Installing Agent-based OpenShift 4.14 on a Bare Metal Server

Revised: April 12, 2024

New and Changed Information

The following table provides an overview of the significant changes up to this current release. The table does not provide an exhaustive list of all changes or of the new features up to this release.

Cisco ACI CNI plug-in Release Version	Feature
6.0(4)	Cisco Application Centric Infrastructure (ACI) supports Red Hat Agent-based OpenShift on a bare metal server.

Agent-based Openshift 4.14 on Bare Metal

This document pertains to installing OCP with the ACI CNI. However, to identify and resolve issues in your infrastructure not related to the ACI CNI, see the relevant installation guide to first install OCP on your bare metal nodes using the default OVN Kubernetes. *You can check the OpenShift 4.14 container platform documentation.*

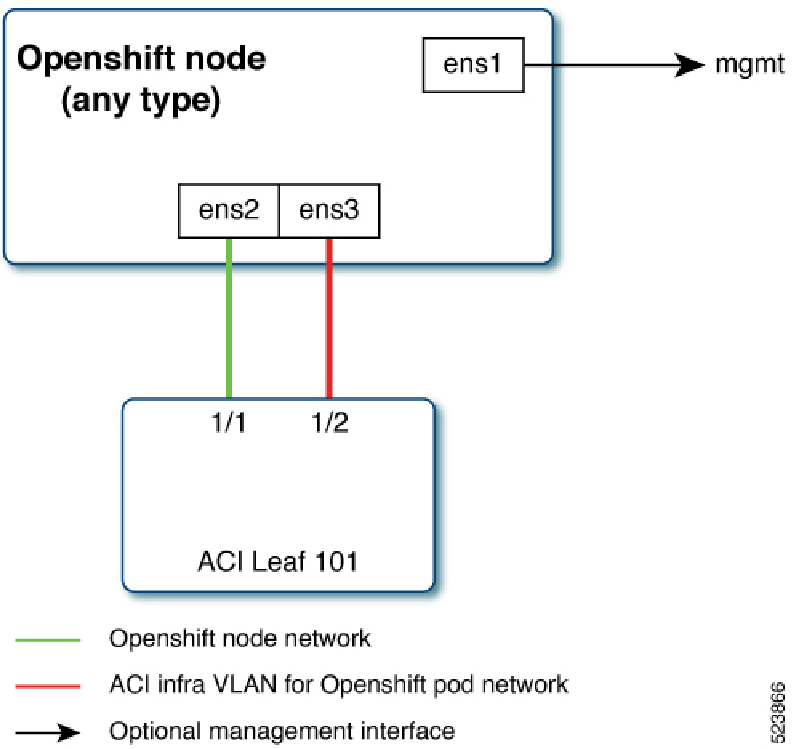
Note This document can not be used standalone. This document should be used along with the *Red Hat OpenShift 4.14 Installing an on-premise cluster with the agent-based installer* document to perform the OpenShift cluster installation.

Requirements for supporting OpenShift 4.14 on a Bare Metal Server

At least two network interfaces are required for bare metal nodes, one for the node network, and the second for the pod network. The design separates OpenShift node traffic from the pod traffic. There are two options available to achieve separation, resulting in control and compute machines each having two network interfaces:

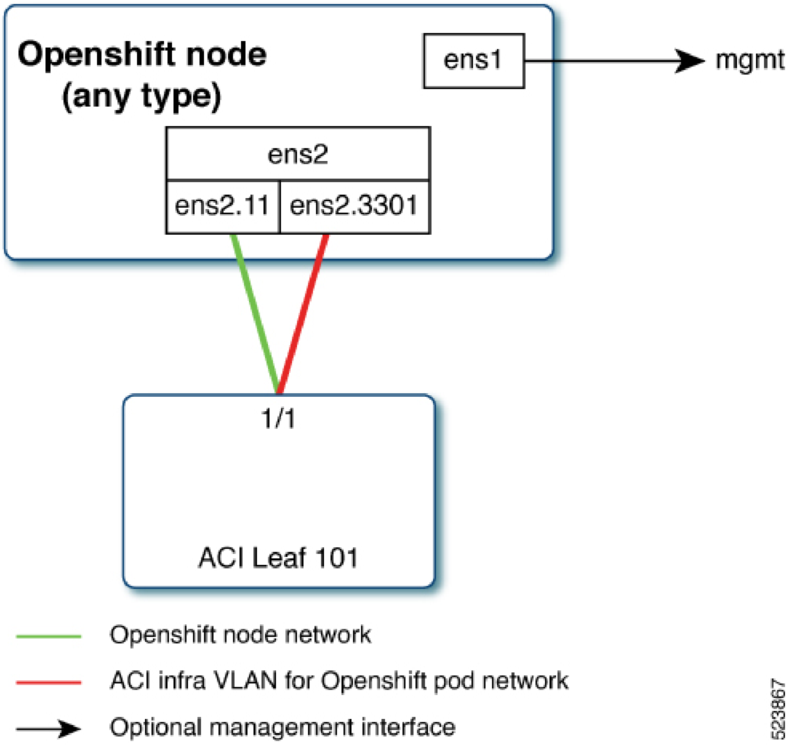
- Separate physical interface for node and infra networks
- Single Sub interface for both node and infra networks

Separate physical interface for node and infra networks


Openshift node (any type)
ens1
mgmt
ens2
ens3
1/1
1/2
ACI Leaf 101
Openshift node network
ACI infra VLAN for Openshift pod network
Optional management interface
523866

The first interface is used for the node network and the second one is used for the pod network. The second interface also carries Cisco ACI control plane traffic. A VLAN tagged subinterface can be configured on the second interface to carry the cluster's pod traffic and also the Cisco ACI control plane traffic.

Single Sub interface for both node and infra networks



The node network and pod network are configured as VLAN subinterface of either bond0 or physical NIC. You can configure the server with additional VLAN(s) for management purpose or use the node network for management network. The design might be dependent on the server provisioning method (PXE or manual ISO boot).

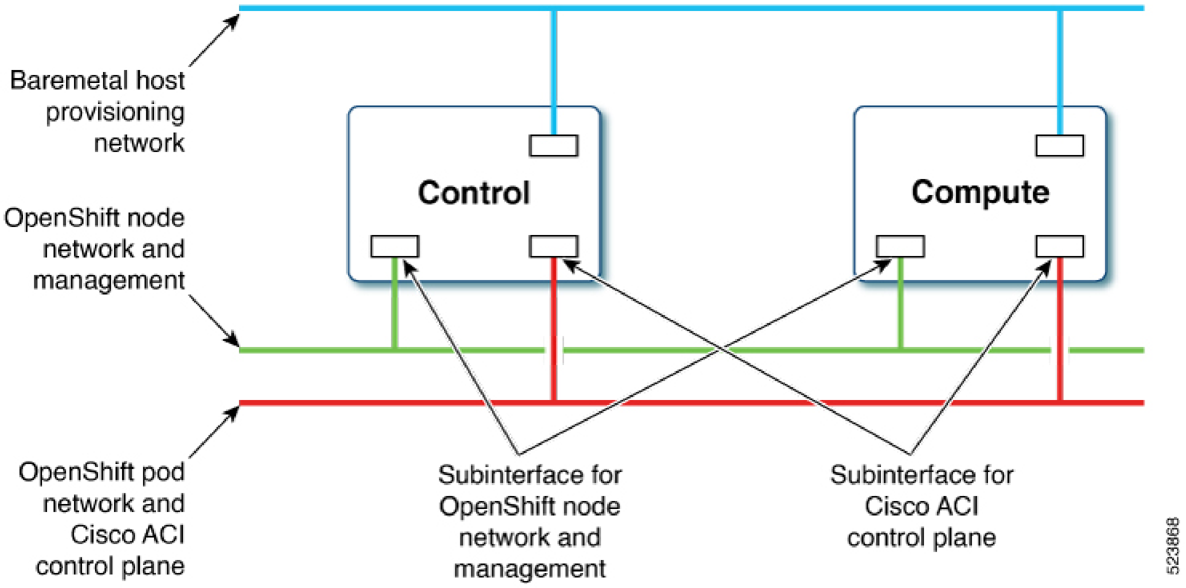
Installation Process

The following sections detail the steps required to install the OpenShift cluster using the ACI CNI.

- Configuring the OpenShift Installer , on page 5
- Configuring ACI Infra and CNI , on page 8
- Preparing Custom Network Configuration for OpenShift Nodes, on page 9

The image below illustrates the various types of networks utilized in the installation process.

At least two network interfaces are necessary for bare metal nodes: one for the node network and the other for the pod network. This design segregates OpenShift node traffic from pod traffic. A third interface is configured for the private network, essential for provisioning bare metal hosts.


Baremetal host provisioning network
OpenShift node network and management
OpenShift pod network and Cisco ACI control plane
Control
Compute
Subinterface for OpenShift node network and management
Subinterface for Cisco ACI control plane
523868

Configuring the OpenShift Installer

Use this procedure to configure the OpenShift installer. The installation will use a 3 node-cluster (control will have scheduling enabled). For scaling nodes post installation, see the section, *Scaling Agent-Based Installation with the Bare Metal Operator*.

Before you begin

Download the OpenShift installer and OC client.

For details of the location from where you can download the installer , see the OpenShift 4.14 document titled, *Installing an on-premise cluster with the Agent-based Installer*.

Procedure

Step 1 Create the `install-config.yaml` file.

```
apiVersion: v1
baseDomain: noiro.local
proxy:
  httpsProxy: <http-proxy>
  httpProxy: <https-proxy>
  noProxy: <no-proxy>
compute:
- name: worker
  replicas: 0
controlPlane:
  name: master
  replicas: 3
metadata:
  name: ocpbm1
networking:
  machineNetwork:
  - cidr: 192.168.1.0/24
  clusterNetwork:
   - cidr: 10.2.0.0/16
     hostPrefix: 23
   networkType: CiscoACI
   serviceNetwork:
   - 172.30.0.0/16
 platform:
   baremetal:
     apiVIPs:
     - 192.168.1.30
     ingressVIPs:
     - 192.168.1.29
 fips: false
pullSecret: <RH-account-pull-secret>
sshKey: <host-ssh-key>
```

Step 2 Create the `agent-config.yaml` file.

```
apiVersion: v1alpha1
kind: AgentConfig
metadata:
  name: ocpbm1
rendezvousIP: 192.168.1.3
AdditionalNTPSources:
  - time.cisco.com
hosts:
  - hostname: ocpbm1-master1
    role: master
    interfaces:
    - name: ens160
      macAddress: 00:50:56:97:16:db
    networkConfig:
      interfaces:
        - name: ens160
          mtu: 9000
          ipv4:
            enabled: false
          ipv6:
            enabled: false
        - name: node
          type: vlan
          mtu: 9000
          state: up
          vlan:
            base-iface: ens160
            id: 11
          ipv4:
            enabled: true
            address:
              - ip: 192.168.1.3
                prefix-length: 24
            dhcp: false
          ipv6:
            enabled: false
        - name: infra
          type: vlan
          mtu: 9000
          state: up
          vlan:
            base-iface: ens160
            id: 3301
          ipv4:
            enabled: true
            dhcp: true
    ipv6:
     enabled: false
  dns-resolver:
   config:
    server:
     - 192.168.1.2
  routes:
   config:
    - destination: 0.0.0.0/0
     next-hop-address: 192.168.1.1
     next-hop-interface: node
    - destination: 224.0.0.0/4
     next-hop-interface: infra
- hostname: ocpbm1-master2
 role: master
 interfaces:
 - name: ens160
  macAddress: 00:50:56:97:63:de
 networkConfig:
  interfaces:
   - name: ens160
    mtu: 9000
    ipv4:
     enabled: false
    ipv6:
     enabled: false
   - name: node
    type: vlan
    mtu: 9000
    state: up
    vlan:
     base-iface: ens160
     id: 11
    ipv4:
     enabled: true
     address:
      - ip: 192.168.1.4
       prefix-length: 24
     dhcp: false
    ipv6:
     enabled: false
   - name: infra
    type: vlan
    mtu: 9000
    state: up
    vlan:
     base-iface: ens160
     id: 3301
    ipv4:
     enabled: true
     dhcp: true
    ipv6:
     enabled: false
  dns-resolver:
   config:
    server:
     - 192.168.1.2
  routes:
   config:
    - destination: 0.0.0.0/0
     next-hop-address: 192.168.1.1
     next-hop-interface: node
    - destination: 224.0.0.0/4
     next-hop-interface: infra
```

```
- hostname: ocpbm1-master3
  role: master
  interfaces:
  - name: ens160
    macAddress: 00:50:56:97:00:e5
  networkConfig:
    interfaces:
      - name: ens160
        mtu: 9000
        ipv4:
          enabled: false
        ipv6:
          enabled: false
      - name: node
        type: vlan
        mtu: 9000
        state: up
        vlan:
          base-iface: ens160
          id: 11
        ipv4:
          enabled: true
          address:
            - ip: 192.168.1.5
              prefix-length: 24
          dhcp: false
        ipv6:
          enabled: false
      - name: infra
        type: vlan
        mtu: 9000
        state: up
        vlan:
          base-iface: ens160
          id: 3301
        ipv4:
          enabled: true
          dhcp: true
        ipv6:
          enabled: false
    dns-resolver:
      config:
        server:
          - 192.168.1.2
    routes:
      config:
        - destination: 0.0.0.0/0
          next-hop-address: 192.168.1.1
          next-hop-interface: node
        - destination: 224.0.0.0/4
          next-hop-interface: infra
```

Configuring ACI Infra and CNI

Use this procedure for configuring ACI infra and CNI using acc-provision.

Procedure

Sample ACI configuration:

```
# Configuration for ACI Fabric
#
aci_config:
  system_id: openupi                   # Every opflex cluster on the same fabric must have a distict
 ID
  apic_hosts:                           # List of APIC hosts to connect to for APIC API access
    - <APIC-IP>
  apic_login:
    username: <username>
    password: <password>
  vmm_domain:                      # Kubernetes VMM domain configuration
    encap_type: vxlan              # Encap mode: vxlan or vlan
    mcast_range:                   # Every vxlan VMM on the same fabric must use a distinct range
        start: 225.115.1.1
        end: 225.115.255.255
  # The following resources must already exist on the APIC,
  # this is a reference to use them
  aep: <AAEP_NAME>             # The attachment profile for ports/VPCs connected to this cluster
  vrf:                          # VRF used to create all subnets used by this Kubernetes cluster
    name: <VRF_NAME>            # This should exist, the provisioning tool does not create it
    tenant: <TENANT_WITH_VRF_DEFINITION>           # This can be tenant for this cluster (system-id)
 or common
  l3out:                        # L3out to use for this kubernetes cluster (in the VRF above)
    name:<L3OUT_NAME>         # This is used to provision external service IPs/LB
    external_networks:
        <EXTERNAL_EPG_NAME>     # This should also exist, the provisioning tool does not create it
agent based installer:
  enable: true
# Networks used by Kubernetes
#
net_config:
  node_subnet: 192.168.1.1/24         # Subnet to use for nodes
  pod_subnet: 10.2.0.1/16           # Subnet to use for Kubernetes Pods
  extern_dynamic: 10.3.0.1/16       # Subnet to use for dynamically allocated external services
  extern_static: 10.4.0.1/16        # Subnet to use for statically allocated external services
  node_svc_subnet: 10.5.0.1/16      # Subnet to use for service graph
  kubeapi_vlan: 11                  # The VLAN used by the internal physdom for nodes
  service_vlan: 21                  # The VLAN used for external LoadBalancer services
  infra_vlan: 3301
```

Note The `*.apps.<cluster_name>.<base_domain>` records in the user-provisioned DNS should refer to the same IP address used in the ingressVIPs in the `install-config.yaml` file.

Customize the sample `acc-provision` input file shown above as per your requirements. Then install the latest `acc-provision` package from here, and run `pip install acc-provision`. Run the `acc-provision` as follows:

```
$ ~/openupi$ pwd
/home/<user>/openupi

$ ~/openupi$ acc-provision -a -c acc_provision_input.yaml -f openshift-4.14-agent-based-baremetal -u
 <user> -p <password> -o aci_deployment.yaml -z aci deployment.yaml.tar.gz
```

This generates a new `aci_deployment.yaml.tar.gz` file which contains the ACI CNI manifests, and is used later during the OpenShift installation.

Preparing Custom Network Configuration for OpenShift Nodes

ACI CNI requires additional VLANs to be extended towards each OpenShift node. Additional VLANS are required for all master and worker nodes.

You can configure additional VLANs on the interface that will be configured with the node network subnet or can be configured on an additional physical interface on the hosts.

The available option to configure a network interface of a host is to provide the configuration in `agent-config.yaml` in NMState format. For details about creating `agent-config.yaml` , see the *Configuring the OpenShift Installer* section.

Modifying the agent-config file

Use this procedure to modify the `agent-config.yaml` file.

Before you begin

The agent-config file, with additional NIC configuration, needs to extend the Cisco ACI internal network (Infra VLAN) up to the server level. This interface is used to carry VxLAN traffic from OVS towards the ACI leaf switch with an appropriate tag for the pod network. To achieve the separation between the OpenShift node traffic and pod traffic, use the *Single Sub interface for both node and infra networks* approach. The relevant details have been discussed in the Requirements for supporting OpenShift 4.14 on a Bare Metal Server section.

The following YAML snippet outlines an AgentConfig. It includes essential details like rendezvous IP, host configurations, and network interface settings for streamlined deployment.

```
apiVersion: v1alpha1
kind: AgentConfig
metadata:
  name: ocpbm1
rendezvousIP: 192.168.1.3. -> A
AdditionalNTPSources:
  - time.cisco.com
hosts: -> B
  - hostname: ocpbm1-master1 -> C
    role: master
    interfaces:
    - name: ens160
      macAddress: 00:50:56:97:16:db
    networkConfig: -> D
      interfaces:
        - name: ens160
          mtu: 9000
          ipv4:
            enabled: false
          ipv6:
            enabled: false
        - name: node
          type: vlan
          mtu: 9000
          state: up
          vlan:
            base-iface: ens160
            id: 11
          ipv4:
            enabled: true
            address:
              - ip: 192.168.1.3
                prefix-length: 24
            dhcp: false
          ipv6:
            enabled: false
        - name: infra
          type: vlan
          mtu: 9000
    state: up
    vlan:
      base-iface: ens160
      id: 3301
    ipv4:
      enabled: true
      dhcp: true
    ipv6:
      enabled: false
dns-resolver:
  config:
    server:
      - 192.168.1.2
routes:
  config:
    - destination: 0.0.0.0/0
      next-hop-address: 192.168.1.1
      next-hop-interface: node
    - destination: 224.0.0.0/4
      next-hop-interface: infra
```

In the above sample, sections have been marked as A, B, C, D. Here are the details for better understanding.

- **A**: This IP address is used to determine which node performs the bootstrapping process as well as running the assisted-service component. You must provide the rendezvous IP address when you do not specify at least one host's IP address in the `networkConfig` parameter. If this address is not provided, one IP address is selected from the provided hosts' `networkConfig`.
- **B**: Host configuration. The number of hosts defined must not exceed the total number of hosts defined in the `install-config.yaml` file, which is the sum of the values of the `compute.replicas` and `controlPlane.replicas` parameters.
- **C**: Overrides the hostname obtained from either the Dynamic Host Configuration Protocol (DHCP) or a reverse DNS lookup. Each host must have a unique hostname supplied by one of these methods.
- **D**: Configures the network interface of a host in NMState format.

Procedure

Step 1 Create a root folder for your cluster.

```
cd /home/<user>/openupi
mkdir upi
```

Step 2 Copy the install-config.yaml, agent-config.yaml in the newly created upi folder.

Step 3 Create the openshift directory.

```
mkdir -p /home/<user>/openupi/upi/openshift
```

Step 4 Extract all the ACI manifest files in upi/openshift/.

```
tar -xvf aci_deployment.yaml.tar.gz -C upi/openshift/
```

Step 5 Create the iso image.

```
openshift-install agent create image --dir=upi --log-level debug
```

Step 6 Boot the agent.x86_64.iso image on the bare metal machines.

The `agent.x86_64.iso` is now ready and can be copied to your HTTP server, so they can be served to your nodes. The `agent.x86_64.iso` file will be consumed by every node and the network configuration for each node will be recognized based on the mac-address mentioned in the NMState configuration for each node.

Updating the Default Ingress Controller

For updating the default Ingress Controller publish strategy to use the ACI Loadbalancer, log in as a user with cluster-admin privileges and run the following:

```
oc replace --force --wait --filename - <<EOF
apiVersion: operator.openshift.io/v1 kind:
IngressController metadata:
  namespace: openshift-ingress-operator
name: default spec:
 endpointPublishingStrategy:
   type: LoadBalancerService
   loadBalancer:
     scope: External
EOF
```

For more details, see the *Configuring the Default Ingress Controller for your Cluster to be Internal* section in the *Ingress Operator in OpenShift Container Platform Red Hat* guide.

Scaling Agent-based Installation with Bare Metal Operator

Use this procedure to add workers or scale nodes in a cluster.

Procedure

Step 1 Power off the bare metal node by using the baseboard management controller (BMC), and ensure it is off.

Step 2 Apply configuration file for the bare metal node, use one of the following example bmh.yaml files, replacing values in the YAML to match your environment:

```
apiVersion: metal3.io/v1alpha1
kind: Provisioning
metadata:
  finalizers:
  - provisioning.metal3.io
  name: provisioning-configuration
spec:
  preProvisioningOSDownloadURLs: {}
  provisioningMacAddresses:
  - <control-node01 mac address>
  - <control-node02 mac address>
  - <control-node03 mac address>
  provisioningNetwork: Managed
  provisioningIP: 192.168.254.30
  provisioningNetworkCIDR: 192.168.254.0/24
  provisioningDHCPRange: 192.168.254.3,192.168.254.10
  provisioningInterface: ens70s0f1
---
apiVersion: v1
```

```
kind: Secret
metadata:
  name: bmc-credentials
  namespace: openshift-machine-api
data:
  username: <base64_of_uid>
  password: <base64_of_pwd>
---
apiVersion: v1
kind: Secret
metadata:
 name: bm-compute-0-netconfig
 namespace: openshift-machine-api
type: Opaque
stringData:
 nmstate: |
  interfaces:
    - name: ens160
      mtu: 9000
      ipv4:
        enabled: false
      ipv6:
        enabled: false
    - name: node
      type: vlan
      mtu: 9000
      state: up
      vlan:
        base-iface: ens160
        id: 11
      ipv4:
        enabled: true
        address:
          - ip: 192.168.1.6
            prefix-length: 24
        dhcp: false
      ipv6:
        enabled: false
    - name: infra
      type: vlan
      mtu: 9000
      state: up
      vlan:
        base-iface: ens160
        id: 3301
      ipv4:
        enabled: true
        dhcp: true
      ipv6:
        enabled: false
  dns-resolver:
    config:
      server:
        - 192.168.1.2
  routes:
    config:
      - destination: 0.0.0.0/0
        next-hop-address: 192.168.1.1
        next-hop-interface: node
      - destination: 224.0.0.0/4
        next-hop-interface: infra
---
apiVersion: metal3.io/v1alpha1
kind: BareMetalHost
```

```
metadata:
  name: compute-0
  namespace: openshift-machine-api
spec:
  automatedCleaningMode: metadata
  online: true
  bootMACAddress: <nic1_mac_address>
  bmc:
    address: <protocol>://<bmc_url>
    credentialsName: bmc-credentials
    disableCertificateVerification: True
  preprovisioningNetworkDataName: bm-compute-0-netconfig
```

Note To enable multiple worker nodes, you must generate distinct netconfig secrets for each node. Additionally, it's crucial to note that deleting a BaremetalHost object will also remove the associated secrets. Therefore, when utilizing multiple BaremetalHost objects, ensure that the credential secret is retained for the non-deleted BaremetalHost instances to maintain proper functionality

Step 3 Check the respective objects created (the required command has been indicated for each object):

- Provisioning Network: Private network used for PXE booting.

  ```
  . oc describe provisioning provisioning-configuration
  ```

- Secret bmc-credentials: Credentials for the bmc access.

  ```
  . oc describe secret - n openshift-machine-api bmc-credentials
  ```

- Secret bm-compute-0-netconfig: Custom Network configuration for worker node.

  ```
  . oc describe secret - n openshift-machine-api bm-compute-0-netconfig
  ```

- BareMetalHost compute-0: Configuration to manage the baremetal node.

  ```
  . oc describe baremetalhost compute-0 -n openshift-machine-api
  ```

Step 4 Scale up the number of replicas to match the number of available bare metal hosts:

```
oc scale machineset -n openshift-machine-api <worker-machineset> --replicas=1
```

What to do next

Proceed with the tracking and verifying installation progress of the cluster; see the *Redhat OpenShift 4.14 document* (mentioned earlier in the chapter).

THE SPECIFICATIONS AND INFORMATION REGARDING THE PRODUCTS REFERENCED IN THIS DOCUMENTATION ARE SUBJECT TO CHANGE WITHOUT NOTICE. EXCEPT AS MAY OTHERWISE BE AGREED BY CISCO IN WRITING, ALL STATEMENTS, INFORMATION, AND RECOMMENDATIONS IN THIS DOCUMENTATION ARE PRESENTED WITHOUT WARRANTY OF ANY KIND, EXPRESS OR IMPLIED.

IN NO EVENT SHALL CISCO OR ITS SUPPLIERS BE LIABLE FOR ANY INDIRECT, SPECIAL, CONSEQUENTIAL, OR INCIDENTAL DAMAGES, INCLUDING, WITHOUT LIMITATION, LOST PROFITS OR LOSS OR DAMAGE TO DATA ARISING OUT OF THE USE OR INABILITY TO USE THIS MANUAL, EVEN IF CISCO OR ITS SUPPLIERS HAVE BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

Any products and features described herein as in development or available at a future date remain in varying stages of development and will be offered on a when-and if-available basis. Any such product or feature roadmaps are subject to change at the sole discretion of Cisco and Cisco will have no liability for delay in the delivery or failure to deliver any products or feature roadmap items that may be set forth in this document.

Any Internet Protocol (IP) addresses and phone numbers used in this document are not intended to be actual addresses and phone numbers. Any examples, command display output, network topology diagrams, and other figures included in the document are shown for illustrative purposes only. Any use of actual IP addresses or phone numbers in illustrative content is unintentional and coincidental.

The documentation set for this product strives to use bias-free language. For the purposes of this documentation set, bias-free is defined as language that does not imply discrimination based on age, disability, gender, racial identity, ethnic identity, sexual orientation, socioeconomic status, and intersectionality. Exceptions may be present in the documentation due to language that is hardcoded in the user interfaces of the product software, language used based on RFP documentation, or language that is used by a referenced third-party product.

Americas Headquarters
Cisco Systems, Inc.
San Jose, CA 95134-1706
USA

Asia Pacific Headquarters
CiscoSystems(USA)Pte.Ltd.
Singapore

Europe Headquarters
CiscoSystemsInternationalBV
Amsterdam,TheNetherlands

Cisco has more than 200 offices worldwide. Addresses, phone numbers, and fax numbers are listed on the Cisco Website at www.cisco.com/go/offices.