



VMware vSphere: NetApp HCI with Cisco ACI

HCI

NetApp
September 15, 2020

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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.

VLAN Pool - HCI-Internal-Phys-Dom-VLAN (Static Allocation)

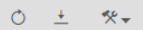


Policy

Operational

Faults

History



Properties

Name: HCI-Internal-Phys-Dom-VLAN

Description: optional

Alias:

Allocation Mode: Static Allocation

Encap Blocks:

VLAN Range	Allocation Mode	Role
[2]	Inherit allocMode from parent	External or On the wire encapsulations
[3201-3250]	Inherit allocMode from parent	External or On the wire encapsulations

Domains:	Name	Type
	HCI-Internal-Phys-Dom	Physical Domain

Show Usage

Close

Submit

Leaf Access Port Policy Group - HCI-Compute-ESX



Properties

Name: HCI-Compute-ESX

Description: optional

Alias:

Link Level Policy: 10G-Auto

CDP Policy: CDP-Disabled

MCP Policy: select a value

CoPP Policy: select a value

LLDP Policy: LLDP-Enabled



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.



Properties


Name:	hci-aci-vds-02
Virtual Switch:	Distributed Switch
Associated Attachable Entity	▲ Name
Profiles:	HCI-Internal







Encapsulation:	vlan
Delimiter:	
Enable Tag Collection:	<input checked="" type="checkbox"/>
Enable VM Folder Data Retrieval:	<input type="checkbox"/>
Access Mode:	<div>Read Only Mode</div> <div>Read Write Mode</div>
Endpoint Retention Time (seconds):	<div>0</div> <div>^</div> <div>v</div>
VLAN Pool:	<div>hci-aci-vmware(dynamic</div> <div>v</div> <div></div>

- 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.

Properties

Name:	hci-vmware-ave		
Virtual Switch:	Cisco AVE		
AVE Time-out Time (seconds):	30	 	
Host Availability Assurance:	<input type="checkbox"/>		
Associated Attachable Entity	▲ Name		
Profiles:	HCI-Internal		

Switching Preference:	No Local Switching	Local Switching	
Enhanced Lag Policy:	select an option		
Encapsulation:	vxlan		
Default Encap Mode:	Unspecified	VLAN	VXLAN

Enable Tag Collection:	<input checked="" type="checkbox"/>	
Enable VM Folder Data Retrieval:	<input type="checkbox"/>	
Endpoint Retention Time (seconds):	0	 
VLAN Pool:	hci-aci-vmware(dynamic)	 
AVE Fabric-Wide Multicast Address:	227.200.100.100	
Must Use a Multicast Address different from the Multicast Address Ranges.		
Pool of Multicast Addresses (one per-EPG):	multicast-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.

hci-aci-vds-02 | ACTIONS ▾

Summary Monitor Configure Permissions Ports Hosts VMs Networks

Manufacturer: VMware, Inc.
Version: 6.6.0
[Upgrades available](#)

Switch Details ▾

Notes ▴

APIC Virtual Switch
[Edit Notes...](#)

VMkernel adapters

Add Networking... Refresh Edit... Remove

Device ▾	Network Label ▾	Switch ▾	IP Address ▾	TCP/IP Stack ▾	vMotion ▾	Provisioning ▾
vmk0	HCI-InfralHCIH...	hci-vmware-ave	172.22.9.60	Default	Disabled	Disabled
vmk1	HCI-InfralHCIH...	hci-vmware-ave	172.22.10.60	Default	Disabled	Disabled
vmk2	HCI-InfralHCIH...	hci-vmware-ave	172.22.10.58	Default	Disabled	Disabled
vmk3	HCI-InfralHCIH...	hci-vmware-ave	172.22.13.60	Default	Enabled	Disabled
vmk4	HCI-InfralAFF-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.

Tenant HCI-Infra

useg-ubuntu-prod

Domains (VMs and Bare-Me...)

Static Leafs

Contracts

Static Endpoint

uSeg Attributes

Subnets

L4-L7 Virtual IPs

uSeg Attributes

Policy History

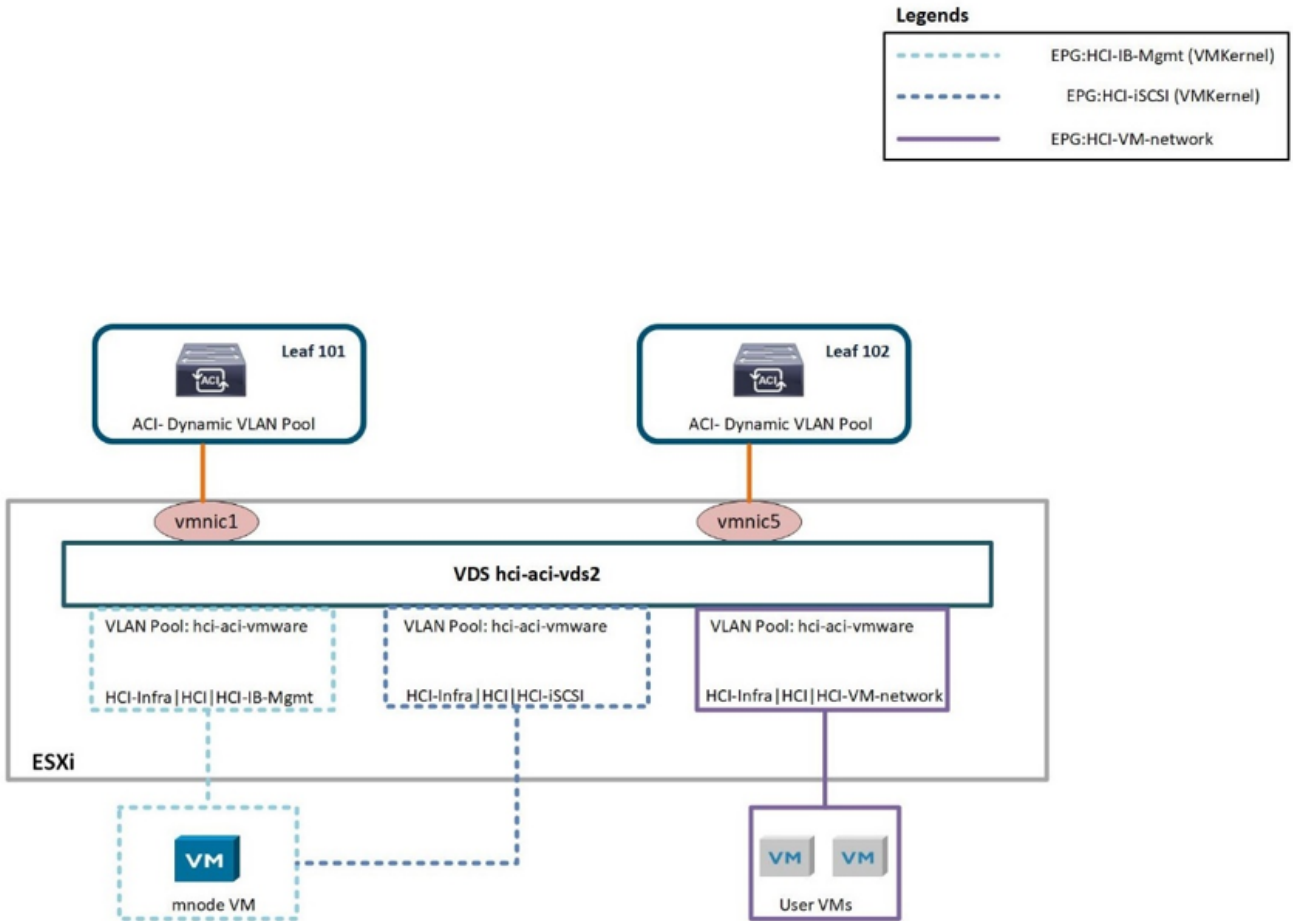
Match Any ▾

VM - Tag ▾ ubuntu Contains ▾ ubuntu-prod

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.

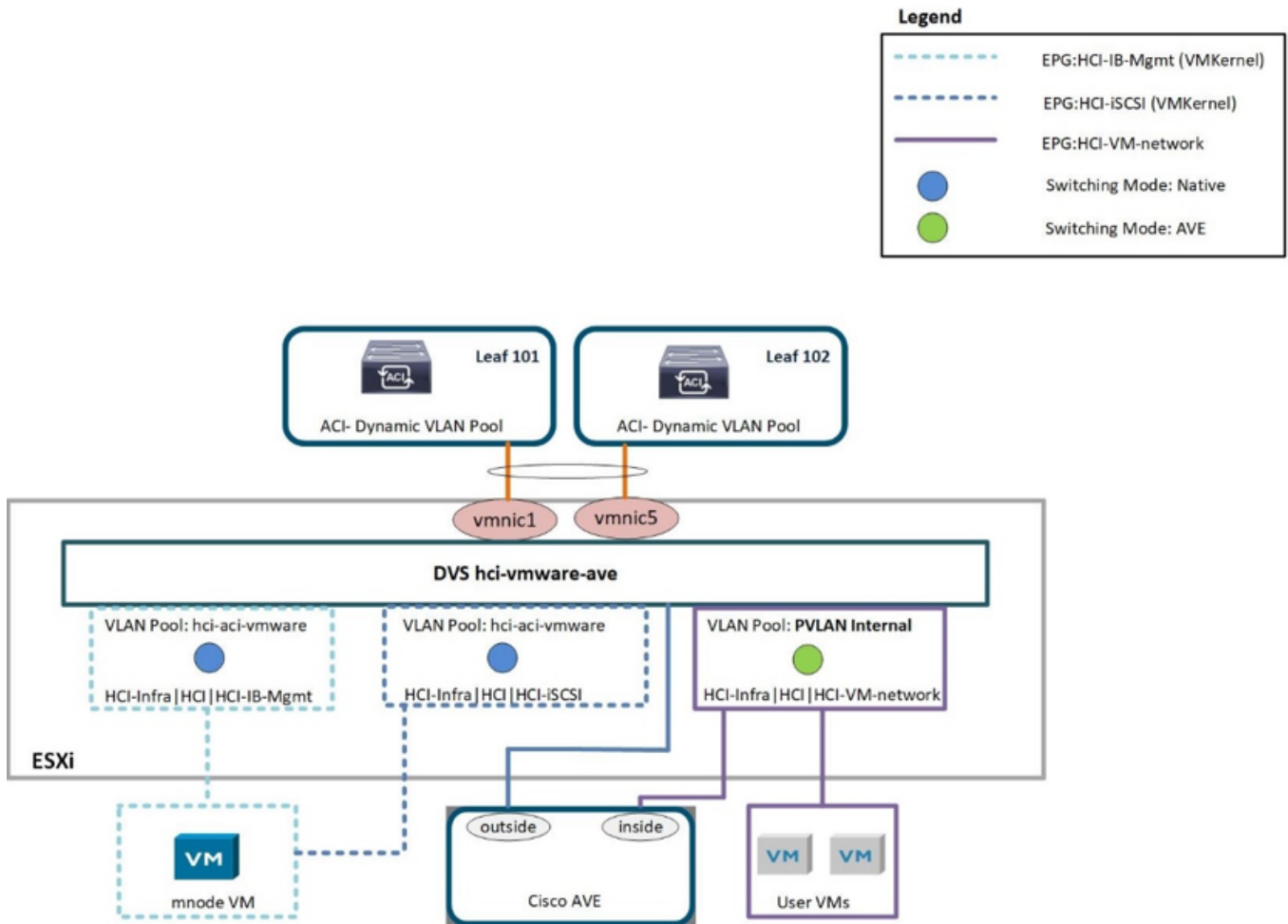
Resource	Configuration Considerations	Best Practices
Endpoint groups	<ul style="list-style-type: none"> • Separate EPG for native VLANs • Static binding of interfaces to HCI storage and compute nodes in native VLAN EPG uses 802.1P mode. This is required for node discovery to run NDE. • Separate EPGs 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 	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • A common leaf access port policy group for all ESXi hosts • One vPC policy group per NetApp HCI storage node • LLDP enabled, CDP disabled 	<ul style="list-style-type: none"> • 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.

Resource	Configuration Considerations	Best Practices
VMM Integration	<ul style="list-style-type: none"> • Local switching preference • Access mode is Read Write. 	<ul style="list-style-type: none"> • MAC-Pinning-Physical-NIC-Load for vSwitch policy • LLDP for discovery policy • Enable Tag collection if micro-segmentation is used
VDS	<ul style="list-style-type: none"> • Both uplinks active for iSCSI port-group • One uplink each for iSCSI-A and iSCSI-B 	<ul style="list-style-type: none"> • 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	<p>Separate EPG for native VLANs</p> <p>Static binding of interfaces towards HCI storage and compute nodes in native VLAN</p> <p>EPG uses 802.1P mode. This is required for node discovery to run NDE.</p> <p>Separate EPGs for iSCSI, iSCSI-A and iSCSI-B with a common BD</p> <p>iSCSI-A and iSCSI-B are for iSCSI multipathing and are used for VMkernel ports on ESXi hosts</p> <p>Physical domain to be attached to iSCSI EPG before running NDE</p> <p>VMM domain is attached to iSCSI, iSCSI-A, and iSCSI-B EPGs</p>	<p>Separate VLAN pool for VMM domain with dynamic allocation turned on</p> <p>Contracts between EPGs to be well defined. Allow only required ports for communication.</p> <p>Use unique native VLAN for NDE node discovery</p> <p>Use native switching mode in VMM domain for EPGs that correspond to port groups being attached to host's VMkernel adapters</p> <p>Use AVE switching mode in VMM domain for EPGs corresponding to port groups carrying user VM traffic</p> <p>For EPGs corresponding to port-groups being attached to VMkernel ports, VMM domain is attached with Pre-Provision for Resolution Immediacy</p>
Interface Policy	<ul style="list-style-type: none"> • One vPC policy group per ESXi host • One vPC policy group per NetApp HCI storage node • LLDP enabled, CDP disabled 	<ul style="list-style-type: none"> • 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

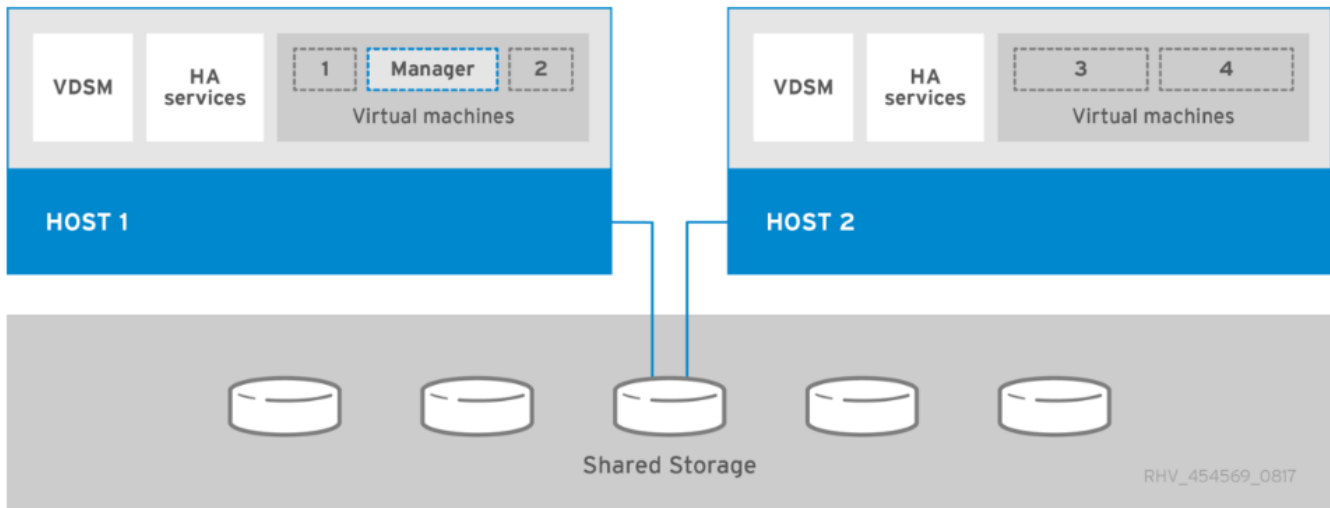
Resource	Configuration Considerations	Best Practices
VMM Integration	<ul style="list-style-type: none"> • Create a new VLAN range [or Encap Block] with role Internal and Dynamic allocation' attached to the VLAN pool intended for VMM domain • Create a pool of multicast addresses (one address per EPG) • 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 	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • - Both uplinks active for iSCSI port-group • - One uplink each for iSCSI-A and iSCSI-B 	<ul style="list-style-type: none"> • 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 ACI 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.

PC/VPC Interface Policy Group - HCI-RHVH01



Properties

Name: HCI-RHVH01

Description: optional

Link Aggregation Type: Port Channel **VPC**

Link Level Policy: 10G-Auto 

CDP Policy: CDP-Disabled 

MCP Policy: select a value

CoPP Policy: select a value

LLDP Policy: LLDP-Enabled 

STP Interface Policy: select a value

Egress Data Plane Policing Policy: select a value

Ingress Data Plane Policing Policy: select a value

Priority Flow Control Policy: select a value

Fibre Channel Interface Policy: select a value

Slow Drain Policy: select a value

Port Channel Policy: LACP-Active 



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

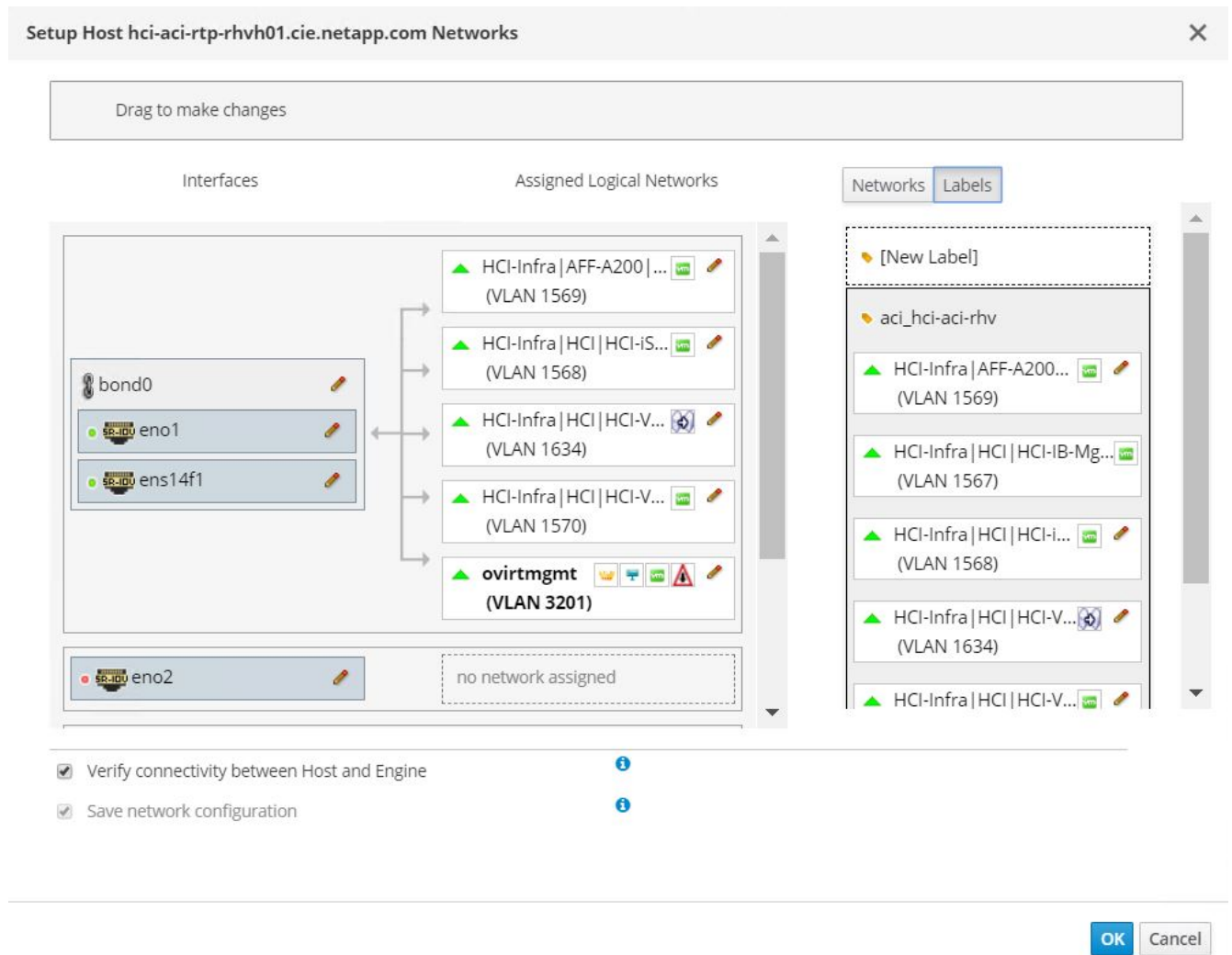
domain and attach the VMM domain to all the required EPGs, using Pre- Provision Resolution Immediacy. This process automatically creates corresponding logical networks and vNIC profiles. The vNIC profiles can be directly used to attach to hosts and VMs for their communication. The networks that are managed 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.

Network > Networks

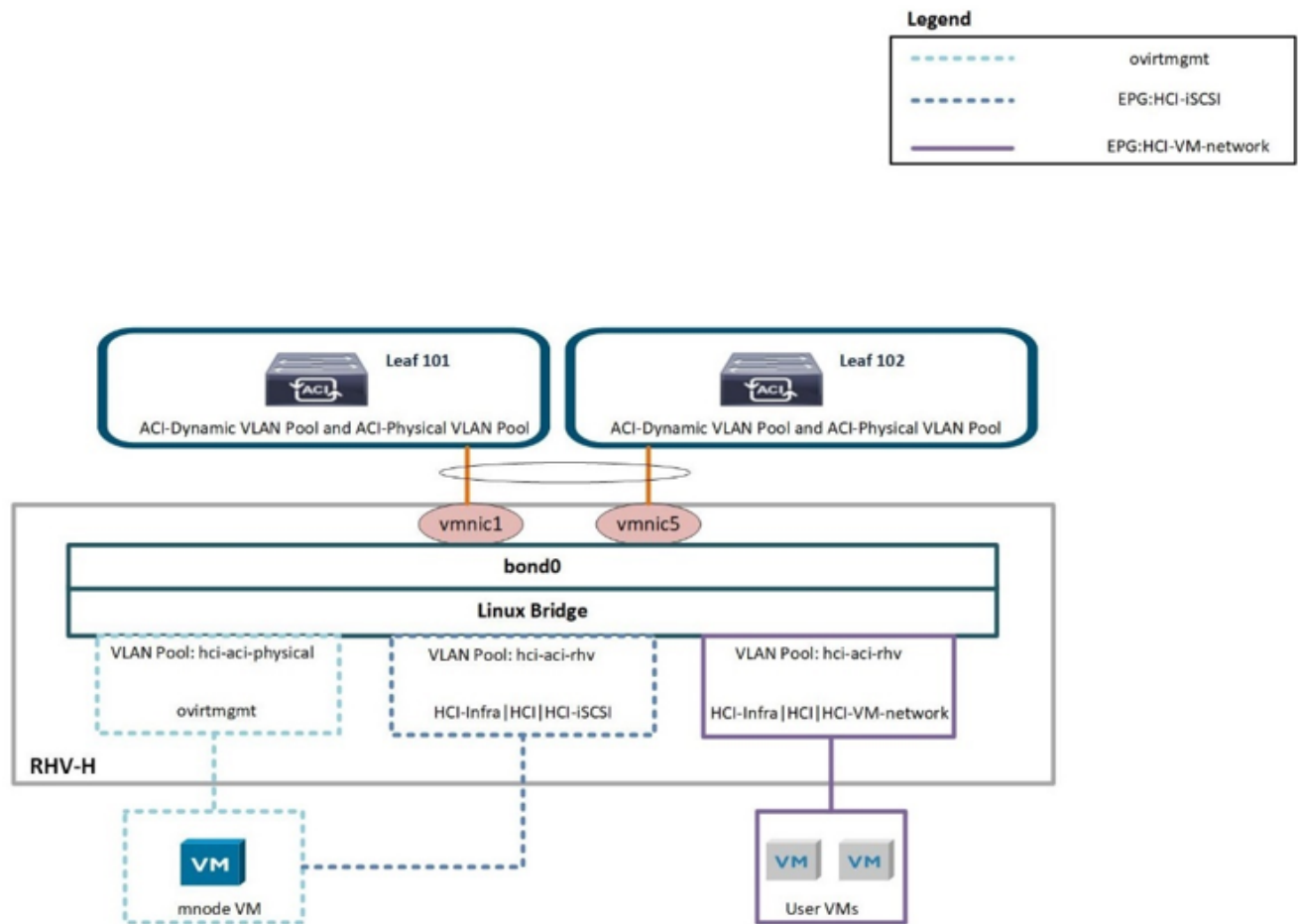
Network:		✕	☆	▼	Q	New	Import	Edit	Remove
↻	▼								1 - 8 < >
Name	Comment	Data Center	Description	Role	VLAN Tag	QoS Nam Label	Provider	MTU	
HCI-Infra AFF-A200 AFF-NFS		Default		🟢	1569	-	aci_hci-aci-rhv	9000	
HCI-Infra HCI HCI-IB-Mgmt		Default		🟢	1567	-	aci_hci-aci-rhv	Default (1500)	
HCI-Infra HCI HCI-5CSI		Default		🟢	1568	-	aci_hci-aci-rhv	9000	
HCI-Infra HCI HCI-VM-motion		Default			1634	-	aci_hci-aci-rhv	Default (1500)	
HCI-Infra HCI HCI-VM-network		Default		🟢	1570	-	aci_hci-aci-rhv	Default (1500)	
ovirtmgmt		Default	Management Network	🟢	3201	-	-	Default (1500)	
quarantine		Default		🟢	666	-	aci_hci-aci-rhv	Default (1500)	
uplinkNetwork		Default	uplinkNetwork	🟢	-	-	-	Default (1500)	



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	<ul style="list-style-type: none"> • 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 	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • One vPC policy group per RHV-H host • One vPC policy group per NetApp HCI storage node • LLDP enabled, CDP disabled 	<ul style="list-style-type: none"> • 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](#)

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