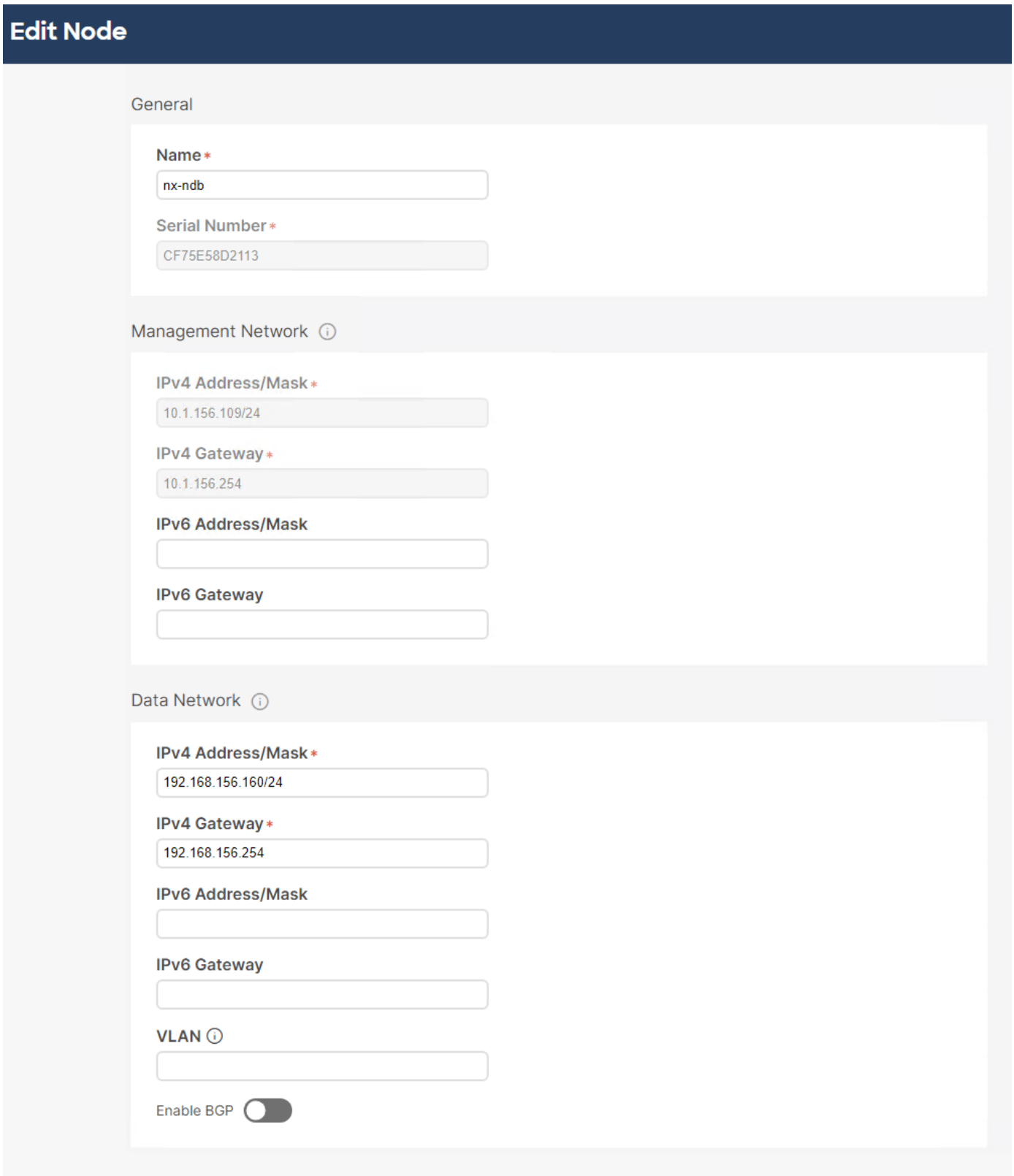
Step 20. Right-click the newly deployed Nexus Dashboard VM and click **Open Remote Console**. Once the console is up, click the green arrow to power on the VM. Once the VM has powered up, open a web browser, and enter the URL displayed on the console.

Step 21. Navigate the security prompts, enter the password from the OVA deployment and click **Begin Setup**.

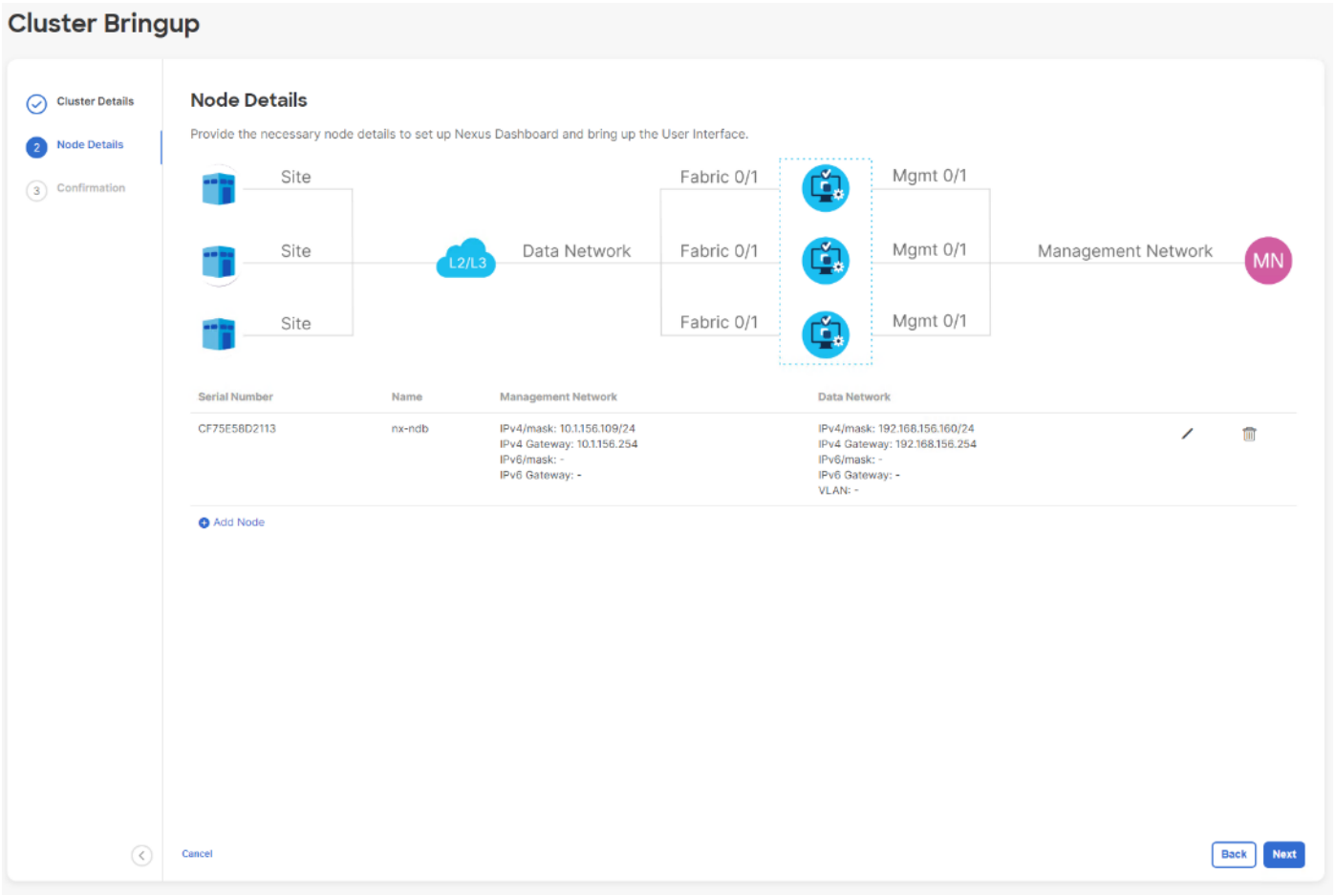
Step 22. Input the Nexus Dashboard name, add NTP server IPs, and DNS server IPs. If your network does not have a proxy server, click the ⓘ to the right of Proxy Server and select **Skip**. Click **Confirm** on the Warning. **Expand View Advanced Settings**. Add the DNS Search Domain and click **Next**.



Step 23. The IB-MGMT Network information should already be filled in for the one Nexus Dashboard node being provisioned. Click the **pencil icon** to the right and fill in the **Node Name**, **IPv4 Address/Mask** and **Gateway** for the OOB-MGMT subnet interface. Click **Update**.



Step 24. Click **Next**.



Step 25. Click **Confirm Installation** to confirm that a one-node Nexus Dashboard is being installed.

Step 26. Click **Configure** to begin the installation.

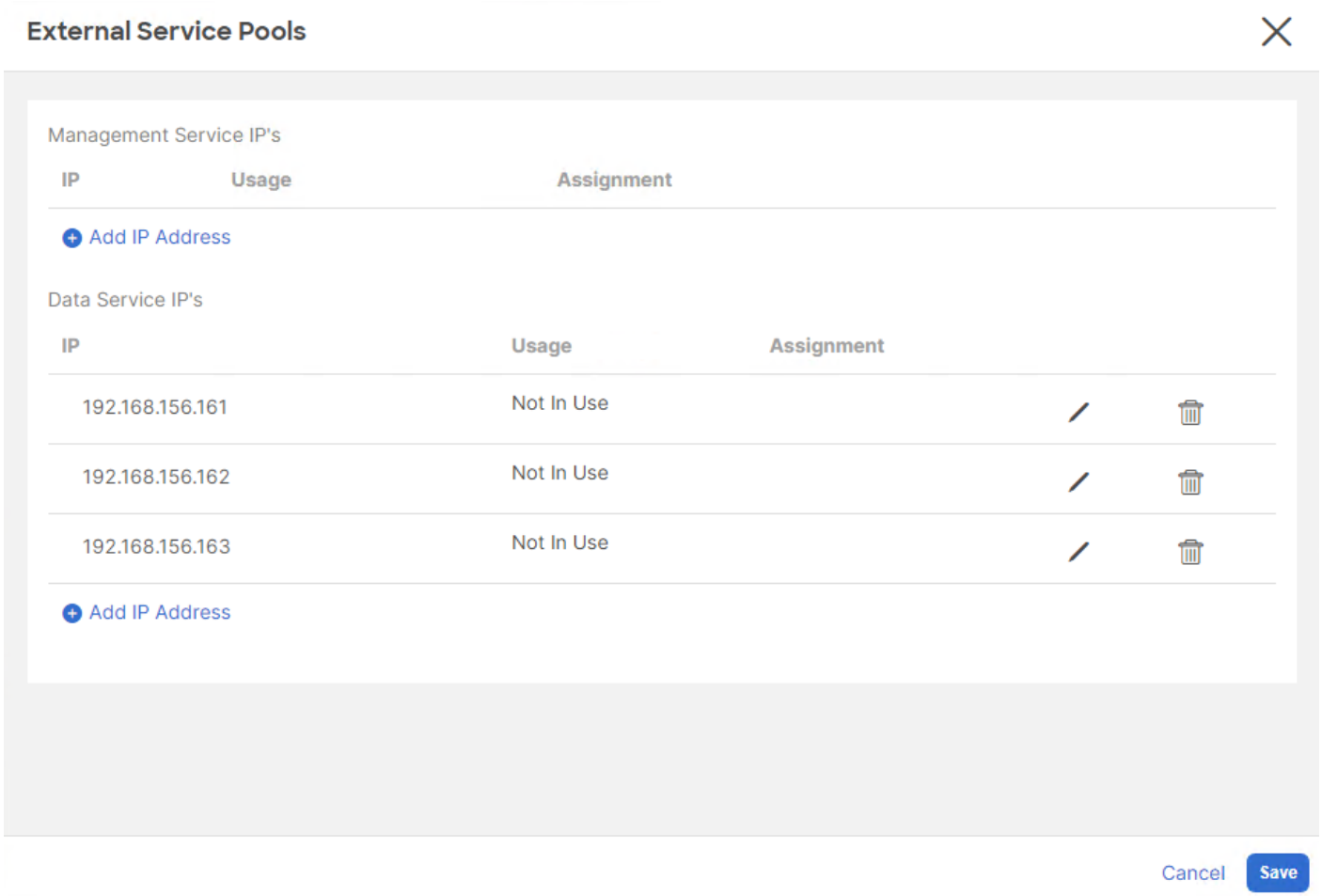
Step 27. Wait for the installation and Cluster Deployment to complete. You will need to refresh the browser and negotiate the security prompts to get the Welcome to Nexus Dashboard page.

Step 28. On the Welcome to Nexus Dashboard page, enter the admin Username and the password entered in the OVA installation and click **Login**.

Step 29. Click **Let's Go** then click **Do not show on login**. Click **Get Started**.

Step 30. Click **Done** then click **Go To Dashboard**. At the top of the window, use the One View drop-down list to select **Admin Console**.

Step 31. On the left select **Infrastructure** then select **Cluster Configuration**. Click the pencil icon to the right of External Service Pools to add Data Service IP's from the OOB-MGMT subnet. Add 3 Data Service IP's from the OOB-MGMT subnet and click **Save**.



Step 32. On the left select **Services**. Select the **App Store** tab. Install NDFC by clicking **Install** under Nexus Dashboard Fabric Controller.

Step 33. Enter your **Cisco ID** and **password** and navigate **Single Sign On (SSO)**.

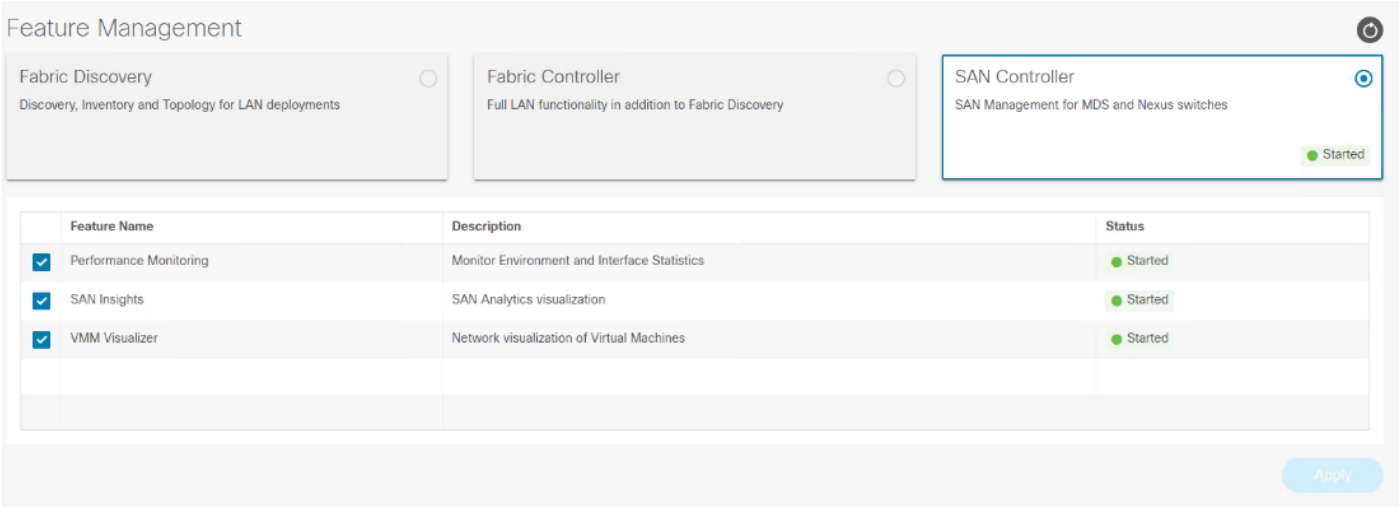
Step 34. Close the Cookies window then click **Agree** and **Download** to accept the License Agreement and download NDFC. NDFC will progress through Downloading to Installing and finally to Installed.

Step 35. Select the **Installed Services** tab. Under Nexus Dashboard Fabric Controller, click **Enable**. The service will take a few minutes to enable.

Step 36. When Enable is replaced by Open under Nexus Dashboard Fabric Controller, click **Open**.

Step 37. Review the Nexus Dashboard Fabric Controller SAN Prerequisites which indicate 3 IPs in the OOB-MGMT subnet will be needed. Check **Do not show this message again** and click **Get started**.

Step 38. Click the circle to the right of SAN Controller, select **Cisco** as the OEM vendor, and click **Confirm**. Select all features that you plan to use and click **Apply** to start the SAN Controller. Wait until the SAN Controller and all Features are Started and have a green status indicator.

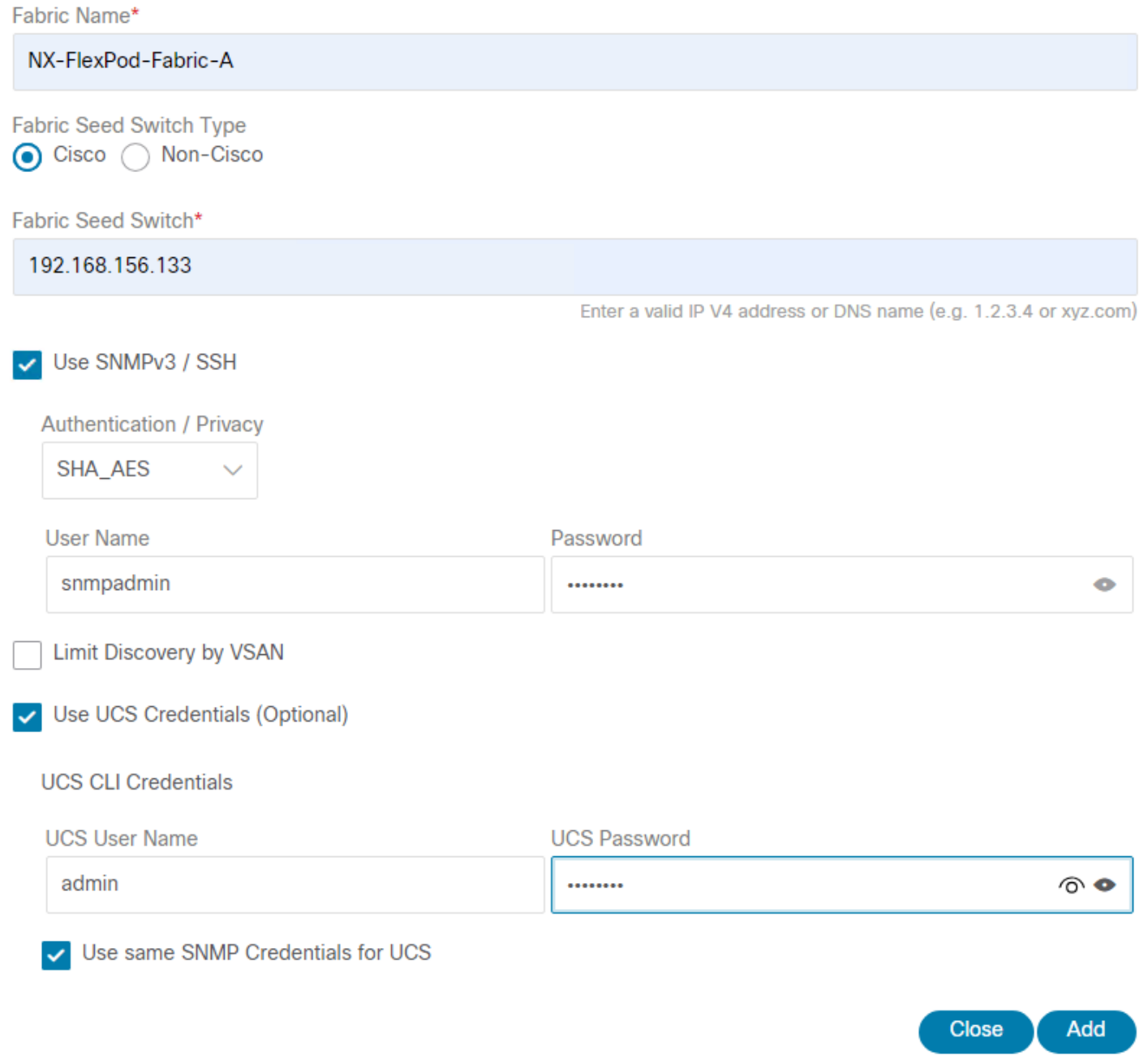


Procedure 2. Configure NDFC-SAN

Step 1. When the NDFC-SAN installation is complete, the browser should redirect to the SAN Controller.

Step 2. Click **SAN > Fabrics** to add the two SAN Fabrics. Under Actions, select **Add Fabric**.

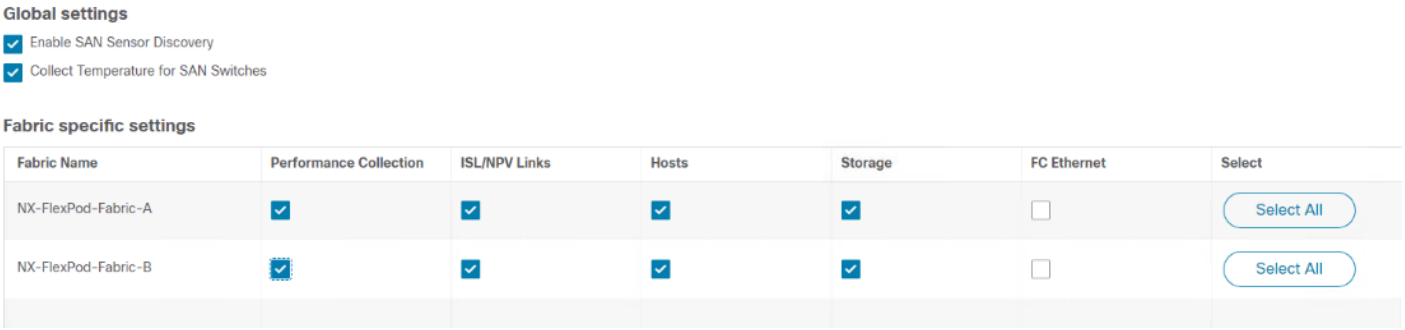
Step 3. Proved a name for the A-side fabric. For the Fabric Seed Switch, enter the IP address of the Fabric A MDS or Nexus SAN switch. Leave **Use SNMPv3/SSH** checked and select **SHA_AES** for Authentication/Privacy. Enter the **snmpadmin User Name** and associated **password**. Check **Use UCS Credentials**. Enter **admin** for the UCS User Name and the associated **password**. Leave **Use same SNMP credentials for UCS** checked. Click **Add**.



Step 4. Once the A-side fabric has been added, repeat Step 3 to add the B-side fabric.

Step 5. If you have purchased NDFC or DCNM server-based or switch-based licenses, follow the instructions that came with the licenses to install them. A new NDFC installation also has a 60-day trial license.

Step 6. Select **SAN** > **Fabrics**. Use the checkbox to select both Fabrics and under Actions select Configure Performance. Enable all desired Performance Data Collection Settings and click **Apply** then click **Confirm**.



Step 7. If you have purchased and installed SAN Analytics licenses on your MDS switches, use the checkbox to select Fabric A and under Actions select **Configure SAN Insights**. Click **Next**. Select your Fabric A Cisco MDS switch. Under Subscriptions select the appropriate subscription. Under Install Query select Storage. Click **Next**. Click **Next**. On the ports connected to storage, select the type of metrics to be collected. Click **Next**. Click **Commit** to setup the storage ports on the MDS and to install the query and configure telemetry in the MDS. When both tasks have a status of Success, click **Close**. Repeat this process for Fabric B. After a few minutes, select Dashboards > SAN Insights. You should see that the SAN Controller is receiving SAN Insights records.

Step 8. ssh into each of the MDS switches and type “show license usage”. If you enable SAN Analytics in Step 7, each switch should show usage of a DCNM-SAN license and a SAN Analytics license.

Step 9. To configure Device Aliases for a fabric, go to **SAN** > **Fabrics**, click on the **Fabric Name**. On the right, click to pop out to the Fabric. Select the **Device Aliases** tab. Here, you can use a checkbox to select an existing Device Alias and under Actions either Edit or Delete it. To Add a Device Alias, under Actions select Add device alias. The first window shows WWPNs that have logged into the Fabric. If you want to add a Device Alias for one of these WWPNs, use the checkbox to select it and click Next. If your WWPN does not appear here, click Next to Pre-provision the device alias. Once you have either edited or Pre-provisioned all device aliases, click **Save Aliases** to save them.

Step 10. To configure Zoning for a fabric, go to **SAN** > **Zoning** then select the appropriate Fabric, VSAN, and Switch. Select the Zoneset and then under Actions select **Edit zones & members**. You can then select a Zone on the left and see its members on the right. Under Actions, you can Add existing members to the zone. Select Device Alias and then add any needed Device Aliases to the zone. Zoning by Enhanced Device Alias is what has been setup in this FlexPod, and it is important to continue to add members by Device Alias. Once you have changed the zones, you will need to Activate the Zoneset to implement the changes.

Note: For more information, please see Cisco NDFC-SAN Controller Configuration Guide, Release 12.1.2e.

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John has been involved in designing, developing, validating, and supporting the FlexPod Converged Infrastructure since it was developed almost 12 years ago. Before his role with FlexPod, he supported and administered a large worldwide training network and VPN infrastructure. John holds a master's degree in Computer Engineering from Clemson University.

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Appendix

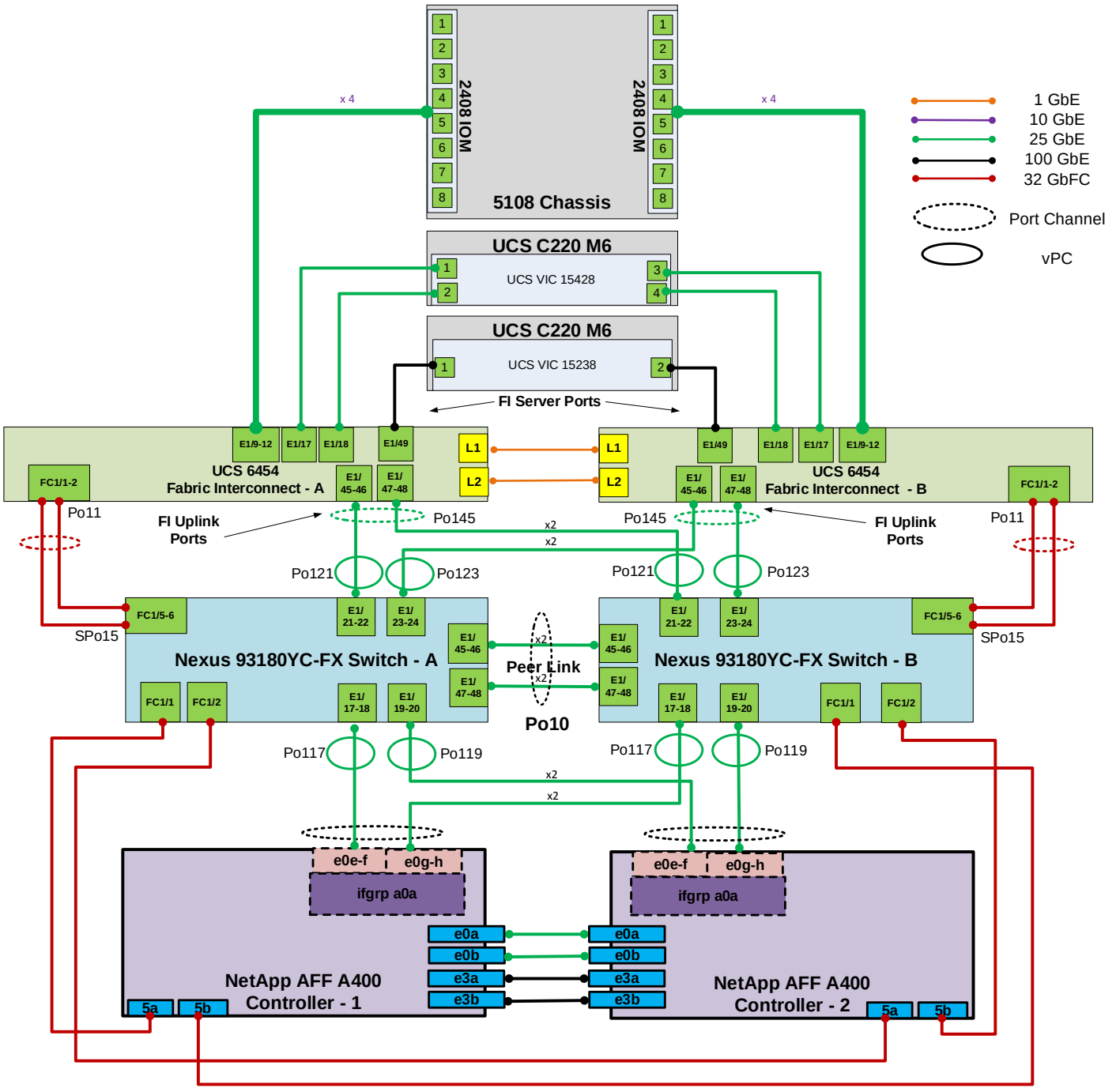
This appendix contains the following:

Note: The features and functionality explained in this Appendix are optional configurations which can be helpful in configuring and managing the FlexPod deployment.

FlexPod with Cisco Nexus SAN Switching Configuration – Part 1

If the Cisco Nexus switches are to be used for both LAN and SAN switching in the FlexPod configuration, either an automated configuration with Ansible or a manual configuration can be done. For either configuration method, the following base switch setup must be done manually. Figure 7 shows the validation lab cabling for this setup.

Figure 7. Cisco Nexus SAN Switching Cabling with FCoE Fabric Interconnect Uplinks



FlexPod Cisco Nexus 93180YC-FX SAN Switching Base Configuration

The following procedures describe how to configure the Cisco Nexus 93180YC-FX switches for use in a base FlexPod environment that uses the switches for both LAN and SAN switching. This procedure assumes you're using Cisco Nexus 9000 10.2(5)M. This procedure also assumes that you have created an FCoE Uplink Port Channel on the appropriate ports in the Cisco UCS IMM Port Policies for each UCS fabric interconnect.

Procedure 1. Set Up Initial Configuration in Cisco Nexus 93180YC-FX A

Step 1. Configure the switch:

Note: On initial boot and connection to the serial or console port of the switch, the NX-OS setup should automatically start and attempt to enter Power on Auto Provisioning.

```
Abort Power On Auto Provisioning [yes - continue with normal setup, skip - bypass password and basic configuration,
no - continue with Power On Auto Provisioning] (yes/skip/no)[no]: yes
Disabling POAP.......Disabling POAP
poap: Rolling back, please wait... (This may take 5-15 minutes)

         ---- System Admin Account Setup ----

Do you want to enforce secure password standard (yes/no) [y]: Enter
Enter the password for "admin": <password>
Confirm the password for "admin": <password>
Would you like to enter the basic configuration dialog (yes/no): yes
Create another login account (yes/no) [n]: Enter
Configure read-only SNMP community string (yes/no) [n]: Enter
Configure read-write SNMP community string (yes/no) [n]: Enter
Enter the switch name: <nexus-A-hostname>
Continue with Out-of-band (mgmt0) management configuration? (yes/no) [y]: Enter
Mgmt0 IPv4 address: <nexus-A-mgmt0-ip>
Mgmt0 IPv4 netmask: <nexus-A-mgmt0-netmask>
Configure the default gateway? (yes/no) [y]: Enter
IPv4 address of the default gateway: <nexus-A-mgmt0-gw>
Configure advanced IP options? (yes/no) [n]: Enter
Enable the telnet service? (yes/no) [n]: Enter
Enable the ssh service? (yes/no) [y]: Enter
Type of ssh key you would like to generate (dsa/rsa) [rsa]: Enter
Number of rsa key bits <1024-2048> [1024]: Enter
Configure the ntp server? (yes/no) [n]: Enter
Configure default interface layer (L3/L2) [L2]: Enter
Configure default switchport interface state (shut/noshut) [noshut]: shut
Enter basic FC configurations (yes/no) [n]: y
Configure default physical FC switchport interface state (shut/noshut) [shut]: Enter
Configure default switchport trunk mode (on/off/auto) [on]: auto
Configure default zone policy (permit/deny) [deny]: Enter
Enable full zoneset distribution? (yes/no) [n]: y
Configure CoPP system profile (strict/moderate/lenient/dense) [strict]: Enter
Would you like to edit the configuration? (yes/no) [n]: Enter
```

Step 2. Review the configuration summary before enabling the configuration:

```
Use this configuration and save it? (yes/no) [y]: Enter
```

Procedure 2. Set Up Initial Configuration in Cisco Nexus 93180YC-FX B

Step 1. Configure the switch:

Note: On initial boot and connection to the serial or console port of the switch, the NX-OS setup should automatically start and attempt to enter Power on Auto Provisioning.

```
Abort Power On Auto Provisioning [yes - continue with normal setup, skip - bypass password and basic configuration,
no - continue with Power On Auto Provisioning] (yes/skip/no)[no]: yes
Disabling POAP.......Disabling POAP
poap: Rolling back, please wait... (This may take 5-15 minutes)

         ---- System Admin Account Setup ----

Do you want to enforce secure password standard (yes/no) [y]: Enter
Enter the password for "admin": <password>
Confirm the password for "admin": <password>
Would you like to enter the basic configuration dialog (yes/no): yes
Create another login account (yes/no) [n]: Enter
Configure read-only SNMP community string (yes/no) [n]: Enter
```

```
Configure read-write SNMP community string (yes/no) [n]: Enter
Enter the switch name: <nexus-B-hostname>
Continue with Out-of-band (mgmt0) management configuration? (yes/no) [y]: Enter
Mgmt0 IPv4 address: <nexus-B-mgmt0-ip>
Mgmt0 IPv4 netmask: <nexus-B-mgmt0-netmask>
Configure the default gateway? (yes/no) [y]: Enter
IPv4 address of the default gateway: <nexus-B-mgmt0-gw>
Configure advanced IP options? (yes/no) [n]: Enter
Enable the telnet service? (yes/no) [n]: Enter
Enable the ssh service? (yes/no) [y]: Enter
Type of ssh key you would like to generate (dsa/rsa) [rsa]: Enter
Number of rsa key bits <1024-2048> [1024]: Enter
Configure the ntp server? (yes/no) [n]: Enter
Configure default interface layer (L3/L2) [L2]: Enter
Configure default switchport interface state (shut/noshut) [noshut]: shut
Enter basic FC configurations (yes/no) [n]: y
Configure default physical FC switchport interface state (shut/noshut) [shut]: Enter
Configure default switchport trunk mode (on/off/auto) [on]: auto
Configure default zone policy (permit/deny) [deny]: Enter
Enable full zoneset distribution? (yes/no) [n]: y
Configure CoPP system profile (strict/moderate/lenient/dense) [strict]: Enter
Would you like to edit the configuration? (yes/no) [n]: Enter
```

Step 2. Review the configuration summary before enabling the configuration:

```
Use this configuration and save it? (yes/no) [y]: Enter
```

Note: SAN switching requires both the SAN_ENTERPRISE_PKG and FC_PORT_ACTIVATION_PKG licenses. Ensure these licenses are installed on each Nexus switch.

Note: This section is structured as a green field switch setup. If existing switches that are switching active traffic are being setup, execute this procedure down through Perform TCAM Carving and Configure Unified Ports in Cisco Nexus 93180YC-FX2 A and B first on one switch and then when that is completed, execute on the other switch.

Procedure 3. Install feature-set fcoe in Cisco Nexus 93180YC-FX A and B

Step 1. Run the following commands to set global configurations:

```
config t
install feature-set fcoe
feature-set fcoe
system default switchport trunk mode auto
system default switchport mode F
```

Note: These steps are provided in case the basic FC configurations were not configured in the switch setup script de-tailed in the previous section.

Procedure 4. Set System-Wide QoS Configurations in Cisco Nexus 93180YC-FX A and B

Step 1. Run the following commands to set global configurations:

```
config t
system qos
service-policy type queuing input default-fcoe-in-que-policy
service-policy type queuing output default-fcoe-8q-out-policy
service-policy type network-qos default-fcoe-8q-nq-policy
copy run start
```

Procedure 5. Perform TCAM Carving and Configure Unified Ports (UP) in Cisco Nexus 93180YC-FX A and B

Note: SAN switching requires TCAM carving for lossless fibre channel no-drop support. Also, unified ports need to be converted to fc ports.

Note: On the Cisco Nexus 93360YC-FX2, UP ports are converted to FC in groups of 4 in columns, for example, 1,2,49,50.

Step 1. Run the following commands:

```
hardware access-list tcam region ing-racl 1536
hardware access-list tcam region ing-ifacl 256
hardware access-list tcam region ing-redirect 256
slot 1
port 1-8 type fc
copy running-config startup-config
reload
This command will reboot the system. (y/n)?  [n] y
```

Step 2. After the switch reboots, log back in as admin. Run the following commands:

```
show hardware access-list tcam region |i i ing-racl
show hardware access-list tcam region |i i ing-ifacl
show hardware access-list tcam region |i i ing-redirect
show int status
```

FlexPod Cisco Nexus 93180YC-FX SAN Switching Ethernet Switching Automated Configuration

For the automated configuration of the Ethernet part of the Cisco Nexus 93180YC-FX switches when using the switches for SAN switching, once the base configuration is set, return to Ansible Nexus Switch Configuration, and execute from there.

FlexPod with Cisco Nexus 93180YC-FX SAN Switching Configuration - Part 2

Note: If the Cisco Nexus 93180YC-FX switch is being used for SAN Switching, this section should be completed in place of the Cisco MDS section of this document.

Procedure 1. FlexPod Cisco Nexus 93180YC-FX SAN Switching Automated Configuration

Automate the configuration of the SAN part of the Cisco Nexus 93180YC-FX switches when using the switches for SAN switching.

Step 1. Verify Nexus switch ssh keys are in /home/admin/.ssh/known_hosts. Adjust known_hosts as necessary if errors occur.

```
ssh admin@<nexus-A-mgmt0-ip>
exit
ssh admin@<nexus-B-mgmt0-ip>
exit
```

Step 2. Edit the FlexPod-UCSM-VMware/FlexPod-UCSM-VMware/inventory file putting the Cisco Nexus A information in for MDS A and the Cisco Nexus B information in for MDS B.

Step 3. Edit the following variable files to ensure proper Cisco Nexus SAN variables are entered:

- FlexPod-UCSM-VMware/FlexPod-UCSM-VMware/group_vars/all.yml
- FlexPod-UCSM-VMware/FlexPod-UCSM-VMware/host_vars/mdsA.yml
- FlexPod-UCSM-VMware/FlexPod-UCSM-VMware/host_vars/mdsB.yml
- FlexPod-UCSM-VMware/FlexPod-UCSM-VMware/roles/NEXUSSANconfig/defaults/main.yml

Note: The SAN variables and port descriptions from the mdsA.yml and mdsB.yml files will be used for the SAN configuration in the Cisco Nexus 93180YC-FX switches.

Step 4. From FlexPod-UCSM-VMware/FlexPod-UCSM-VMware, run the Setup_NexusSAN.yml Ansible playbook.

```
ansible-playbook ./Setup_NexusSAN.yml -i inventory
```

Procedure 2. Switch Testing Commands

Step 1. The following commands can be used to check for correct switch configuration:

Note: Some of these commands need to run after further configuration of the FlexPod components are complete to see complete results.

```
show run
show run int
show int
show int status
show int brief
show flogi database
show device-alias database
show zone
show zoneset
show zoneset active
```

Create a FlexPod ESXi Custom ISO using VMware vCenter

In this Cisco Validated Design (CVD), the Cisco Custom Image for ESXi 8.0 Install CD was used to install VMware ESXi. After this installation, the NetApp NFS Plug-in for VMware VAAI and Cisco UCS Tool had to be installed or updated during the FlexPod deployment. vCenter 8.0 or later can be used to produce a FlexPod custom ISO containing the updated drivers. This ISO can be used to install VMware ESXi 8.0 without having to do any additional driver updates. In previous FlexPod CVD documents, VMware Image Builder was used to produce this ISO. In this document, the capability to manage an ESXi cluster with a single image under VMware Lifecycle Manager will be used to produce this ISO.

Procedure 1. Create a FlexPod ESXi Custom ISO using VMware vCenter Lifecycle Manager

Step 1. Download the following listed .zip files:

- NetApp NFS Plug-in for VMware VAAI 2.0.1 – From this downloaded file, extract the NetAppNasPlugin2.0.1.zip file.
- UCS Tools VIB for ESXi 8.0 – ucs-tool-esxi_1.3.1-1OEM.zip

Step 2. Log into the VMware vCenter HTML5 Client as administrator@vsphere.local.

Step 3. Under the Menu on the upper left, select **Lifecycle Manager**.

Step 4. Under ACTIONS, select **Import Updates**.

Step 5. In the Import Updates window, click **BROWSE** and navigate to the **NetAppNasPlugin2.0.1.zip** file. Select the file and click **Open**.

Step 6. Repeat Step 5 to import the **ucs-tool-esxi_1.3.1-1OEM.zip** file.

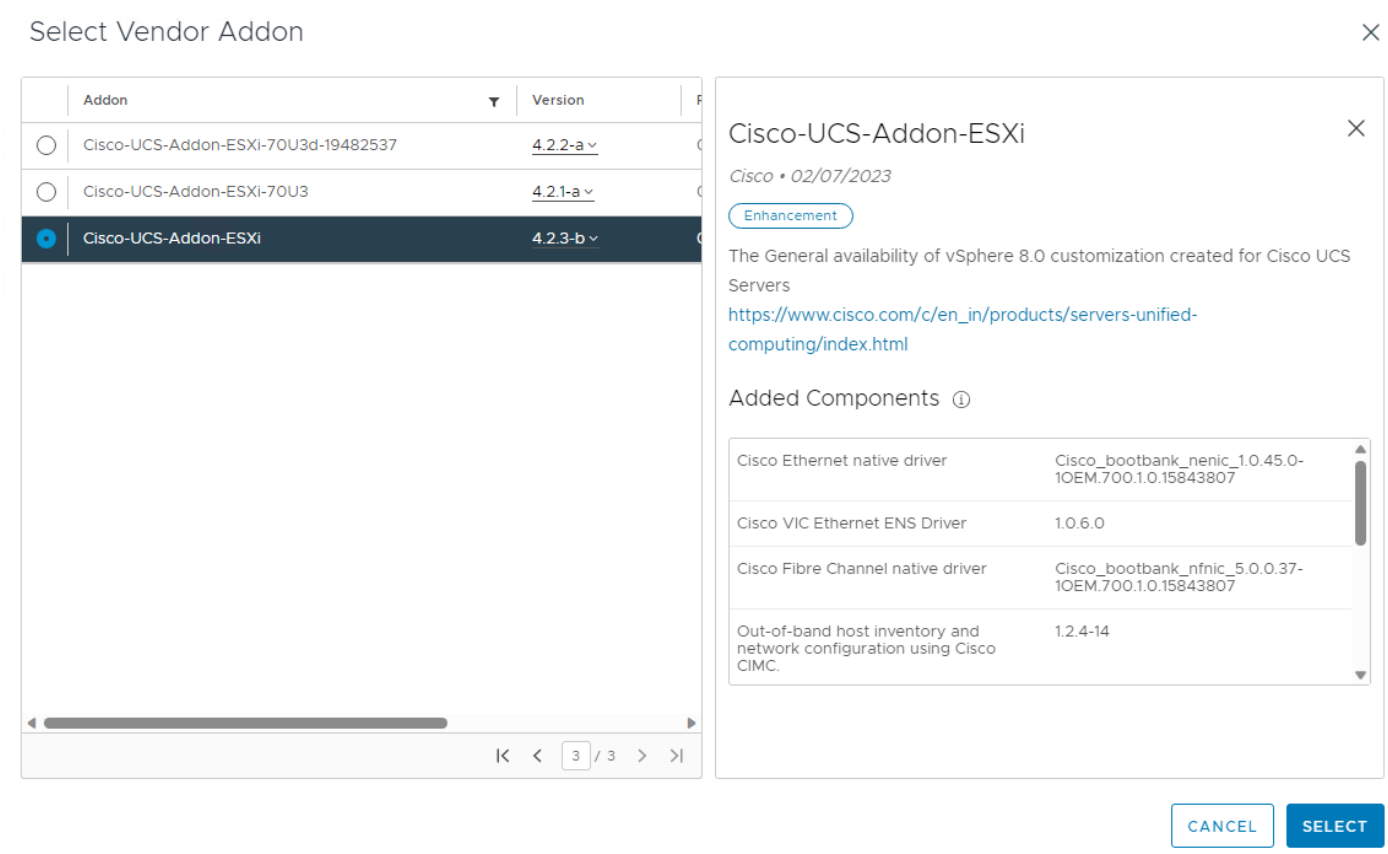
Step 7. Under Inventory, select the FlexPod-Management cluster and select the **Updates** tab to the right.

Step 8. On the right side of the page, select **MANAGE WITH A SINGLE IMAGE**.

Step 9. Click **SETUP IMAGE**.

Step 10. For the ESXi Version, select the latest ESXi 8.0 version (8.0c – 21493926) at the time this document was written.

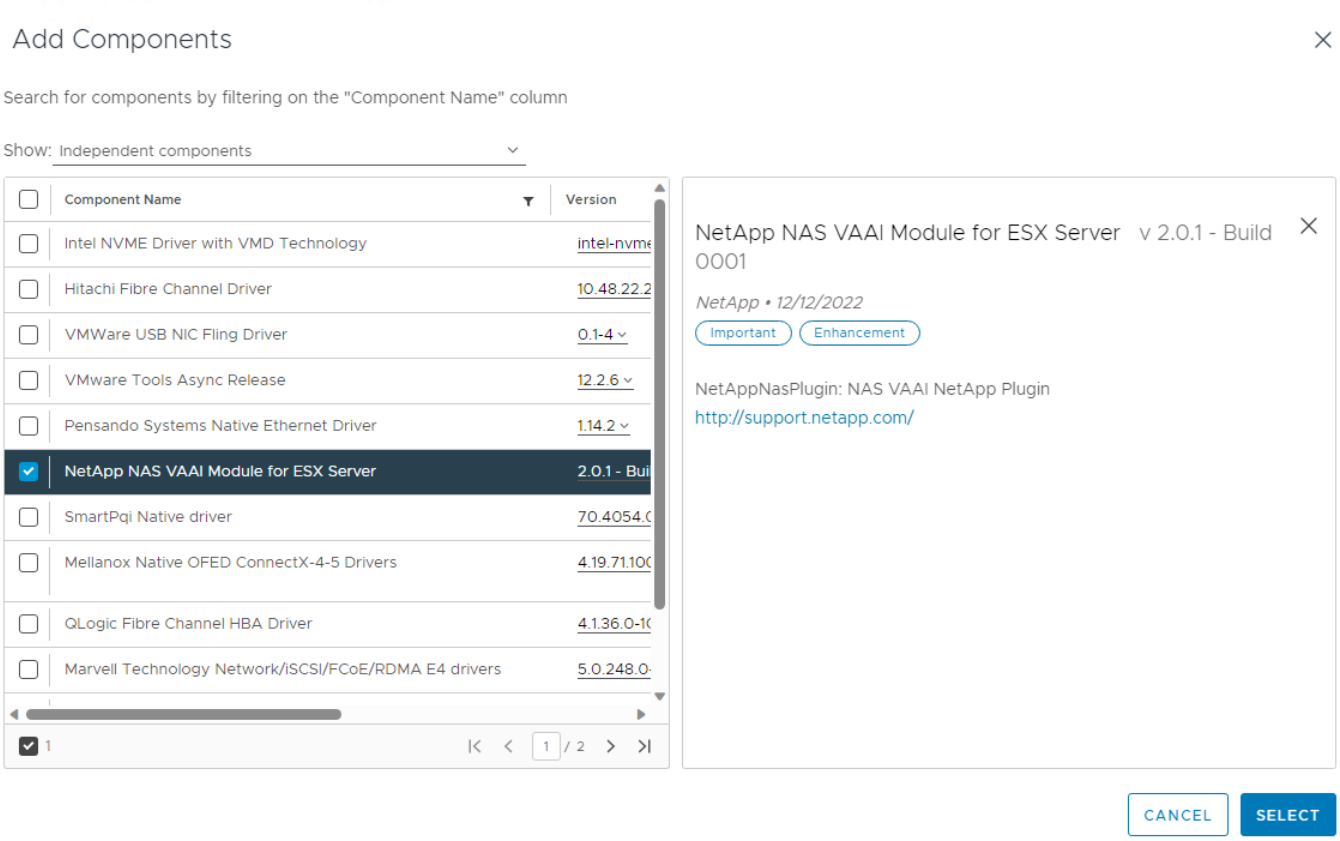
Step 11. To the right of Vendor Addon, click **SELECT**. Navigate to **Cisco-UCS-Addon-ESXi** and select version **4.2.3-b** (4.3.1-a will initially be selected). Click **SELECT**.



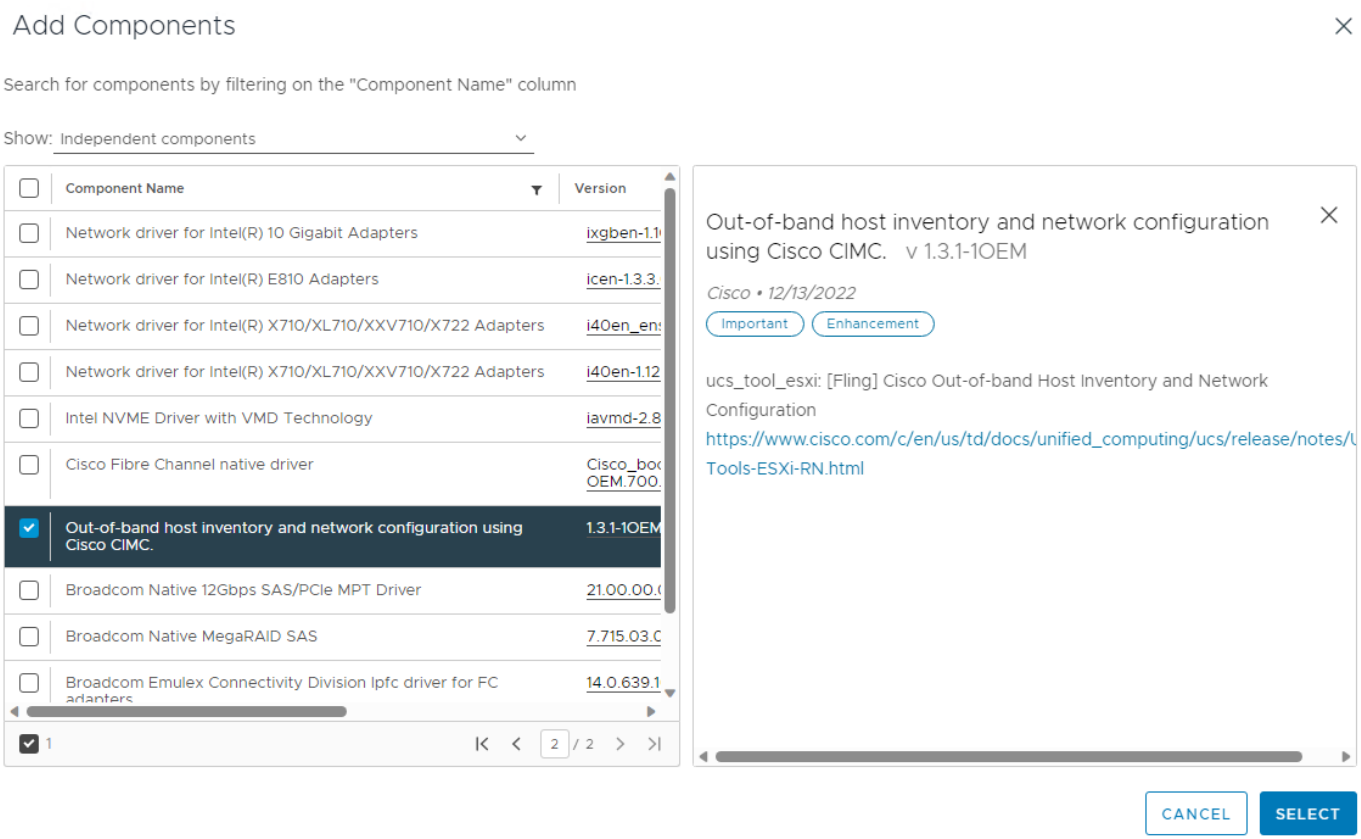
Step 12. Do not select a Firmware and Drivers Addon.

Step 13. To the right of Components, click **Show details**. Click **ADD COMPONENTS**.

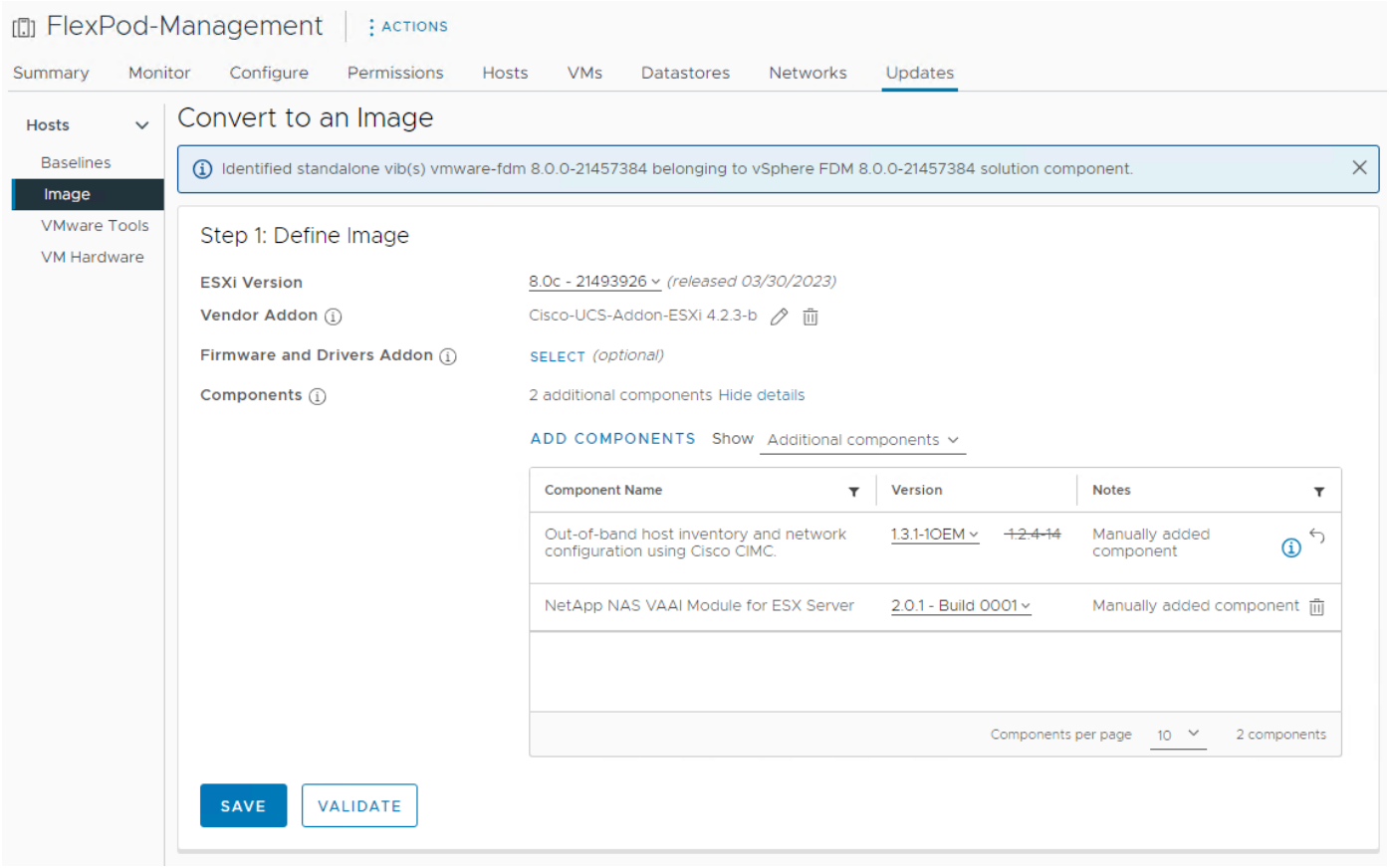
Step 14. In the Add Components window, click the checkbox to select the **NetApp NAS VAAI Module for ESX Server** and click **SELECT**.



Step 15. Click **ADD COMPONENTS**. Navigate to and use the checkbox to select **Out-of-band host inventory and network configuration using Cisco CIMC**. Click **SELECT**.

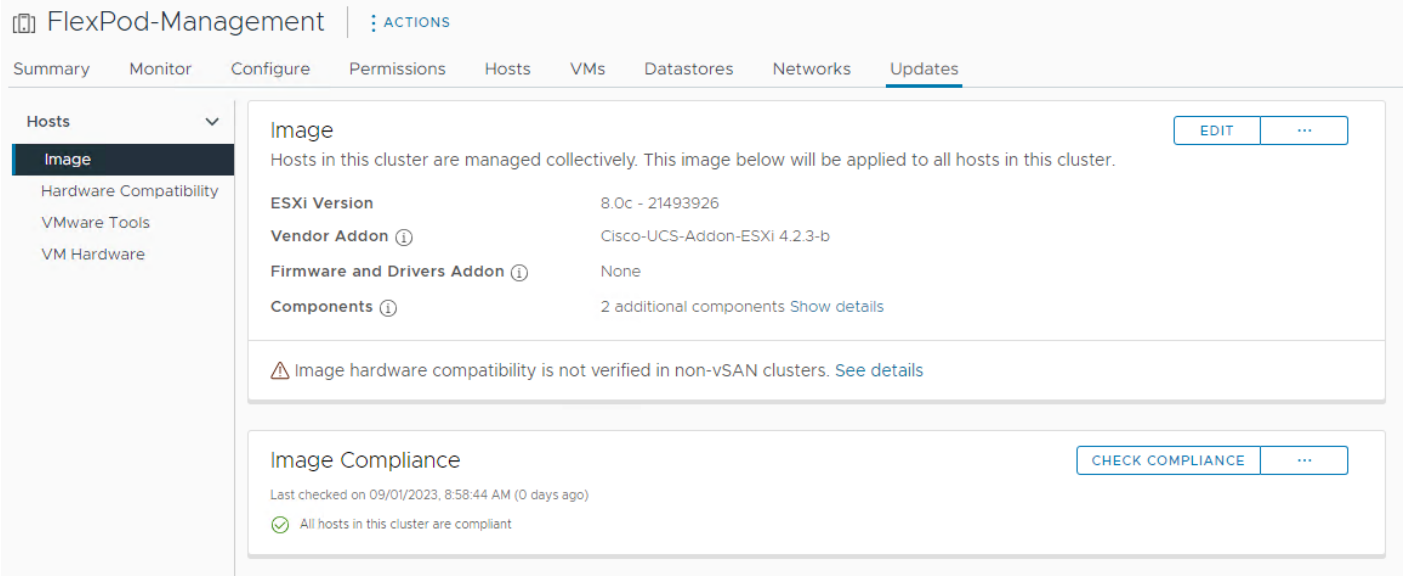


Step 16. The image selection is now complete. Click **SAVE** to save the image.



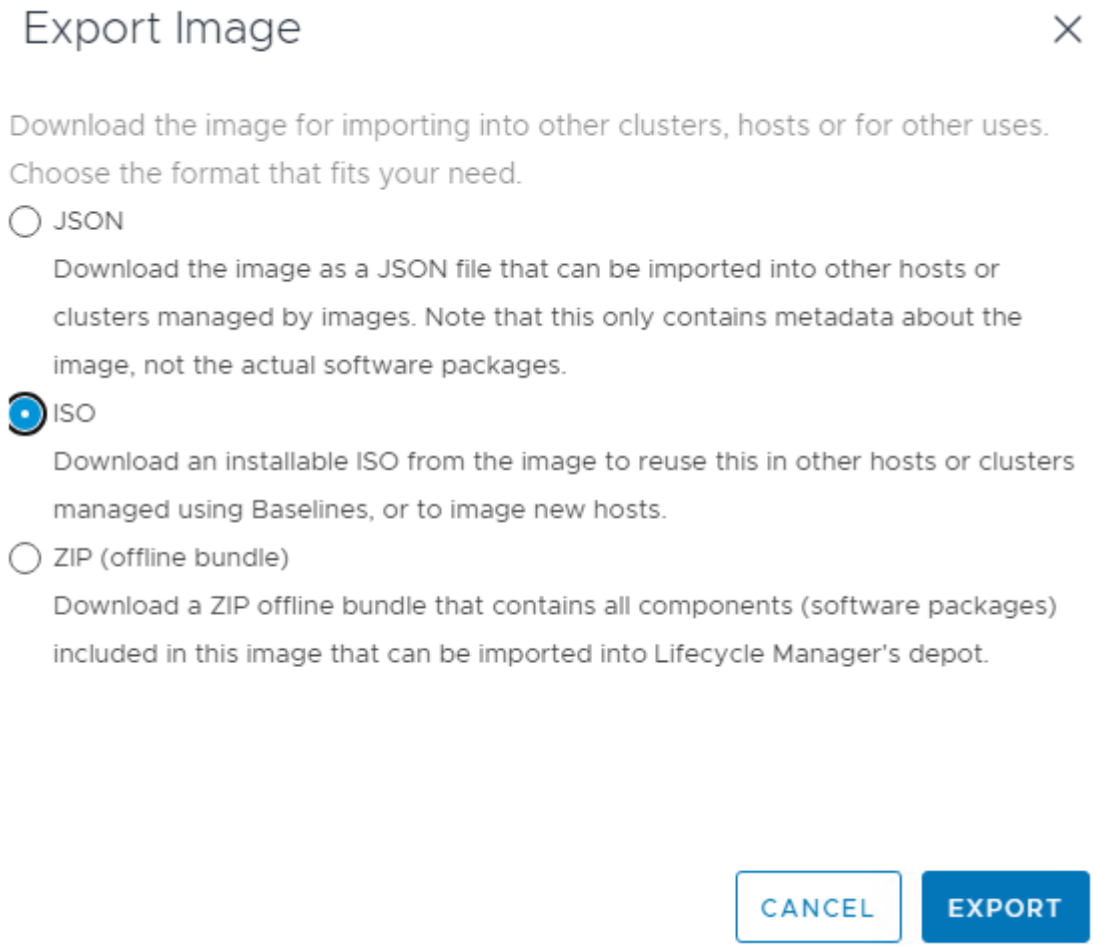
Step 17. Click **FINISH IMAGE SETUP** and then click **YES, FINISH IMAGE SETUP**.

Step 18. vCenter will complete an Image Compliance Check and all servers should be out of compliance because of the updated VMware ESXi version. You can click **REMEDIATE ALL** followed by **START REMEDIATION** and the servers will be put in Maintenance Mode, upgraded, and brought into compliance one at a time without affecting running VMs. This process will take time depending on the size of the cluster. Once all hosts have been remediated, they should all be compliant with the image.



Step 19. The image built in this process can be exported both to a bootable ISO to install or upgrade additional ESXi hosts and to a JSON file to set up other ESXi clusters. To create a bootable ISO, under Inventory select the FlexPod-Management cluster, select the **Updates** tab, and click the three dots,

, on the right. Select **Export**. In the Export Image window, select **ISO** and click **EXPORT**. The ISO will be downloaded to your downloads folder. You can rename the image to a more user-friendly name.



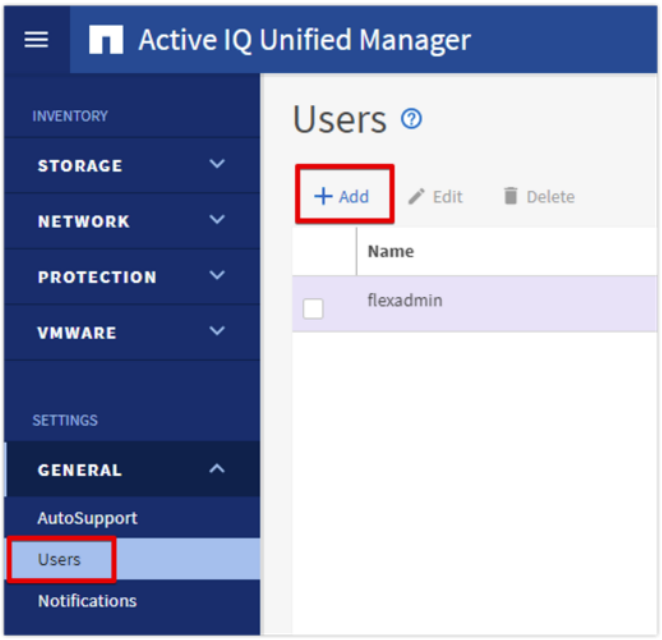
Step 20. To export a JSON file, in the Export Image window select **JSON** and click **EXPORT**. A JSON file will be downloaded to your Downloads folder. This file can be imported into another ESXi cluster to manage that cluster with this same ESXi image.

Step 21. The standalone Nexus Dashboard host can be upgraded by using the exported ISO. You will need to shutdown the Nexus Dashboard VM (by right-clicking the VM and selecting **Power > Shut Down Guest OS**) and then put the Nexus Dashboard ESXi host in Maintenance Mode once the Nexus Dashboard VM has shutdown. Go to **Cisco USC Manager** and launch a **KVM Console** for this host. Use the **Virtual Media** tab to map the downloaded ISO and the use the **Power** tab to **Reset System**. Once the ESXi Installer has booted follow the prompts to upgrade the host. Once the upgrade process is complete, **reboot** the host. When the host has reconnected to vCenter, **Exit Maintenance Mode**, and **Power On the Nexus Dashboard VM**.

Active IQ Unified Manager User Configuration

Procedure 1. Add Local Users to Active IQ Unified Manager

Step 1. Navigate to **Settings** > **General** section and click **Users**.



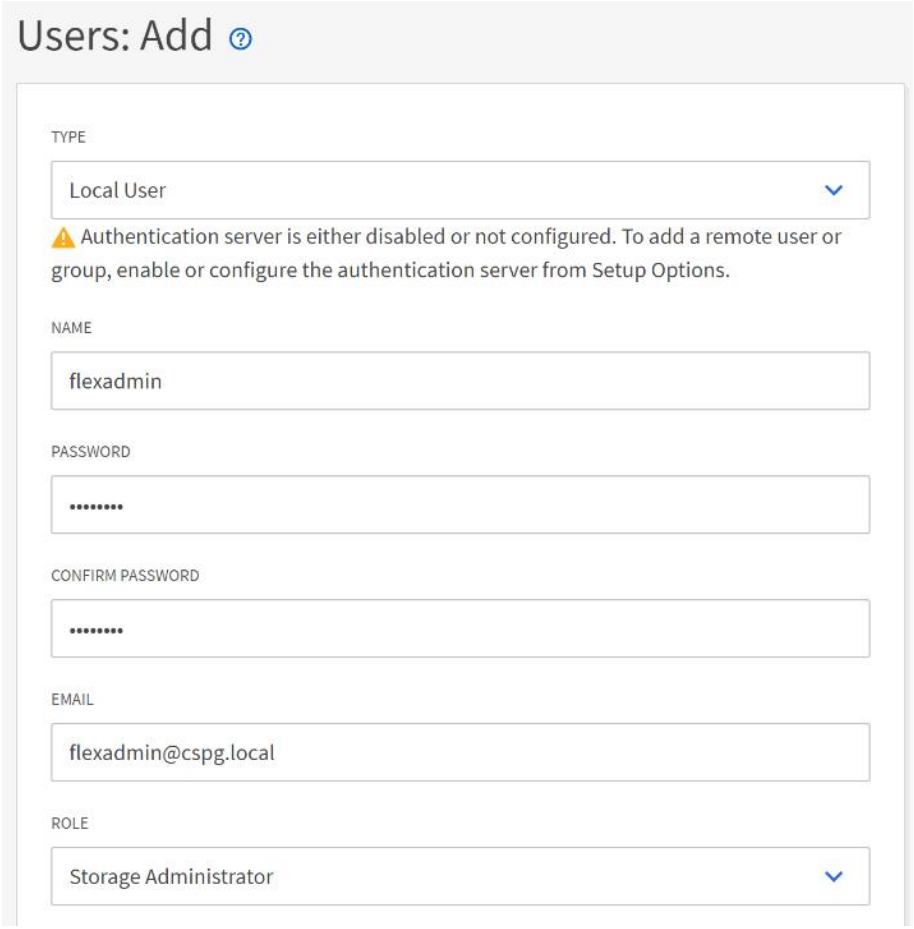
Step 2. Click **+ Add** and complete the requested information:

a. Select Local User for the Type.

b. Enter a username and password.

c. Add the user's email address.

d. Select the appropriate role for the new user.



Step 3. Click **SAVE** to finish adding the new user.

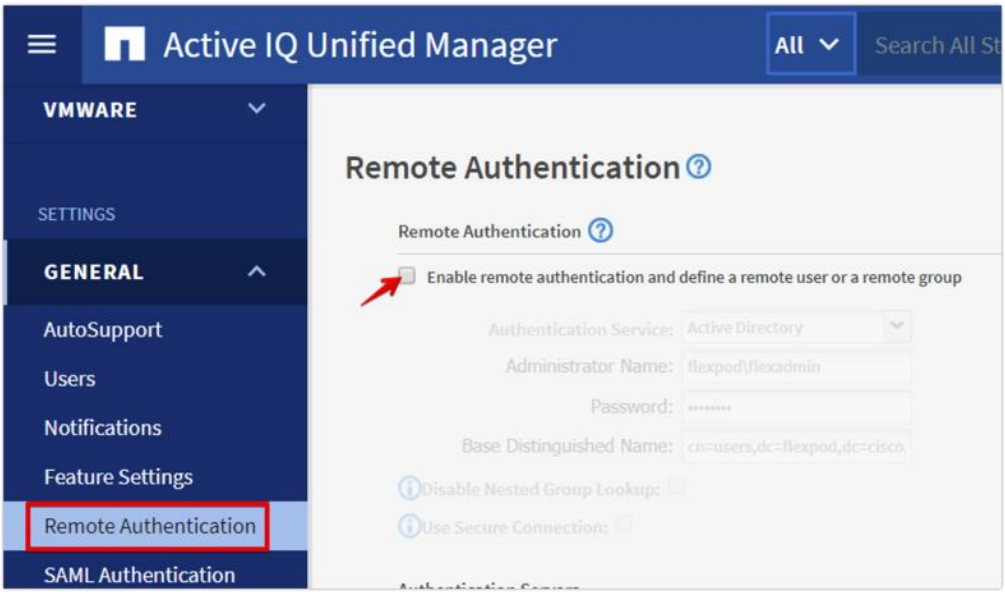
Procedure 2. Configure Remote Authentication

Simplify user management and authentication for Active IQ Unified Manager by integrating it with Microsoft Active Directory.

Note: You must be logged on as the maintenance user created during the installation or another user with Application Administrator privileges to configure remote authentication.

Step 1. Navigate to **General** and select **Remote Authentication**.

Step 2. Select the option to enable Remote Authentication and define a remote user or remote group.



Step 3. Select **Active Directory** from the authentication service list.

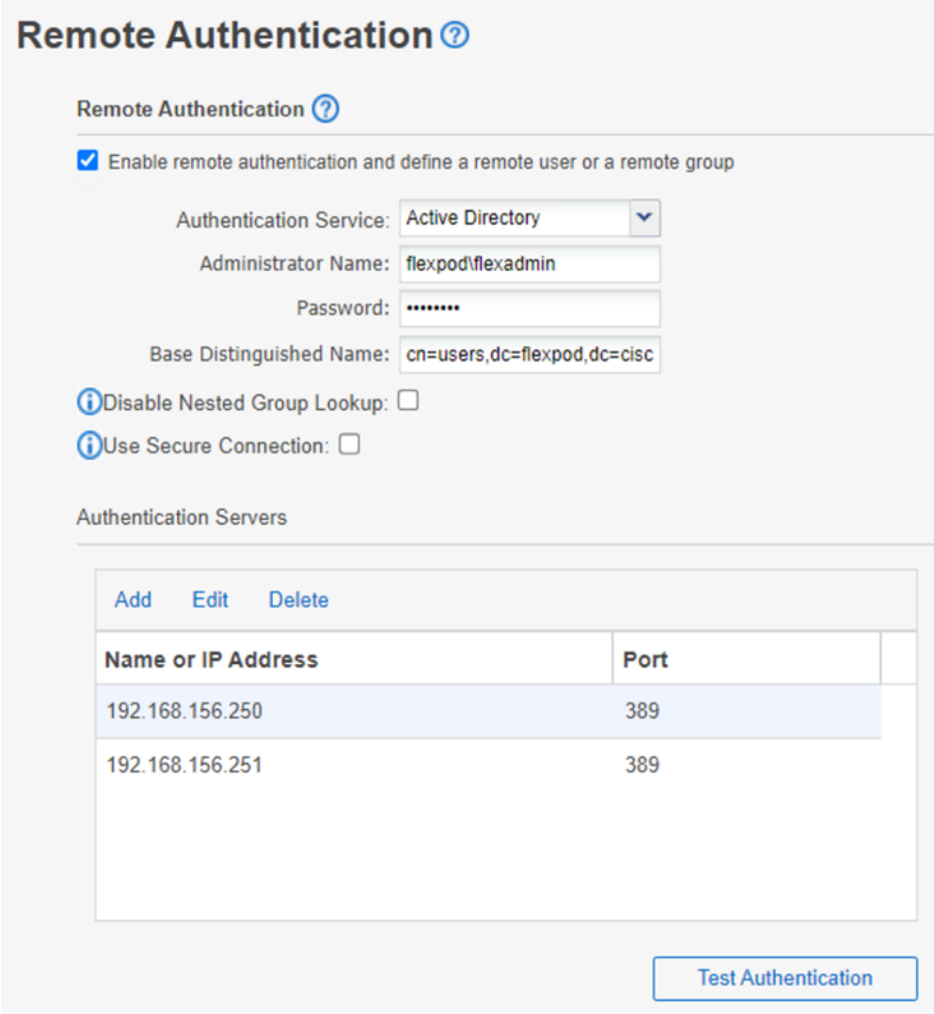
Step 4. Enter the Active Directory service account name and password. The account name can be in the format of domain\user or user@domain.

Step 5. Enter the base DN where your Active Directory users reside.

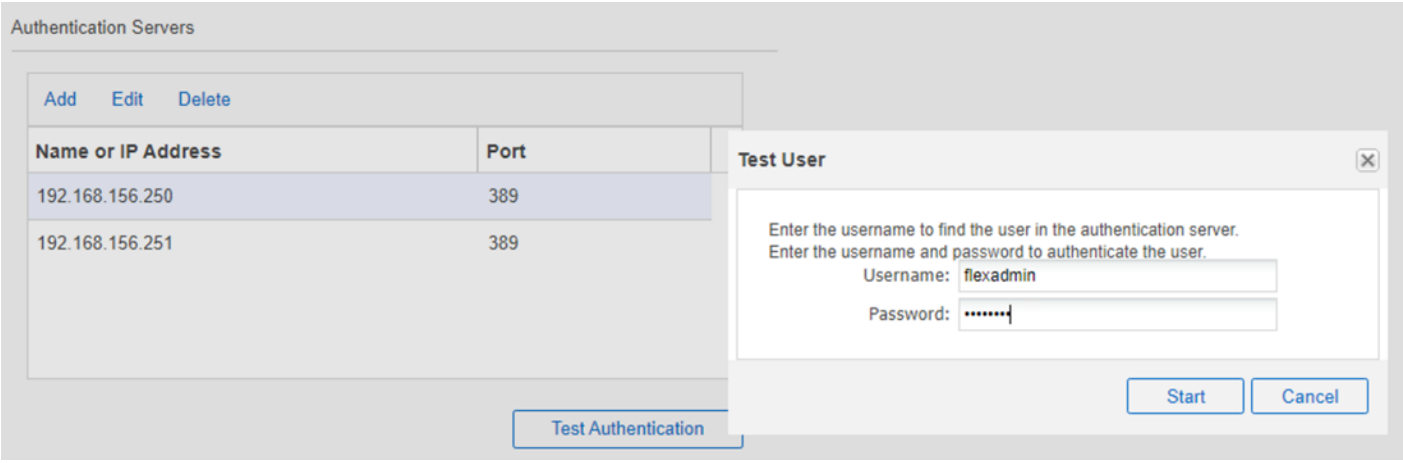
Step 6. If Active Directory LDAP communications are protected via SSL enable the **Use Secure Connection** option.

Step 7. Add one or more Active Directory domain controllers by clicking **Add** and entering the IP or FQDN of the domain controller.

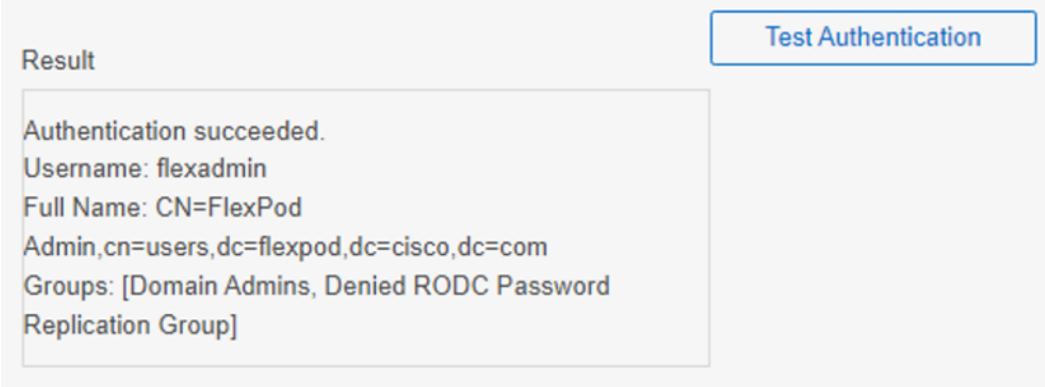
Step 8. Click **Save** to enable the configuration.



Step 9. Click **Test Authentication** and enter an Active Directory username and password to test authentication with the Active Directory authentication servers. Click **Start**.



A result message displays indicating authentication was successful:



Procedure 3. Add a Remote User to Active IQ Unified Manager

Step 1. Navigate to the **General** section and select **Users**.

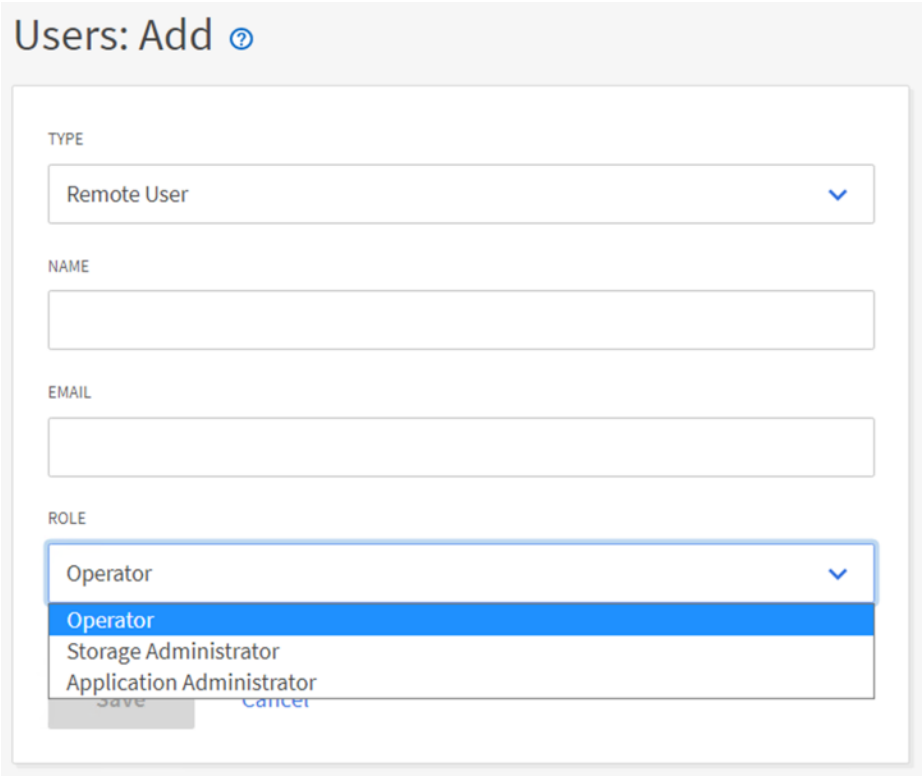
Step 2. Click **Add** and select **Remote User** from the Type drop-down list.

Step 3. Enter the following information into the form:

a. The username of the Active Directory user.

b. Email address of the user.

c. Select the appropriate role (Operator / Storage Administrator / Application Administrator) for the user.



Step 4. Click **Save** to add the remote user to Active IQ Unified Manager.

Note: Please review the Active IQ Unified Manager documentation page for the definitions of the various user roles:

https://docs.netapp.com/us-en/active-iq-unified-manager/config/reference_definitions_of_user_roles.html

Active IQ Unified Manager vCenter Configuration

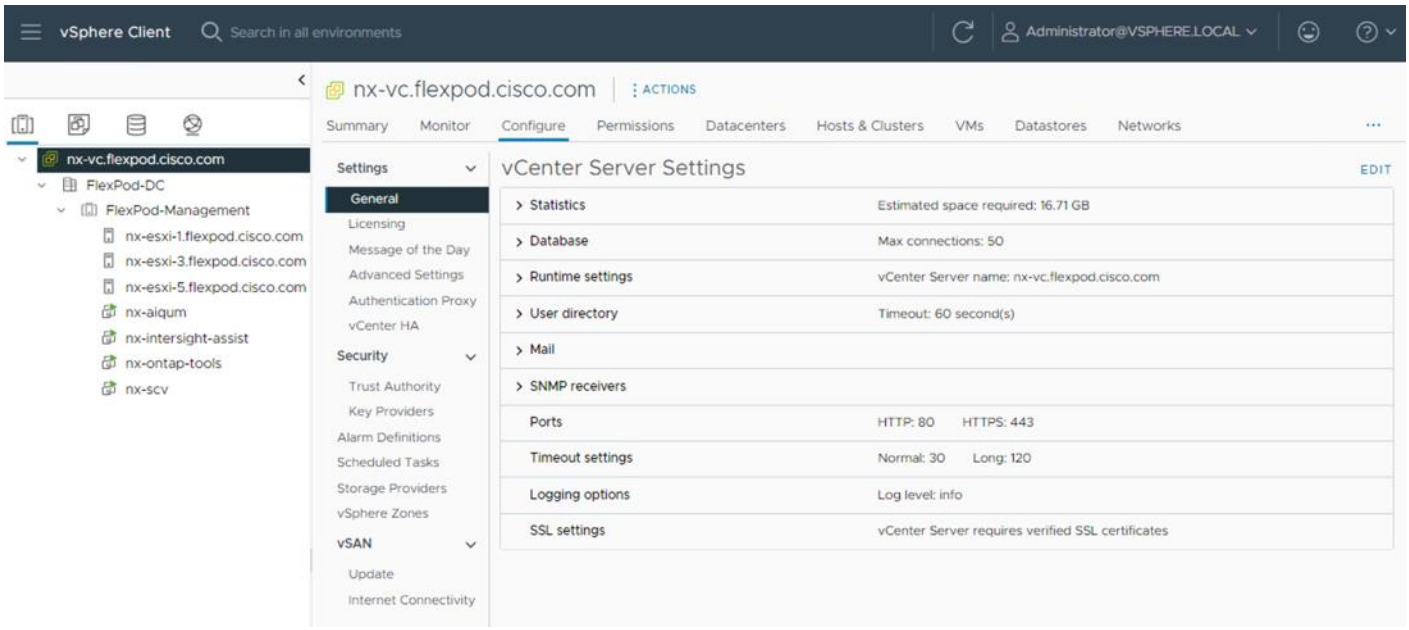
Active IQ Unified Manager provides visibility into vCenter and the virtual machines running inside the datastores backed by ONTAP storage. Virtual machines and storage are monitored to enable quick identification of performance issues within the various components of the virtual infrastructure stack.

Note: Before adding vCenter into Active IQ Unified Manager, the log level of the vCenter server must be changed.

Procedure 1. Configure Active IQ Unified Manager vCenter

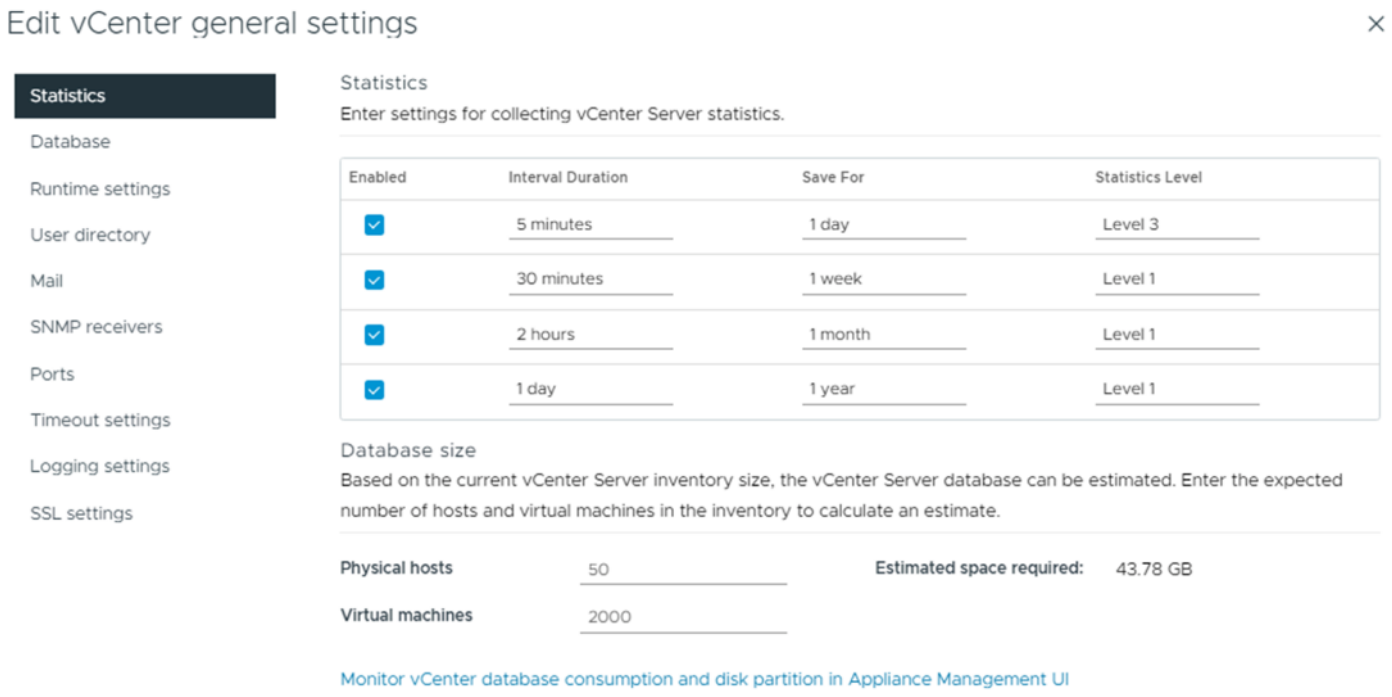
Step 1. In the vSphere client navigate to **Menu** > **VMs and Templates** and select the vCenter instance from the top of the object tree.

Step 2. Click the **Configure** tab, expand **Settings**, and select **General**.



Step 3. Click **EDIT**.

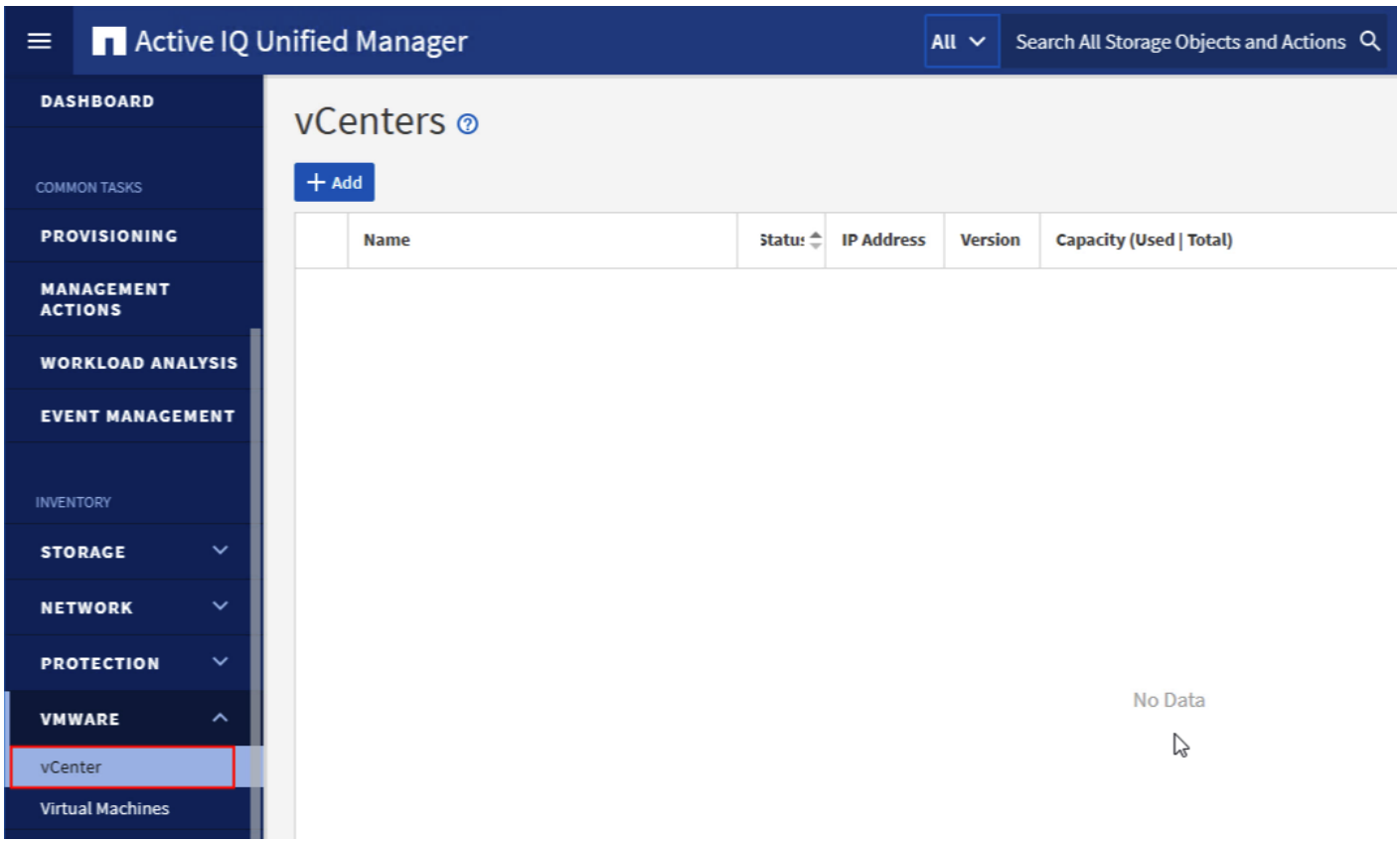
Step 4. In the pop-up window under Statistics, locate the 5 minutes Interval Duration row and change the setting to **Level 3** under the Statistics Level column.



Step 5. Click **SAVE**.

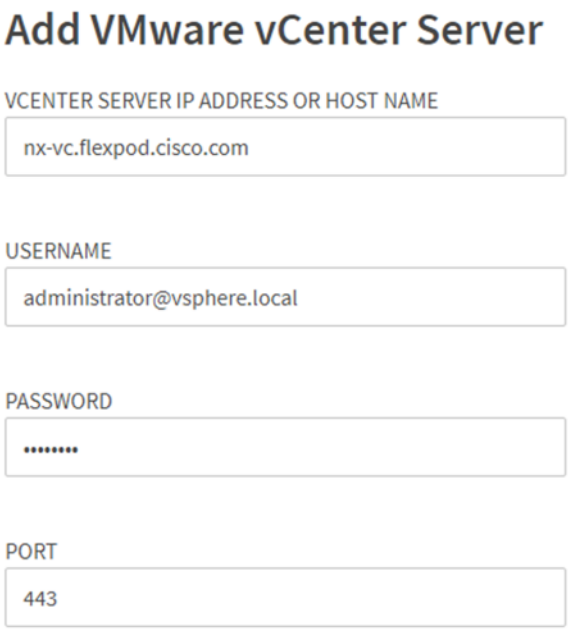
Step 6. Switch to the Active IQ Unified Manager and navigate to the **VMware** section located under **Inventory**.

Step 7. Expand VMware and select **vCenter**.

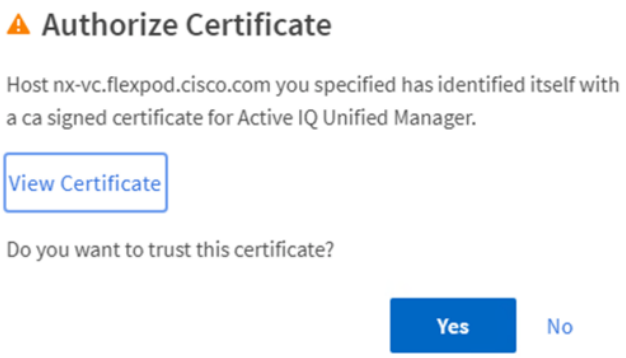


Step 8. Click **Add**.

Step 9. Enter the VMware vCenter server details and click **Save**.



Step 10. A dialog box will appear asking to authorize the certificate. Click **Yes** to accept the certificate and add the vCenter server.



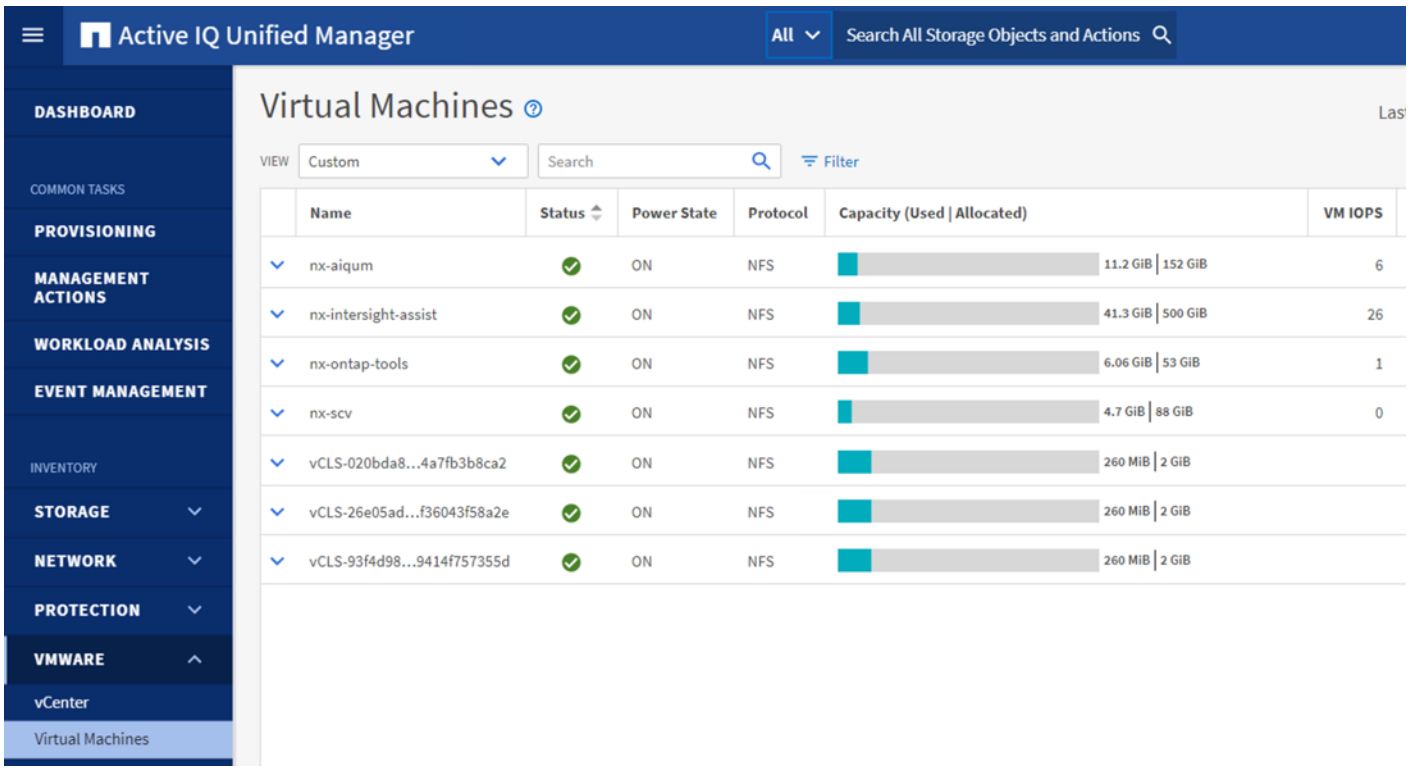
Note: It may take up to 15 minutes to discover vCenter. Performance data can take up to an hour to become available.

Procedure 2. View Virtual Machine Inventory

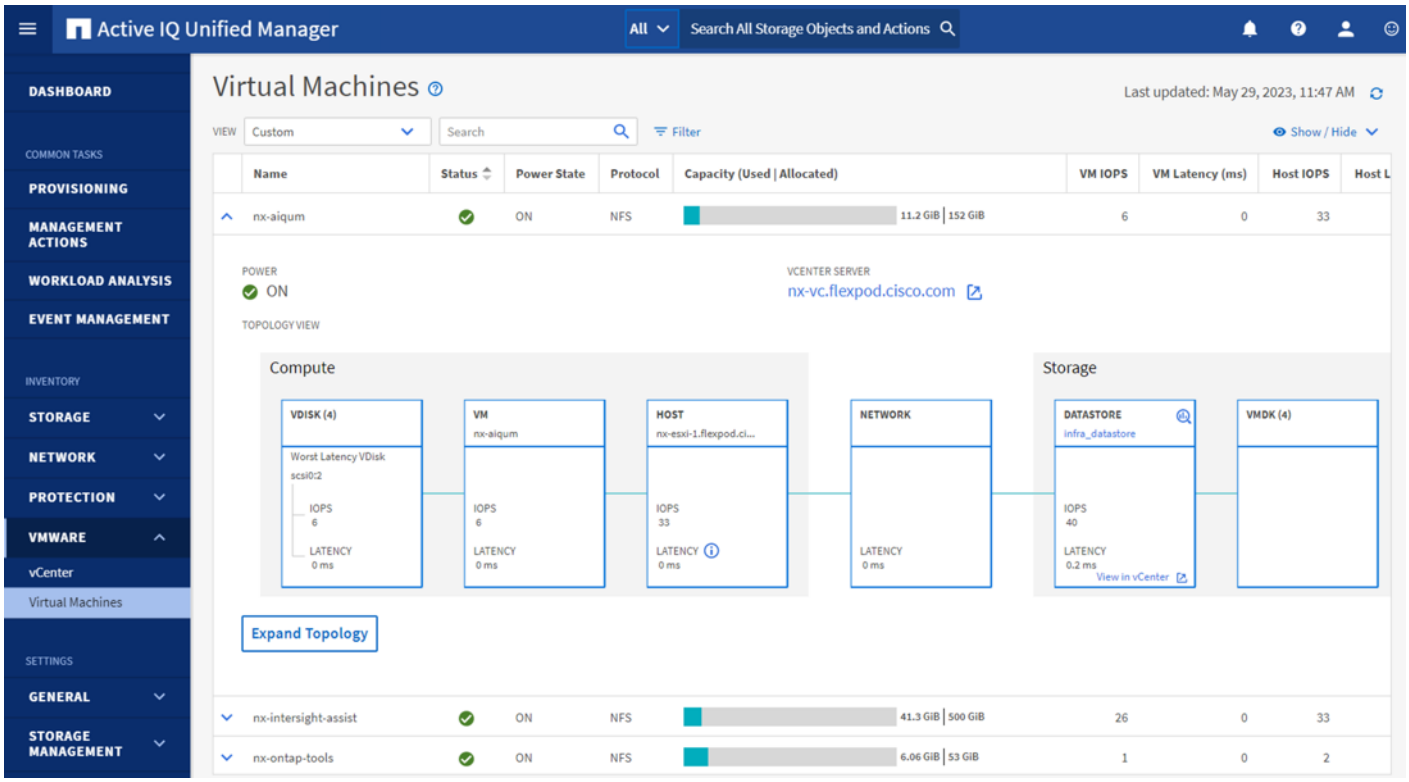
The virtual machine inventory is automatically added to Active IQ Unified Manager during discovery of the vCenter server. Virtual machines can be viewed in a hierarchical display detailing storage capacity, IOPS and latency for each component in the virtual infrastructure to troubleshoot the source of any performance related issues.

Step 1. Log into **NetApp Active IQ Unified Manager**.

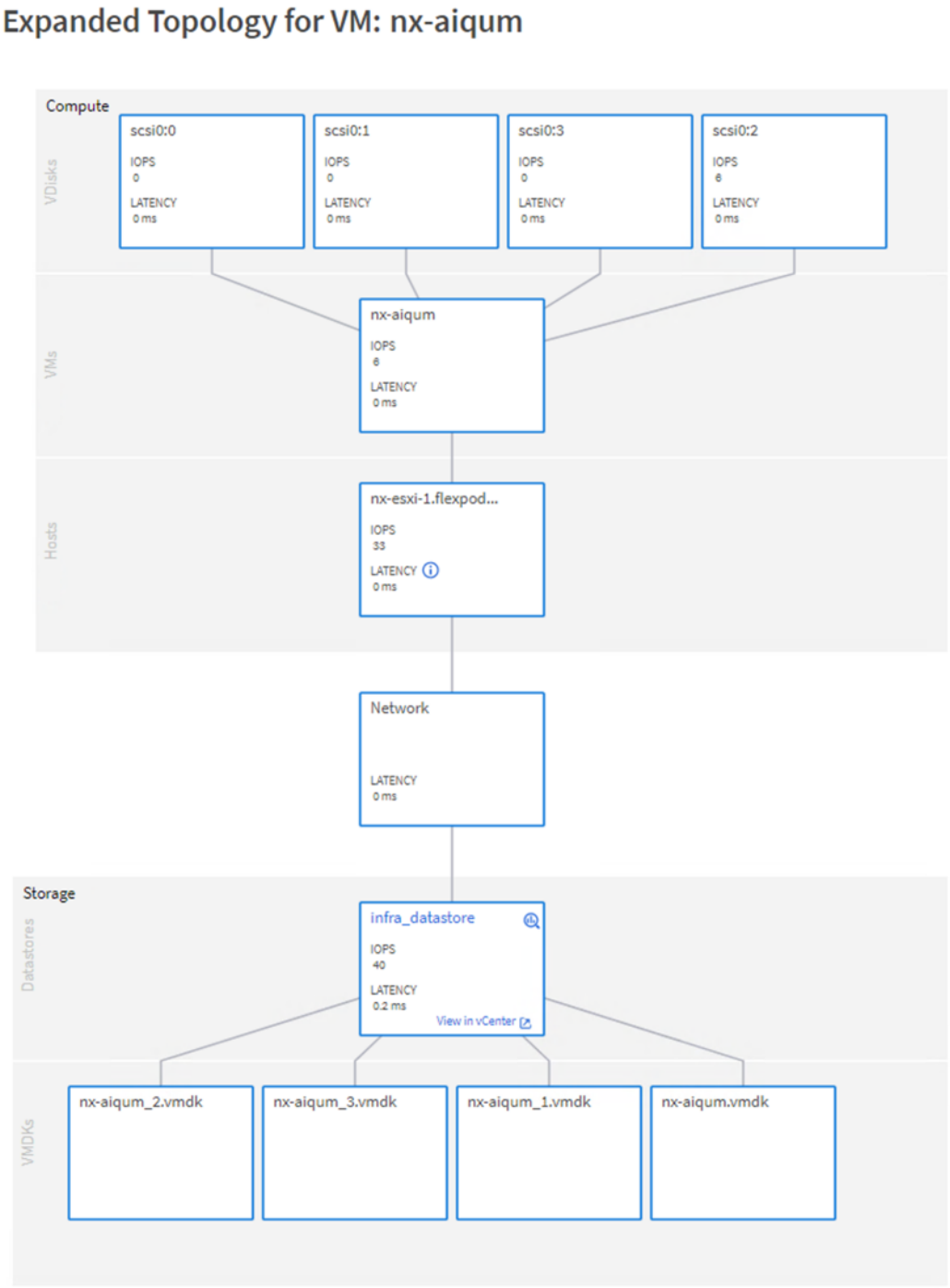
Step 2. Navigate to the VMware section located under Inventory, expand the section, and click **Virtual Machines**.



Step 3. Select a VM and click the blue caret to expose the topology view. Review the compute, network, and storage components and their associated IOPS and latency statistics.



Step 4. Click **Expand Topology** to see the entire hierarchy of the virtual machine and its virtual disks as it is connected through the virtual infrastructure stack. The VM components are mapped from vSphere and compute through the network to the storage.



NetApp Active IQ

NetApp Active IQ is a data-driven service that leverages artificial intelligence and machine learning to provide analytics and actionable intelligence for ONTAP storage systems. Active IQ uses AutoSupport data to deliver

proactive guidance and best practices recommendations to optimize storage performance and minimize risk. Additional Active IQ documentation is available on the Active IQ Documentation Resources web page.

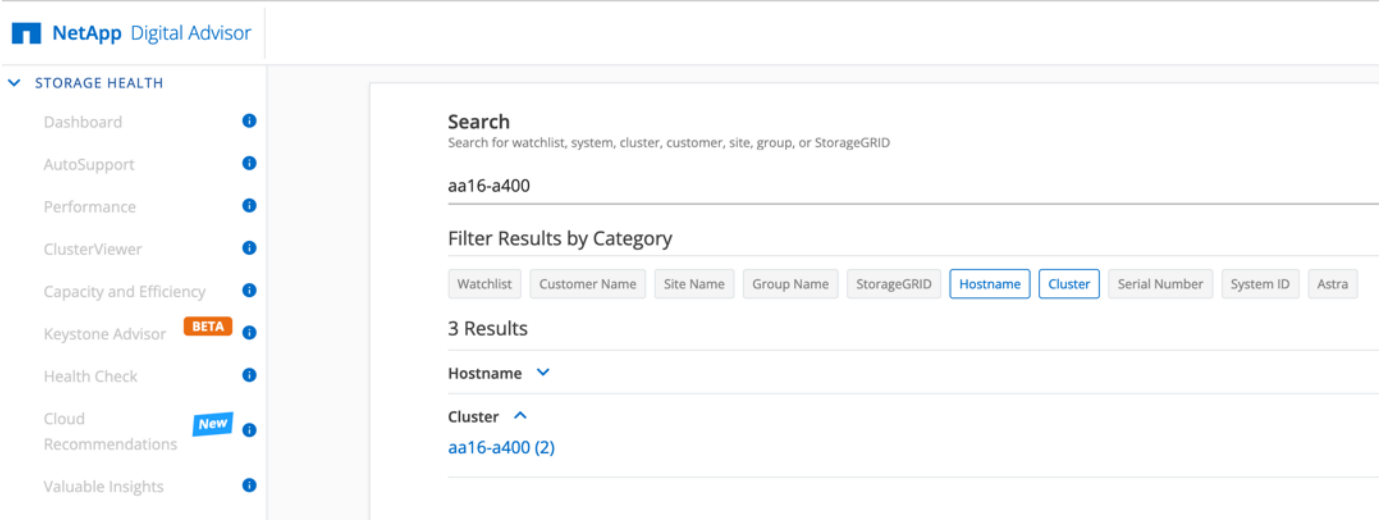
Note: Active IQ is automatically enabled when AutoSupport is configured on the NetApp ONTAP storage controllers.

Procedure 1. Configure NetApp Active IQ

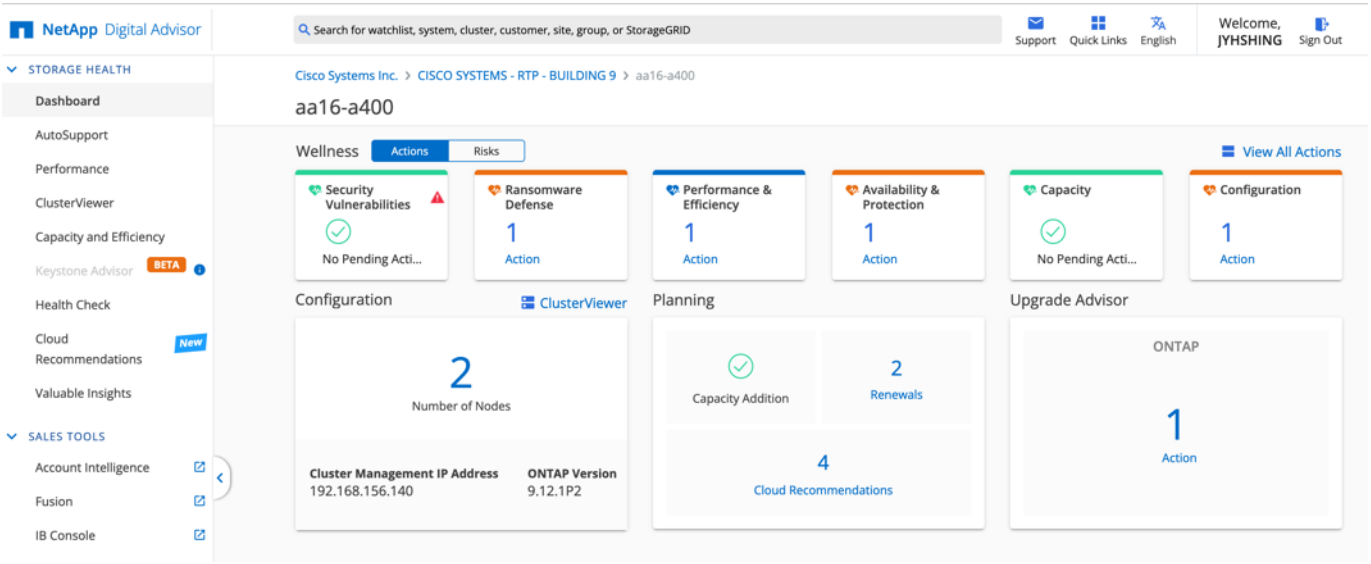
Step 1. Navigate to the Active IQ portal at https://activeiq.netapp.com/.

Step 2. Login with NetApp support account ID.

Step 3. At the Welcome screen enter the cluster name or one of controller serial numbers in the search box. Active IQ will automatically begin searching for the cluster and display results below:



Step 4. Click the <**cluster name**> (for example, aa02-a800) to launch the dashboard for this cluster.



Procedure 2. Add a Watchlist to the Digital Advisor Dashboard

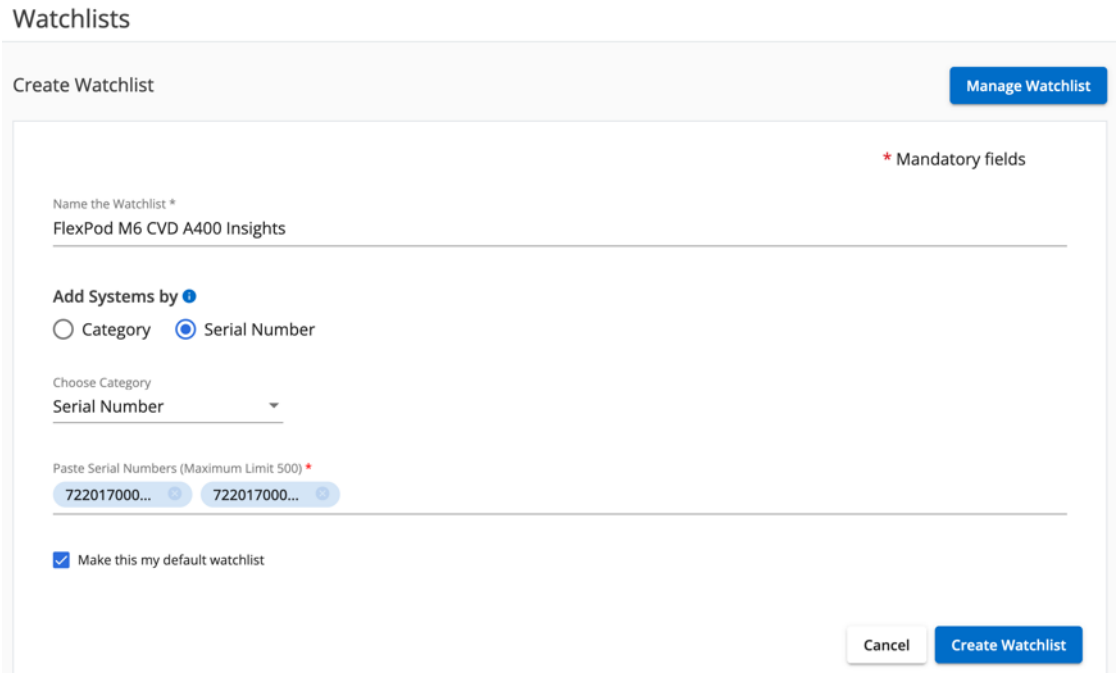
The Active IQ Digital advisor provides a summary dashboard and system wellness score based on the health and risks that Active IQ has identified. The dashboard provides a quick way to identify and get proactive recommendations on how to mitigate risks in the storage environment including links to technical reports and mitigation plans. This procedure details the steps to create a watchlist and launch Digital advisor dashboard for the watchlist.

Step 1. Click **GENERAL > Watchlists**.

Step 2. Enter a name for the watchlist.

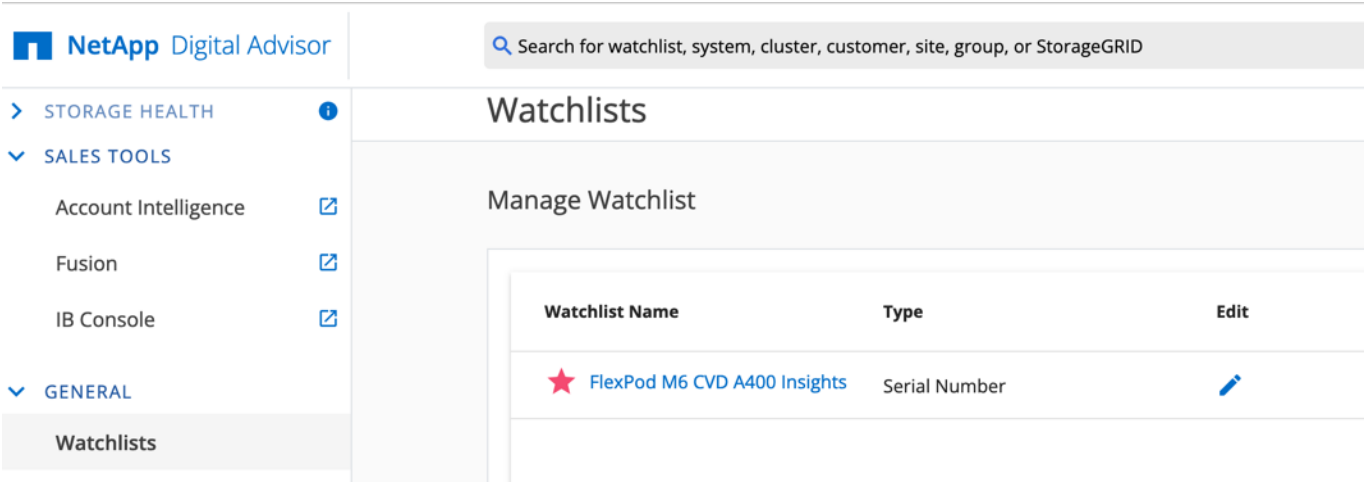
Step 3. Select the radio button to add systems by serial number and enter the cluster serial numbers to the watchlist.

Step 4. Check the box for **Make this my default watchlist** if desired.



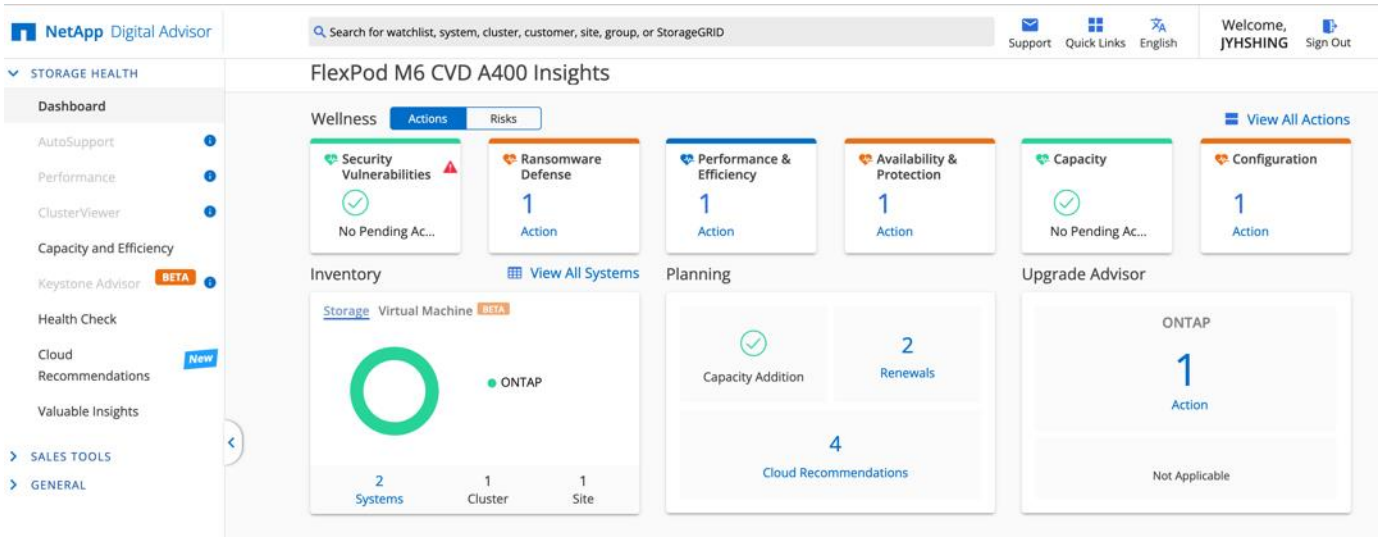
Step 5. Click **Create Watchlist**.

Step 6. Click **GENERAL** > **Watchlists** in the left menu bar again to list the watchlist created.

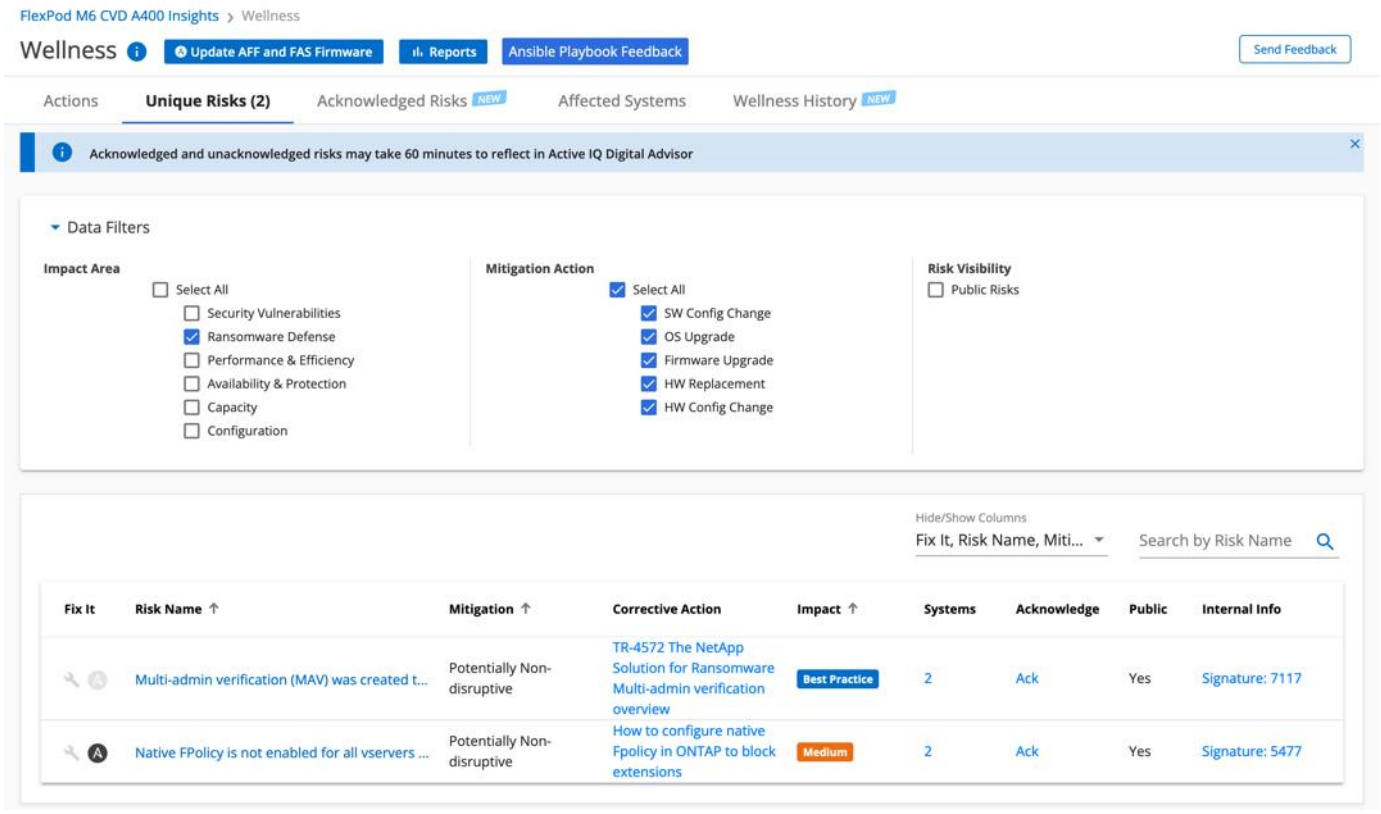


Step 7. Click the blue Watchlist Name to launch the specific watchlist in **Digital Advisor Dashboard**.

Step 8. Review the dashboard to learn more about any recommended actions or risks.



Step 9. Switch between the **Actions** and **Risks** tabs to view the risks by category or a list of all risks with their impact and links to corrective actions.



Step 10. Click the links in the Corrective Action column to read the best practice information or knowledge base article about how to remediate the risk.

Note: Additional tutorials and video walk-throughs of Active IQ features can be viewed here: https://docs.netapp.com/us-en/active-iq/

FlexPod Backups

Procedure 1. Cisco Nexus and MDS Backups

The configuration of the Cisco Nexus 9000 and Cisco MDS 9132T switches can be backed up manually at any time with the copy command, but automated backups can be enabled using the NX-OS feature scheduler.

An example of setting up automated configuration backups of one of the NX-OS switches is shown below:

```
config t
feature scheduler
scheduler logfile size 1024
scheduler job name backup-cfg
copy running-config tftp://<server-ip>/$(SWITCHNAME)-cfg.$(TIMESTAMP) vrf management
exit
scheduler schedule name daily
job name backup-cfg
time daily 2:00
end
```

Note: Using “vrf management” in the copy command is only needed when Mgmt0 interface is part of VRF management. “vrf management is not needed in Cisco MDS switches.

Step 1. Verify the scheduler job has been correctly setup using following command(s):

```
show scheduler job
Job Name: backup-cfg
--------------------
copy running-config tftp://10.1.156.150/$(SWITCHNAME)-cfg.$(TIMESTAMP) vrf management

==============================================================================


show scheduler schedule
Schedule Name       : daily
---------------------------
User Name           : admin
Schedule Type       : Run every day at 2 Hrs 0 Mins
Last Execution Time : Yet to be executed
-----------------------------------------------
     Job Name            Last Execution Status
-----------------------------------------------
backup-cfg                              -NA-
==============================================================================
```

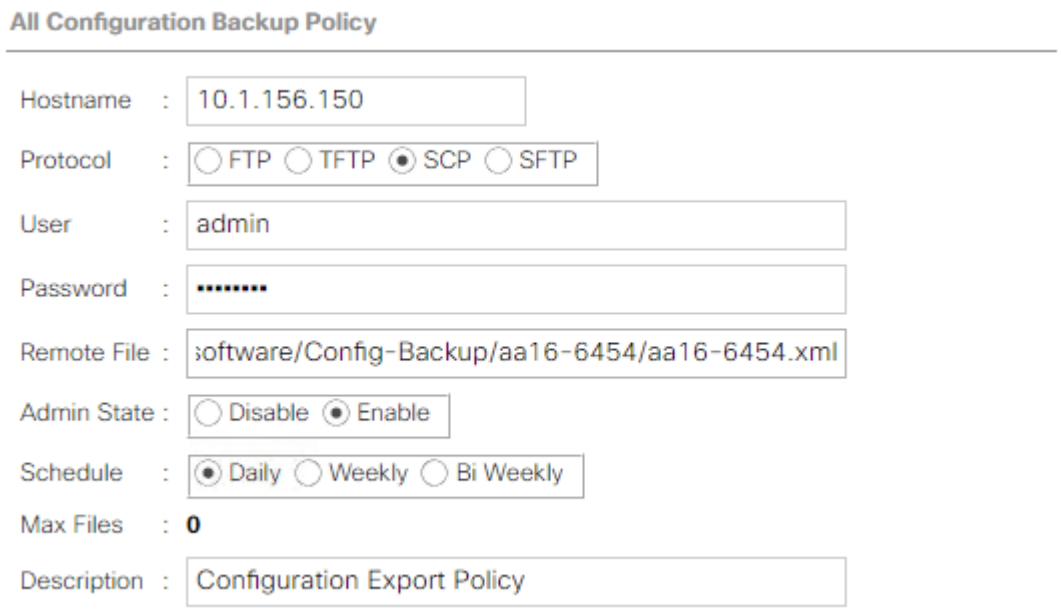
The documentation for the feature scheduler can be found here: https://www.cisco.com/c/en/us/td/docs/dcn/nx-os/nexus9000/102x/configuration/system-management/cisco-nexus-9000-series-nx-os-system-management-configuration-guide-102x/m-configuring-the-scheduler-10x.html

Procedure 2. Cisco UCS Manager Backups

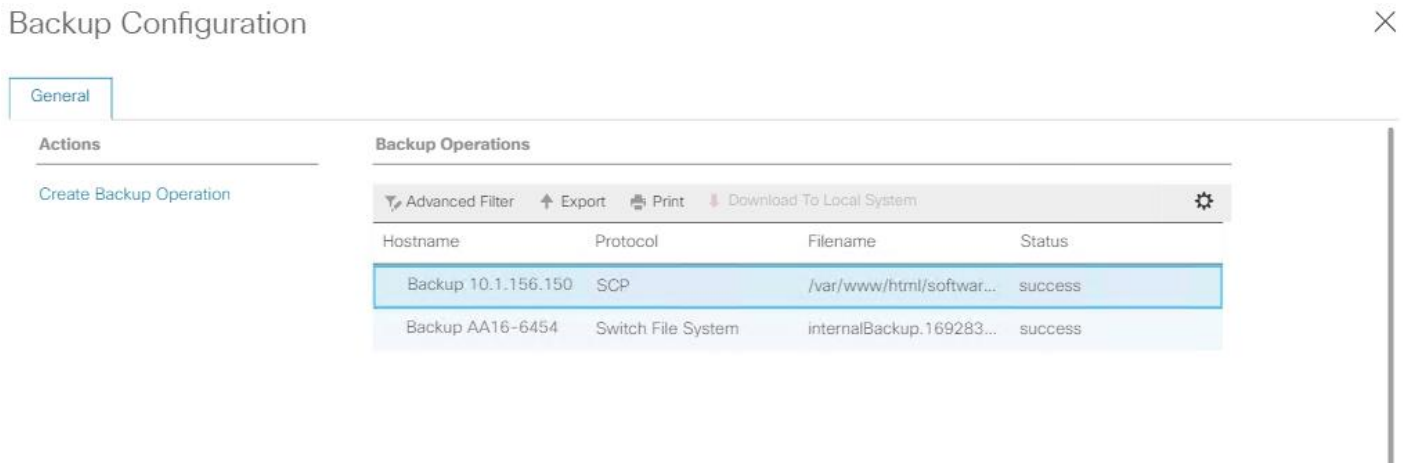
The configuration of the Cisco UCS Manager can be backed up manually at any time with the copy command, but automated backups can also be enabled.

Step 1. Log into **Cisco UCS Manager** and select **Admin** > **All** > **Policy Backup & Export**.

Step 2. Under All Configuration Backup Policy, fill in the information for the appropriate backup type. Note that you will need to Enable the Admin State before you can fill in the Remote File.



Step 3. Click the **General** tab and select **Backup Configuration**. In this window, after a few minutes, you can see the result of the scheduled backup.



Note: For these backups to complete correctly, the Password Encryption Key must be set under **Admin** > **All** > **User Management** > **Locally Authenticated Users**.

Procedure 3. NetApp ONTAP Configuration Backup

The configuration backup files of the NetApp ONTAP cluster and nodes are automatically created according to the following schedules:

- Every 8 hours

- Daily
- Weekly

At each of these times, a node configuration backup file is created on each healthy node in the cluster. All of these node configuration backup files are then collected in a single cluster configuration backup file along with the replicated cluster configuration and saved on one or more nodes in the cluster.

An example of viewing the ONTAP cluster configuration backup files is shown below:

```
AA16-A400::> set advanced
Warning: These advanced commands are potentially dangerous; use them only when directed to do so by NetApp personnel.
Do you want to continue? {y|n}: y
AA16-A400::*> row 0
  (rows)
AA16-A400::*> system configuration backup show
Node        Backup Name                                 Time                Size
---------   ----------------------------------------- ------------------ -----
AA16-A400-01  AA16-A400.8hour.2023-08-31.18_15_00.7z 08/31 18:15:00     34.60MB
AA16-A400-01  AA16-A400.8hour.2023-09-01.02_15_00.7z 09/01 02:15:00     35.65MB
AA16-A400-01  AA16-A400.8hour.2023-09-01.10_15_00.7z 09/01 10:15:00     36.05MB
AA16-A400-01  AA16-A400.daily.2023-08-31.00_10_01.7z 08/31 00:10:01     34.87MB
AA16-A400-01  AA16-A400.daily.2023-09-01.00_10_01.7z 09/01 00:10:01     35.09MB
AA16-A400-01  AA16-A400.weekly.2023-08-27.00_15_00.7z 08/27 00:15:00    23.50MB
AA16-A400-02  AA16-A400.8hour.2023-09-01.02_15_00.7z 09/01 02:15:00     35.65MB
AA16-A400-02  AA16-A400.8hour.2023-09-01.10_15_00.7z 09/01 10:15:00     36.05MB
AA16-A400-02  AA16-A400.daily.2023-08-30.00_10_00.7z 08/30 00:10:00     32.69MB
AA16-A400-02  AA16-A400.daily.2023-08-31.00_10_01.7z 08/31 00:10:01     34.87MB
AA16-A400-02  AA16-A400.daily.2023-09-01.00_10_01.7z 09/01 00:10:01     35.09MB
AA16-A400-02  AA16-A400.weekly.2023-08-27.00_15_00.7z 08/27 00:15:00    23.50MB
12 entries were displayed.
AA16-A400::*> set admin
AA16-A400::>
```

You can use the system configuration backup settings commands to manage configuration backup schedules and specify a remote URL (HTTP, HTTPS, FTP, FTPS, or TFTP) where the configuration backup files will be uploaded in addition to the default locations in the cluster.

An example of setting up an automated ONTAP cluster configuration backup upload destination using TFTP is shown below:

```
AA16-A400::> set advanced
Warning: These advanced commands are potentially dangerous; use them only when directed to do so by NetApp personnel.
Do you want to continue? {y|n}: y
AA16-A400::*> system configuration backup setting modify -destination tftp://10.1.156.150/ONTAP
AA16-A400::*> system configuration backup setting show
Backup Destination URL                            Username
------------------------------------------------- -------------
tftp://10.1.156.150/ONTAP

AA16-A400::*> set admin
AA16-A400::>
```

Procedure 4. VMware VCSA Backup

Note: Basic scheduled backup for the vCenter Server Appliance is available within the native capabilities of the VCSA.

Step 1. Connect to the VCSA Console at **https://<VCSA IP>:5480**.

Step 2. Log in as **root**.

Step 3. Click **Backup** in the list to open the Backup Schedule Dialogue.

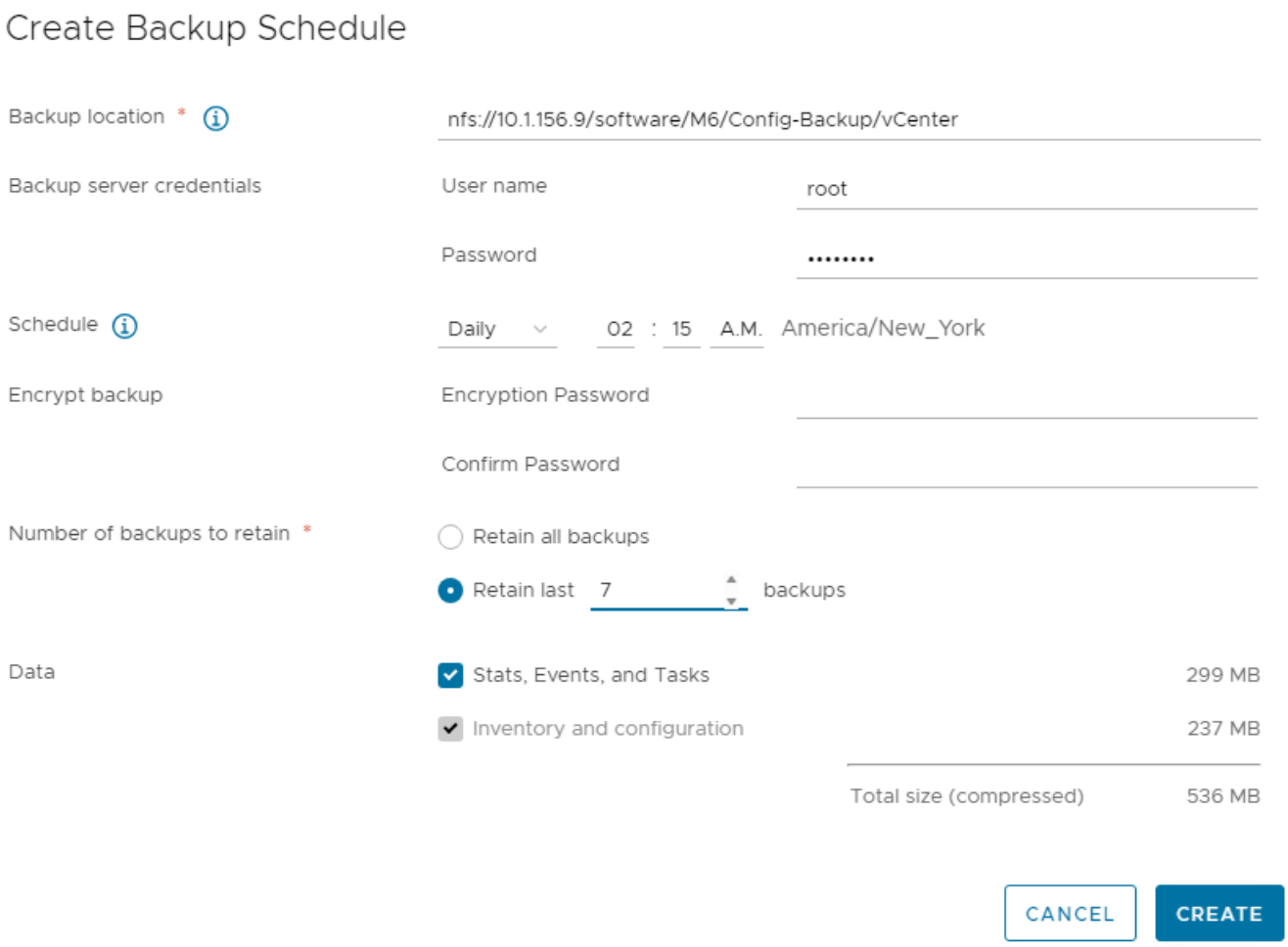
Step 4. To the right of Backup Schedule, click **CONFIGURE**.

Step 5. Specify the following:

a. The Backup location with the protocol to use (FTPS,HTTPS,SFTP,FTP,NFS,SMB, and HTTP)

b. The Username and Password. For the NFS (NFS3) example captured below, the username is root and use a random password because NFSv3 sys security was configured.

c. The Number of backups to retain.



Step 6. Click **CREATE**.

The Backup Schedule Status should now show **Activated**.

Step 7. To test the backup setup, select **BACKUP NOW** and select "**Use backup location and user name from backup schedule**" to test the backup location. Fill in the password, add an optional Description and click **START**.

Step 8. Restoration can be initiated with the backed-up files using the Restore function of the VCSA 8.0 Installer.

Glossary of Acronyms

AAA—Authentication, Authorization, and Accounting

ACP—Access-Control Policy

ACI—Cisco Application Centric Infrastructure

ACK—Acknowledge or Acknowledgement

ACL—Access-Control List

AD—Microsoft Active Directory

AFI—Address Family Identifier

AMP—Cisco Advanced Malware Protection

AP—Access Point

API—Application Programming Interface

APIC— Cisco Application Policy Infrastructure Controller (ACI)

ASA—Cisco Adaptative Security Appliance

ASM—Any-Source Multicast (PIM)

ASR—Aggregation Services Router

Auto-RP—Cisco Automatic Rendezvous Point protocol (multicast)

AVC—Application Visibility and Control

BFD—Bidirectional Forwarding Detection

BGP—Border Gateway Protocol

BMS—Building Management System

BSR—Bootstrap Router (multicast)

BYOD—Bring Your Own Device

CAPWAP—Control and Provisioning of Wireless Access Points Protocol

CDP—Cisco Discovery Protocol

CEF—Cisco Express Forwarding

CMD—Cisco Meta Data

CPU—Central Processing Unit

CSR—Cloud Services Routers

CTA—Cognitive Threat Analytics

CUWN—Cisco Unified Wireless Network

CVD—Cisco Validated Design

CYOD—Choose Your Own Device

DC—Data Center

DHCP—Dynamic Host Configuration Protocol

DM—Dense-Mode (multicast)

DMVPN—Dynamic Multipoint Virtual Private Network

DMZ—Demilitarized Zone (firewall/networking construct)

DNA—Cisco Digital Network Architecture

DNS—Domain Name System

DORA—Discover, Offer, Request, ACK (DHCP Process)

DWDM—Dense Wavelength Division Multiplexing

ECMP—Equal Cost Multi Path

EID—Endpoint Identifier

EIGRP—Enhanced Interior Gateway Routing Protocol

EMI—Electromagnetic Interference

ETR—Egress Tunnel Router (LISP)

EVPN—Ethernet Virtual Private Network (BGP EVPN with VXLAN data plane)

FHR—First-Hop Router (multicast)

FHRP—First-Hop Redundancy Protocol

FMC—Cisco Firepower Management Center

FTD—Cisco Firepower Threat Defense

GBAC—Group-Based Access Control

GbE—Gigabit Ethernet

Gbit/s—Gigabits Per Second (interface/port speed reference)

GRE—Generic Routing Encapsulation

GRT—Global Routing Table

HA—High-Availability

HQ—Headquarters

HSRP—Cisco Hot-Standby Routing Protocol

HTDB—Host-tracking Database (SD-Access control plane node construct)

IBNS—Identity-Based Networking Services (IBNS 2.0 is the current version)

ICMP— Internet Control Message Protocol

IDF—Intermediate Distribution Frame; essentially a wiring closet.

IEEE—Institute of Electrical and Electronics Engineers

IETF—Internet Engineering Task Force

IGP—Interior Gateway Protocol

IID—Instance-ID (LISP)

IOE—Internet of Everything

IoT—Internet of Things

IP—Internet Protocol

IPAM—IP Address Management

IPS—Intrusion Prevention System

IPSec—Internet Protocol Security

ISE—Cisco Identity Services Engine

ISR—Integrated Services Router

IS-IS—Intermediate System to Intermediate System routing protocol

ITR—Ingress Tunnel Router (LISP)

LACP—Link Aggregation Control Protocol

LAG—Link Aggregation Group

LAN—Local Area Network

L2 VNI—Layer 2 Virtual Network Identifier; as used in SD-Access Fabric, a VLAN.

L3 VNI— Layer 3 Virtual Network Identifier; as used in SD-Access Fabric, a VRF.

LHR—Last-Hop Router (multicast)

LISP—Location Identifier Separation Protocol

MAC—Media Access Control Address (OSI Layer 2 Address)

MAN—Metro Area Network

MEC—Multichassis EtherChannel, sometimes referenced as ***MCEC***

MDF—Main Distribution Frame; essentially the central wiring point of the network.

MnT—Monitoring and Troubleshooting Node (Cisco ISE persona)

MOH—Music on Hold

MPLS—Multiprotocol Label Switching

MR—Map-resolver (LISP)

MS—Map-server (LISP)

MSDP—Multicast Source Discovery Protocol (multicast)

MTU—Maximum Transmission Unit

NAC—Network Access Control

NAD—Network Access Device

NAT—Network Address Translation

NBAR—Cisco Network-Based Application Recognition (NBAR2 is the current version).

NFV—Network Functions Virtualization

NSF—Non-Stop Forwarding

OSI—Open Systems Interconnection model

OSPF—Open Shortest Path First routing protocol

OT—Operational Technology

PAgP—Port Aggregation Protocol

PAN—Primary Administration Node (Cisco ISE persona)

PCI DSS—Payment Card Industry Data Security Standard

PD—Powered Devices (PoE)

PETR—Proxy-Egress Tunnel Router (LISP)

PIM—Protocol-Independent Multicast

PITR—Proxy-Ingress Tunnel Router (LISP)

PnP—Plug-n-Play

PoE—Power over Ethernet (Generic term, may also refer to IEEE 802.3af, 15.4W at PSE)

PoE+—Power over Ethernet Plus (IEEE 802.3at, 30W at PSE)

PSE—Power Sourcing Equipment (PoE)

PSN—Policy Service Node (Cisco ISE persona)

pxGrid—Platform Exchange Grid (Cisco ISE persona and publisher/subscriber service)

PxTR—Proxy-Tunnel Router (LISP – device operating as both a PETR and PITR)

QoS—Quality of Service

RADIUS—Remote Authentication Dial-In User Service

REST—Representational State Transfer

RFC—Request for Comments Document (IETF)

RIB—Routing Information Base

RLOC—Routing Locator (LISP)

RP—Rendezvous Point (multicast)

RP—Redundancy Port (WLC)

RP—Route Processer

RPF—Reverse Path Forwarding

RR—Route Reflector (BGP)

RTT—Round-Trip Time

SA—Source Active (multicast)

SAFI—Subsequent Address Family Identifiers (BGP)

SD—Software-Defined

SDA—Cisco Software Defined-Access

SDN—Software-Defined Networking

SFP—Small Form-Factor Pluggable (1 GbE transceiver)

SFP+— Small Form-Factor Pluggable (10 GbE transceiver)

SGACL—Security-Group ACL

SGT—Scalable Group Tag, sometimes reference as Security Group Tag

SM—Spare-mode (multicast)

SNMP—Simple Network Management Protocol

SSID—Service Set Identifier (wireless)

SSM—Source-Specific Multicast (PIM)

SSO—Stateful Switchover

STP—Spanning-tree protocol

SVI—Switched Virtual Interface

SVL—Cisco StackWise Virtual

SWIM—Software Image Management

SXP—Scalable Group Tag Exchange Protocol

Syslog—System Logging Protocol

TACACS+—Terminal Access Controller Access-Control System Plus

TCP—Transmission Control Protocol (OSI Layer 4)

UCS— Cisco Unified Computing System

UDP—User Datagram Protocol (OSI Layer 4)

UPoE—Cisco Universal Power Over Ethernet (60W at PSE)

UPoE+— Cisco Universal Power Over Ethernet Plus (90W at PSE)

URL—Uniform Resource Locator

VLAN—Virtual Local Area Network

VM—Virtual Machine

VN—Virtual Network, analogous to a VRF in SD-Access

VNI—Virtual Network Identifier (VXLAN)

vPC—virtual Port Channel (Cisco Nexus)

VPLS—Virtual Private LAN Service

VPN—Virtual Private Network

VPNv4—BGP address family that consists of a Route-Distinguisher (RD) prepended to an IPv4 prefix

VPWS—Virtual Private Wire Service

VRF—Virtual Routing and Forwarding

VSL—Virtual Switch Link (Cisco VSS component)

VSS—Cisco Virtual Switching System

VXLAN—Virtual Extensible LAN

WAN—Wide-Area Network

WLAN—Wireless Local Area Network (generally synonymous with IEEE 802.11-based networks)

WoL—Wake-on-LAN

xTR—Tunnel Router (LISP - device operating as both an ETR and ITR)

Glossary of Terms

This glossary addresses some terms used in this document, for the purposes of aiding understanding. This is not a complete list of all multicloud terminology. Some Cisco product links are supplied here also, where considered useful for the purposes of clarity, but this is by no means intended to be a complete list of all applicable Cisco products.

aaS/XaaS **(IT capability provided as a Service)**	Some IT capability, X, provided as a service (XaaS). Some benefits are: • The provider manages the design, implementation, deployment, upgrades, resiliency, scalability, and overall delivery of the service and the infrastructure that supports it.

	• There are very low barriers to entry, so that services can be quickly adopted and dropped in response to business demand, without the penalty of inefficiently utilized CapEx. • The service charge is an IT OpEx cost (pay-as-you-go), whereas the CapEx and the service infrastructure is the responsibility of the provider. • Costs are commensurate to usage and hence more easily controlled with respect to business demand and outcomes. Such services are typically implemented as "microservices," which are accessed via REST APIs. This architectural style supports composition of service components into systems. Access to and management of aaS assets is via a web GUI and/or APIs, such that Infrastructure-as-code (IaC) techniques can be used for automation, for example, Ansible and Terraform. The provider can be any entity capable of implementing an aaS "cloud-native" architecture. The cloud-native architecture concept is well-documented and supported by open-source software and a rich ecosystem of services such as training and consultancy. The provider can be an internal IT department or any of many third-party companies using and supporting the same open-source platforms. Service access control, integrated with corporate IAM, can be mapped to specific users and business activities, enabling consistent policy controls across services, wherever they are delivered from.
Ansible	An infrastructure automation tool, used to implement processes for instantiating and configuring IT service components, such as VMs on an IaaS platform. Supports the consistent execution of processes defined in YAML "playbooks" at scale, across multiple targets. Because the Ansible artefacts (playbooks) are text-based, they can be stored in a Source Code Management (SCM) system, such as GitHub. This allows for software development like processes to be applied to infrastructure automation, such as, Infrastructure-as-code (see IaC below). https://www.ansible.com
AWS **(Amazon Web Services)**	Provider of IaaS and PaaS. https://aws.amazon.com
Azure	Microsoft IaaS and PaaS. https://azure.microsoft.com/en-gb/
Co-located data center	"A colocation center (CoLo)...is a type of data center where equipment, space, and bandwidth are available for rental to retail customers. Colocation facilities provide space, power, cooling, and physical security for the server, storage, and networking equipment of other firms and also connect them to a variety of telecommunications and network service providers with a minimum of cost and complexity." https://en.wikipedia.org/wiki/Colocation_centre

Containers **(Docker)**	A (Docker) container is a means to create a package of code for an application and its dependencies, such that the application can run on different platforms which support the Docker environment. In the context of aaS, microservices are typically packaged within Linux containers orchestrated by Kubernetes (K8s). https://www.docker.com https://www.cisco.com/c/en/us/products/cloud-systems-management/containerplatform/index.html
DevOps	The underlying principle of DevOps is that the application development and operations teams should work closely together, ideally within the context of a toolchain that automates the stages of development, test, deployment, monitoring, and issue handling. DevOps is closely aligned with IaC, continuous integration and deployment (CI/CD), and Agile software development practices. https://en.wikipedia.org/wiki/DevOps https://en.wikipedia.org/wiki/CI/CD
Edge compute	Edge compute is the idea that it can be more efficient to process data at the edge of a network, close to the endpoints that originate that data, or to provide virtualized access services, such as at the network edge. This could be for reasons related to low latency response, reduction of the amount of unprocessed data being transported, efficiency of resource utilization, and so on. The generic label for this is Multi-access Edge Computing (MEC), or Mobile Edge Computing for mobile networks specifically. From an application experience perspective, it is important to be able to utilize, at the edge, the same operations model, processes, and tools used for any other compute node in the system. https://en.wikipedia.org/wiki/Mobile_edge_computing
IaaS **(Infrastructure as-a-Service)**	Infrastructure components provided aaS, located in data centers operated by a provider, typically accessed over the public Internet. IaaS provides a base platform for the deployment of workloads, typically with containers and Kubernetes (K8s).
IaC **(Infrastructure as-Code)**	Given the ability to automate aaS via APIs, the implementation of the automation is typically via Python code, Ansible playbooks, and similar. These automation artefacts are programming code that define how the services are consumed. As such, they can be subject to the same code management and software development regimes as any other body of code. This means that infrastructure automation can be subject to all of the quality and consistency benefits, CI/CD, traceability, automated testing, compliance checking, and so on, that could be applied to any coding project. https://en.wikipedia.org/wiki/Infrastructure_as_code
IAM **(Identity and Access Management)**	IAM is the means to control access to IT resources so that only those explicitly authorized to access given resources can do so. IAM is an essential foundation to a secure multicloud environment. https://en.wikipedia.org/wiki/Identity_management_
IBM **(Cloud)**	IBM IaaS and PaaS. https://www.ibm.com/cloud

Intersight	Cisco Intersight™ is a Software-as-a-Service (SaaS) infrastructure lifecycle management platform that delivers simplified configuration, deployment, maintenance, and support. https://www.cisco.com/c/en/us/products/servers-unified-computing/intersight/index.html
GCP **(Google Cloud Platform)**	Google IaaS and PaaS. https://cloud.google.com/gcp
Kubernetes **(K8s)**	Kubernetes is an open-source system for automating deployment, scaling, and management of containerized applications. https://kubernetes.io
Microservices	A microservices architecture is characterized by processes implementing fine-grained services, typically exposed via REST APIs and which can be composed into systems. The processes are often container-based, and the instantiation of the services often managed with Kubernetes. Microservices managed in this way are intrinsically well suited for deployment into IaaS environments, and as such, are the basis of a cloud native architecture. https://en.wikipedia.org/wiki/Microservices
PaaS **(Platform-as-a-Service)**	PaaS is a layer of value-add services, typically for application development, deployment, monitoring, and general lifecycle management. The use of IaC with IaaS and PaaS is very closely associated with DevOps practices.
Private on-premises data center	A data center infrastructure housed within an environment owned by a given enterprise is distinguished from other forms of data center, with the implication that the private data center is more secure, given that access is restricted to those authorized by the enterprise. Thus, circumstances can arise where very sensitive IT assets are only deployed in a private data center, in contrast to using public IaaS. For many intents and purposes, the underlying technology can be identical, allowing for hybrid deployments where some IT assets are privately deployed but also accessible to other assets in public IaaS. IAM, VPNs, firewalls, and similar are key technologies needed to underpin the security of such an arrangement.
REST API	Representational State Transfer (REST) APIs is a generic term for APIs accessed over HTTP(S), typically transporting data encoded in JSON or XML. REST APIs have the advantage that they support distributed systems, communicating over HTTP, which is a well-understood protocol from a security management perspective. REST APIs are another element of a cloud-native applications architecture, alongside microservices. https://en.wikipedia.org/wiki/Representational_state_transfer
SaaS **(Software-as-a-Service)**	End-user applications provided “aaS” over the public Internet, with the underlying software systems and infrastructure owned and managed by the provider.
SAML **(Security Assertion**	Used in the context of Single-Sign-On (SSO) for exchanging authentication and authorization data between an identity provider, typically an IAM system, and a service provider (some form of SaaS). The SAML protocol exchanges XML documents that contain security assertions used by

Markup Language)	the aaS for access control decisions. https://en.wikipedia.org/wiki/Security_Assertion_Markup_Language
Terraform	An open-source IaC software tool for cloud services, based on declarative configuration files. https://www.terraform.io

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