Deploying NetApp HCI with Cisco ACI

NetApp HCI Solutions

NetApp
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VMware vSphere: NetApp HCI with Cisco ACI

VMware vSphere is an industry-leading virtualization platform that provides a way to build a resilient and reliable virtual infrastructure. vSphere contains virtualization, management, and interface layers. The two core components of VMware vSphere are ESXi server and the vCenter Server. VMware ESXi is hypervisor software installed on a physical machine that facilitates hosting of VMs and virtual appliances. vCenter Server is the service through which you manage multiple ESXi hosts connected in a network and pool host resources. For more information on VMware vSphere, see the documentation here.

Workflow

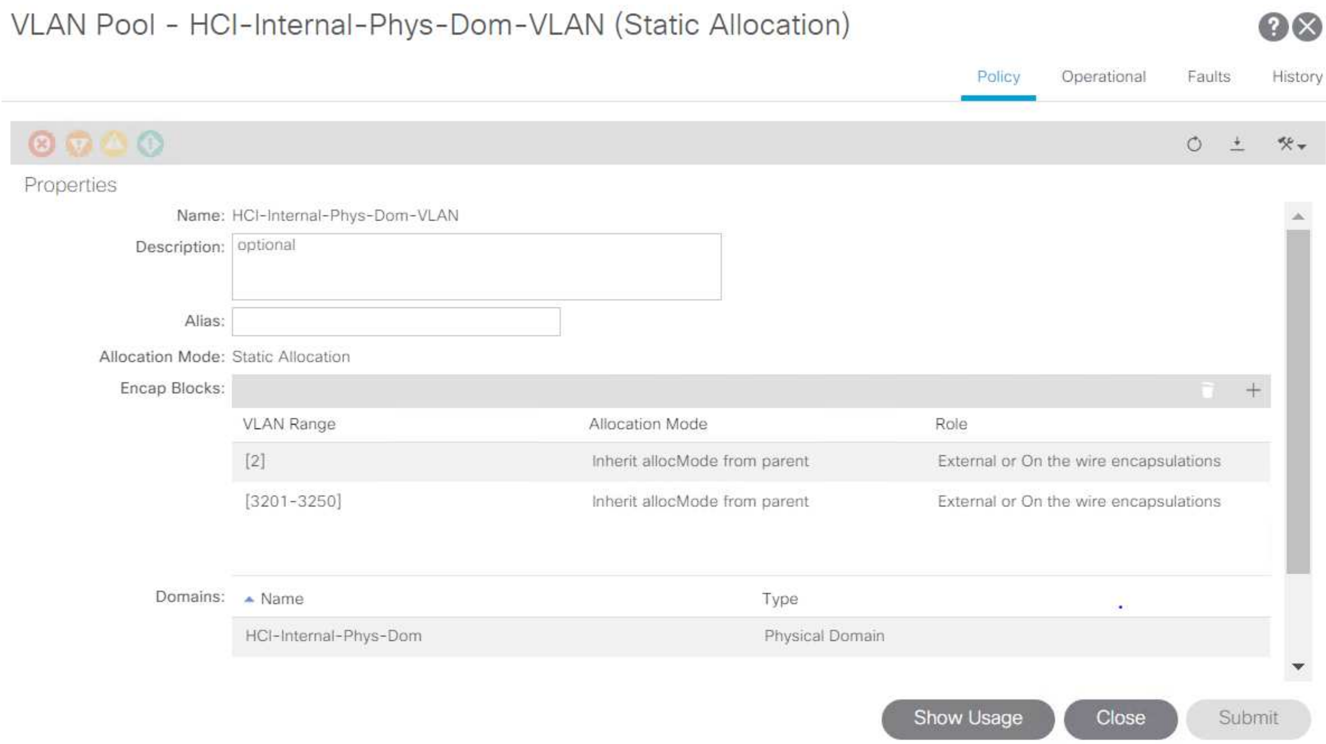
The following workflow was used to up the virtual environment. Each of these steps might involve several individual tasks.

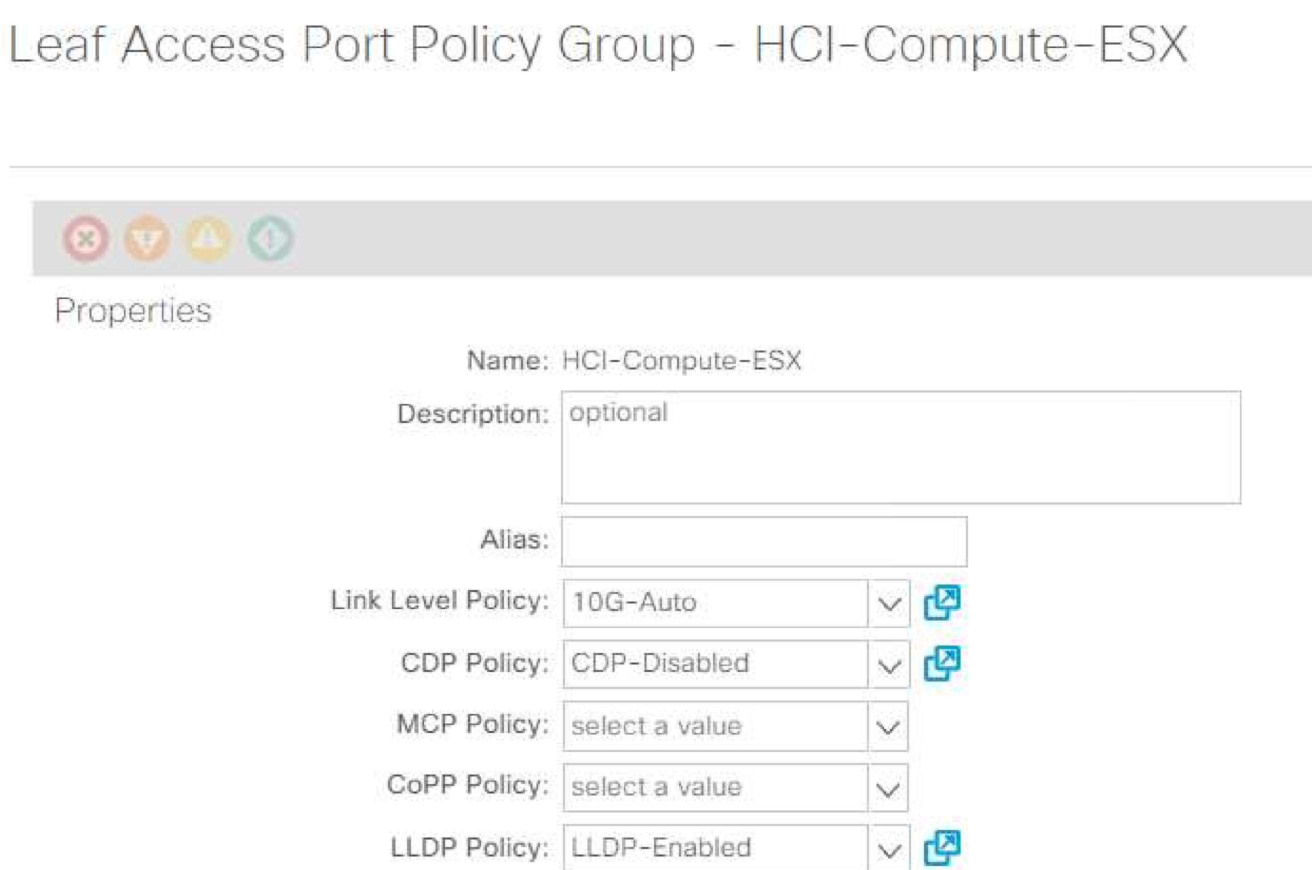
1. Install and configure Nexus 9000 switches in ACI mode and APIC software on the UCS C-series server. See the Install and Upgrade documentation for detailed steps.
2. Configure and setup ACI fabric by referring to the documentation.
3. Configure the tenants, application profiles, bridge domains, and EPGs required for NetApp HCI nodes. NetApp recommends using one BD to one EPG framework, except for iSCSI. See the documentation here for more details. The minimum set of EPGs required are in-band management, iSCSI, iSCSI-A, iSCSI-B, VM motion, VM-data network, and native.

   > iSCSI multipathing requires two iSCSI EPGs: iSCSI-A and iSCSI-B, each with one active uplink.

   > NetApp mNode requires an iSCSI EPG with both uplinks active.

4. Create the VLAN pool, physical domain, and AEP based on the requirements. Create the switch and interface profiles for individual ports. Then attach the physical domain and configure the static paths to the EPGs. See the configuration guide for more details.



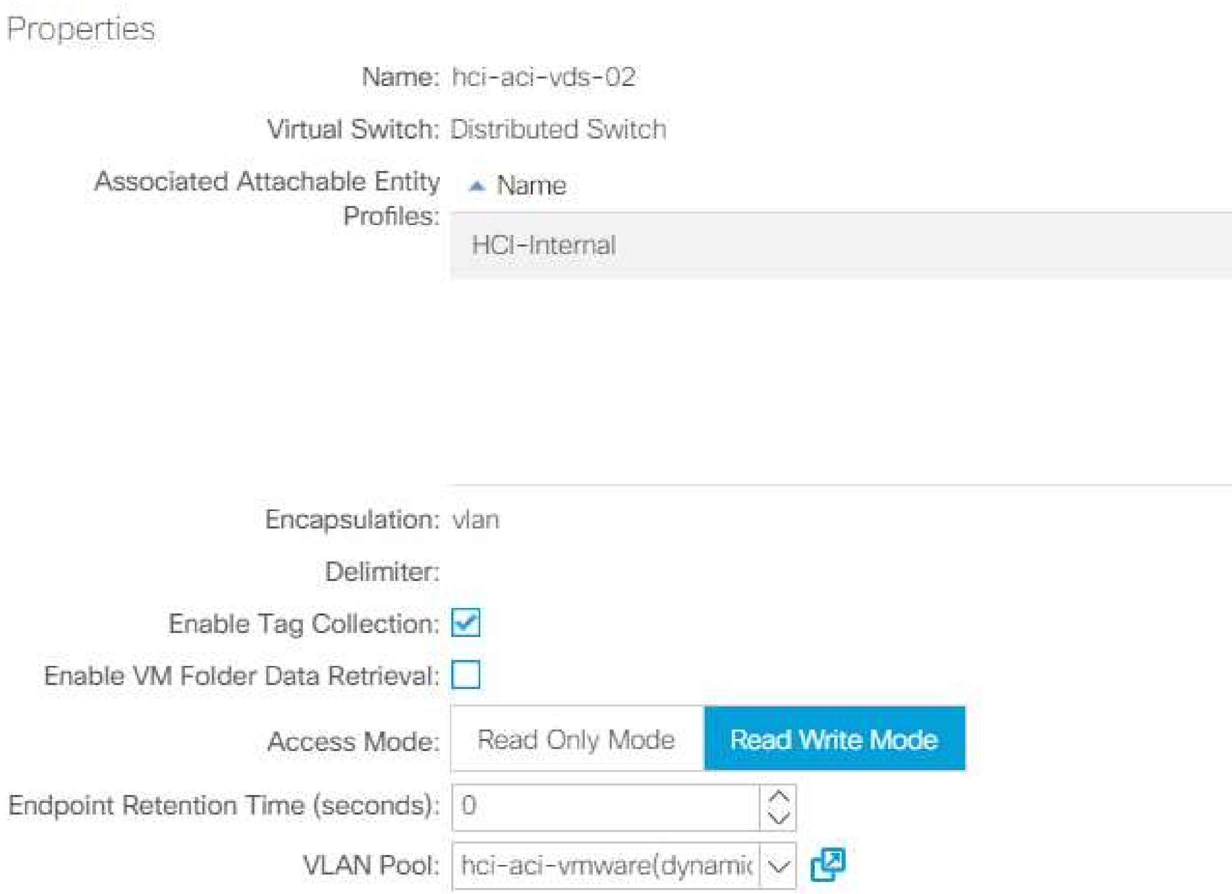


Use an access port policy group for interfaces connecting to NetApp HCI compute nodes, and use vPC policy group for interfaces to NetApp HCI storage nodes.

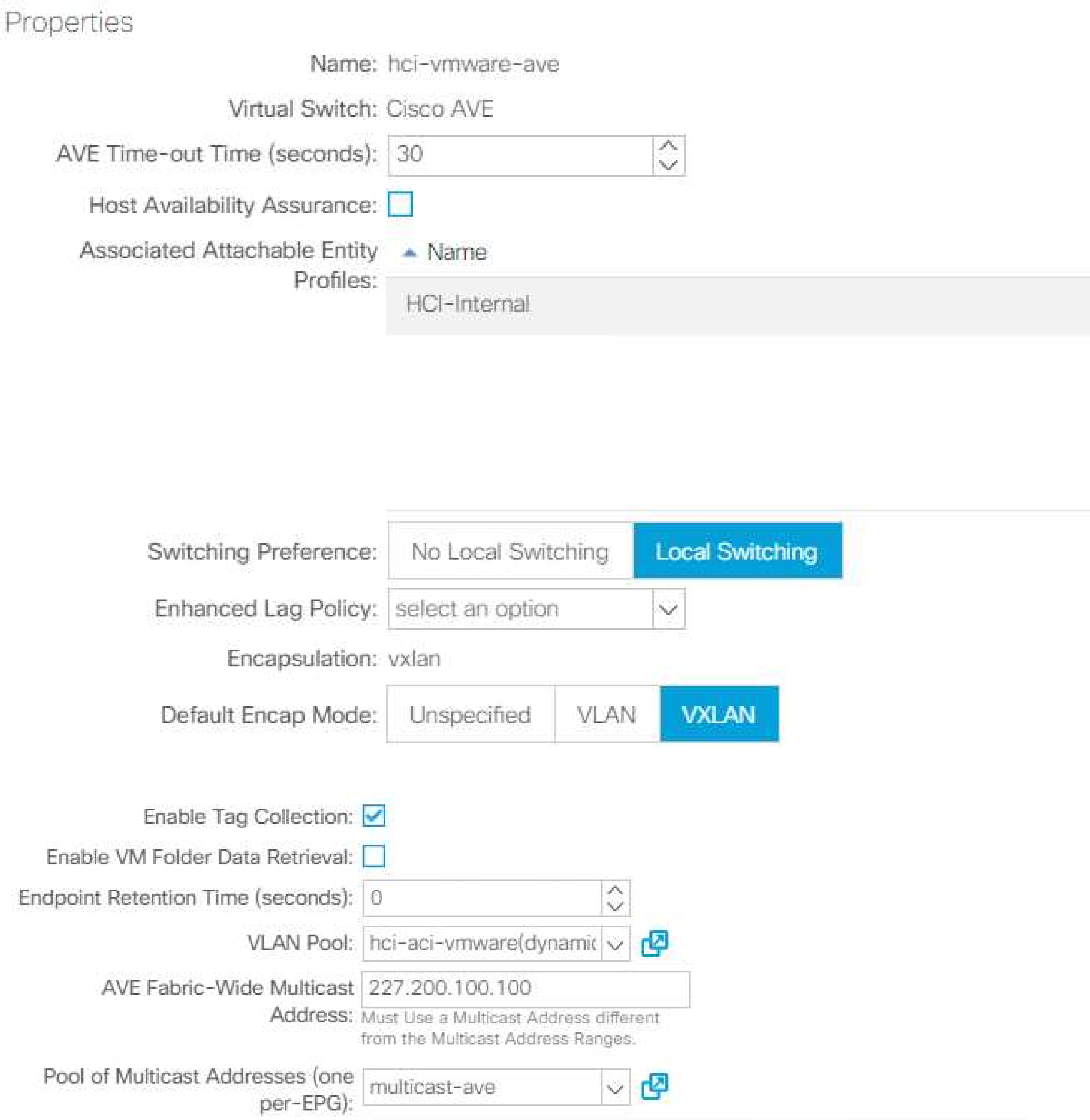
5. Create and assign contracts for tightly-controlled access between workloads. For more information on

configuring the contracts, see the guide here.

6. Install and configure NetApp HCI using NDE. NDE configures all the required parameters, including VDS port groups for networking, and also installs the mNode VM. See the deployment guide for more information.
7. Though VMM integration of Cisco ACI with VMware VDS is optional, using the VMM integration feature is a best practice. When not using VMM integration, an NDE-installed VDS can be used for networking with physical domain attachment on Cisco ACI.
8. If you are using VMM integration, NDE-installed VDS cannot be fully managed by ACI and can be added as read-only VMM domain. To avoid that scenario and make efficient use of Cisco ACI's VMM networking feature, create a new VMware VMM domain in ACI with an explicit dynamic VLAN pool. The VMM domain created can integrate with any supported virtual switch.
    a. **Integrate with VDS.** If you wish to integrate ACI with VDS, select the virtual switch type to be VMware Distributed Switch. Consider the configuration best practices noted in the following table. See the configuration guide for more details.

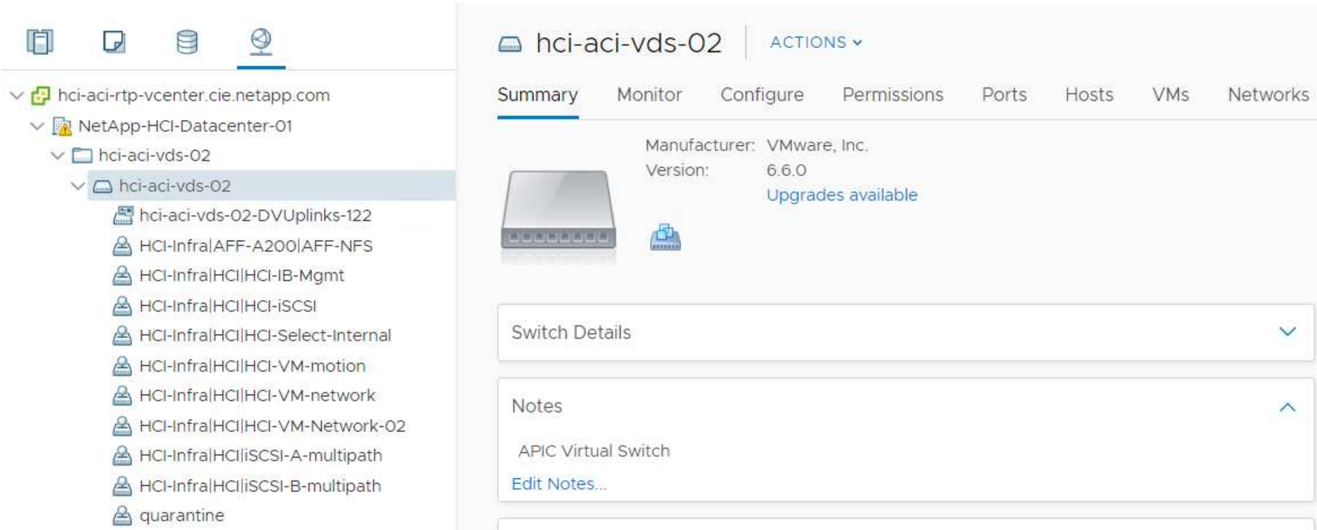


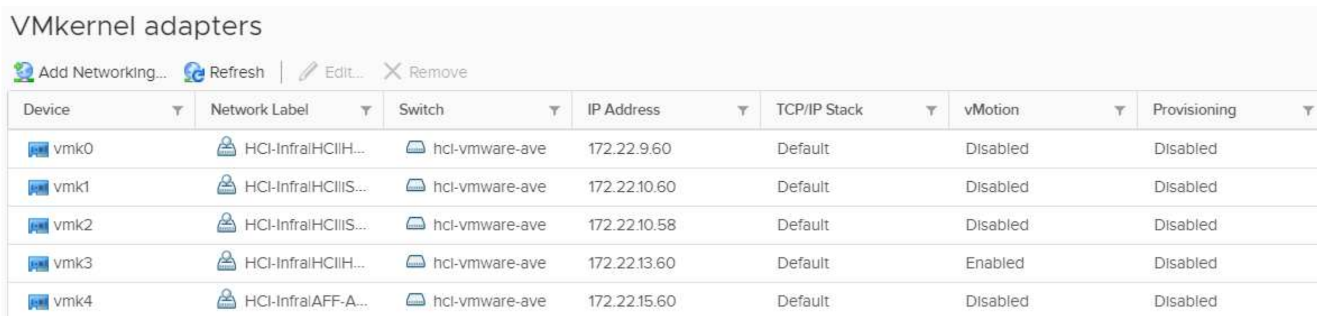
    b. **Integrate with Cisco AVE.** If you are integrating Cisco AVE with Cisco ACI, select the virtual switch type to be Cisco AVE. Cisco AVE requires a unique VLAN pool of type Internal for communicating between internal and external port groups. Follow the configuration best practices noted in this table. See the installation guide to install and configure Cisco AVE.



9. Attach the VMM domain to the EPGs using Pre-Provision Resolution Immediacy. Then migrate all the VMNICs, VMkernel ports, and VNICs from the NDE-created VDS to ACI-created VDS or AVE and so on. Configure the uplink failover and teaming policy for iSCSI-A and iSCSI-B to have one active uplink each. VMs can now attach their VMNICs to ACI-created port groups to access network resources. The port groups on VDS that are managed by Cisco ACI are in the format of <tenant-name>|<application-profile-name>|<epg-name>.

> ⓘ Pre-Provision Resolution Immediacy is required to ensure the port policies are downloaded to the leaf switch even before the VMM controller is attached to the virtual switch.

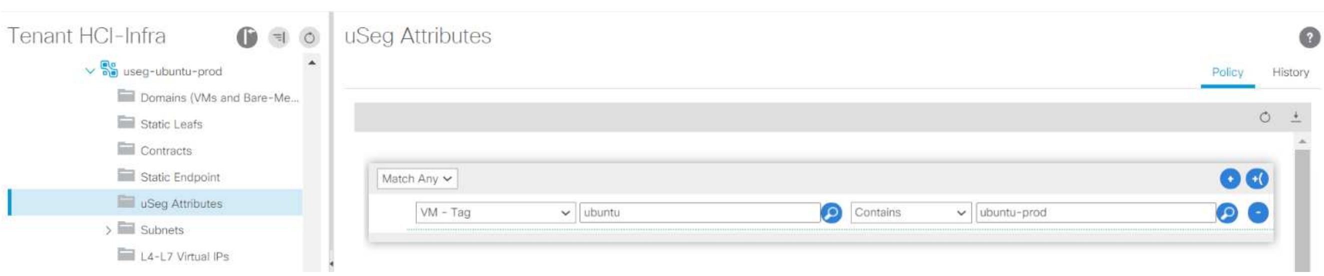



VMkernel adapters

Add Networking... Refresh Edit... Remove

Device	Network Label	Switch	IP Address	TCP/IP Stack	vMotion	Provisioning
vmk0	HCI-Infra|HCI|H...	hci-vmware-ave	172.22.9.60	Default	Disabled	Disabled
vmk1	HCI-Infra|HCI|iS...	hci-vmware-ave	172.22.10.60	Default	Disabled	Disabled
vmk2	HCI-Infra|HCI|iS...	hci-vmware-ave	172.22.10.58	Default	Disabled	Disabled
vmk3	HCI-Infra|HCI|H...	hci-vmware-ave	172.22.13.60	Default	Enabled	Disabled
vmk4	HCI-Infra|AFF-A...	hci-vmware-ave	172.22.15.60	Default	Disabled	Disabled

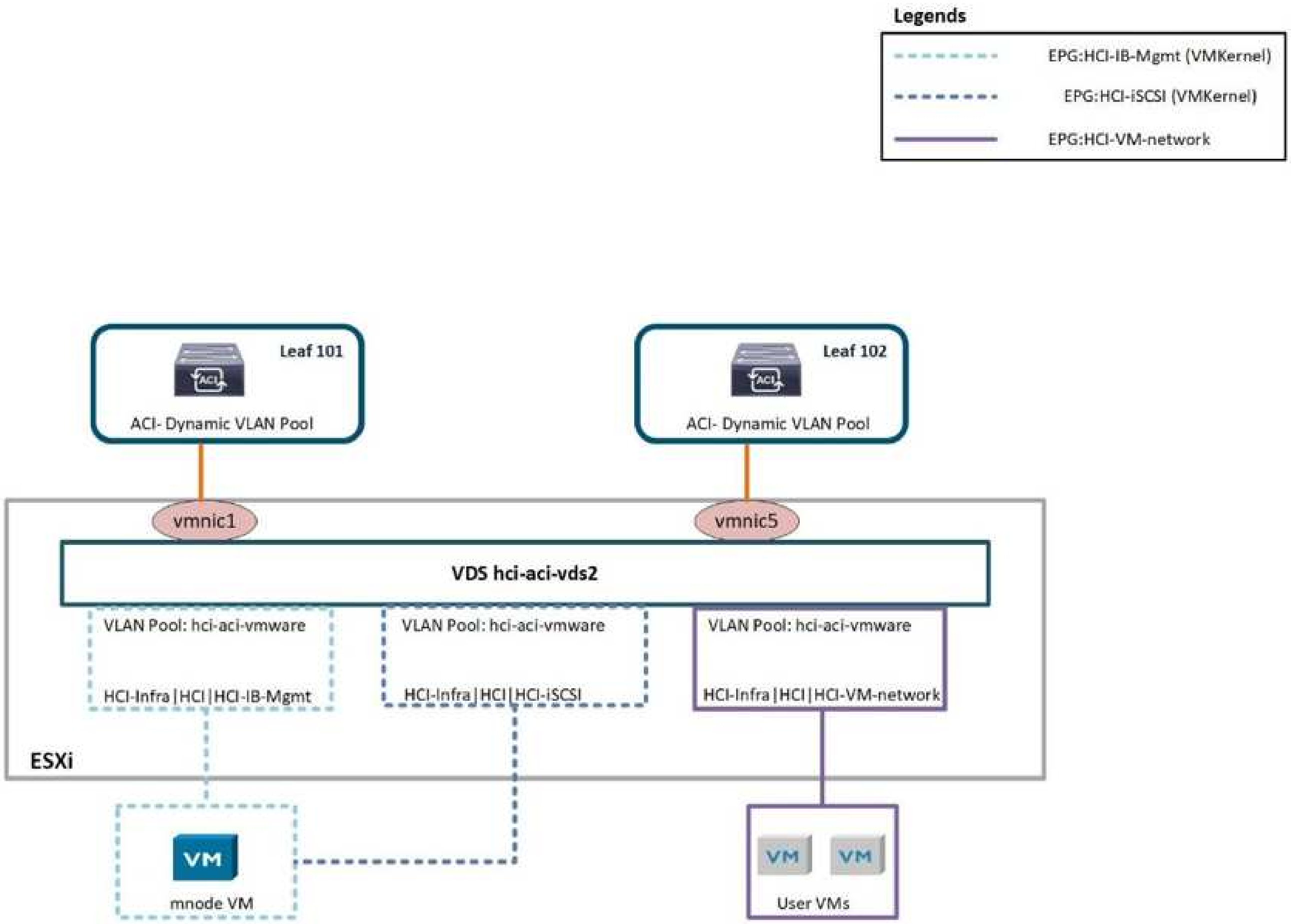
10. If you intend to use micro-segmentation, then create micro-segment (uSeg) EPGs attaching to the right BD. Create attributes in VMware vSphere and attach them to the required VMs. Ensure the VMM domain has Enable Tag Collection enabled. Configure the uSeg EPGs with the corresponding attribute and attach the VMM domain to it. This provides more granular control of communication on the endpoint VMs.



The networking functionality for VMware vSphere on NetApp HCI in this solution is provided either using VMware VDS or Cisco AVE.

VMware VDS

VMware vSphere Distributed Switch (VDS) is a virtual switch that connects to multiple ESXi hosts in the cluster or set of clusters allowing virtual machines to maintain consistent network configuration as they migrate across multiple hosts. VDS also provides for centralized management of network configurations in a vSphere environment. For more details, see the VDS documentation.



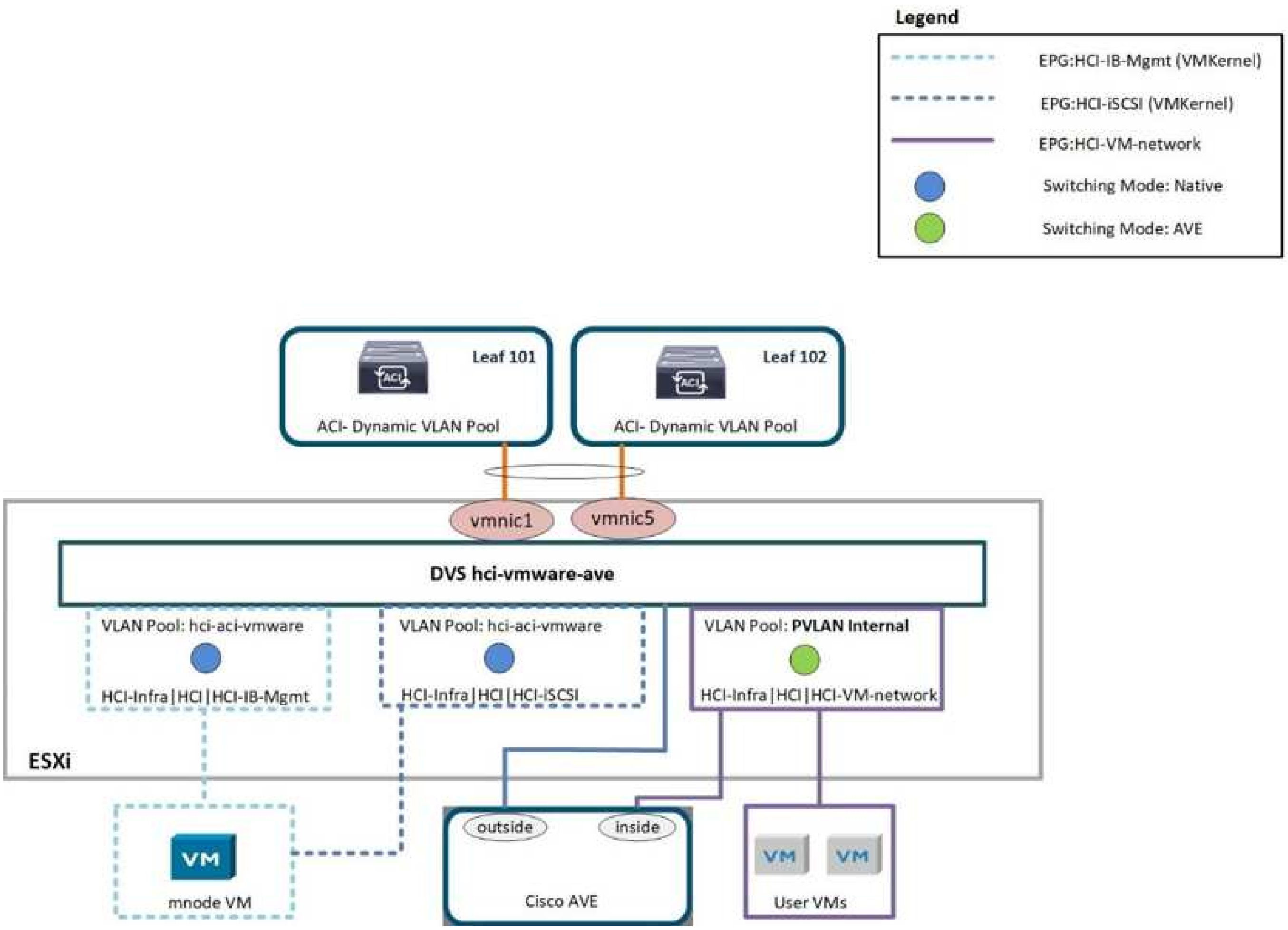
The following table outlines the necessary parameters and best practices for configuring and integrating Cisco ACI with VMware VDS.

Resource	Configuration Considerations	Best Practices
Endpoint groups	• Separate EPG for native VLANs • Static binding of interfaces to HCI storage and compute nodes in native VLAN EPG uses 802.1P mode. This is required for node discovery to run NDE. • Separate EPGs for iSCSI, iSCSI-A, and iSCSI-B with a common BD • iSCSI-A and iSCSI-B are for iSCSI multipathing and are used for VMkernel ports on ESXi hosts • Physical domain to be attached to iSCSI EPG before running NDE • VMM domain to be attached to iSCSI, iSCSI-A, and iSCSI-B EPGs	• Contracts between EPGs to be well defined. Allow only required ports for communication. • Use unique native VLAN for NDE node discovery • For EPGs corresponding to port-groups being attached to VMkernel ports, VMM domain to be attached with Pre-Provision for Resolution Immediacy
Interface policy	• A common leaf access port policy group for all ESXi hosts • One vPC policy group per NetApp HCI storage node • LLDP enabled, CDP disabled	• Separate VLAN pool for VMM domain with dynamic allocation turned on • Recommended to use vPC with LACP Active port-channel policy for interfaces towards NetApp HCI Storage Nodes • Recommended to use individual interfaces for Compute Nodes, No LACP.
VMM Integration	• Local switching preference • Access mode is Read Write.	• MAC-Pinning-Physical-NIC-Load for vSwitch policy • LLDP for discovery policy • Enable Tag collection if micro-segmentation is used
VDS	• Both uplinks active for iSCSI port-group • One uplink each for iSCSI-A and iSCSI-B	• Load balancing method for all port-groups to be ‘Route based on physical NIC load’ • iSCSI VMkernel port migration to be done one at a time from NDE deployed VDS to ACI integrated VDS

For traffic load-balancing, port channels with vPCs can be used on Cisco ACI along with LAGs on VDS with LACP in active mode. However, using LACP can affect storage performance when compared to iSCSI multipathing.

Cisco AVE

Cisco ACI Virtual Edge (AVE) is a virtual switch offering by Cisco that extends the Cisco ACI policy model to virtual infrastructure. It is a hypervisor- independent distributed network service that sits on top of the native virtual switch of the hypervisor. It leverages the underlying virtual switch using a VM-based solution to provide network visibility into the virtual environments. For more details on Cisco AVE, see the documentation. The following figure depicts the internal networking of Cisco AVE on an ESXi host (as tested).



The following table lists the necessary parameters and best practices for configuring and integrating Cisco ACI with Cisco AVE on VMware ESXi. Cisco AVE is currently only supported with VMware vSphere.

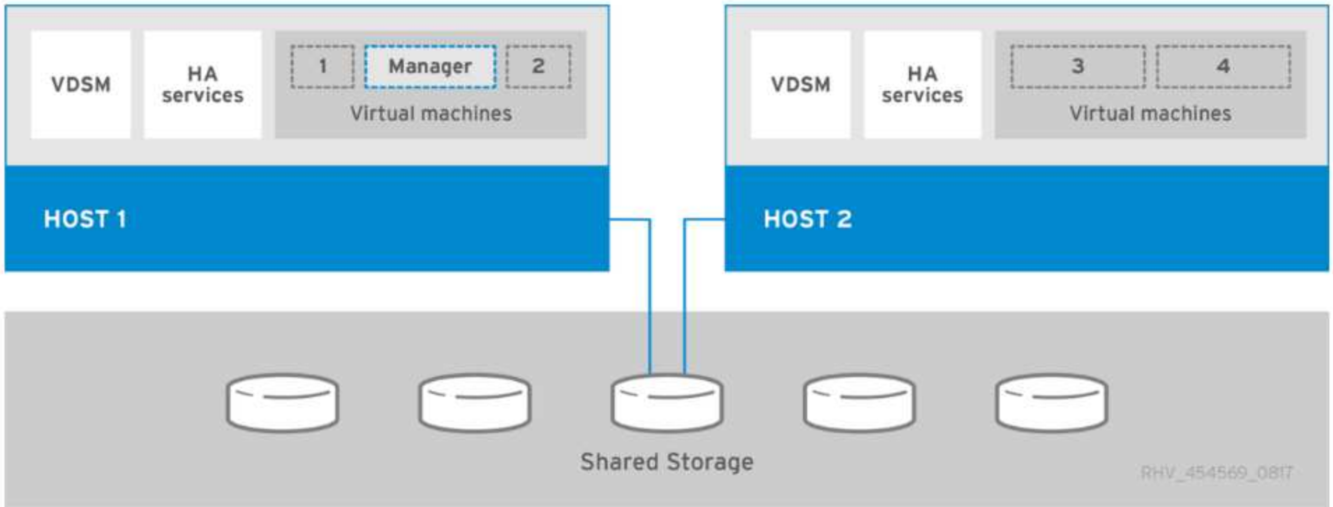
Resource	Configuration Considerations	Best Practices
Endpoint Groups	Separate EPG for native VLANs Static binding of interfaces towards HCI storage and compute nodes in native VLAN EPG uses 802.1P mode. This is required for node discovery to run NDE. Separate EPGs for iSCSI, iSCSI-A and iSCSI-B with a common BD iSCSI-A and iSCSI-B are for iSCSI multipathing and are used for VMkernel ports on ESXi hosts Physical domain to be attached to iSCSI EPG before running NDE VMM domain is attached to iSCSI, iSCSI-A, and iSCSI-B EPGs	Separate VLAN pool for VMM domain with dynamic allocation turned on Contracts between EPGs to be well defined. Allow only required ports for communication. Use unique native VLAN for NDE node discovery Use native switching mode in VMM domain for EPGs that correspond to port groups being attached to host's VMkernel adapters Use AVE switching mode in VMM domain for EPGs corresponding to port groups carrying user VM traffic For EPGs corresponding to port-groups being attached to VMkernel ports, VMM domain is attached with Pre-Provision for Resolution Immediacy
Interface Policy	• One vPC policy group per ESXi host • One vPC policy group per NetApp HCI storage node • LLDP enabled, CDP disabled	• NetApp recommends using vPCs to ESXi hosts • Use static mode on port-channel policy for vPCs to ESXi • Use Layer-4 SRC port load balancing hashing method for port-channel policy • NetApp recommends using vPC with LACP active port-channel policy for interfaces to NetApp HCI storage nodes

Resource	Configuration Considerations	Best Practices
VMM Integration	• Create a new VLAN range [or Encap Block] with role Internal and Dynamic allocation' attached to the VLAN pool intended for VMM domain • Create a pool of multicast addresses (one address per EPG) • Reserve another multicast address different from the pool of multicast addresses intended for AVE fabric-wide multicast address • Local switching preference • Access mode to be Read Write mode	• Static mode on for vSwitch policy • Ensure that vSwitch port-channel policy and interface policy group's port-channel policy are using the same mode • LLDP for discovery policy • Enable Tag collection if using micro-segmentation • Recommended option for Default Encap mode is VXLAN
VDS	• - Both uplinks active for iSCSI port-group • - One uplink each for iSCSI-A and iSCSI-B	• iSCSI VMkernel port migration is done one at a time from NDE deployed VDS to ACI integrated VDS • Load balancing method for all port-groups to be Route based on IP hash

For traffic load balancing, port channel with vPCs can be used on Cisco ACI along with LAGs on ESXi hosts with LACP in active mode. However, using LACP can affect storage performance when compared to iSCSI multipathing.

Red Hat Virtualization: NetApp HCI with Cisco ACI

Red Hat Virtualization (RHV) is an enterprise virtual data center platform that runs on Red Hat Enterprise Linux using the KVM hypervisor. The key components of RHV include Red Hat Virtualization Hosts (RHV- H) and the Red Hat Virtualization Manager (RHV- M). RHV-M provides centralized, enterprise-grade management for the physical and logical resources within the virtualized RHV environment. RHV-H is a minimal, light-weight operating system based on Red Hat Enterprise Linux that is optimized for the ease of setting up physical servers as RHV hypervisors. For more information on RHV, see the documentation here. The following figure provides an overview of RHV.

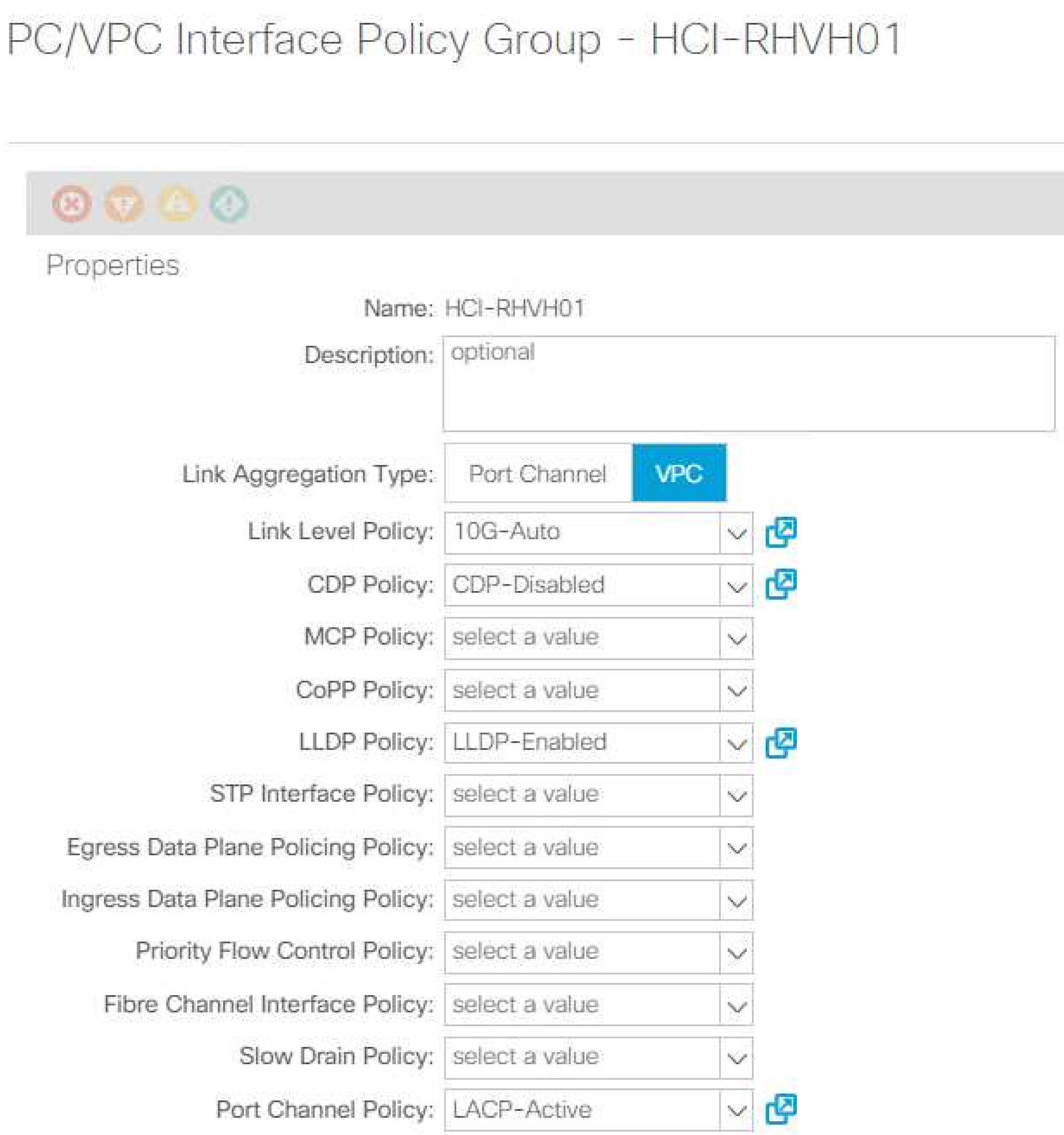


Starting with Cisco APIC release 3.1, Cisco ACI supports VMM integration with Red Hat Virtualization environments. The RHV VMM domain in Cisco APIC is connected to RHV-M and directly associated with a data center object. All the RHV-H clusters under this data center are considered part of the VMM domain. Cisco ACI automatically creates logical networks in RHV- M when the EPGs are attached to the RHV VMM domain in ACI. RHV hosts that are part of a Red Hat VMM domain can use Linux bridge or Open vSwitch as its virtual switch. This integration simplifies and automates networking configuration on RHV-M, saving a lot of manual work for system and network administrators.

Workflow

The following workflow is used to set up the virtual environment. Each of these steps might involve several individual tasks.

1. Install and configure Nexus 9000 switches in ACI mode and APIC software on the UCS C-series server. Refer to the Install and Upgrade documentation for detailed steps.
2. Configure and setup the ACI fabric by referring to the documentation.
3. Configure tenants, application profiles, bridge domains, and EPGs required for NetApp HCI nodes. NetApp recommends using one BD to one EPG framework, except for iSCSI. See the documentation here for more details. The minimum set of EPGs required are in-band management, iSCSI, VM motion, VM-data network, and native.
4. Create the VLAN pool, physical domain, and AEP based on the requirements. Create the switch and interface profiles and policies for vPCs and individual ports. Then attach the physical domain and configure the static paths to the EPGs. see the configuration guide for more details. This table lists best practices for integrating ACI with Linux bridge on RHV.

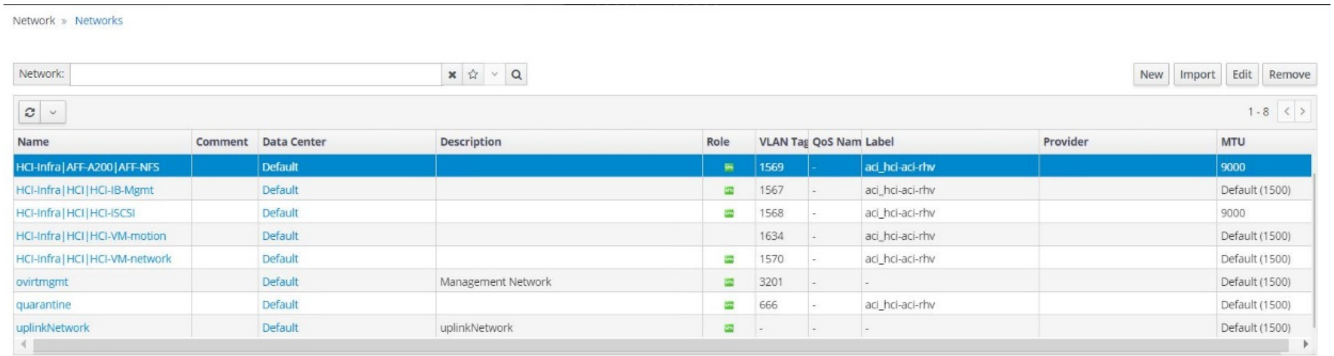


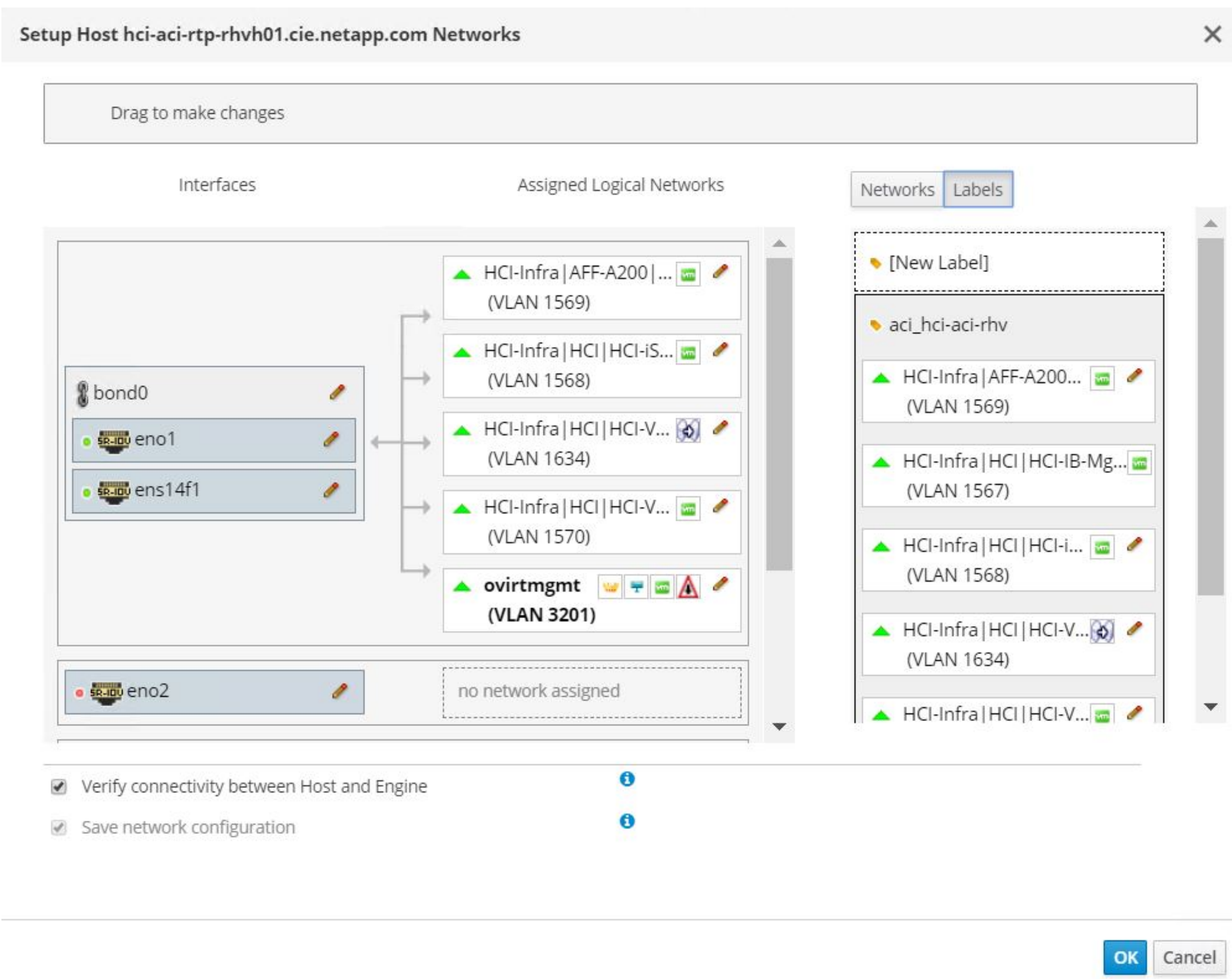
> Use a vPC policy group for interfaces connecting to NetApp HCI storage and compute nodes.

5. Create and assign contracts for tightly controlled access between workloads. For more information on configuring the contracts, see the guide here.
6. Install and configure the NetApp HCI Element cluster. Do not use NDE for this install; rather, install a standalone Element cluster on the HCI storage nodes. Then configure the required volumes for installation of RHV. Install RHV on NetApp HCI. Refer to RHV on NetApp HCI NVA for more details.
7. RHV installation creates a default management network called ovirtmgmt. Though VMM integration of Cisco ACI with RHV is optional, leveraging VMM integration is preferred. Do not create other logical networks manually. To use Cisco ACI VMM integration, create a Red Hat VMM domain and attach the VMM domain to all the required EPGs, using Pre- Provision Resolution Immediacy. This process automatically creates corresponding logical networks and vNIC profiles. The vNIC profiles can be directly

used to attach to hosts and VMs for their communication. The networks that are managed by Cisco ACI are in the format <tenant-name>|<application-profile-name>|<epg-name> tagged with a label of format aci_<rhv-vmm-domain-name>. See Cisco's whitepaper for creating and configuring a VMM domain for RHV. Also, see this table for best practices when integrating RHV on NetApp HCI with Cisco ACI.

> Except for ovirtmgmt, all other logical networks can be managed by Cisco ACI.

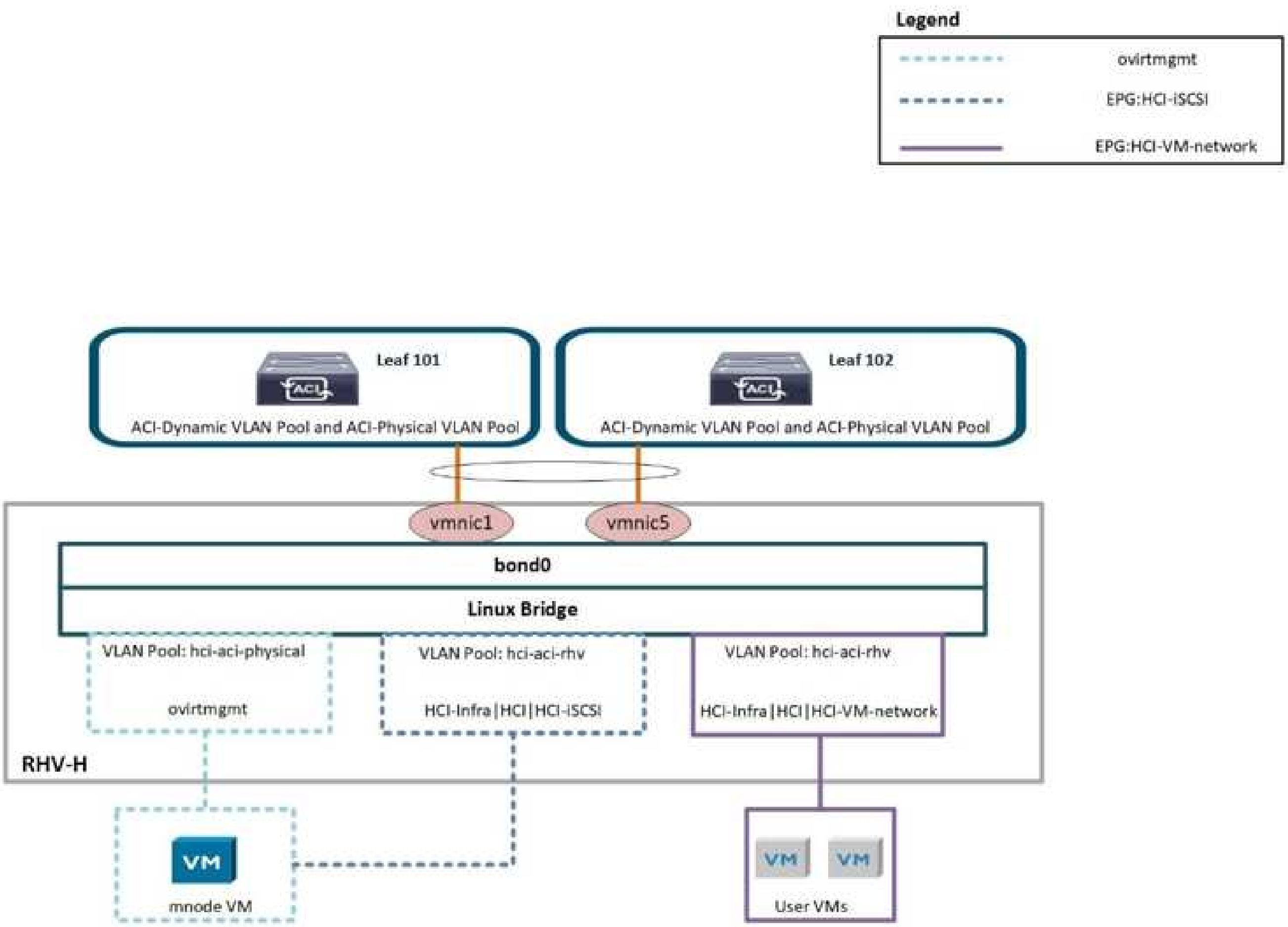




The networking functionality for RHVH hosts in this solution is provided by Linux bridge.

Linux Bridge

Linux Bridge is a default virtual switch on all Linux distributions that is usually used with KVM/QEMU-based hypervisors. It is designated to forward traffic between networks based on MAC addresses and thus is regarded as a layer-2 virtual switch. For more information, see the documentation here. The following figure depicts the internal networking of Linux Bridge on RHV-H (as tested).



The following table outlines the necessary parameters and best practices for configuring and integrating Cisco ACI with Linux Bridge on RHV hosts.

Resource	Configuration considerations	Best Practices
Endpoint groups	• Separate EPG for native VLAN • Static binding of interfaces towards HCI storage and compute nodes in native VLAN EPG to be on 802.1P mode • Static binding of vPCs required on In-band management EPG and iSCSI EPG before RHV installation	• Separate VLAN pool for VMM domain with dynamic allocation turned on • Contracts between EPGs to be well defined. Allow only required ports for communication. • Use unique native VLAN for discovery during Element cluster formation • For EPGs corresponding to port-groups being attached to VMkernel ports, VMM domain to be attached with 'Pre-Provision' for Resolution Immediacy
Interface policy	• One vPC policy group per RHV-H host • One vPC policy group per NetApp HCI storage node • LLDP enabled, CDP disabled	• Recommended to use vPC towards RHV-H hosts • Use 'LACP Active' for the port-channel policy • Use only 'Graceful Convergence' and 'Symmetric Hashing' control bits for port-channel policy Use 'Layer4 Src-port' load balancing hashing method for port-channel policy Recommended to use vPC with LACP Active port-channel policy for interfaces towards NetApp HCI storage nodes
VMM Integration	Do not migrate host management logical interfaces from ovirtmgmt to any other logical network	iSCSI host logical interface to be migrated to iSCSI logical network managed by ACI VMM integration

ⓘ Except for the ovirtmgmt logical network, it is possible to create all other infrastructure logical networks on Cisco APIC and map them to the VMM domain. 'ovirtmgmt' logical network uses the static path binding on the In-band management EPG attached with the physical domain.

Next: KVM on RHEL: NetApp HCI with Cisco ACI

Red Hat Virtualization: NetApp HCI with Cisco ACI

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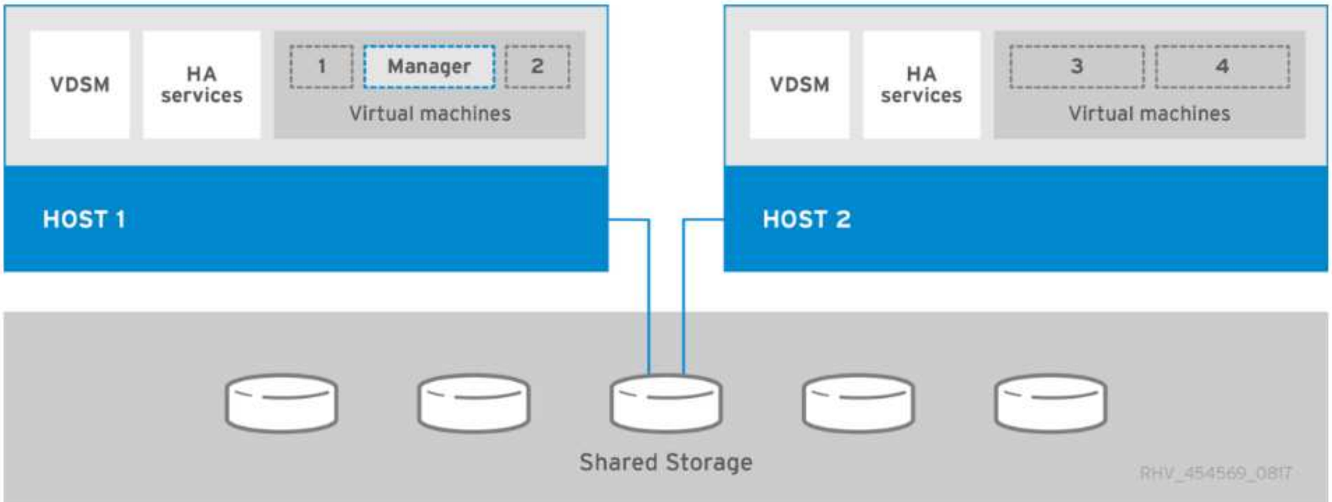

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Workflow

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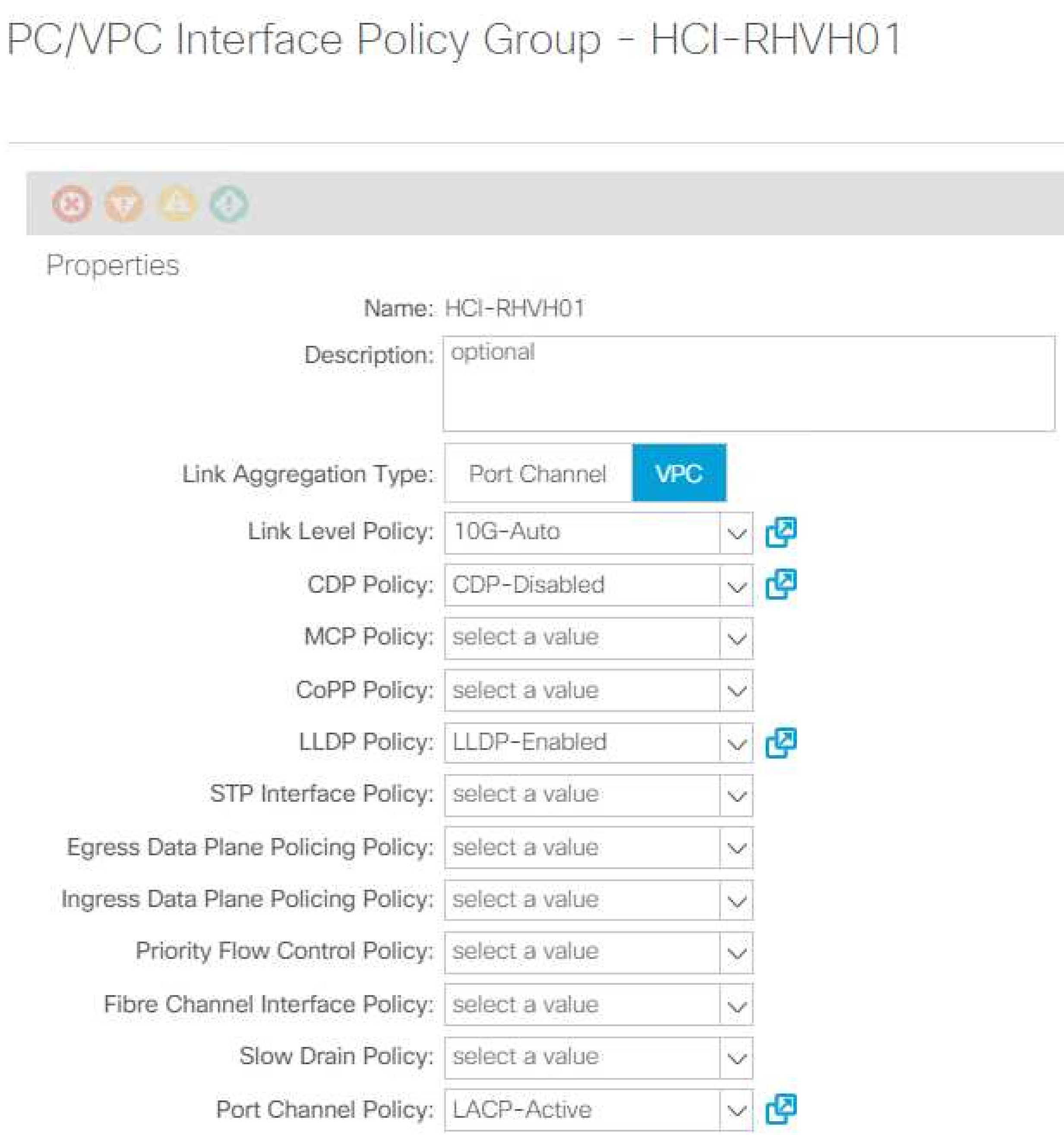
4. Create the VLAN pool, physical domain, and AEP based on the requirements. Create the switch and interface profiles and policies for vPCs and individual ports. Then attach the physical domain and configure the static paths to the EPGs. see the configuration guide for more details. This table lists best practices for integrating ACI with Linux bridge on RHV.

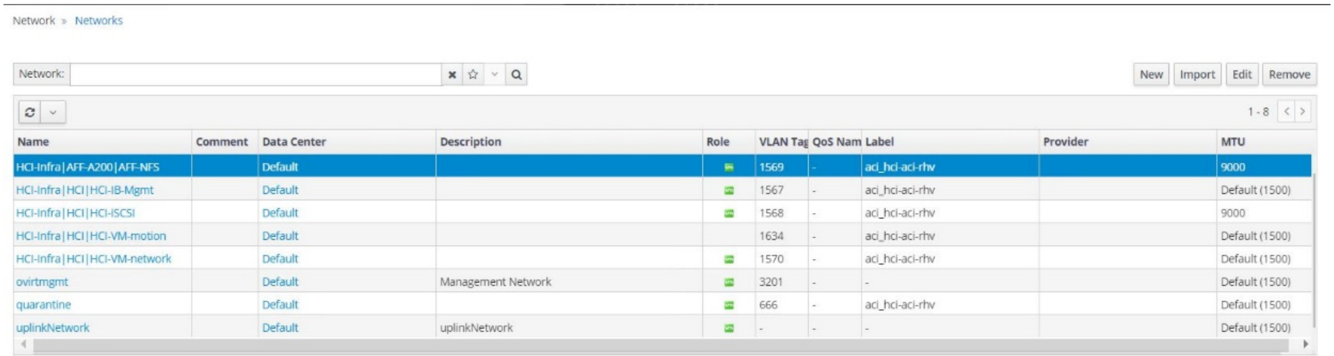


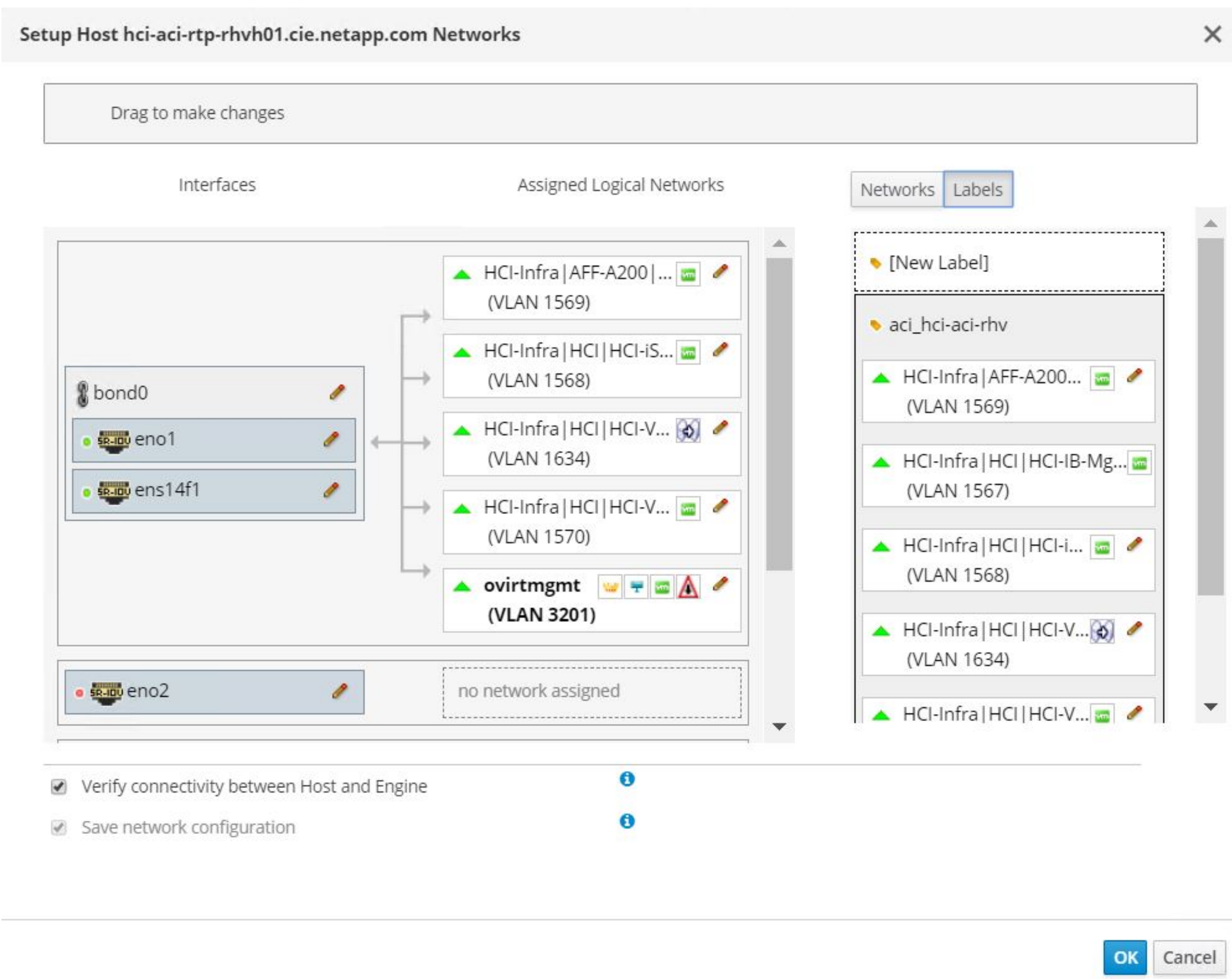
> Use a vPC policy group for interfaces connecting to NetApp HCI storage and compute nodes.

5. Create and assign contracts for tightly controlled access between workloads. For more information on configuring the contracts, see the guide here.
6. Install and configure the NetApp HCI Element cluster. Do not use NDE for this install; rather, install a standalone Element cluster on the HCI storage nodes. Then configure the required volumes for installation of RHV. Install RHV on NetApp HCI. Refer to RHV on NetApp HCI NVA for more details.
7. RHV installation creates a default management network called ovirtmgmt. Though VMM integration of Cisco ACI with RHV is optional, leveraging VMM integration is preferred. Do not create other logical networks manually. To use Cisco ACI VMM integration, create a Red Hat VMM domain and attach the VMM domain to all the required EPGs, using Pre- Provision Resolution Immediacy. This process automatically creates corresponding logical networks and vNIC profiles. The vNIC profiles can be directly

used to attach to hosts and VMs for their communication. The networks that are managed by Cisco ACI are in the format `<tenant-name>|<application-profile-name>|<epg-name>` tagged with a label of format `aci_<rhv-vmm-domain-name>`. See Cisco's whitepaper for creating and configuring a VMM domain for RHV. Also, see this table for best practices when integrating RHV on NetApp HCI with Cisco ACI.

> Except for ovirtmgmt, all other logical networks can be managed by Cisco ACI.

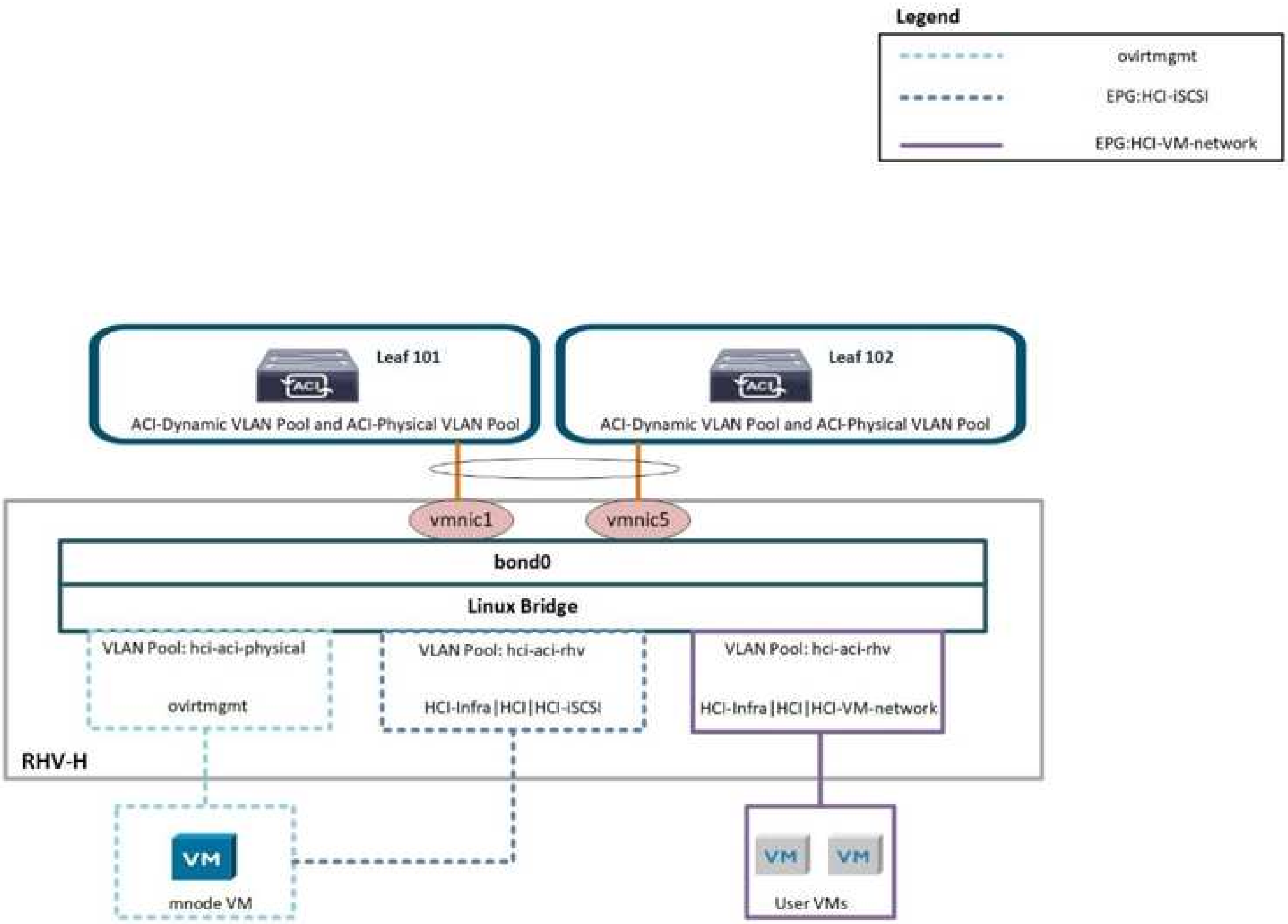




The networking functionality for RHVH hosts in this solution is provided by Linux bridge.

Linux Bridge

Linux Bridge is a default virtual switch on all Linux distributions that is usually used with KVM/QEMU-based hypervisors. It is designated to forward traffic between networks based on MAC addresses and thus is regarded as a layer-2 virtual switch. For more information, see the documentation here. The following figure depicts the internal networking of Linux Bridge on RHV-H (as tested).



The following table outlines the necessary parameters and best practices for configuring and integrating Cisco ACI with Linux Bridge on RHV hosts.

Resource	Configuration considerations	Best Practices
Endpoint groups	• Separate EPG for native VLAN • Static binding of interfaces towards HCI storage and compute nodes in native VLAN EPG to be on 802.1P mode • Static binding of vPCs required on In-band management EPG and iSCSI EPG before RHV installation	• Separate VLAN pool for VMM domain with dynamic allocation turned on • Contracts between EPGs to be well defined. Allow only required ports for communication. • Use unique native VLAN for discovery during Element cluster formation • For EPGs corresponding to port-groups being attached to VMkernel ports, VMM domain to be attached with ‘Pre-Provision’ for Resolution Immediacy
Interface policy	• One vPC policy group per RHV-H host • One vPC policy group per NetApp HCI storage node • LLDP enabled, CDP disabled	• Recommended to use vPC towards RHV-H hosts • Use ‘LACP Active’ for the port-channel policy • Use only ‘Graceful Convergence’ and ‘Symmetric Hashing’ control bits for port-channel policy Use ‘Layer4 Src-port’ load balancing hashing method for port-channel policy Recommended to use vPC with LACP Active port-channel policy for interfaces towards NetApp HCI storage nodes
VMM Integration	Do not migrate host management logical interfaces from ovirtmgmt to any other logical network	iSCSI host logical interface to be migrated to iSCSI logical network managed by ACI VMM integration

Except for the ovirtmgmt logical network, it is possible to create all other infrastructure logical networks on Cisco APIC and map them to the VMM domain. ‘ovirtmgmt’ logical network uses the static path binding on the In-band management EPG attached with the physical domain.

Next: KVM on RHEL: NetApp HCI with Cisco ACI

KVM on RHEL: NetApp HCI with Cisco ACI

KVM (for Kernel-based Virtual Machine) is an open-source full virtualization solution for Linux on x86 hardware such as Intel VT or AMD-V. In other words, KVM lets you turn a

Linux machine into a hypervisor that allows the host to run multiple, isolated VMs.

KVM converts any Linux machine into a type-1 (bare-metal) hypervisor. KVM can be implemented on any Linux distribution, but implementing KVM on a supported Linux distribution—like Red Hat Enterprise Linux—expands KVM’s capabilities. You can swap resources among guests, share common libraries, and optimize system performance.

Workflow

The following high-level workflow was used to set up the virtual environment. Each of these steps might involve several individual tasks.

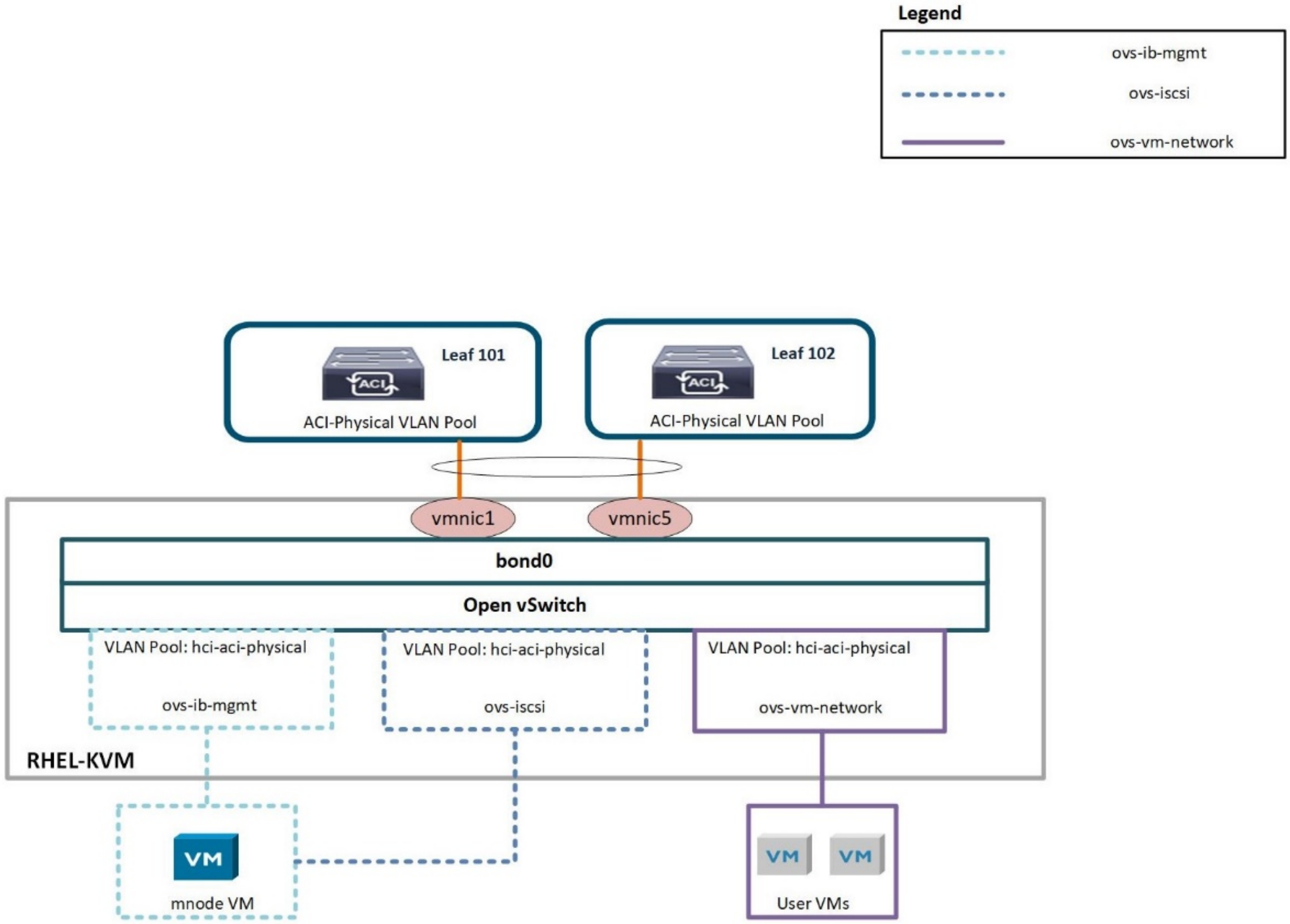
1. Install and configure Nexus 9000 switches in ACI mode, and install and configure APIC software on a UCS C-series server. See the Install and Upgrade documentation for detailed steps.
2. Configure and set up the ACI fabric by referring to the documentation.
3. Configure the tenants, application profiles, bridge domains, and EPGs required for NetApp HCI nodes. NetApp recommends using a one-BD-to-one-EPG framework except for iSCSI. See the documentation here for more details. The minimum set of EPGs required are in-band management, iSCSI, VM Motion, VM-data network, and native.
4. Create the VLAN pool, physical domain, and AEP based on the requirements. Create the switch and interface profiles and policies for vPCs and individual ports. Then attach the physical domain and configure the static paths to the EPGs. See the configuration guide for more details. Also see this table <link> for best practices for integrating ACI with Open vSwitch on the RHEL–KVM hypervisor.

   > Use a vPC policy group for interfaces connecting to NetApp HCI storage and compute nodes.

5. Create and assign contracts for tightly-controlled access between workloads. For more details on configuring the contracts, see the guide here.
6. Install and configure a NetApp HCI Element cluster. Do not use NDE for this installation; rather, install a standalone Element cluster on HCI storage nodes. Then configure the required volumes for the installation of RHEL. Install RHEL, KVM, and Open vSwitch on the NetApp HCI compute nodes. Configure storage pools on the hypervisor using Element volumes for a shared storage service for hosts and VMs. For more details on installation and configuration of KVM on RHEL, see the Red Hat documentation. See the OVS documentation for details on configuring Open vSwitch.
7. RHEL KVM hypervisor’s Open vSwitch cannot be VMM integrated with Cisco ACI. Physical domain and static paths must be configured on all required EPGs to allow the required VLANs on the interfaces connecting the ACI leaf switches and RHEL hosts. Also configure the corresponding OVS bridges on RHEL hosts and configure VMs to use those bridges. The networking functionality for the RHEL KVM hosts in this solution is achieved using Open vSwitch virtual switch.

Open vSwitch

Open vSwitch is an open-source, enterprise-grade virtual switch platform. It uses virtual network bridges and flow rules to forward packets between hosts. Programming flow rules work differently in OVS than in the standard Linux Bridge. The OVS plugin does not use VLANs to tag traffic. Instead, it programs flow rules on the virtual switches that dictate how traffic should be manipulated before forwarded to the exit interface. Flow rules determine how inbound and outbound traffic should be treated. The following figure depicts the internal networking of Open vSwitch on an RHEL-based KVM host.



The following table outlines the necessary parameters and best practices for configuring Cisco ACI and Open vSwitch on RHEL based KVM hosts.

Resource	Configuration Considerations	Best Practices
Endpoint groups	• Separate EPG for native VLAN • Static binding of interfaces towards HCI storage and compute nodes in native VLAN EPG to be on 802.1P mode • Static binding of vPCs required on in-band management EPG and iSCSI EPG before KVM installation	• Separate VLAN pool for physical domain with static allocation turned on • Contracts between EPGs to be well defined. Allow only required ports for communication. • Use unique native VLAN for discovery during Element cluster formation

Resource	Configuration Considerations	Best Practices
Interface Policy	- One vPC policy group per RHEL host - One vPC policy group per NetApp HCI storage node - LLDP enabled, CDP disabled	• NetApp recommends using vPC towards RHV-H hosts • Use LACP Active for the port-channel policy • Use only Graceful Convergence and Symmetric Hashing control bits for port-channel policy • Use Layer4 Src-Port load-balancing hashing method for port-channel policy • NetApp recommends using vPC with LACP Active port-channel policy for interfaces towards NetApp HCI storage nodes

Next: ONTAP on AFF: NetApp HCI and Cisco ACI

ONTAP on AFF: NetApp HCI and Cisco ACI

NetApp AFF is a robust storage platform that provides low-latency performance, integrated data protection, multiprotocol support, and nondisruptive operations. Powered by NetApp ONTAP data management software, NetApp AFF ensures nondisruptive operations, from maintenance to upgrades to complete replacement of your storage system.

NetApp ONTAP is a powerful storage operating system with capabilities like inline compression, nondisruptive hardware upgrades, and cross-storage import. A NetApp ONTAP cluster provides a unified storage system with simultaneous data access and management of Network File System (NFS), Common Internet File System (CIFS), iSCSI, Fibre Channel (FC), Fibre Channel over Ethernet (FCoE), and NVMe/FC protocols. ONTAP provides robust data protection capabilities, such as NetApp MetroCluster, SnapLock, Snapshot copies, SnapVault, SnapMirror, SyncMirror technologies and more. For more information, see the ONTAP documentation.

To extend the capabilities of storage to file services and add many more data protection abilities, ONTAP can be used in conjunction with NetApp HCI. If NetApp ONTAP already exists in your environment, you can easily integrate it with NetApp HCI and Cisco ACI.

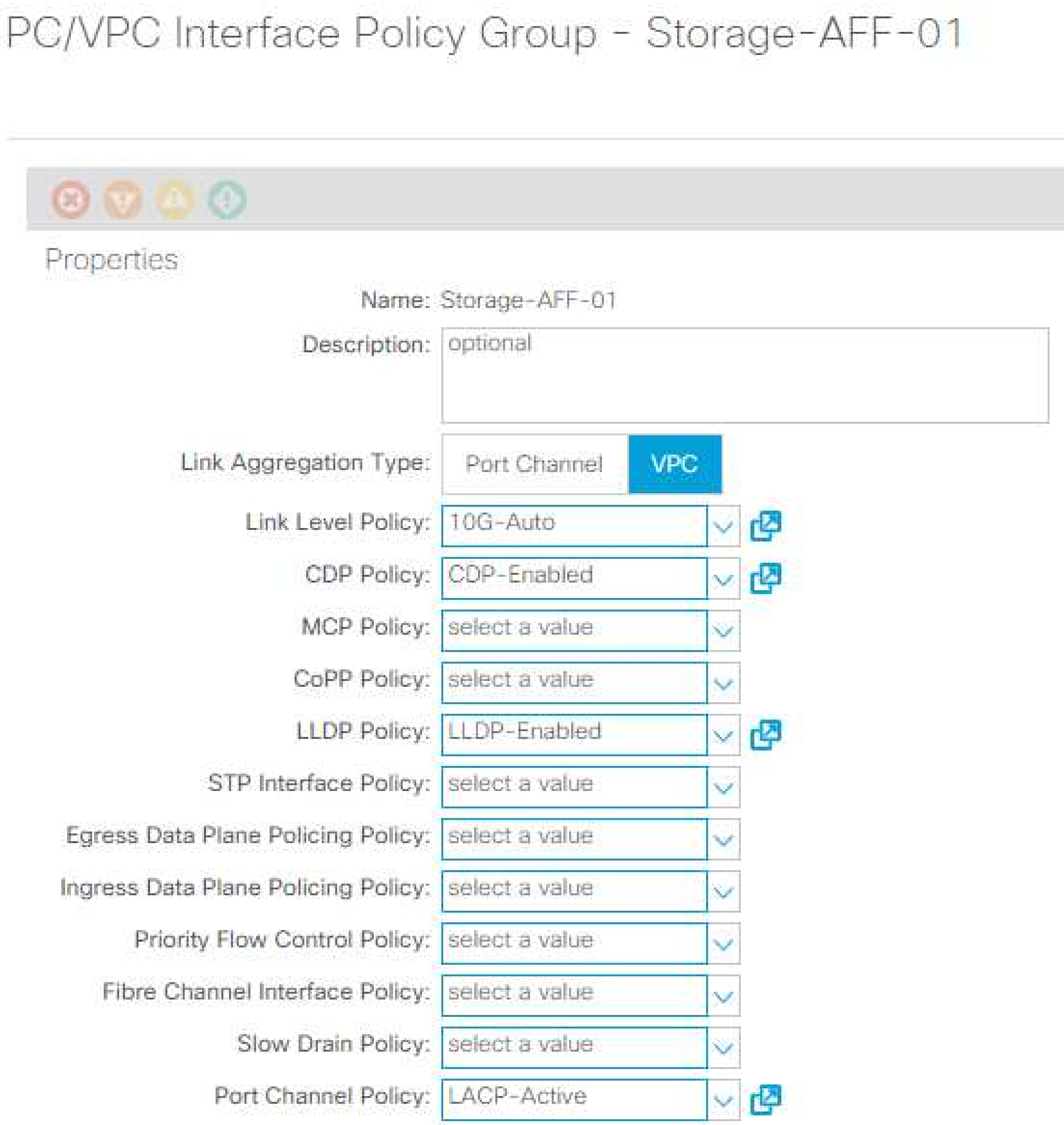
Workflow

The following high-level workflow was used to set up the environment. Each of these steps might involve several individual tasks.

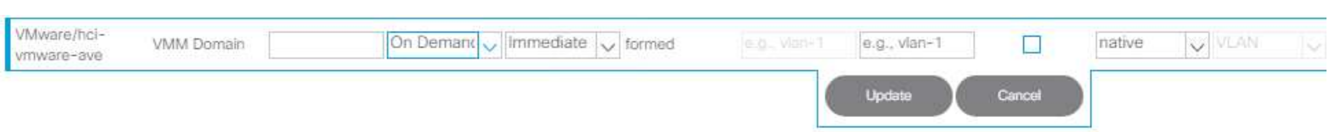
1. Create a separate bridge domain and EPG on ACI for NFS and/or other protocols with the corresponding subnets. You can use the same HCI-related iSCSI EPGs.
2. Make sure you have proper contracts in place to allow inter-EPG communication for only the required

ports.

3. Configure the interface policy group and selector for interfaces towards AFF controllers. Create a vPC policy group with the LACP Active mode for port-channel policy.



4. Attach both a physical and VMM domain to the EPGs created. Attach the vPC policy as static paths and, in the case of theCisco AVE virtual switch, use Native switching mode when you attach the VMM domain.



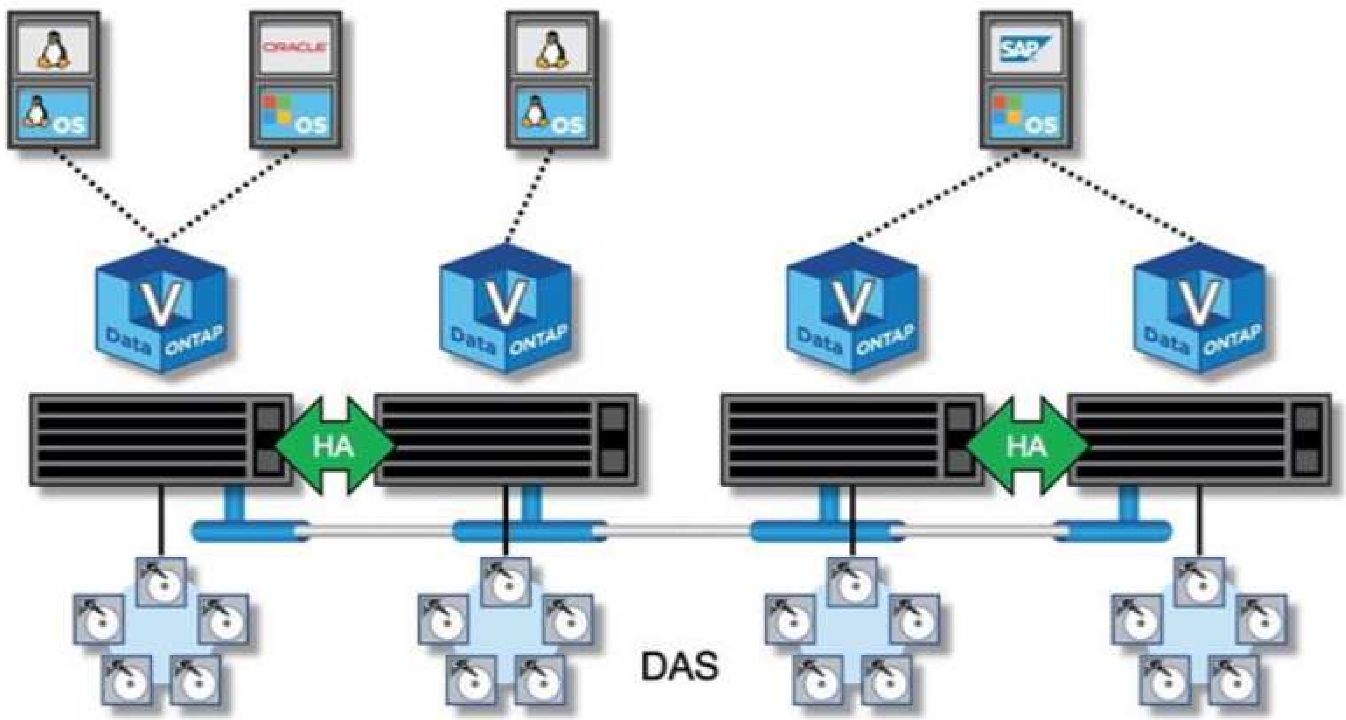
5. Install and configure an ONTAP cluster on the AFF controllers. Then create and configure NFS and/or iSCSI volumes/LUNs. See the AFF and ONTAP documentation for more information.
6. Create a VMkernel adapter (in the case of VMware ESXi) or a logical interface (in the case of RHV-H and RHEL-KVM hosts) attaching the NFS (or other protocols) port group or logical network.
7. Create additional datastores, storage domains, or storage pools on hypervisors (VMware, RHV, or KVM) using AFF storage.

Next: ONTAP Select with VMware vSphere: NetApp HCI and Cisco ACI

ONTAP Select with VMware vSphere: NetApp HCI and Cisco ACI

NetApp ONTAP Select is the NetApp solution for software-defined storage (SDS), bringing enterprise-class storage management features to the software-defined data center. ONTAP Select extends ONTAP functionality to extreme edge use cases including IoT and tactical servers as a software-defined storage appliance that acts as a full storage system. It can run as a simple VM on top of a virtual environment to provide a flexible and scalable storage solution.

Running ONTAP as software on top of another software application allows you to leverage much of the qualification work done by the hypervisor. This capability is critical for helping us to rapidly expand our list of supported platforms. Also, positioning ONTAP as a virtual machine (VM) allows customers to plug into existing management and orchestration frameworks, which allows rapid provisioning and end-to-end automation from deployment to sunsetting. The following figure provides an overview of a four-node ONTAP Select instance.

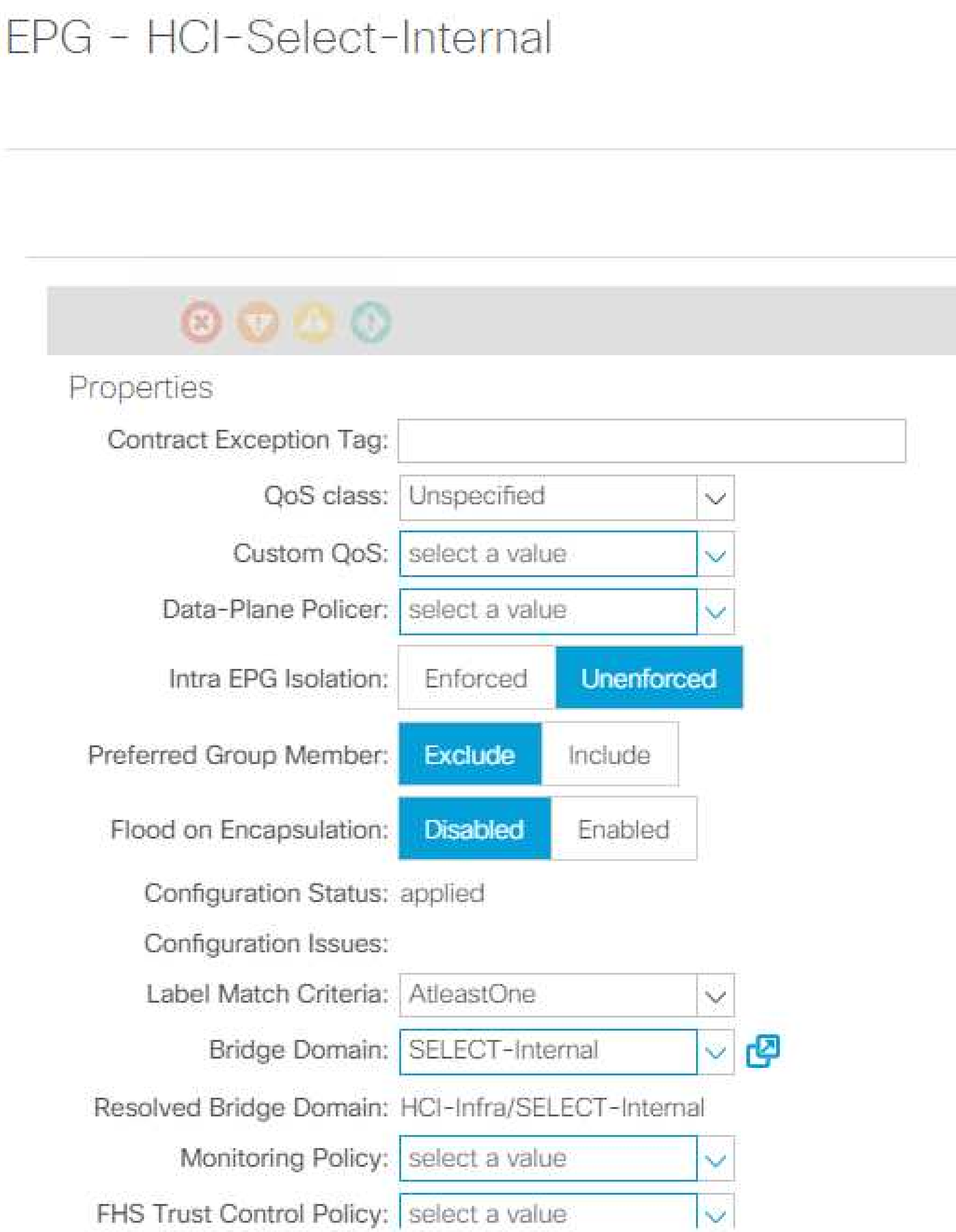


Deploying ONTAP Select in the environment to use the storage offered by NetApp HCI extends the capabilities of NetApp Element.

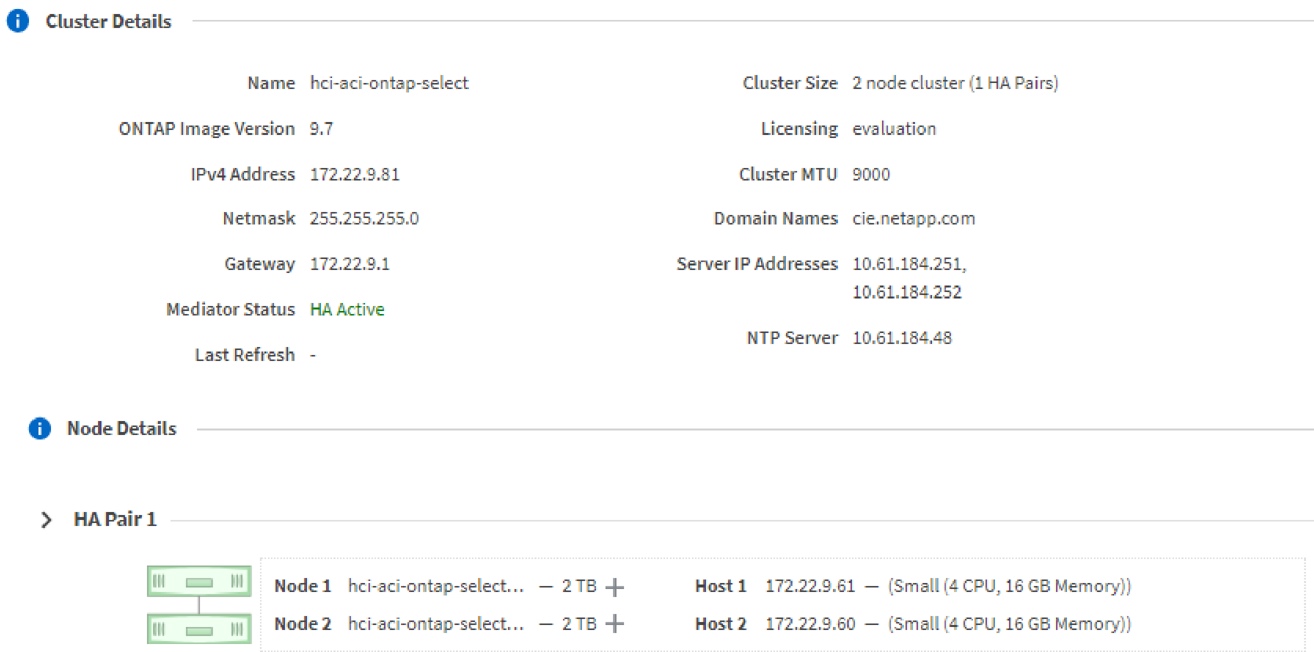
Workflow

The following workflow was used to set up the environment. In this solution, we deployed a two-node ONTAP Select cluster. Each of these steps might involve several individual tasks.

1. Create an L2 BD and EPG for the OTS cluster's internal communication and attach the VMM domain to the EPG in the Native switching mode (in case of a Cisco AVE virtual switch) with Pre-Provision Resolution Immediacy.



2. Verify that you have a VMware vSphere license.
3. Create a datastore that hosts OTS.
4. Deploy and configure ONTAP Select according to the ONTAP Select documentation.

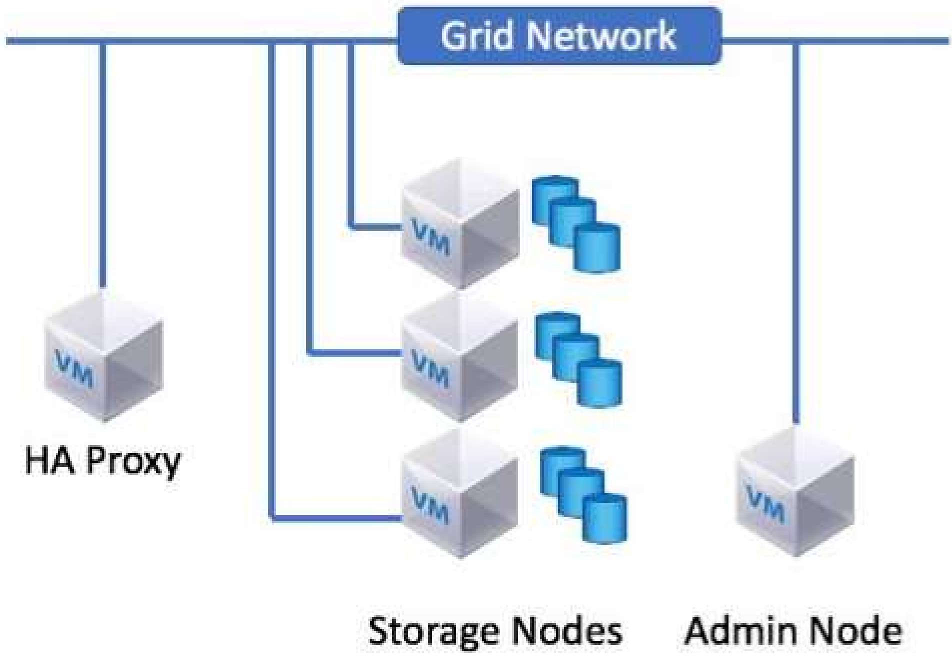


5. Create additional datastores using ONTAP Select to make use of additional capabilities.

Next: StorageGRID with VMware vSphere: NetApp HCI and Cisco ACI

StorageGRID with VMware vSphere: NetApp HCI and Cisco ACI

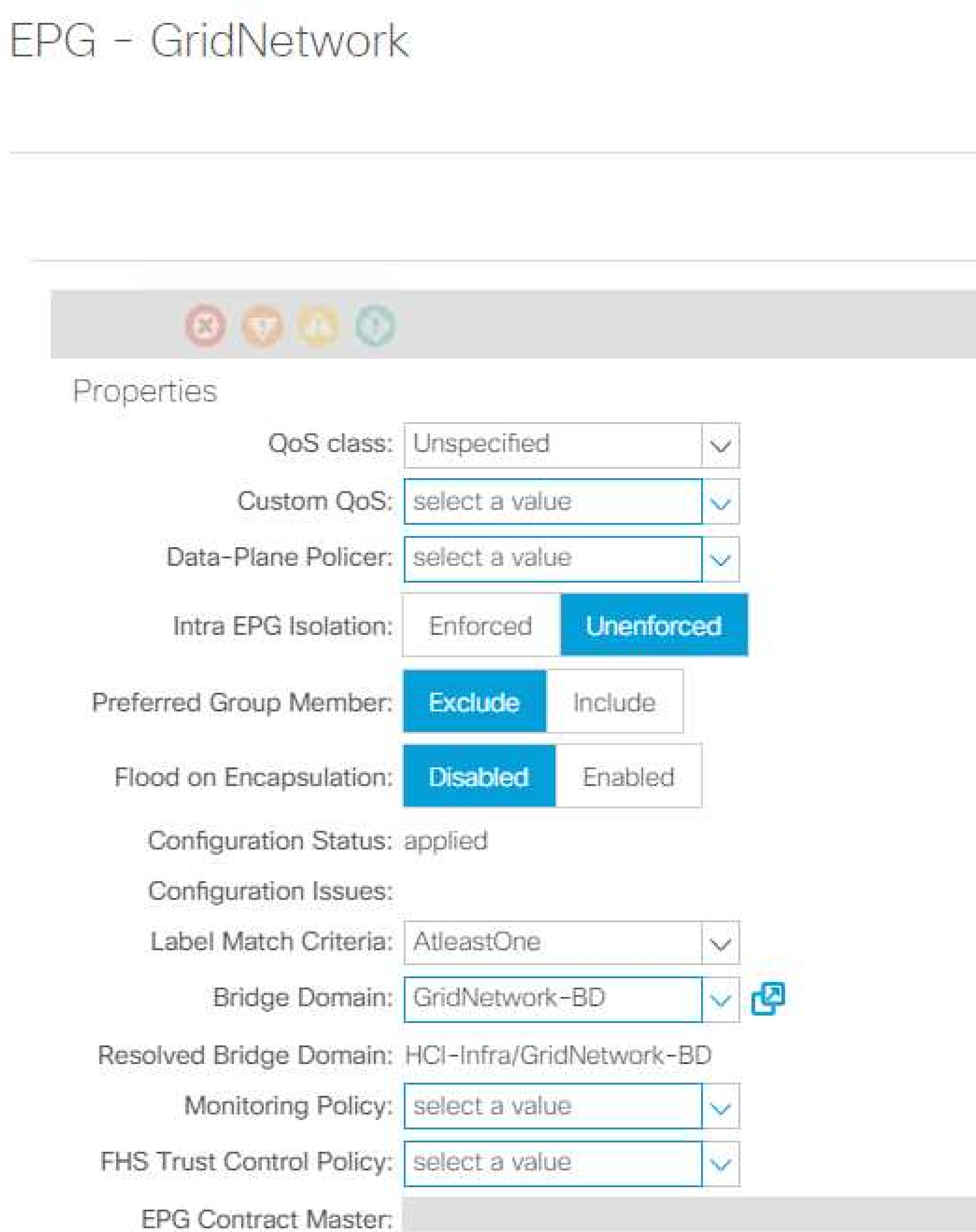
StorageGRID is a robust software-defined, object-based storage platform that stores and manages unstructured data with a tiered approach along with intelligent policy-driven management. It allows you to manage data while optimizing durability, protection, and performance. StorageGRID can also be deployed as hardware or as an appliance on top of a virtual environment that decouples storage management software from the underlying hardware. StorageGRID opens a new realm of supported storage platforms, increasing flexibility and scalability. StorageGRID platform services are also the foundation for realizing the promise of the hybrid cloud, letting you tier and replicate data to public or other S3-compatible clouds. See the StorageGRID documentation for more details. The following figure provides an overview of StorageGRID nodes.



Workflow

The following workflow was used to set up the environment. Each of these steps might involve several individual tasks.

1. Create an L2 BD and EPG for the grid network used for internal communication between the nodes in the StorageGRID system. However, if your network design for StorageGRID consists of multiple grid networks, then create an L3 BD instead of an L2 BD. Attach the VMM domain to the EPG with the Native switching mode (in the case of a Cisco AVE virtual switch) and with Pre-Provision Resolution Immediacy. The corresponding port group is used for the grid network on StorageGRID nodes.



2. Create a datastore to host the StorageGRID nodes.
3. Deploy and configure StorageGRID. For more details on installation and configuration, see the StorageGRID documentation. If the environment already has ONTAP or ONTAP Select, then you can use the NetApp Fabric Pool feature. Fabric Pool is an automated storage tiering feature in which active data resides on local high-performance solid-state drives (SSDs) and inactive data is tiered to low-cost object storage. It was first made available in NetApp ONTAP 9.2. For more information on Fabric Pool, see the documentation here.

Next: Validation Results