Cisco APIC Getting Started Guide, Release 5.2(x)

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Americas Headquarters
Cisco Systems, Inc.
170 West Tasman Drive
San Jose, CA 95134-1706
USA
http://www.cisco.com
Tel: 408 526-4000
800 553-NETS (6387)
Fax: 408 527-0883

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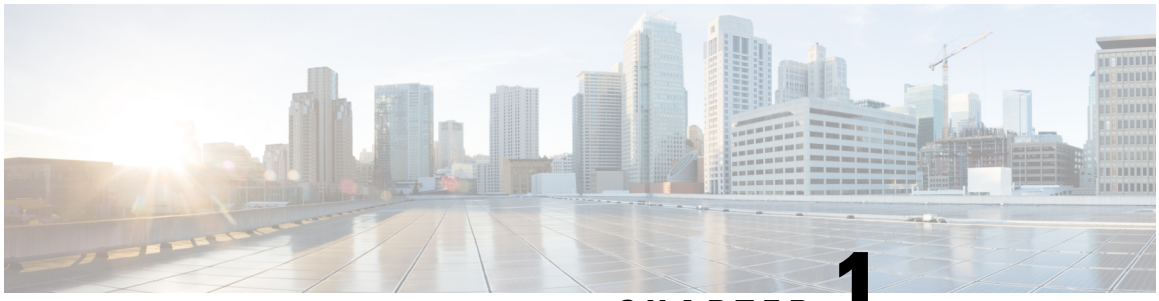


CHAPTER 1

New and Changed Information

This chapter contains the following sections:

New and Changed Information

The following tables provide an overview of the significant changes to this guide for this release. The tables do not provide an exhaustive list of all changes made to the guide or of the new features up to this release.

Table 1: New Features and Changed Information for Cisco APIC Release 5.2(4)

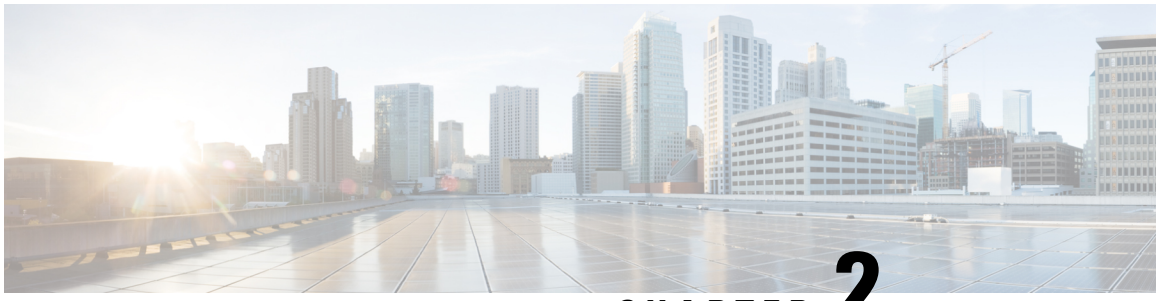
Feature	Description	Where Documented
Cisco NX-OS to Cisco ACI POAP Auto-conversion IPN support	You can now add or replace a Cisco ACI switch that reaches to the Cisco APIC cluster only through an IPN device.	Guidelines and Limitations for Cisco NX-OS to Cisco ACI POAP Auto-conversion, on page 52

Table 2: New Features and Changed Information for Cisco APIC Release 5.2(3)

Feature	Description	Where Documented
Cisco NX-OS to Cisco ACICisco ACI POAP Auto-conversion	Cisco NX-OS to Cisco ACI power-on auto-provisioning (POAP) auto-conversion automates the process of upgrading software images and installing configuration files on nodes that are being deployed in the network for the first time.	About Cisco NX-OS to Cisco ACI POAP Auto-conversion, on page 51

Table 3: New Features and Changed Information for Cisco APIC Release 5.2(1)

Feature	Description	Where Documented
APIC Cluster Connectivity to the Fabric Over a Layer 3 Network	Support for APIC cluster not directly connected to the Fabric, but connected by a layer 3 inter-pod network (IPN). Enable "Standalone APIC Cluster" in initial cluster setup.	• Setup for Active and Standby APIC, on page 8 • See also *Deploying APIC Cluster Connectivity to the Fabric Over a Layer 3 Network* knowledge base article.



CHAPTER 2

Initial Setup

This chapter contains the following sections:

For Next Steps, See...

This table provides a list of additional documents that are useful references along with the *Cisco APIC Getting Started Guide*. These Cisco APIC documents and others are available at the APIC documents landing page.

Tip To find documentation for a specific Cisco APIC feature, type the feature name in the **Choose a Topic** box in the APIC documents landing page.

Documents
Application Centric Infrastructure Fabric Hardware Installation Guide
Cisco APIC Installation, Upgrade, and Downgrade Guide
Cisco APIC Basic Configuration Guide
Cisco APIC Layer 2 Networking Configuration Guide
Cisco APIC Layer 3 Networking Configuration Guide
Cisco APIC Security Configuration Guide
Cisco APIC System Management Configuration Guide

Documents
Cisco ACI Virtualization Guide
Cisco Application Centric Infrastructure Fundamentals
Cisco APIC Layer 4 to Layer 7 Services Deployment Guide

Most of these links take you to the section of the documentation landing page that contains the specified document. Click the arrow at the right end of the section title to expand the document list for that section, then find the document for your release.

If the document for a release does not exist, the document for the previous release applies. For example, the *Cisco APIC System Management Configuration Guide* was not republished for the 5.0 releases because there are no changes from the 4.2 releases. Therefore, you should use the document for the 4.2 releases.

Simplified Approach to Configuring in Cisco APIC

Cisco APIC supports a simplified approach to configuring the ACI with an additional NX-OS style CLI interface. The existing methods of configuration using REST API and the GUI are supported as well.

In addition to the simple approach available for network administrators and other users of the NX-OS style CLI, there is intelligence embedded in this approach as compared to the GUI or the REST API. In several instances, the NX-OS style CLI can create the ACI model constructs implicitly for a user's ease of use, and they also provide validations to ensure consistency in configuration. This functionality reduces and prevents faults.

For further details about configurations and tasks, see the *Cisco APIC Basic Configuration Guide* and the *Cisco APIC NX-OS Style Command-Line Interface Configuration Guide*.

Changing the BIOS Default Password

The APIC controller ships with a default BIOS password. The default password is 'password'. When the boot process starts, the boot screen displays the BIOS information on the console server.

To change the default BIOS password perform the following task:

Procedure

Step 1 During the BIOS boot process, when the screen displays **Press <F2> Setup**, press **F2**.
The **Entering Setup** message displays as it accesses the setup menu.

Step 2 At the **Enter Password** dialog box, enter the current password.

Note The default is 'password'.

Step 3 In the **Setup Utility**, choose the **Security** tab, and choose **Set Administrator Password**.

Step 4 In the **Enter Current Password** dialog box, enter the current password.

Step 5 In the **Create New Password** dialog box, enter the new password.

Step 6 In the **Confirm New Password** dialog box, re-enter the new password.

Step 7 Choose the **Save & Exit** tab.

Step 8 In the **Save & Exit Setup** dialog box, choose **Yes**.

Step 9 Wait for the reboot process to complete.
The updated BIOS password is effective.

About the APIC

The Cisco Application Centric Infrastructure (ACI) is a distributed, scalable, multitenant infrastructure with external end-point connectivity controlled and grouped through application-centric policies. The Application Policy Infrastructure Controller (APIC) is the unified point of automation, management, monitoring, and programmability for the ACI. The APIC supports the deployment, management, and monitoring of any application anywhere, with a unified operations model for the physical and virtual components of the infrastructure. The APIC programmatically automates network provisioning and control that is based on the application requirements and policies. It is the central control engine for the broader cloud network; it simplifies management and allows flexibility in how application networks are defined and automated. It also provides northbound Representational State Transfer (REST) APIs. The APIC is a distributed system that is implemented as a cluster of many controller instances.

Setting up the Cisco APIC

This section describes how to establish a local serial connection to the Cisco APIC server to begin the initial basic configuration. For additional connection information, including instructions on connecting to the server remotely for setup, refer to "Initial Server Setup" in the *Cisco APIC M3/L3 Server Installation and Service Guide*.

Initial Connection

The Cisco APIC M3/L3 Server operates on a Cisco Integrated Management Controller (CIMC) platform. You can make an initial connection to the CIMC platform using one of these methods:

- Use a KVM cable (Cisco PID N20-BKVM) to connect a keyboard and monitor to the KVM connector on the front panel of the server.
- Connect a USB keyboard and VGA monitor to the corresponding connectors on the rear panel of the server.

Note You cannot use the front panel VGA and the rear panel VGA at the same time.

You can make a serial connection using one of the following methods. Two of these methods require a configuration change in the CIMC:

Note You cannot use more than one of these methods simultaneously.

- Use the DB9 connector of the KVM cable
- Use the rear panel RJ-45 console port (after enabling in the CIMC)
- Connect by Serial-over-LAN (SoL) (after enabling in the CIMC)

The default connection settings from the factory are:

- The serial port baud rate is 115200
- The RJ-45 console port located on the rear panel is disabled in the CIMC
- SoL is disabled in the CIMC

The following are additional notes about serial access:

- If you are using a Cisco Integrated Management Controller (CIMC) for your setup, setup the CIMC first, and then access the Cisco APIC through the CIMC KVM or continue to access the Cisco APIC locally through the rear panel USB/VGA port. If you choose the CIMC KVM access, you will have remote access available later which is required during operations.
- If you are using the RJ-45 console port, connect to CIMC using SSH and enable the SoL port using the following commands:

```
scope sol
  set enabled yes
  set baud-rate 115200
  commit
  exit
```

After enabling SoL, enter the command **connect host** to access the APIC console.

Note When using SoL, physically disconnect the rear panel RJ-45 console port.

Initial Cisco APIC Setup

When the Cisco Application Policy Infrastructure Controller (Cisco APIC) is launched for the first time, the Cisco APIC console presents a series of initial setup options. For many options, you can press **Enter** to choose the default setting that is displayed in brackets. At any point in the setup dialog, you can restart the dialog from the beginning by pressing **Ctrl-C**.

Important Notes

- If the UNIX user ID is not explicitly specified in the response from the remote authentication server, then some Cisco APIC software releases assign a default ID of 23999 to all users. If the response from the remote authentication server fails to specify a UNIX ID, all users will share the same ID of 23999 and this can result in the users being granted higher or lower privileges than the configured privileges through the RBAC policies on the Cisco APIC.
- Cisco recommends that you assign unique UNIX user IDs in the range of 16000 to 23999 for the AV Pairs that are assigned to the users when in Bash shell (using SSH, Telnet, or Serial/KVM consoles). If a situation arises where the Cisco AV Pair does not provide a UNIX user ID, the user is assigned a user

ID of 23999 or similar number from the range that also enables the user's home directories, files, and processes accessible to the remote users with a UNIX ID of 23999.

To ensure that your remote authentication server does not explicitly assign a UNIX ID in its **cisco-av-pair** response, open an SSH session to the Cisco APIC and log in as an administrator (using a remote user account). Once logged in, run the following commands (replace **userid** with the username that you logged in with):

- **admin@apic1: remoteuser-userid> cd /mit/uni/userext/remoteuser-userid**
- **admin@apic1: remoteuser-userid> cat summary**

- Cisco recommends against modifying any parameters using CIMC. If there are any issues, ensure that the default setting for CIMC management node is **Dedicated Mode** and not **Shared**. If **Dedicated Mode** is not used, it can prevent the discovery of fabric nodes.
- Do not upgrade software or firmware using the CIMC user interface, XML, or SSH interfaces unless the modified property and software or firmware version are supported with your specific Cisco APIC version.
- Set the NIC mode to **Dedicated**, when setting up the CIMC, in the CIMC Configuration Utility. After the CIMC is configured, in the CIMC GUI, verify that you have the following parameters set.

Parameters	Settings
LLDP	Disabled on the VIC
TPM Support	Enabled on the BIOS
TPM Enabled Status	Enabled
TPM Ownership	Owned

- Beginning with Release 5.0(2), if you log in to your Cisco APIC using https, and then attempt to log in to the same Cisco APIC using http in the same browser window without first logging out of the Cisco APIC in the https window, you might see the following error message:

  ```
  Need a valid webtoken cookie (named APIC-Cookie) or a signed request with signature in the cookie.
  ```

  If this occurs, resolve the issue using either of the following methods:

  - Log out of the Cisco APIC in the https window, or
  - Delete the cookies in the browser window

  You should be able to successfully log into the Cisco APIC using http after resolving the issue with either of the methods above.

- During the initial setup, the system will prompt you to select IPv4, or IPv6, or dual stack configuration. Choosing dual stack will enable accessing the Cisco APIC and Cisco Application Centric Infrastructure (Cisco ACI) fabric out-of-band management interfaces with either IPv4 or IPv6 addresses. While the examples in the table below use IPv4 addresses, you can use whatever IP address configuration options you chose to enable during the initial setup.
- A minimum subnet mask of /19 is recommended.

- Connecting the Cisco APIC to the Cisco ACI fabric requires a 10G interface on the ACI-mode leaf switch. You cannot connect the Cisco APIC directly to the Cisco Nexus 9332PQ, Cisco Nexus 93180LC, or Cisco Nexus 9336C-FX2 ACI-mode leaf switches unless you use a 40G to 10G converter (part number CVR-QSFP-SFP10G), in which case the port on the leaf switches will auto-negotiate to 10G without requiring any manual configuration.

Note Starting with Cisco APIC release 2.2(1n), the Cisco Nexus 93180LC leaf switch is supported.

- The fabric ID is set during the Cisco APIC setup and it cannot be changed unless you perform a clean reload of the fabric. To change the fabric ID, export the Cisco APIC configuration, change the sam.config file, and perform a clean reload of the Cisco APIC and leaf switches. Remove the "fvFabricExtConnP" setting from the exported configuration before importing the configuration into the Cisco APIC after the Cisco APIC comes up. All Cisco APICs in a cluster must have the same fabric ID.
- All logging is enabled by default.
- For login and cluster operations, non-default HTTPS port (default is 443) is not supported for layer 3 physical APIC.

About Cold Standby for a Cisco APIC Cluster

The Cold Standby functionality for a Cisco APIC cluster enables you to operate the Cisco APICs in a cluster in an active/standby mode. In a Cisco APIC cluster, the designated active Cisco APICs share the load and the designated standby Cisco APICs can act as an replacement for any of the Cisco APICs in an active cluster.

An admin user can set up the Cold Standby functionality when the Cisco APIC is launched for the first time. We recommend that you have at least 3 active Cisco APICs in a cluster, and one or more standby Cisco APICs. An admin user must initiate the switch over to replace an active Cisco APIC with a standby Cisco APIC. See the *Cisco APIC Management, Installation, Upgrade, and Downgrade Guide* for more information.

Setup for Active and Standby APIC

Table 4: Setup for Active APIC

Name	Description	Default Value
Fabric name	Fabric domain name	ACI Fabric1
Fabric ID	Fabric ID	1
Number of active controllers	Cluster size	3 **Note** When setting up a Cisco APIC in an active-standby mode, you must have at least 3 active Cisco APICs in a cluster.
POD ID	POD ID	1
Standby controller	Setup standby controller	NO

Name	Description	Default Value
Controller ID	Unique ID number for the active Cisco APIC instance.	Valid range: 1-32
Standalone APIC Cluster	Is the Cisco APIC cluster not directly connected to the Fabric, but connected by a layer 3 inter-pod network (IPN). This feature is available only on Cisco APIC release 5.2(1) and later.	NO See the knowledge base article *Deploying APIC Cluster Connectivity to the Fabric Over a Layer 3 Network* for additional setup instructions.
Controller name	Active controller name	apic1
IP address pool for tunnel endpoint addresses	Tunnel endpoint address pool	10.0.0.0/16 This value is for the infrastructure virtual routing and forwarding (VRF) only. This subnet should not overlap with any other routed subnets in your network. If this subnet does overlap with another subnet, change this subnet to a different /16 subnet. The minimum supported subnet for a 3 Cisco APIC cluster is /23. If you are using Release 2.0(1) the minimum is /22. The 172.17.0.0/16 subnet is not supported for the infra TEP pool due to a conflict of address space with the docker0 interface. If you must use the 172.17.0.0/16 subnet for the infra TEP pool, you must manually configure the docker0 IP address to be in a different address space in each Cisco APIC before you attempt to put the Cisco APICs in a cluster.
VLAN ID for infrastructure network[1]	Infrastructure VLAN for Cisco APIC-to-switch communication including virtual switches **Note** Reserve this VLAN for Cisco APIC use only. The infrastructure VLAN ID must not be used elsewhere in your environment and must not overlap with any other reserved VLANs on other platforms.	

Name	Description	Default Value
IP address pool for bridge domain multicast address (GIPo)	IP addresses used for fabric multicast. For Cisco APIC in a Cisco ACI Multi-Site topology, this GIPo address can be the same across sites.	225.0.0.0/15 Valid range: 225.0.0.0/15 to 231.254.0.0/15, prefixlen must be 15 (128k IPs)
IPv4/IPv6 addresses for the out-of-band management	IP address that you use to access the Cisco APIC through the GUI, CLI, or API. This address must be a reserved address from the VRF of a customer	—
IPv4/IPv6 addresses of the default gateway	Gateway address for communication to external networks using out-of-band management	—
Management interface speed/duplex mode	Interface speed and duplex mode for the out-of-band management interface	auto Valid values are as follows • auto • 10baseT/Half • 10baseT/Full • 100baseT/Half • 100baseT/Full • 1000baseT/Full
Strong password check	Check for a strong password	[Y]
Password	Password of the system administrator This password must be at least 8 characters with one special character.	—

[1] To change the VLAN ID after the initial APIC setup, export your configurations, rebuild the fabric with a new infrastructure VLAN ID and import the configurations so that the fabric does not revert to the old infrastructure VLAN ID. See the KB article about *Using Export and Import to Recover Configuration State*.

Table 5: Setup for Standby APIC

Name	Description	Default Value
Fabric name	Fabric domain name	ACI Fabric1
Fabric ID	Fabric ID	1
Number of active controllers	Cluster size	3 **Note** When setting up Cisco APIC in an active-standby mode, you must have at least 3 active Cisco APICs in a cluster.
POD ID	ID of the POD	1
Standby controller	Setup standby controller	Yes
Standby Controller ID	Unique ID number for the standby Cisco APIC instance	Recommended range: >20
Controller name	Standby controller name	NA
IP address pool for tunnel endpoint addresses	Tunnel endpoint address pool	10.0.0.0/16 This value is for the infrastructure virtual routing and forwarding (VRF) only. This subnet should not overlap with any other routed subnets in your network. If this subnet does overlap with another subnet, change this subnet to a different /16 subnet. The minimum supported subnet for a 3 Cisco APIC cluster is /23. If you are using Release 2.0(1) the minimum is /22.
VLAN ID for infrastructure network[2]	Infrastructure VLAN for Cisco APIC-to-switch communication including virtual switches **Note** Reserve this VLAN for Cisco APIC use only. The infrastructure VLAN ID must not be used elsewhere in your environment and must not overlap with any other reserved VLANs on other platforms.	

Name	Description	Default Value
IPv4/IPv6 addresses for the out-of-band management	IP address that you use to access the Cisco APIC through the GUI, CLI, or API. This address must be a reserved address from the VRF of a customer	—
IPv4/IPv6 addresses of the default gateway	Gateway address for communication to external networks using out-of-band management	—
Management interface speed/duplex mode	Interface speed and duplex mode for the out-of-band management interface	auto Valid values are as follows • auto • 10baseT/Half • 10baseT/Full • 100baseT/Half • 100baseT/Full • 1000baseT/Full
Strong password check	Check for a strong password	[Y]
Password	Password of the system administrator This password must be at least 8 characters with one special character.	—

[2] To change the VLAN ID after the initial APIC setup, export your configurations, rebuild the fabric with a new infrastructure VLAN ID and import the configurations so that the fabric does not revert to the old infrastructure VLAN ID. See the KB article about *Using Export and Import to Recover Configuration State*.

Example

The following is a sample of the initial setup dialog as displayed on the console:

```
Cluster configuration ...
  Enter the fabric name [ACI Fabric1]:
  Enter the fabric ID (1-128) [1]:
  Enter the number of active controllers in the fabric (1-9) [3]:
  Enter the POD ID (1-9) [1]:
  Is this a standby controller? [NO]:
  Enter the controller ID (1-3) [1]:
  Enter the controller name [apic1]: sec-ifc5
  Enter address pool for TEP addresses [10.0.0.0/16]:
```

```
  Note: The infra VLAN ID should not be used elsewhere in your environment
        and should not overlap with any other reserved VLANs on other platforms.
  Enter the VLAN ID for infra network (2-4094): 3914
  Enter address pool for BD multicast addresses (GIPO) [225.0.0.0/15]:

Out-of-band management configuration ...
  Enable IPv6 for Out of Band Mgmt Interface? [N]:
  Enter the IPv4 address [192.168.10.1/24]: 172.23.142.29/21
  Enter the IPv4 address of the default gateway [None]: 172.23.136.1
  Enter the interface speed/duplex mode [auto]:

admin user configuration ...
  Enable strong passwords? [Y]:
  Enter the password for admin:

  Reenter the password for admin:

Cluster configuration ...
  Fabric name: ACI Fabric1
  Fabric ID: 1
  Number of controllers: 3
  Controller name: sec-ifc5
  POD ID: 1
  Controller ID: 1
  TEP address pool: 10.0.0.0/16
  Infra VLAN ID: 3914
  Multicast address pool: 225.0.0.0/15

Out-of-band management configuration ...
  Management IP address: 172.23.142.29/21
  Default gateway: 172.23.136.1
  Interface speed/duplex mode: auto

admin user configuration ...
  Strong Passwords: Y
  User name: admin
  Password: ********

The above configuration will be applied ...

Warning: TEP address pool, Infra VLAN ID and Multicast address pool
         cannot be changed later, these are permanent until the
         fabric is wiped.

Would you like to edit the configuration? (y/n) [n]:
```

Provisioning IPv6 Management Addresses on APIC Controllers

IPv6 management addresses can be provisioned on the APIC controller at setup time or through a policy once the APIC controller is operational. Pure IPv4, Pure IPv6 or dual stack (i.e both IPv6 and IPv4 addresses) are supported. The following snippet is of a typical setup screen that describes how to setup dual stack (IPv6 and IPv4) addresses for out-of-band management interfaces during the setup:

```
Cluster configuration …

  Enter the fabric name [ACI Fabric1]:
  Enter the number of controllers in the fabric (1-9) [3]:
  Enter the controller ID (1-3) [1]:
  Enter the controller name [apic1]: infraipv6-ifc1
  Enter address pool for TEP addresses [10.0.0.0/16]:
  Note: The infra VLAN ID should not be used elsewhere in your environment
        and should not overlap with any other reserved VLANs on other platforms.
```

```
  Enter the VLAN ID for infra network (1-4094): 3914
  Enter address pool for BD multicast addresses (GIPO) [225.0.0.0/15]:

Out-of-band management configuration ...
  Enable IPv6 for Out of Band Mgmt Interface? [N]: Y (Enter Y to Configure IPv6 Address for
 Out of Band Management Address)
  Enter the IPv6 address [0:0:0:0:0:ffff:c0a8:a01/40]: 2001:420:28e:2020:0:ffff:ac1f:88e4/64
 (IPv6 Address)
  Enter the IPv6 address of the default gateway  [None]: 2001:420:28e:2020:acc:68ff:fe28:b540
 (IPv6 Gateway)
  Enable IPv4 also for Out of Band Mgmt Interface? [Y]: (Enter Y to Configure IPv4 Address
 for Out of Band Management Address)
  Enter the IPv4 address [192.168.10.1/24]: 172.31.136.228/21 (IPv4 Address)
  Enter the IPv4 address of the default gateway [None]: 172.31.136.1 (IPv4 Gateway)
  Enter the interface speed/duplex mode [auto]:

admin user configuration ...
  Enable strong passwords? [Y]:
  Enter the password for admin:

  Reenter the password for admin:
```

Accessing the GUI

Procedure

Step 1 Open one of the supported browsers:

- Chrome version 59 (at minimum)
- Firefox version 54 (at minimum)
- Internet Explorer version 11 (at minimum)
- Safari version 10 (at minimum)

Note A known issue exists with the Safari browser and unsigned certificates. Read the information presented here before accepting an unsigned certificate for use with WebSockets. When you access the HTTPS site, the following message appears:

"Safari can't verify the identity of the website APIC. The certificate for this website is invalid. You might be connecting to a website that is pretending to be an APIC, which could put your confidential information at risk. Would you like to connect to the website anyway?"

To ensure that WebSockets can connect, you must do the following:

Click **Show Certificate**.

Choose **Always Trust** in the three drop-down lists that appear.

If you do not follow these steps, WebSockets will not be able to connect.

Step 2 Enter the URL: **https://***mgmt_ip-address*

Use the out-of-band management IP address that you configured during the initial setup. For example, https://192.168.10.1.

Note Only https is enabled by default. By default, http and http-to-https redirection are disabled.

Note If you see the following error message when logging into your Cisco APIC:

```
Need a valid webtoken cookie (named APIC-Cookie) or a signed request with signature
in the cookie.
```

This is due to a known issue that occurs when you are logging into a Cisco APIC using both https and http. See the "Important Notes" section in Setting up the Cisco APIC , on page 5 for more information on this issue and the workaround.

Step 3 When the login screen appears, enter the administrator name and password that you configured during the initial setup.

Step 4 In the **Domain** field, from the drop-down list, choose the appropriate domain that is defined.

If multiple login domains are defined, the **Domain** field is displayed. If the user does not choose a domain, the DefaultAuth login domain is used for authentication by default. This may result in login failure if the username is not in the DefaultAuth login domain.

What to do next

To learn about the features and operation of the Application Centric Infrastructure fabric and the Application Policy Infrastructure Controller, see the available white papers and the *Cisco Application Centric Infrastructure Fundamentals Guide*.

Accessing the REST API

Procedure

By using a script or a browser-based REST client, you can send an API POST or GET message of the form: **https://***apic-ip-address***/api/***api-message-url*

Use the out-of-band management IP address that you configured during the initial setup.

Note
- Only https is enabled by default. By default, http and http-to-https redirection are disabled.
- You must send an authentication message to initiate an API session. Use the administrator login name and password that you configured during the initial setup.

Accessing the NX-OS Style CLI

You can access the APIC NX-OS style CLI either directly from a terminal or through the APIC GUI.

For information about using the NX-OS style CLI commands, see the *Cisco APIC NX-OS Style Command-Line Interface Configuration Guide* and the *Cisco APIC NX-OS Style CLI Command Reference*.

Guidelines and Restrictions for the APIC NX-OS Style CLI

- The CLI is supported only for users with administrative login privileges.
- The APIC NX-OS style CLI uses similar syntax and other conventions to the Cisco NX-OS CLI, but the APIC operating system is not a version of Cisco NX-OS software. Do not assume that a Cisco NX-OS CLI command works with or has the same function on the APIC CLI.
- If FIPS is enabled in the Cisco ACI setups, then SHA256 support is mandatory on the SSH Client. Additionally, to have the SHA256 support, the openssh-client must be running version 6.6.1 or higher.
- In releases earlier than Cisco APIC Release 1.2, the default CLI was a Bash shell with commands to directly operate on managed objects (MOs) and properties of the Management Information Model. Beginning with Cisco APIC Release 1.2, the default CLI is a NX-OS style CLI. The object model CLI is available by typing the **bash** command at the initial CLI prompt.

Accessing the NX-OS Style CLI from a Terminal

Procedure

Step 1 From a secure shell (SSH) client, open an SSH connection to APIC at *username@ip-address*.

Use the administrator login name and the out-of-band management IP address that you configured during the initial setup. For example, admin@192.168.10.1.

Step 2 When prompted, enter the administrator password.

What to do next

When you enter the NX-OS style CLI, the initial command level is the EXEC level. You can stay in EXEC mode or you can type **configure** to enter global configuration mode. In any mode, type **?** to see the available commands.

For information about using the NX-OS style CLI commands, see the *Cisco APIC NX-OS Style Command-Line Interface Configuration Guide* and the *Cisco APIC NX-OS Style CLI Command Reference*.

Accessing the NX-OS Style CLI from the GUI

Procedure

Step 1 From the menu bar, choose **System > Controllers**.

Step 2 In the navigation pane, click **Controllers**.

Step 3 Right-click the desired APIC and choose **Launch SSH**.

Step 4 Follow the displayed instructions to open an SSH session to the selected controller.

What to do next

When you enter the NX-OS style CLI, the initial command level is the EXEC level. You can stay in EXEC mode or you can type **configure** to enter global configuration mode. In any mode, type **?** to see the available commands.

For information about using the NX-OS style CLI commands, see the *Cisco APIC NX-OS Style Command-Line Interface Configuration Guide* and the *Cisco APIC NX-OS Style CLI Command Reference*.

Accessing the Object Model CLI

Note In releases earlier than Cisco APIC Release 1.2, the default CLI was a Bash shell with commands to directly operate on managed objects (MOs) and properties of the Management Information Model. Beginning with Cisco APIC Release 1.2, the default CLI is a NX-OS style CLI. The object model CLI is available by typing the **bash** command at the initial CLI prompt.

Procedure

Step 1 From a secure shell (SSH) client, open an SSH connection to *username@ip-address*.

Use the administrator login name and the out-of-band management IP address that you configured during the initial setup. For example, `ssh admin@192.168.10.1`.

Step 2 When prompted, enter the administrator password that you configured during the initial setup.

You are now in the NX-OS style CLI for APIC.

Step 3 Type **bash** to enter the object model CLI.

Step 4 To return to the NX-OS style CLI, type **exit**.

This example shows how to enter the object model CLI and how to return to the NX-OS style CLI:

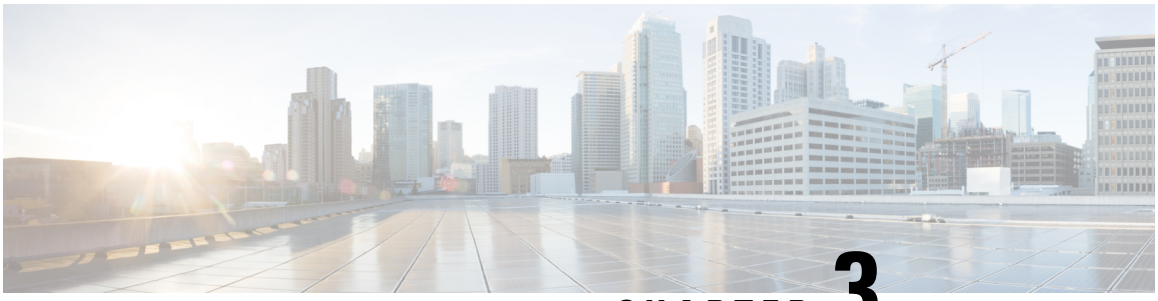
```
$ ssh admin@192.168.10.1
Application Policy Infrastructure Controller
admin@192.168.10.1's password: cisco123
apic#             <---- NX-OS style CLI prompt
apic# bash
admin@apic1:~>    <---- object model CLI prompt
admin@apic1:~> exit
apic#
```

What to do next

Every user must use the shared directory called `/home`. This directory gives permissions for a user to create directories and files; files created within `/home` inherit the default umask permissions and are accessible by the user and by root. We recommend that users create a `/home/userid` directory to store files, such as `/home/jsmith`, when logging in for the first time.

For more information about accessing switches using the ACI CLI using modes of operation such as BASH or VSH, see the *Cisco APIC Command Line Interface User Guide* and the *Cisco ACI Switch Command Reference*.

For detailed information about configuring the APIC CLI, see the *Cisco APIC Object Model Command Line Interface User Guide*.



CHAPTER 3

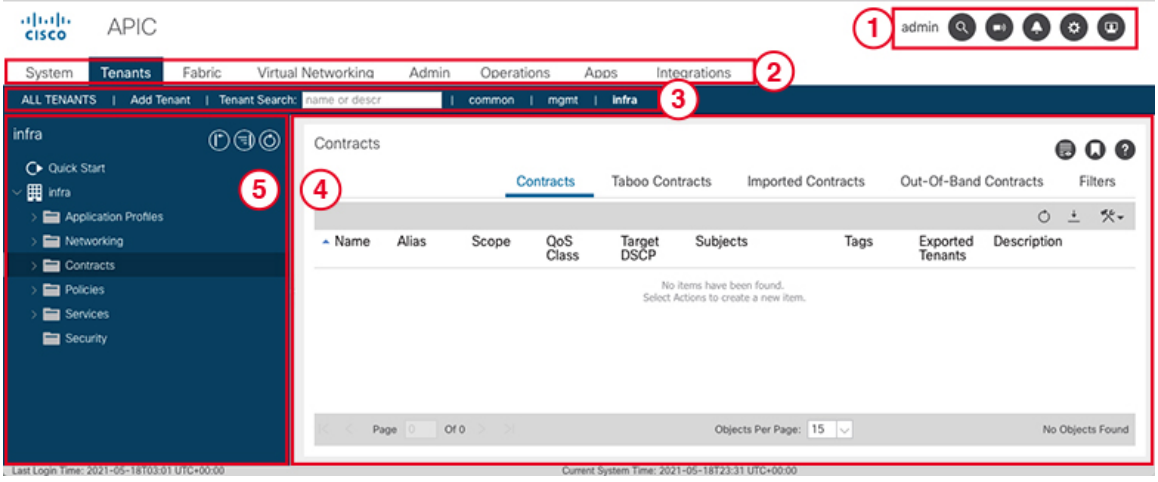
APIC GUI Overview

This chapter contains the following sections:

Overview of the GUI

The APIC GUI is a browser-based graphical interface for configuring and monitoring the ACI fabric. The GUI is organized to provide hierarchical navigation to all components, logical and physical, of the overall system. The primary control regions of the GUI are shown in the following figure.

Figure 1: APIC GUI Regions



The functions of these regions are described in the following links:

1. Menu bar tools—See Menu Bar and Submenu Bar, on page 20
2. Menu bar—See Menu Bar and Submenu Bar, on page 20
3. Submenu bar—See Menu Bar and Submenu Bar, on page 20
4. Work pane—See Work Pane, on page 26
5. Navigation pane—See Navigation Pane, on page 26

Below the Navigation pane, the Last Login is displayed, showing the date and time of the last instance of the current user's login.

As you operate the GUI to make configuration changes and retrieve information, the GUI communicates with the underlying operating system by exchanging REST API messages. You can observe these API messages using the API Inspector tool described in Viewing an API Interchange in the GUI, on page 30.

Menu Bar and Submenu Bar

The menu bar is displayed across the top of the APIC GUI. The menu bar provides access to the main configuration tabs, along with access to tools such as search, notifications, and preferences. Immediately below the menu bar is the submenu bar, which presents specific configuration areas for each selected menu bar tab. The submenu bar tabs are different for each menu bar tab and might also differ depending upon your specific configuration or privilege level.

Tip In the APIC GUI configuration instructions, you will see notation such as **Fabric** > **Fabric Policies**. In this example, you are asked to click the **Fabric** tab in the menu bar followed by the **Fabric Policies** tab in the submenu bar.

At the far right side of the menu bar are the following menu bar tools:

Menu Bar Tools	Description
username	The name of the currently logged in local user.
	Search, on page 23
	Feedback, on page 24
	Alerts, on page 24

Menu Bar Tools	Description
	System Tools, on page 24
	User Profile and Preferences, on page 25

The individual menu bar tabs and tools are described in the following sections.

Menu Bar Tabs

System Tab

Use the **System** tab to collect and display a summary of the overall system health, its history, and a table of system-level faults.

In addition, the **System** tab provides the following functions:

- You can configure global system policies in the **System Settings** submenu.
- You can view your licensing status in the **Smart Licensing** submenu.
- You can view user sessions in the **Active Sessions** submenu.

Tenants Tab

Use the **Tenants** tab in the menu bar to perform tenant management. The submenu bar provides a list of all tenants, an **Add Tenant** link, and links to three built-in tenants plus up to two of the most recently used tenants.

- A tenant contains policies that enable qualified users domain-based access control. Qualified users can access privileges such as tenant administration and networking administration.
- A user requires read/write privileges for accessing and configuring policies in a domain. A tenant user can have specific privileges into one or more domains.
- In a multitenancy environment, a tenant provides group user access privileges so that resources are isolated from one another (such as for endpoint groups and networking). These privileges also enable different users to manage different tenants.

The built-in tenants are:

- The **common** tenant is preconfigured for defining policies that provide common behavior for all the tenants in the fabric. A policy defined in the common tenant is usable by any tenant.
- The **infra** tenant is preconfigured for configuration related to the fabric infrastructure
- The **mgmt** tenant is preconfigured for inband and out-of-band connectivity configurations of hosts and fabric nodes (leafs, spines, and controllers).

Note For Layer 2 configuration of ports, you can type into the node and path fields to filter ports.

Fabric Tab

The **Fabric** tab contains the following tabs in the submenu bar:

- **Inventory** tab—Displays the individual components of the fabric.
- **Fabric Policies** tab—Displays the monitoring and troubleshooting policies and fabric protocol settings or fabric maximum transmission unit (MTU) settings.
- **Access Policies** tab—Displays the access policies that apply to the edge ports of the system. These ports are on the leaf switches that communicate externally.

Virtual Networking Tab

Use the **Virtual Networking** tab to view and configure the inventory of the various virtual machine (VM) managers. You can configure and create various management domains under which connections to individual management systems (such as VMware vCenters or VMware vShield) can be configured. Use the **Inventory** tab in the submenu bar to view the hypervisors and VMs that are managed by these VM management systems (also referred to as controllers in API).

Admin Tab

Use the **Admin** tab to perform administrative functions such as authentication, authorization, and accounting functions, scheduling policies, retaining and purging records, upgrading firmware, and controlling features such as syslog, Call Home, and SNMP.

Operations Tab

The **Operations** tab provides the following built-in tools for planning and monitoring fabric resources.

- **Visibility & Troubleshooting**—Shows the location of specified end points in the fabric and displays the traffic path, including any L4-L7 devices.
- **Capacity Dashboard**—Displays the available capacity of configurable resources such as end points, bridge domains, tenants, and contexts.
- **EP Tracker**—Enables you to view virtual and bare metal endpoint connections and disconnections to leaf switches and FEXes.
- **Visualization**—Provides visualization of traffic maps.

Capacity Dashboard

The capacity dashboard displays the available capacity of configurable resources such as endpoints, bridge domains, tenants, and contexts. The dashboard contains the following tabs:

- **Fabric Capacity**: Displays the capacity of the managed objects within the fabric. Each tile provides the current and maximum capacity of each object, as well as the percentage of the maximum capacity that is used. You can hover your cursor over some of the tiles to see more information.

- **Leaf Capacity**: Displays the capacity of the managed objects for each leaf switch that the Cisco Application Policy Infrastructure Controller (APIC) manages.
  - For all of the objects, the GUI displays the current resource usage and maximum resource capacity, as well as the percentage of the maximum resource capacity that is used.
  - The data for some of the objects is split into subcategories, such as local and remote for ESG MAC addresses.
  - The data for MAC, IPv4, and IPv6 addresses shows the total number of local and remote addresses.
  - The data for /32 routes and /128 routes provides the following information:
    - **UC**: The total IPv4 /32 or /128 unicast routes. This value persists through each interval without resetting to zero.
    - **EP**: The total IPv4 /32 or /128 endpoints. This value persists through each interval without resetting to zero.
    - **MCast**: The total IPv4 /32 or /128 multicast routes. This value persists through each interval without resetting to zero.
  - You can click the **Configure Profile** button in the **Switch** column to configure the forward scale profile for that switch.
  - You can click any other part of a row to see detailed capacity usage information for that switch. For resources with the **Absolute** entry, this is the current resource usage. In the case of /32 and /128 routes, **Absolute** is the total of unicast routes, endpoints, and multicast routes being used. **Percentage** is the percentage of the maximum resource capacity that being used.

Apps Tab

The **Apps** tab displays all the applications installed or uploaded to APIC. The tab allows an APIC administrator to upload, enable, upgrade, install, or uninstall a packaged application in APIC.

Integrations Tab

Use the **Integrations** tab to view all third-party integrations.

Menu Bar Tools

Search

Click the Search icon to display the search field. The search field enables you to locate objects by name or other distinctive fields.

Figure 2: Search

The search function allows the use of wildcards (*).

Feedback

Click the feedback menu bar icon to send comments to Cisco.

Figure 3: Feedback

Alerts

Click the alert menu bar icon to view a list of active alerts. When system alerts are available, a numeric badge will appear on the alert icon indicating the number of active alerts. When critical system notifications are available, the alert icon will blink red. To view the alerts, click the following icon.

Figure 4: Alerts

To disable blinking of the alert icon, remove all critical alerts from the alert list. A disabled **Close** button on a critical alert indicates that you must first resolve the underlying issue before the alert can be cleared.

System Tools

To access the system tools, click the following menu bar icon and select an item from the drop-down list.

Figure 5: System Tools

The following selections are available:

- **Help**—Display the online help.
- **Documentation**—Display links to API documentation and to the APIC documentation home page.
- **Show API Inspector**—Open the API Inspector, which is a built-in tool of the APIC that allows you to view the internal API messages between the GUI and the APIC operating system to execute tasks. For more information, see Viewing an API Interchange in the GUI, on page 30.
- **Start Remote Logging**—Forward logging information to a remote URL.
- **Object Store Browser**—Open the Managed Object Browser, or Visore, which is a utility built into APIC that provides a graphical view of the managed objects (MOs) using a browser.
- **Show Debug Info**—Open a status bar at the bottom of the GUI to display information such as current managed object (MO) and system time. When the status bar is open, this selection changes to **Hide Debug Info**.
- **Config Sync Issues**— Open the Configuration Objects Pending Resolution panel. This panel shows if there are any transactions involving user-configurable objects that have yet to take effect in APIC. You can use information in the panel to help with debugging.

- **About**—Display the APIC version.

Note Global system settings are configured in **System** > **System Settings**.

User Profile and Preferences

To configure settings and preferences for the logged in user, click the following menu bar icon and select an item from the drop-down list.

Figure 6: User Profile and Preferences

The following selections are available:

- **Favorites**—Display links to menus bookmarked by the user.

  Menus that display the Favorites icon ( ) can be bookmarked by clicking the icon.

- **Change My Password**—Change the password of the currently logged in local user.
- **Change My SSH Keys**—Change the user's public SSH key used for certificate-based login.
- **Change My X509 Certificate**—Change the user's X.509-format certificate for login.
- **View My Permissions**—Display the user's role-based read and write privileges for domains and accessible objects.
- **Settings**—Change general GUI settings.
  - **Remember Tree Selection**—Enable the GUI to keep the navigation tree expanded when returning to a window. For example, if you enable this property and expand the navigation tree in the Tenants tab, click on the Fabric tab, then return to the Tenants tab, the tree will remain expanded.
  - **Preserve Tree Divider Position**—Enable the GUI to keep the position of the tree divider after dragging the tree divider to the desired location.
  - **Disable Notification on Success**—Suppress the success dialog box notification.
  - **Disable Deployment Warning at Login**—Disable the Deployment Warning dialog box when logging in. See Deployment Warning and Policy Usage Information, on page 29.
  - **Default Page Size for Tables**—Set the GUI table size.
  - **Show All UI Sections**—Display hidden UI configuration options.
  - **Show What's New at Login**—Display splash screen at login, showing recent features.
  - **Enable Single-Browser Session (SBS)**—Allows logging in to the APIC GUI and then opening additional browser tabs or windows to the same APIC without being required to log in from each new tab or window. See Single-Browser Session Management, on page 29.

- **Change Deployment Settings**—Enable and set the scope of the deployment notification. See Deployment Warning and Policy Usage Information, on page 29.
- **Logout**—Exit the APIC configuration GUI.

Navigation Pane

Use the **Navigation** pane, which is on the left side of the APIC GUI below the submenu bar, to navigate to all elements of the submenu category.

For each submenu category, the **Navigation** pane is organized as a hierarchical tree of objects, logical and physical, related to that category. These objects typically represent ports, policies, or groupings of other objects. When you select an object in the **Navigation** pane, details of the object display in the **Work** pane.

When you right-click an object in the **Navigation** pane, you might be presented with a menu of possible actions related to the object, such as one or more of the following actions:

- **Delete**—Delete the object.
- **Create <type of object>**—Create a new object.
- **Save as...**—Download the object and its properties in JSON or XML format to a local file.
- **Post...**—Export the object and its properties to an existing local file.
- **Share**—Displays the URL of the object. You can copy the URL and send it to others.
- **Open In Object Store Browser**—Open the object in Visore, a built-in utility that displays an object and its properties. This information may be useful in troubleshooting or for developing API tools.
- **Clone**—Create a copy of the object. This action is useful for deriving a new contract or policy based on an existing contract or policy.

Note If any container in the **Navigation** pane, for example **Application Profiles** under a **Tenant**, contains more than 40 profiles, you cannot click on a profile and expand it in the Navigation pane. You must select the desired profile from the **Work** pane and expand it.

Work Pane

Use the **Work** pane, which is on the right side of the APIC GUI, to display details about the component that you selected in the **Navigation** pane.

The **Work** pane includes the following elements:

- A content area that displays tabs. These tabs enable you to access information that is related to the component that you chose in the **Navigation** pane. The tabs displayed in the content area depend upon the selected component.

- A link to context-sensitive online help that is represented by a question mark icon in the upper right corner. 
- For some components, a link to conceptual information related to the component, represented by a list icon in the upper right corner. 
- You can bookmark almost any page, which enables you to go back to that page easily by choosing the bookmark from your list of bookmarks.

  Bookmarked links are accessible from the **User Profile and Preferences** icon in the Menu Bar.
- You can mark a tab as the "favorite" on a page. Whenever you navigate to that page, that tab will be the default tab that is displayed. This feature is enabled only for the tabs in the **Work** pane; you cannot mark a menu bar tab as a favorite.

Common Pages in the Work Pane

In addition to displaying specific task menus, the Work pane also displays several types of special-purpose menus described in this section.

Quick Start Pages

Many APIC menu and submenu tabs open an initial Quick Start page, which summarizes the purpose of the tab, provides links to step-by-step instructions and videos for commonly-used procedures, and provides shortcut links to commonly-used subsections within the tab. An overall Quick Start page at **System > QuickStart** assists you in performing common and basic procedures, providing step-by-step instructions, available concept information, and links to main functional areas in the GUI.

Dashboard Pages

Dashboard pages provide at-a-glance summaries of the status of the ACI system and major system components, including health score trends, components with below-threshold health scores, and fault counts. You can configure health score thresholds to determine when components will appear in the dashboard. The system dashboard page at **System > Dashboard** summarizes the health of the overall ACI system, while switch dashboard pages at **Fabric > Inventory > Pod n > component > Dashboard** summarize the health and faults of each spine and leaf switch.

Summary Pages

Many top-level folders in the Navigation pane display tile-based Summary pages in the Work pane that link to subfolders. Some Summary pages, such as those in **Fabric > Inventory > Pod n**, contain tiles summarizing major components along with brief health and fault information for each component. Other Summary pages, such as those in **Fabric > Fabric Policies > Policies**, contain tiles that describe the configuration areas served by the contained folders.

Personalizing the Interface

Naming the APIC GUI

An ACI controller cluster comprises three or more APICs. In some cases, it might be helpful to know which APIC you are viewing. Perform the following steps to add a custom name to the heading of the APIC GUI.

Procedure

Step 1 On the APIC menu bar, choose **System** > **System Settings**.

Step 2 In the **Navigation** pane, click **APIC Identification Preferences**.

Step 3 In the work pane, type the desired APIC name in the **GUI Alias** box.

Step 4 Click **Submit**.
The APIC name appears in parentheses at the top left of the GUI.

Adding a Login Banner to the CLI or GUI

You can define banners to be displayed when the user is prompted to log in to the CLI or GUI. The CLI banner is a simple text string to be printed at the terminal before the password prompt. You can define a banner for the APIC CLI and a separate banner for the switch CLI. The GUI banner displays at the APIC URL before user login authentication. The GUI banner is defined as a URL of a site hosting the desired HTML.

Procedure

Step 1 On the APIC menu bar, choose **System** > **System Settings**.

Step 2 In the **Navigation** pane, click **APIC Identification Preferences**.

Step 3 In the work pane, complete the following fields as desired:

a) To configure an APIC CLI banner, type the banner text into the **Controller CLI Banner** textbox.

b) To configure a switch CLI banner, type the banner text into the **Switch CLI Banner** textbox.

c) To configure an APIC GUI banner, type the URL of a site hosting the desired HTML into the **GUI Banner (URL)** textbox.

Note The URL site owner must allow the site to be placed in an iFrame to display the informational banner. If the owner of the site sets the `x-frame-option` to `deny` or `sameorigin`, the site the URL points to will not appear.

Step 4 Click **Submit**.

Single-Browser Session Management

Beginning with Cisco APIC Release 4.0(1), you can log in to the APIC GUI and then open additional browser tabs or windows to the same APIC without being required to log in from each new tab or window. This behavior is disabled by default and can be enabled by checking the **Enable Single-Browser Session (SBS)** checkbox in the **User Profile and Preferences > Settings** menu from the main menu bar tools.

If you want to log in to APIC from different tabs or windows of a browser using different credentials, make sure the single-browser session management feature is disabled.

Deployment Warning and Policy Usage Information

By configuring **Deployment Warning Settings**, you can enable the automatic display of policy usage information whenever you modify or delete policies that might affect other resources or policies. The policy usage information allows you to identify which resources and policies are being used by the policy that you are currently modifying or deleting. Tables display the nodes where the given policy is used and other policies that use this policy. By default, usage information is displayed within a dialog box whenever you attempt to modify a policy. Also, at any time, you can click the **Show Usage** button at the bottom of the screen to view the same information.

The **Deployment Warning Settings** dialog box allows you to enable and alter the scope of deployment notification that displays policy usage information. You can access this dialog box by selecting **Change Deployment Settings** in the menu bar tool **User Settings and Preferences** drop-down list or through a button on the **Policy Usage Information** dialog box.

When the **Policy** tab is selected in the upper right corner of the **Deployment Warning Settings** dialog box, you can configure the following policy options:

- **(Global) Show Deployment Warning on Delete/Modify**—Enable the **Deployment Warning** notification for every policy deletion or modification across the APIC.
- **(Local) Show Deployment Warning on Delete/Modify**—Set the rule for the **Deployment Warning** notification for specific policy configuration.
  - **Use Global Settings**—Use the setting selected for **(Global) Show Deployment Warning on Delete/Modify**.
  - **Yes**—Display the **Deployment Warning** notification before submitting configuration modifications on any policy change. Valid for this browser session only.
  - **No**—Do not display the **Deployment Warning** notification before submitting configuration modifications on any policy change. Valid for this browser session only.

When the **History** tab is selected in the upper right corner of the **Deployment Warning Settings** dialog box, you can view tables of **Events** and **Audit Log** entries for previous deployment warnings.

Graphical Configuration of Ports

The APIC GUI provides a graphical method for configuring ports, port channels, and virtual port channels on the leaf switches in the fabric, configure ports for dynamic breakout, and link interfaces to FEX switches. This configuration capability is present in the following GUI locations:

- **Fabric > Inventory > Topology**
- **Fabric > Inventory > Pod**
- **Fabric > Inventory > Pod > Leaf**
- **Fabric > Inventory > Pod > Spine**

In the Work pane's **Interface** tab, click on the **+** button (at the top left), select one or more switches to configure, and click **Add Selected**. To select multiple switches, use **Ctrl+Click** or **Shift+Click**.

The switches are graphically displayed with their ports and links. If you have configured a breakout port, a block containing the sub ports is displayed below the leaf diagram.

Note If you accessed the **Interface** tab from a leaf switch, the leaf switch is automatically added.

Select the interfaces to configure. When interfaces are selected, the available configuration buttons appear. Depending on the number of selected interfaces and where they are located, you can then click one of the following buttons at the top of the page:

- **L2**—Layer 2. Visible when you click one or more leaf interfaces on the switch diagrams.
- **PC**—Port Channel. Visible when you click one or more leaf interfaces on the switch diagrams.
- **VPC**—Virtual Port Channel. Visible when you click at least one interface on two switch diagrams.
- **FEX**—Fabric Extender. Visible when you click one or more leaf interfaces on the switch diagrams.
- **Breakout**—Breakout mode. Visible when you click one or more leaf interfaces on the switch diagrams.
- **Fabric**—Add policies to a fabric interface. Visible when you click a port that is eligible to be a fabric port.
- **Uplink** and **Downlink**—Convert eligible uplinks to downlinks and vice versa.
- **Spine**—Visible when you click one or more leaf interfaces on the switch diagrams.

Viewing an API Interchange in the GUI

When you perform a task in the APIC graphical user interface (GUI), the GUI creates and sends internal API messages to the operating system to execute the task. By using the API Inspector, which is a built-in tool of the APIC, you can view and copy these API messages. A network administrator can replicate these messages in order to automate key operations, or you can use the messages as examples to develop external applications that will use the API.

Procedure

Step 1 Log in to the APIC GUI.

Step 2 In the upper right corner of the APIC window, click the System Tools icon to view the drop-down list.

Step 3 In the drop-down list, choose the **Show API Inspector**.

The **API Inspector** opens in a new browser window.

Step 4 In the **Filters** toolbar of the **API Inspector** window, choose the types of API log messages to display.

The displayed messages are color-coded according to the selected message types. This table shows the available message types:

Name	Description
trace	Displays trace messages.
debug	Displays debug messages. This type includes most API commands and responses.
info	Displays informational messages.
warn	Displays warning messages.
error	Displays error messages.
fatal	Displays fatal messages.
all	Checking this checkbox causes all other checkboxes to become checked. Unchecking any other checkbox causes this checkbox to be unchecked.

Step 5 In the **Search** toolbar, you can search the displayed messages for an exact string or by a regular expression.

This table shows the search controls:

Name	Description
Search	In this text box, enter a string for a direct search or enter a regular expression for a regex search. As you type, the first matched field in the log list is highlighted.
Reset	Click this button to clear the contents of the Search text box.
Regex	Check this checkbox to use the contents of the Search text box as a regular expression for a search.
Match case	Check this checkbox to make the search case sensitive.
Disable	Check this checkbox to disable the search and clear the highlighting of search matches in the log list.
Next	Click this button to cause the log list to scroll to the next matched entry. This button appears only when a search is active.
Previous	Click this button to cause the log list to scroll to the previous matched entry. This button appears only when a search is active.
Filter	Check this checkbox to hide nonmatched lines. This checkbox appears only when a search is active.

Name	Description
Highlight all	Check this checkbox to highlight all matched fields. This checkbox appears only when a search is active.

Step 6 In the **Options** toolbar, you can arrange the displayed messages.

This table shows the available options:

Name	Description
Log	Check this checkbox to enable logging.
Wrap	Check this checkbox to enable wrapping of lines to avoid horizontal scrolling of the log list
Newest at the top	Check this checkbox to display log entries in reverse chronological order.
Scroll to latest	Check this checkbox to scroll immediately to the latest log entry.
Clear	Click this button to clear the log list.
Close	Click this button to close the API Inspector.

Example

This example shows two debug messages in the API Inspector window:

```
13:13:36 DEBUG - method: GET url: http://192.0.20.123/api/class/infraInfra.json
response: {"imdata":[{"infraInfra":{"attributes":{"instanceId":"0:0","childAction":"",
"dn":"uni/infra","lcOwn":"local","name":"","replTs":"never","status":""}}}]}

13:13:40 DEBUG - method: GET url: http://192.0.20.123/api/class/l3extDomP.json?
query-target=subtree&subscription=yes
response: {"subscriptionId":"72057598349672459","imdata":[]}
```

GUI Icons

Table 6: Frequently Displayed Icons in the APIC GUI

Icons	Description
	Search, on page 23

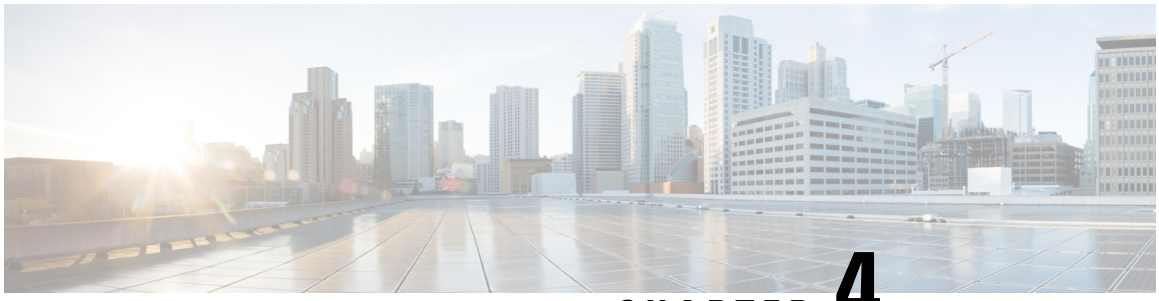
Icons	Description
	Alerts, on page 24
	User Profile and Preferences, on page 25
	System Tools, on page 24
	Bookmark this page
	Displays online help information for the current menu page
	Displays concept information for the current menu page
	Quick Start
	Plays a Quick Start video
	Displays a Quick Start procedure
	Link to related section
	Topology
	Pod
	Collapse Tree View
	Expand Tree View

Icons	Description
	Collapse All Nodes
	Displays a drop-down list of actions
	Refresh the displayed information
	Download to a file
	Upload a file

Fault, Statistics, and Health Level Icons

Table 7: Severity Levels of Faults Displayed in the APIC GUI

Icons	Description
	Critical—This icon displays a fault level with critical severity.
	Major—This icon displays a fault level with major severity.
	Minor—This icon displays a fault level with minor severity.
	Warning—This icon displays a fault level that requires a warning.



CHAPTER 4

Fabric Initialization and Switch Discovery

This chapter contains the following sections:

Initializing the Fabric

About Fabric Initialization

You can build a fabric by adding switches to be managed by the APIC and then validating the steps using the GUI, the CLI, or the API.

Note Before you can build a fabric, you must have already created an APIC cluster over the out-of-band network.

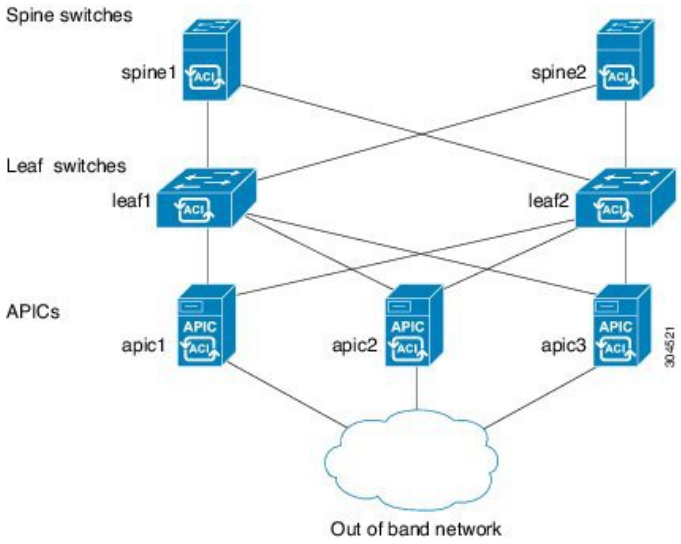
Fabric Topology (Example)

An example of a fabric topology is as follows:

- Two spine switches (spine1, spine2)
- Two leaf switches (leaf1, leaf2)
- Three instances of APIC (apic1, apic2, apic3)

The following figure shows an example of a fabric topology.

Figure 7: Fabric Topology Example



Connections: Fabric Topology

An example of the connection details for the fabric topology is as follows:

Name	Connection Details
leaf1	eth1/1 = apic1 (eth2/1) eth1/2 = apic2 (eth2/1) eth1/3 = apic3 (eth2/1) eth1/49 = spine1 (eth5/1) eth1/50 = spine2 (eth5/2)
leaf2	eth1/1 = apic1 (eth 2/2) eth1/2 = apic2 (eth 2/2) eth1/3 = apic3 (eth 2/2) eth1/49 = spine2 (eth5/1) eth1/50 = spine1 (eth5/2)
spine1	eth5/1 = leaf1 (eth1/49) eth5/2 = leaf2 (eth1/50)
spine2	eth5/1 = leaf2 (eth1/49) eth5/2 = leaf1 (eth1/50)

Multi-Tier Fabric Topology (Example)

3-tier Core-Aggregation-Access architectures are common in data center network topologies. As of the Cisco APIC Release 4.1(1), you can create a multi-tier ACI fabric topology that corresponds to the

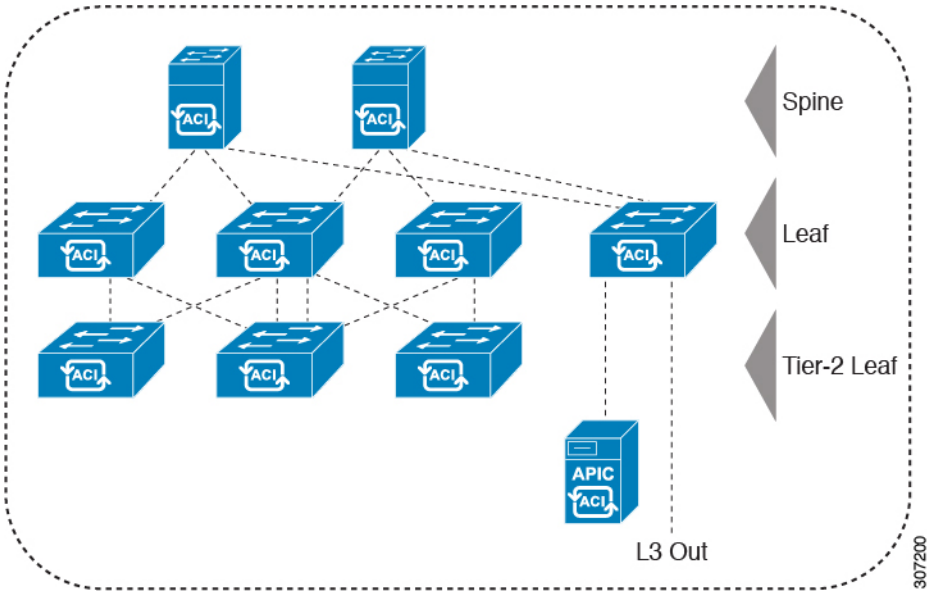
Core-Aggregation-Access architecture, thus mitigating the need to upgrade costly components such as rack space or cabling. The addition of a tier-2 leaf layer makes this topology possible. The tier-2 leaf layer supports connectivity to hosts or servers on the downlink ports and connectivity to the leaf layer (aggregation) on the uplink ports.

In the multi-tier topology, the leaf switches initially have uplink connectivity to the spine switches and downlink connectivity to the tier-2 leaf switches. To make the entire topology an ACI fabric, all ports on the leaf switches connecting to tier-2 leaf fabric ports must be configured as fabric ports (if not already using the default fabric ports). After APIC discovers the tier-2 leaf switch, you can change the downlink port on the tier-2 leaf to a fabric port and connect to an uplink port on the middle layer leaf.

Note If you are not using the default fabric ports to connect leaf switches to tier-2 leaf, you must convert the leaf ports from downlink to uplink (leaf switch reload required). For more information about changing port connectivity, see the Access Interfaces chapter of the *Cisco APIC Layer 2 Networking Configuration Guide*.

The following figure shows an example of a multi-tier fabric topology.

Figure 8: Multi-Tier Fabric Topology Example



While the topology in the above image shows the Cisco APIC and L3Out/EPG connected to the leaf aggregation layer, the tier-2 leaf access layer also supports connectivity to APICs and L3Out/EPGs.

Note Only Cisco Nexus 9000 Series switches with model numbers that end in EX, and later are supported as tier-2 leaf switches and as leaf switches, if there are tier-2 leaf switches attached to them. See the table below.

Tier-2 leaf switches attached to remote leaf switches are not supported.

Table 8: Supported Switches and Port Speeds for Multi-Tier Architecture

Switch	Maximum supported downlink port* (as tier-2 leaf)	Maximum supported fabric ports (as tier-2 leaf)	Maximum supported fabric ports (as tier-1 leaf)
Nexus 93180YC-EX	48x1/10/25-Gbps 4x40/100-Gbps	48 x 10/25-Gbps 6 x 40/100-Gbps	48 x 10/25-Gbps 6 x 40/100-Gbps
Nexus 93108TC-EX	48x100M/1/10G BASE-T 4x40/100-Gpbs	6 x 40/100-Gbps	6 x 40/100-Gbps
N9K-9348GC-FXP**	48 x 100M/1G BASE-T	4 x 10/25-Gbps 2 x 40/100-Gbps	4 x 10/25-Gbps 2 x 40/100-Gbps
N9K-93180YC-FX	48 x 1/10/25-Gbps 4x40/100-Gbps	48 x 10/25-Gbps 6 x 40/100-Gbps	48 x 10/25-Gbps 6 x 40/100-Gbps
N9K-93108TC-FX	48 x 100M/1/10G BASE-T 4x40/100-Gbps	6 x 40/100-Gbps	6 x 40/100-Gbps
N9K-93240YC-FX2	48x1/10/25-Gbps 10x40/100-Gbps	48x1/10/25-Gbps 12x40/100-Gbps	48x10/25-Gbps fiber ports 12x40/100-Gbps
N9K-C9336C-FX2	34 x 40/100-Gbps	36 x 40/100-Gbps	36 x 40/100-Gbps
N9K-C93216TC-FX2***	96 x 10G BASE-T 10 x 40/100-Gbps	12 x 40/100-Gbps	12 x 40/100-Gbps
N9K-C93360YC-FX2***	96 x 10/25-Gbps 10 x 40/100-Gbps	52 x 10/25Gbps 12 x 40/100Gbps	52 x 10/25Gbps 12 x 40/100Gbps
N9K-C9364C-GX	62 x 40/100-Gbps	62 x 40/100-Gbps	62 x 40/100-Gbps

* Last 2 original fabric ports cannot be used as downlink ports.

** If tier-2 leaf does not require much bandwidth, it can be used as tier-1 though it has fewer fiber ports. Copper port cannot be used as a fabric port.

*** Supported beginning with Cisco APIC Release 4.1(2).

Changing the External Routable Subnet

These procedures describe how to change the external routable subnet, if you find that you have to make changes to the information in the subnets or TEP table after you've made those configurations.

Note Changing an external routable subnet configuration using multiple subnets is not supported.

Procedure

Step 1 Navigate to the area where you originally configured the external routable subnet.

a) On the menu bar, click **Fabric** > **Inventory**.
b) In the Navigation pane, click **Pod Fabric Setup Policy**.
c) On the **Fabric Setup Policy** panel, double-click the pod where you originally configured the external routable subnet.

The **Fabric Setup Policy for a POD** page for this pod appears.

d) Locate the information for the subnets or TEP table, depending on the release of your APIC software:

- For releases prior to 4.2(3), locate the **Routable Subnets** table.
- For 4.2(3) only, locate the **External Subnets** table.
- For 4.2(4) and later, locate the **External TEP** table.

Step 2 Locate the external routable subnet that you want to delete in the table and determine if the state of that subnet is set to **active** or **inactive**.

If the state is set to **active**, change the state to **inactive**:

a) Double-click on the entry in the subnets or TEP table for the existing external routable subnet that you want to delete.
b) Change the state for the subnet to **inactive**, then click **Update**.

Step 3 Delete the existing external routable subnet.

a) Click on the entry in the subnets or TEP table for the existing external routable subnet that you want to delete.
b) Click the trashcan icon at the top of the table, then click **Yes** in the pop-up confirmation window to delete the external routable subnet.

Step 4 Wait for at least 30 seconds, then configure a new external routable subnet.

a) Click **+** in the subnets or TEP table to configure a new external routable subnet.
b) Enter the IP address and Reserve Address, if necessary, and set the state to **active** or **inactive**.

- The IP address is the subnet prefix that you wish to configure as the routeable IP space.
- The Reserve Address is a count of addresses within the subnet that must not be allocated dynamically to the spine switches and remote leaf switches. The count always begins with the first IP in the subnet and increments sequentially. If you wish to allocate the Unicast TEP from this pool, then it must be reserved.

c) Click **Update** to add the new external routable subnet to the subnets or TEP table.
d) On the **Fabric Setup Policy** panel, click **Submit**.

Step 5 Verify that the new routable IP address is configured correctly.

Log into the APIC controller through the CLI and enter the following command:

```
apic1# avread | grep routableAddress
```

Output similar to the following should appear:

```
routableAddress   14.3.0.228             14.3.0.229             14.3.1.228
```

Step 6 Check the NAT entries created on the spine switch.

Log into the spine switch through the CLI and enter the following command:

```
spine1# show nattable
```

Output similar to the following should appear:

```
-----NAT TABLE---------
Private Ip  Routable Ip
----------  -----------
10.0.0.2    14.3.0.229

10.0.0.1    14.3.0.228

10.0.0.3    14.3.1.228
```

Switch Discovery

About Switch Discovery with the APIC

The APIC is a central point of automated provisioning and management for all the switches that are part of the ACI fabric. A single data center might include multiple ACI fabrics; each data center might have its own APIC cluster and Cisco Nexus 9000 Series switches that are part of the fabric. To ensure that a switch is managed only by a single APIC cluster, each switch must be registered with that specific APIC cluster that manages the fabric.

The APIC discovers new switches that are directly connected to any switch it currently manages. Each APIC instance in the cluster first discovers only the leaf switch to which it is directly connected. After the leaf switch is registered with the APIC, the APIC discovers all spine switches that are directly connected to the leaf switch. As each spine switch is registered, that APIC discovers all the leaf switches that are connected to that spine switch. This cascaded discovery allows the APIC to discover the entire fabric topology in a few simple steps.

Switch Registration with the APIC Cluster

After a switch is registered with the Cisco Application Policy Infrastructure Controller (APIC), the switch is part of the Cisco APIC-managed fabric inventory. With the Cisco Application Centric Infrastructure (ACI) fabric, the Cisco APIC is the single point of provisioning, management, and monitoring for switches in the infrastructure.

The following guidelines and limitations apply:

- Before you begin registering a switch, make sure that all switches in the fabric are physically connected and booted in the desired configuration. For information about the installation of the chassis, see http://www.cisco.com/c/en/us/support/cloud-systems-management/application-policy-infrastructure-controller-apic/products-installation-guides-list.html.
- The infrastructure IP address range must not overlap with other IP addresses used in the ACI fabric for in-band and out-of-band networks.

- When a switch is power cycled or upgraded, downlink interfaces will be in the admin-down state until the switch can download the configurations again from the Cisco APICs to prevent external devices from sending traffic to the switch that is not yet ready. Fabric links and down links for Cisco APIC connectivity are exempt from being changed to the admin-down state. To achieve this exemption, the leaf switch remembers the downlink interface that was connected to the Cisco APICs prior to the power cycle or upgrade. Because of this, you must not change the Cisco APIC connectivity until the switches are fully operational again after the power cycle or upgrade.

Switch Role Considerations

- The default fabric links must be used for initial switch discovery from another switch.
- If a default spine switch is connected to the Cisco Application Policy Infrastructure Controller (APIC) directly, the switch will be converted to a leaf switch automatically. During the conversion period, the fault will be present in the Cisco APIC, which is a normal behaviour. The fault will be removed after the switch conversion is finished.
- For a leaf switch, you can configure a port profile to convert a port to be a downlink or fabric link after the port is registered to the Cisco APIC. For more information, see the *Cisco APIC Layer 2 Networking Configuration Guide* at the following site:

  https://www.cisco.com/c/en/us/support/cloud-systems-management/application-policy-infrastructure-controller-apic/tsd-products-support-series-home.html#Configuration_Guides

The following table specifies the default role for the switches for which you are able to change their role:

Table 9: Default Switch Roles

Switch Product ID	Default Role	First Release to Support a Role Change[1]
N9K-C93600CD-GX	Leaf	5.2(1)
N9K-C9364C-GX	Leaf	5.1(3)
N9K-C9316D-GX	Spine	5.1(4)

[1] Specifies the first release to support changing the role change for the indicated switch. Role changing for that switch is supported in all subsequent releases.

Registering an Unregistered Switch Using the GUI

Note The infrastructure IP address range must not overlap with other IP addresses used in the ACI fabric for in-band and out-of-band networks.

Before you begin

Make sure that all switches in the fabric are physically connected and booted.

Procedure

Step 1 On the menu bar, choose **Fabric** > **Inventory**.

Step 2 In the Navigation pane, choose **Fabric Membership**.

Step 3 In the Work pane, click the **Nodes Pending Registration** tab.

Switches in the **Nodes Pending Registration** tab table can have the following conditions:

- A newly discovered but unregistered node has a node ID of 0 and has no IP address.
- A manually entered (in Cisco Application Policy Infrastructure Controller (APIC)) but unregistered switch has an original status of **Undiscovered** until it is physically connected to the network. Once connected, the status changes to **Discovered**.

Step 4 In the **Nodes Pending Registration** table, locate a switch with an ID of 0 or a newly connected switch with the serial number you want to register.

Step 5 (Optional) Double-click the row of that node if you want to see more information about the node.

A dialog appears that shows you various node properties, such as the ACI-mode switch release and information about LLDP neighbors.

Step 6 Right-click the row of that switch, choose **Register**, and perform the following actions:

a) Verify the displayed Serial Number to determine which switch is being added.

b) Configure or edit the following settings:

Field	Setting
Pod ID	Identifier of the pod where the node is located.
Node ID	A number greater than 100. The first 100 IDs are reserved for Cisco APIC appliance nodes. **Note** We recommend that leaf nodes and spine nodes be numbered differently. For example, number spines in the 100 range (such as 101, 102) and number leafs in the 200 range (such as 201, 202). After the node ID is assigned, it cannot be updated. After the node has been added to the **Registered Nodes** tab table, you can update the node name by right-clicking the table row and choosing **Edit Node and Rack Name**.
RL TEP Pool	Tunnel endpoint (TEP) pool identifier for the node.
Node Name	The node name, such as leaf1 or spine3.

Field	Setting
Role	The assigned node role. The options are: • **spine** • **leaf** • **virtualleaf** • **virtualspine** • **remote leaf** • **tier-2-leaf** If you choose a role other than the default role for the node, the node automatically reboots during the registration to change the role.
Rack Name	The name of the rack in which the node is installed. Choose **Default**, or choose **Create Rack** to add a name and description.

c) Click **Register**.

Cisco APIC assigns an IP address to the node and the node is added to the **Registered Nodes** tab table. Next and if applicable, other nodes that are connected to this node are discovered and appear in the **Nodes Pending Registration** tab table.

Step 7 Continue to monitor the **Nodes Pending Registration** tab table. As more nodes appear, repeat these steps to register each new node until all installed nodes are registered.

Adding a Switch Before Discovery Using the GUI

You can add a switch description before the switch is physically connected to the network by following these steps:

Before you begin

Make sure that you know the serial number of the switch.

Procedure

Step 1 On the menu bar, choose **Fabric** > **Inventory**.

Step 2 In the Navigation pane, choose **Fabric Membership**.

Step 3 On the **Registered Nodes** or **Nodes Pending Registration** work pane, click the Actions icon, then click **Create Fabric Node Member**.

The **Create Fabric Node Member** dialog appears.

Step 4 Configure the following settings:

Field	Setting
Pod ID	Identify the pod where the node is located.
Serial Number	Required: Enter the serial number of the switch.
Node ID	Required: Enter a number greater than 100. The first 100 IDs are reserved for Cisco Application Policy Infrastructure Controller (APIC) appliance nodes. **Note** We recommend that you number leaf nodes and spine nodes differently. For example, number leaf nodes in the 100 range (such as 101, 102) and number spine nodes in the 200 range (such as 201, 202). After the node ID is assigned, it cannot be updated. After the node has been added to the **Registered Nodes** tab table, you can update the node name by right-clicking the table row and choosing **Edit Node and Rack Name**.
Switch Name	The node name, such as leaf1 or spine3.
Node Type	Choose the type (role) for the node. The options are: • **leaf** Put a check in one of the following boxes if applicable: • **Is Remote**: Specifies that the node is a remote leaf switch. • **Is Virtual**: Specifies that the node is virtual. • **Is Tier-2 Leaf**: The fabric node member (leaf switch) being created will take on the characteristics of a tier-2 leaf switch in a multi-tier architecture. • **spine** Put a check in the following box if applicable: • **Is Virtual**: Specifies that the node is virtual. • **unknown** If you choose a role other than the default role for the node, the node automatically reboots during the registration to change the role.
VPC Pair	Optional. If the node is part of a vPC pair, choose the ID of the node with which to pair this node.
VPC Domain ID	Enter the vPC domain ID for the vPC pair. The range is from 1 to 1000. This field only appears if you entered a value for **VPC Pair**, and is required in that case.

The Cisco APIC adds the new node to the **Nodes Pending Registration** tab table.

What to do next

Connect the physical switch to the network. Once connected, the Cisco APIC matches the serial number of the physical switch to the new entry. Monitor the **Nodes Pending Registration** tab table until the **Status** for the new switch changes from **Undiscovered** to **Discovered**. Follow the steps in the Registering an Unregistered Switch Using the GUI, on page 41 section to complete the fabric initialization and discovery process for the new switch.

Auto Firmware Update on Switch Discovery

When **Auto Firmware Update on Switch Discovery** is enabled, APIC automatically updates the firmware of the new switch in the following scenarios:

- A new switch discovery with a new node ID
- A switch replacement with an existing node ID
- An initialization and rediscovering of an existing node

In releases earlier than Cisco APIC Release 5.1(1), this feature was named **Enforce Bootscript Version Validation** and was located at **Admin > Firmware > Infrastructure > Nodes**. In Cisco APIC Release 5.1(1), the feature is renamed and moved to its current location.

Procedure

Step 1 On the menu bar, navigate to **Fabric > Inventory > Fabric Membership > Auto Firmware Update**.

Step 2 Check the **Auto Firmware Update on Switch Discovery** checkbox to enable the feature.

Step 3 Select the target firmware version for updating new switches in the **Default Firmware Version** drop-down list.

Note If the node ID of the new switch is part of a firmware update group under **Admin > Firmware**, such as a replacement scenario, the new switch is updated to the target version specified by the update group. Otherwise, it's updated to the default firmware version specified in this procedure.

When the selected **Default Firmware Version** is "any," this feature won't update the firmware of a new switch that has an ID that isn't part of a firmware update group. A new switch that has a node ID that is part of a firmware update group will be updated to the target version specified by the update group.

Step 4 Click **Submit**.

Switch Discovery Validation and Switch Management from the APIC

After the switches are registered with the APIC, the APIC performs fabric topology discovery automatically to gain a view of the entire network and to manage all the switches in the fabric topology.

Each switch can be configured, monitored, and upgraded from the APIC without having to access the individual switches.

Validating the Registered Switches Using the GUI

Procedure

Step 1 On the menu bar, navigate to **Fabric > Inventory > Fabric Membership**.

Step 2 In the **Fabric Membership** work pane, click the **Registered Nodes** tab.
The switches in the fabric are displayed in the **Registered Nodes** tab table with their node IDs. In the table, all the registered switches are displayed with the IP addresses that are assigned to them.

Validating the Fabric Topology

After all the switches are registered with the APIC cluster, the APIC automatically discovers all the links and connectivity in the fabric and discovers the entire topology as a result.

Validating the Fabric Topology Using the GUI

Procedure

Step 1 On the menu bar, navigate to **Fabric > Inventory > Pod *number***.

Step 2 In the **Work** pane, click the **Topology** tab.
The displayed diagram shows all attached switches, APIC instances, and links.

Step 3 (Optional) Hover over any component to view its health, status, and inventory information.

Step 4 (Optional) To view the port-level connectivity of a leaf switch or spine switch, double-click its icon in the topology diagram.

Step 5 (Optional) To refresh the topology diagram, click the icon in the upper right corner of the **Work** pane.

Unmanaged Switch Connectivity in VM Management

The hosts that are managed by the VM controller (for example, a vCenter), can be connected to the leaf port through a Layer 2 switch. The only prerequisite required is that the Layer 2 switch must be configured with a management address, and this management address must be advertised by Link Layer Discovery Protocol (LLDP) on the ports that are connected to the switches. Layer 2 switches are automatically discovered by the APIC, and they are identified by the management address. To view the unmanaged switches in APIC, navigate to **Fabric > Inventory > Fabric Membership** and click the **Unmanaged Fabric Nodes** tab.

Troubleshooting Switch Discovery Issues

The ACI-mode switch software includes a comprehensive leaf and spine switch discovery validation program. The validation program is launched with a switch CLI command when a switch is stuck in the discovery mode.

The validation program performs the following tests:

1. System state—Checks the state of the `topSystem` managed object (MO).
   a. If the state is "out-of-service," checks for any scheduled upgrades.
   b. If the state is "downloading bootscript," a failure has occurred in the downloading bootscript. The failure is reported. If the switch is an L3out spine, the program additionally checks the bootstrap download state and reports any failure.
2. DHCP status—Checks for DHCP status and information, such as the TEP IP, node Id, and name assigned from the `dhcpResp` MO.
3. AV details—Checks whether the APICs are registered and whether they have valid IP addresses.
4. IP reachability—Uses the **iping** command to verify IP reachability to the address assigner APIC. To retest this condition, use the **show discoveryissues apic** *ipaddress* command.
5. infra VLAN received—Checks for the presence of the infra VLAN details in the `lldpInst` MO. If this switch belongs to a pod that has no APIC, no infra VLAN details are present, and this section of the test result can be ignored.
6. LLDP adjacency—Checks for the presence of LLDP adjacencies and for any wiring mismatch issues. LLDP issues can generate fault reports such as infra VLAN mismatch, chassis ID mismatch, or no connection to the front end ports.
7. Switch version—Reports the running firmware version of the switch. Also reports the version of the APIC, if available.
8. FPGA/BIOS—Checks for any FPGA/BIOS version mismatch on the switch.
9. SSL validation—Checks for validity of the SSL certificate details using the **acidiag verifyssl -s** *serialNumber* command.
10. Policy downloads—Checks the `pconsBootStrap` MO to see whether registration to APIC (PM shards) is complete and whether all policies were downloaded successfully.
11. Time—Reports the current time on the switch.
12. Hardware status—Checks the module, power, and fan status from the `eqptCh, eqptFan, eqptPsu, eqptFt` and `eqptLC` MOs.

Running the Test Manually

To run the switch discovery validation program, log in to the spine or leaf switch CLI console and execute the following command:

show discoveryissues [apic *ipaddress***]**

Example of a Successful Test

The following example shows the switch discovery validation program output for a successful test.

```
spine1# show discoveryissues

Checking the platform type.............SPINE!
Check01 - System state - in-service               [ok]
```

```
Check02 - DHCP status                [ok]
    TEP IP: 10.0.40.65 Node Id: 106 Name: spine1
Check03 - AV details check               [ok]
Check04 - IP rechability to apic               [ok]
    Ping from switch to 10.0.0.1 passed
Check05 - infra VLAN received               [ok]
    infra vLAN:1093
Check06 - LLDP Adjacency               [ok]
    Found adjacency with LEAF
Check07 - Switch version               [ok]
    version: n9000-14.2(0.167)  and apic version: 5.0(0.25)
Check08 - FPGA/BIOS out of sync test               [ok]
Check09 - SSL check               [check]
    SSL certificate details are valid
Check10 - Downloading policies               [ok]
Check11 - Checking time               [ok]
    2019-08-21 17:15:45
Check12 - Checking modules, power and fans               [ok]
```

Example of a Failed Test

The following example shows the switch discovery validation program output for a switch with discovery issues.

```
spine1# show discoveryissues

Checking the platform type.............SPINE!
Check01 - System state - out-of-service               [FAIL]
    Upgrade status is notscheduled
    Node upgrade is notscheduled state
Check02 - DHCP status               [FAIL]
    ERROR: discover not being sent by switch
    Ignore this, if the IP is already known by switch
    ERROR: node Id not configured
    ERROR: Ip not assigned by dhcp server
    ERROR: Address assigner's IP not populated
    TEP IP: unknown Node Id: unknown Name: unknown
Check03 - AV details check               [ok]
Check04 - IP reachability to apic               [FAIL]
    please rerun the CLI with argument apic Ip
    (show discoveryissues apic <ip>) to check its reachability from switch
Check05 - infra VLAN received               [FAIL]
    Please ignore if this switch is part of a pod with no apic
Check06 - LLDP Adjacency               [FAIL]
    Error: spine not connected to any leaf
Check07 - Switch version               [ok]
    version: n9000-14.2(0.146)  and apic version: unknown
Check08 - FPGA/BIOS out of sync test               [ok]
Check09 - SSL check               [ok]
    SSL certificate details are valid
Check10 - Downloading policies               [FAIL]
    Registration to all PM shards is not complete
    Policy download is not complete
    Pcons booststrap is in triggered state
Check11 - Checking time               [ok]
    2019-07-17 19:26:29
Check12 - Checking modules, power and fans               [FAIL]
    Line card state is testing
```

Finding Your Switch Inventory Using the GUI

This section explains how to find your switch model and serial numbers using the Cisco APIC GUI.

Before you begin

You must have access to the Cisco APIC GUI

Procedure

Step 1 On the menu bar, choose **Fabric > Inventory**.

Step 2 In the navigation pane, click a **Pod** icon.
Your switch icons appear in the navigation pane.

Step 3 In the navigation pane, click on a switch icon.
A list of tabs appears at the top of the work pane.

Step 4 Click the **General** tab.
Your switch information appears in the work pane.

Maintenance Mode

Maintenance Mode

Following are terms that are helpful to understand when using maintenance mode:

- **Maintenance mode**: Used to isolate a switch from user traffic for debugging purposes. You can put a switch in **maintenance mode** by enabling the **Maintenance (GIR)** field in the **Fabric Membership** page in the APIC GUI, located at **Fabric** > **Inventory** > **Fabric Membership** (right-click on a switch and choose **Maintenance (GIR)**).

  If you put a switch in **maintenance mode**, that switch is not considered as a part of the operational ACI fabric infra and it will not accept regular APIC communications.

You can use maintenance mode to gracefully remove a switch and isolate it from the network in order to perform debugging operations. The switch is removed from the regular forwarding path with minimal traffic disruption.

In graceful removal, all external protocols are gracefully brought down except the fabric protocol (IS-IS) and the switch is isolated from the network. During maintenance mode, the maximum metric is advertised in IS-IS within the Cisco Application Centric Infrastructure (Cisco ACI) fabric and therefore the leaf switch in maintenance mode does not attract traffic from the spine switches. In addition, all front-panel interfaces on the switch are shutdown except for the fabric interfaces. To return the switch to its fully operational (normal) mode after the debugging operations, you must recommission the switch. This operation will trigger a stateless reload of the switch.

In graceful insertion, the switch is automatically decommissioned, rebooted, and recommissioned. When recommissioning is completed, all external protocols are restored and maximum metric in IS-IS is reset after 10 minutes.

The following protocols are supported:

- Border Gateway Protocol (BGP)
- Enhanced Interior Gateway Routing Protocol (EIGRP)
- Intermediate System-to-Intermediate System (IS-IS)
- Open Shortest Path First (OSPF)
- Link Aggregation Control Protocol (LACP)

Protocol Independent Multicast (PIM) is not supported.

Important Notes

- If a border leaf switch has a static route and is placed in maintenance mode, the route from the border leaf switch might not be removed from the routing table of switches in the ACI fabric, which causes routing issues.

  To work around this issue, either:

  - Configure the same static route with the same administrative distance on the other border leaf switch, or
  - Use IP SLA or BFD for track reachability to the next hop of the static route

- While the switch is in maintenance mode, the Ethernet port module stops propagating the interface related notifications. As a result, if the remote switch is rebooted or the fabric link is flapped during this time, the fabric link will not come up afterward unless the switch is manually rebooted (using the **acidiag touch clean** command), decommissioned, and recommissioned.
- While the switch is in maintenance mode, CLI 'show' commands on the switch show the front panel ports as being in the up state and the BGP protocol as up and running. The interfaces are actually shut and all other adjacencies for BGP are brought down, but the displayed active states allow for debugging.
- For multi-pod / multi-site, **IS-IS metric for redistributed routes** should be set to less than 63 to minimize the traffic disruption when bringing the node back into the fabric. To set the **IS-IS metric for redistributed routes**, choose **Fabric** > **Fabric Policies** > **Pod Policies** > **IS-IS Policy**.
- Existing GIR supports all Layer 3 traffic diversion. With LACP, all the Layer 2 traffic is also diverted to the redundant node. Once a node goes into maintenance mode, LACP running on the node immediately informs neighbors that it can no longer be aggregated as part of port-channel. All traffic is then diverted to the vPC peer node.
- The following operations are not allowed in maintenance mode:
  - **Upgrade**: Upgrading the network to a newer version
  - **Stateful Reload**: Restarting the GIR node or its connected peers
  - **Stateless Reload**: Restarting with a clean configuration or power-cycle of the GIR node or its connected peers
  - **Link Operations**: Shut / no-shut or optics OIR on the GIR node or its peer node
  - **Configuration Change**: Any configuration change (such as clean configuration, import, or snapshot rollback)

- **Hardware Change**: Any hardware change (such as adding, swapping, removing FRU's or RMA)

Removing a Switch to Maintenance Mode Using the GUI

Use this procedure to remove a switch to maintenance mode using the GUI. During the removal of a switch to maintenance mode, the out-of-band management interfaces will remain up and accessible.

Procedure

Step 1 On the menu bar, choose **Fabric** > **Inventory**.

Step 2 In the navigation pane, click **Fabric Membership**.

Step 3 In the **Registered Nodes** table in the work pane, right-click the row of the switch to be removed to maintenance mode and select **Maintenance (GIR)**.

Step 4 Click **OK**.

The gracefully removed switch displays **Maintenance** in the **Status** column.

Inserting a Switch to Operational Mode Using the GUI

Use this procedure to insert a switch to operational mode using the GUI.

Procedure

Step 1 On the menu bar, choose **Fabric** > **Inventory**.

Step 2 In the navigation pane, click **Fabric Membership**.

Step 3 In the **Registered Nodes** table in the work pane, right-click the row of the switch to be inserted to operational mode and select **Commision**.

Step 4 Click **Yes**.

Cisco NX-OS to Cisco ACI POAP Auto-conversion

About Cisco NX-OS to Cisco ACI POAP Auto-conversion

Beginning with the 5.2(3) release, Cisco NX-OS to Cisco Application Centric Infrastructure (ACI) power-on auto-provisioning (POAP) auto-conversion automates the process of upgrading software images and installing configuration files on nodes that are being deployed in the network for the first time. When a Cisco NX-OS node with the POAP auto-conversion feature boots and does not find the startup configuration, the node enters the POAP mode and starts DHCP discovery on all ports. The node locates a DHCP server and bootstraps itself with its interface IP address, gateway, and DNS server IP addresses. The device also obtains the IP

address of a TFTP server and downloads a configuration script that enables the node to download and install the appropriate software image and configuration file. This process converts the Cisco NX-OS node from the standalone mode to the Cisco ACI-mode.

To auto-convert a Cisco NX-OS node to a Cisco ACI node using POAP, you need to specify an interface on a Cisco ACI switch node that is connected to the Cisco NX-OS node that needs to be auto-converted. The interface specified on the Cisco ACI switch enables the handling of POAP and allows the Cisco NX-OS node to use the Cisco Application Policy Infrastructure Controller (APIC) as its DHCP server for auto-conversion. The Cisco ACI switch node must be already registered to the Cisco ACI fabric and be active, meaning that the node is reachable from the Cisco APIC cluster. This auto-conversion can be used both when adding a new switch to the fabric or when replacing an existing Cisco ACI switch.

Guidelines and Limitations for Cisco NX-OS to Cisco ACI POAP Auto-conversion

The following guidelines and limitations apply when using Cisco NX-OS to Cisco Application Centric Infrastructure (ACI) power-on auto-provisioning (POAP) auto-conversion:

- Because a Cisco NX-OS node that is being converted starts to send discover packets on all interfaces including management, any external DHCP server (apart from the Cisco Application Policy Infrastructure Controller's (APIC's) server) should be removed, as they may intercept POAP discover packets and disrupt the conversion.
- Cisco NX-OS to Cisco ACI POAP auto-conversion is supported when the NX-OS device to be converted is connected to an existing Cisco ACI switch node that has reachability to the Cisco APIC cluster. Due to this reason, the following scenarios are not supported:
  - When discovering the first Cisco ACI switch from APIC 1.
  - When replacing a Cisco ACI leaf node when a Cisco APIC is singled-homed to the leaf node.
  - When adding or replacing a Cisco ACI switch that reaches to the Cisco APIC cluster only through an IPN device. That is, when adding a Cisco NX-OS node as a new remote leaf node, adding a Cisco NX-OS node as a first spine node in a new pod, replacing a remote leaf node, or replacing a spine node in a Cisco ACI Multi-Pod setup with only one spine node in the pod. This scenario is supported beginning with the Cisco APIC 5.2(4) release with the required configurations on the IPN device.
- Modular spine node supervisor replacement is not supported.
- POAP supports switches that have -EX, -FX, -GX, or a later suffix in the product IDs (PIDs), as well as the Cisco N9K-C9364C and N9K-C9332C switches.
- After you auto-convert a spine or leaf node, the **show system reset-reason** CLI command does not display any information regarding conversion. The output only states the following:

  ```
  reset-requested-by-cli-command-reload
  ```
- You must use optical cables between Cisco ACI switches and Cisco NX-OS switches. You cannot use copper cables in this case.
- The Cisco ACI switch image that needs to be used for auto-conversion must be present on the Cisco APIC cluster's firmware repository. You can use the GUI to check that the image is present by going to **Admin** > **Firmware** > **Images**.

Converting a Cisco NX-OS Node to Cisco ACI With POAP Auto-conversion Using the GUI

The following procedure converts an existing Cisco NX-OS node from the standalone mode to the Cisco ACI mode using power-on auto-provisioning (POAP) auto-conversion. This process does not decommission the node.

Before you begin

You must have enabled **Auto Firmware Update on Switch Discovery** with the target Cisco ACI firmware version. For more information, see the *Cisco APIC Getting Started Guide*.

Procedure

Step 1 On the menu bar, choose **Fabric** > **Inventory**.

Step 2 In the Navigation pane, choose **Fabric Membership**.

Step 3 In the Work pane, choose the **Registered Nodes** tab.

Step 4 (Optional) When replacing an existing Cisco ACI switch node with a new switch that may be running NX-OS, right-click the node to be replaced and choose **Remove From Controller** as you would do for a regular replacement scenario.

Step 5 In the action menu at the top right of the table, choose **Add with NXOS to ACI Conversion**.

In the replacement scenario, if the switch node to be replaced is decommissioned or inactive, you can alternatively right-click the node and choose **Replace with NXOS to ACI Conversion**. This will perform actions **Remove From Controller** from step 4 and **Add with NXOS to ACI Conversion** from step 5 at the same time.

Step 6 In the dialog, fill out the fields as follows:

- **Node ID**: Choose the ID of a node that is connected to the node that you want to convert. You can click the trash can to delete a node or **+** to add another node. Specify at least one node. You can click **Hide Interfaces** to hide the interface information if you need more space in the GUI when configuring additional nodes.
- **Interface ID**: Choose the ID of one of the node's interfaces that is connected to the node that you want to convert. You can click the trash can to delete an interface or **+** to add another interface. Configure only one interface in each node to handle POAP for POAP auto-conversion.

Step 7 Click **Submit**.

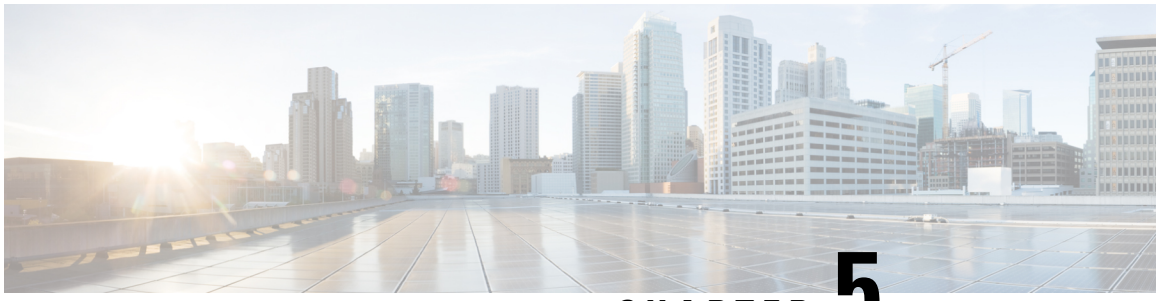
Step 8 Choose the **Nodes Pending Registration** tab.

After the node appears in this tab, the node registration procedure is the same as for regular Cisco ACI switches.

Step 9 (Optional) After the switch is registered and has joined the fabric with the `Active` status, you may delete the POAP auto-conversion setting on the interface that you configured in step 6. After the conversion completes, delete the POAP settings from the connected node:

a) Choose the **Registered Nodes** tab.
b) Double-click the row of the node from which you want to delete the POAP settings.
c) In the dialog, choose the **NXOS Conversion Policy** tab.

d) Select the pathname that you want to delete, then click the delete icon (the trashcan).



CHAPTER 5

Cisco APIC Cluster Management

APIC Cluster Overview

The Cisco Application Policy Infrastructure Controller (APIC) appliance is deployed in a cluster. A minimum of three controllers are configured in a cluster to provide control of the Cisco ACI fabric. The ultimate size of the controller cluster is directly proportionate to the size of the ACI deployment and is based on transaction-rate requirements. Any controller in the cluster can service any user for any operation, and a controller can be transparently added to or removed from the cluster.

This section provides guidelines and examples related to expanding, contracting, and recovering the APIC cluster.

Expanding the Cisco APIC Cluster

Expanding the Cisco APIC cluster is the operation to increase any size mismatches, from a cluster size of N to size N+1, within legal boundaries. The operator sets the administrative cluster size and connects the APICs with the appropriate cluster IDs, and the cluster performs the expansion.

During cluster expansion, regardless of in which order you physically connect the APIC controllers, the discovery and expansion takes place sequentially based on the APIC ID numbers. For example, APIC2 is discovered after APIC1, and APIC3 is discovered after APIC2 and so on until you add all the desired APICs to the cluster. As each sequential APIC is discovered, a single data path or multiple data paths are established, and all the switches along the path join the fabric. The expansion process continues until the operational cluster size reaches the equivalent of the administrative cluster size.

Contracting the Cisco APIC Cluster

Contracting the Cisco APIC cluster is the operation to decrease any size mismatches, from a cluster size of N to size N -1, within legal boundaries. As the contraction results in increased computational and memory load for the remaining APICs in the cluster, the decommissioned APIC cluster slot becomes unavailable by operator input only.

During cluster contraction, you must begin decommissioning the last APIC in the cluster first and work your way sequentially in reverse order. For example, APIC4 must be decommissioned before APIC3, and APIC3 must be decommissioned before APIC2.

Cluster Management Guidelines

The Cisco Application Policy Infrastructure Controller (APIC) cluster comprises multiple Cisco APICs that provide operators a unified real time monitoring, diagnostic, and configuration management capability for the Cisco Application Centric Infrastructure (ACI) fabric. To assure optimal system performance, use the following guidelines when making changes to the Cisco APIC cluster:

- Prior to initiating a change to the cluster, always verify its health. When performing planned changes to the cluster, all controllers in the cluster should be healthy. If one or more of the Cisco APICs' health status in the cluster is not "fully fit," remedy that situation before proceeding. Also, assure that cluster controllers added to the Cisco APIC are running the same version of firmware as the other controllers in the Cisco APIC cluster.
- We recommend that you have at least 3 active Cisco APICs in a cluster, along with additional standby Cisco APICs. In most cases, we recommend a cluster size of 3, 5, or 7 Cisco APICs. We recommend 4 Cisco APICs for a two site multi-pod fabric that has between 80 to 200 leaf switches.
- Disregard cluster information from Cisco APICs that are not currently in the cluster; they do not provide accurate cluster information.
- Cluster slots contain a Cisco APIC `ChassisID`. Once you configure a slot, it remains unavailable until you decommission the Cisco APIC with the assigned `ChassisID`.
- If a Cisco APIC firmware upgrade is in progress, wait for it to complete and the cluster to be fully fit before proceeding with any other changes to the cluster.
- When moving a Cisco APIC, first ensure that you have a healthy cluster. After verifying the health of the Cisco APIC cluster, choose the Cisco APIC that you intend to shut down. After the Cisco APIC has shut down, move the Cisco APIC, re-connect it, and then turn it back on. From the GUI, verify that the all controllers in the cluster return to a fully fit state.

Note Only move one Cisco APIC at a time.

- When moving a Cisco APIC that is connected to a set of leaf switches to another set of leaf switches or when moving a Cisco APIC to different port within the same leaf switch, first ensure that you have a healthy cluster. After verifying the health of the Cisco APIC cluster, choose the Cisco APIC that you intend to move and decommission it from the cluster. After the Cisco APIC is decomissioned, move the Cisco APIC and then commission it.

- Before configuring the Cisco APIC cluster, ensure that all of the Cisco APICs are running the same firmware version. Initial clustering of Cisco APICs running differing versions is an unsupported operation and may cause problems within the cluster.
- Unlike other objects, log record objects are stored only in one shard of a database on one of the Cisco APICs. These objects get lost forever if you decommission or replace that Cisco APIC.
- When you decommission a Cisco APIC, the Cisco APIC loses all fault, event, and audit log history that was stored in it. If you replace all Cisco APICs, you lose all log history. Before you migrate a Cisco APIC, we recommend that you manually backup the log history.

Expanding the APIC Cluster Size

Follow these guidelines to expand the APIC cluster size:

- Schedule the cluster expansion at a time when the demands of the fabric workload will not be impacted by the cluster expansion.
- If one or more of the APIC controllers' health status in the cluster is not "fully fit", remedy that situation before proceeding.
- Stage the new APIC controller(s) according to the instructions in their hardware installation guide. Verify in-band connectivity with a PING test.
- Increase the cluster target size to be equal to the existing cluster size controller count plus the new controller count. For example, if the existing cluster size controller count is 3 and you are adding 3 controllers, set the new cluster target size to 6. The cluster proceeds to sequentially increase its size one controller at a time until all new the controllers are included in the cluster.

Note Cluster expansion stops if an existing APIC controller becomes unavailable. Resolve this issue before attempting to proceed with the cluster expansion.

- Depending on the amount of data the APIC must synchronize upon the addition of each appliance, the time required to complete the expansion could be more than 10 minutes per appliance. Upon successful expansion of the cluster, the APIC operational size and the target size will be equal.

Note Allow the APIC to complete the cluster expansion before making additional changes to the cluster.

Reducing the APIC Cluster Size

Follow these guidelines to reduce the APIC cluster size and decommission the APIC controllers that are removed from the cluster:

Note Failure to follow an orderly process to decommission and power down APIC controllers from a reduced cluster can lead to unpredictable outcomes. Do not allow unrecognized APIC controllers to remain connected to the fabric.

- Reducing the cluster size increases the load on the remaining APIC controllers. Schedule the APIC controller size reduction at a time when the demands of the fabric workload will not be impacted by the cluster synchronization.
- If one or more of the APIC controllers' health status in the cluster is not "fully fit", remedy that situation before proceeding.
- Reduce the cluster target size to the new lower value. For example if the existing cluster size is 6 and you will remove 3 controllers, reduce the cluster target size to 3.
- Starting with the highest numbered controller ID in the existing cluster, decommission, power down, and disconnect the APIC controller one by one until the cluster reaches the new lower target size.

  Upon the decommissioning and removal of each controller, the APIC synchronizes the cluster.

Note After decommissioning an APIC controller from the cluster, power it down and disconnect it from fabric. Before returning it to service, do a wiped clean back to factory reset.

- Cluster synchronization stops if an existing APIC controller becomes unavailable. Resolve this issue before attempting to proceed with the cluster synchronization.
- Depending on the amount of data the APIC must synchronize upon the removal of a controller, the time required to decommission and complete cluster synchronization for each controller could be more than 10 minutes per controller.

Note Complete the entire necessary decommissioning steps, allowing the APIC to complete the cluster synchronization accordingly before making additional changes to the cluster.

Replacing Cisco APIC Controllers in the Cluster

Follow these guidelines to replace Cisco APIC controllers:

- If the health status of any Cisco APIC controller in the cluster is not **Fully Fit**, remedy the situation before proceeding.
- Schedule the Cisco APIC controller replacement at a time when the demands of the fabric workload will not be impacted by the cluster synchronization.
- Make note of the initial provisioning parameters and image used on the Cisco APIC controller that will be replaced. The same parameters and image must be used with the replacement controller. The Cisco APIC proceeds to synchronize the replacement controller with the cluster.

Note Cluster synchronization stops if an existing Cisco APIC controller becomes unavailable. Resolve this issue before attempting to proceed with the cluster synchronization.

- You must choose a Cisco APIC controller that is within the cluster and not the controller that is being decommissioned. For example: Log in to Cisco APIC1 or APIC2 to invoke the shutdown of APIC3 and decommission APIC3.
- Perform the replacement procedure in the following order:
  1. Make note of the configuration parameters and image of the APIC being replaced.
  2. Decommission the APIC you want to replace (see Decommissioning a Cisco APIC in the Cluster Using the GUI, on page 61)
  3. Commission the replacement APIC using the same configuration and image of the APIC being replaced (see Commissioning a Cisco APIC in the Cluster Using the GUI, on page 61)
- Stage the replacement Cisco APIC controller according to the instructions in its hardware installation guide. Verify in-band connectivity with a PING test.

Note Failure to decommission Cisco APIC controllers before attempting their replacement will preclude the cluster from absorbing the replacement controllers. Also, before returning a decommissioned Cisco APIC controller to service, do a wiped clean back to factory reset.

- Depending on the amount of data the Cisco APIC must synchronize upon the replacement of a controller, the time required to complete the replacement could be more than 10 minutes per replacement controller. Upon successful synchronization of the replacement controller with the cluster, the Cisco APIC operational size and the target size will remain unchanged.

Note Allow the Cisco APIC to complete the cluster synchronization before making additional changes to the cluster.

- The UUID and fabric domain name persist in a Cisco APIC controller across reboots. However, a clean back-to-factory reboot removes this information. If a Cisco APIC controller is to be moved from one fabric to another, a clean back-to-factory reboot must be done before attempting to add such an controller to a different Cisco ACI fabric.

Expanding the APIC Cluster Using the GUI

This procedure adds one or more Cisco Application Policy Infrastructure Controllers (APICs) to an existing cluster.

Before you begin

You must first set up any Cisco APIC that you will add to the cluster. For information about setting up a Cisco APIC, see Setting up the Cisco APIC , on page 5.

Procedure

Step 1 On the menu bar, choose **System** > **Controllers**.

Step 2 In the **Navigation** pane, expand **Controllers** > ***apic_name*** > **Cluster as Seen by Node**.

For *apic_name*, you must choose a Cisco APIC that is within the cluster that you wish to expand.

The **Cluster as Seen by Node** window appears in the **Work** pane with the **APIC Cluster** and **Standby APIC** tabs. In the **APIC Cluster** tab, the controller details appear. This includes the current cluster target and current sizes, the administrative, operational, and health states of each controller in the cluster.

Step 3 Verify that the health state of the cluster is **Fully Fit** before you proceed with contracting the cluster.

Step 4 In the **Work** pane, click **Actions** > **Change Cluster Size**.

Step 5 In the **Change Cluster Size** dialog box, in the **Target Cluster Administrative Size** field, choose the target number to which you want to expand the cluster. Click **Submit**.

Note You cannot have a cluster size of two Cisco APICs. You can have a cluster of one, three, or more Cisco APICs.

Step 6 In the **Confirmation** dialog box, click **Yes**.
In the **Work** pane, under **Properties**, the **Target Size** field must display your target cluster size.

Step 7 Physically connect all the Cisco APICs that are being added to the cluster.
In the **Work** pane, in the **Cluster** > **Controllers** area, the Cisco APICs are added one by one and displayed in the sequential order starting with N + 1 and continuing until the target cluster size is achieved.

Step 8 Verify that the Cisco APICs are in operational state, and the health state of each controller is **Fully Fit**.

Contracting the APIC Cluster Using the GUI

Procedure

Step 1 On the menu bar, choose **System** > **Controllers**. In the **Navigation** pane, expand **Controllers** > **apic_controller_name** > **Cluster as Seen by Node**.

You must choose an **apic_name** that is within the cluster and not the controller that is being decommissioned.

The **Cluster as Seen by Node** window appears in the **Work** pane with the **APIC Cluster** and **Standby APIC** tabs. In the **APIC Cluster** tab, the controller details appear. This includes the current cluster target and current sizes, the administrative, operational, and health states of each controller in the cluster.

Step 2 Verify that the health state of the cluster is **Fully Fit** before you proceed with contracting the cluster.

Step 3 In the **Work** pane, click **Actions** > **Change Cluster Size**.

Step 4 In the **Change Cluster Size** dialog box, in the **Target Cluster Administrative Size** field, choose the target number to which you want to contract the cluster. Click **Submit**.

Note It is not acceptable to have a cluster size of two APICs. A cluster of one, three, or more APICs is acceptable.

Step 5 From the **Active Controllers** area of the **Work** pane, choose the APIC that is last in the cluster.

Example:

In a cluster of three, the last in the cluster is three as identified by the controller ID.

Step 6 Right-click on the controller you want to decommission and choose **Decommission**. When the **Confirmation** dialog box displays, click **Yes**.
The decommissioned controller displays **Unregistered** in the **Operational State** column. The controller is then taken out of service and not visible in the **Work** pane any longer.

Step 7 Repeat the earlier step to decommission the controllers one by one for all the APICs in the cluster in the appropriate order of highest controller ID number to the lowest.

Note The operation cluster size shrinks only after the last appliance is decommissioned, and not after the administrative size is changed. Verify after each controller is decommissioned that the operational state of the controller is unregistered, and the controller is no longer in service in the cluster.

You should be left with the remaining controllers in the APIC cluster that you desire.

Commissioning and Decommissioning Cisco APIC Controllers

Commissioning a Cisco APIC in the Cluster Using the GUI

Procedure

Step 1 From the menu bar, choose **System** > **Controllers**.

Step 2 In the **Navigation** pane, expand **Controllers** > **apic_controller_name** > **Cluster as Seen by Node**.
The **Cluster as Seen by Node** window appears in the **Work** pane with the **APIC Cluster** and **Standby APIC** tabs. In the **APIC Cluster** tab, the controller details appear. This includes the current cluster target and current sizes, the administrative, operational, and health states of each controller in the cluster.

Step 3 From the **APIC Cluster** tab of the **Work** pane, verify in the **Active Controllers** summary table that the cluster **Health State** is **Fully Fit** before continuing.

Step 4 From the **Work** pane, right-click the decommissioned controller that is displaying **Unregistered** in the **Operational State** column and choose **Commission**.
The controller is highlighted.

Step 5 In the **Confirmation** dialog box, click **Yes**.

Step 6 Verify that the commissioned Cisco APIC is in the operational state and the health state is **Fully Fit**.

Decommissioning a Cisco APIC in the Cluster Using the GUI

This procedure decommissions a Cisco Application Policy Infrastructure Controller (APIC) in the cluster.

Note Unlike other objects, log record objects are stored only in one shard of a database on one of the Cisco APICs. These objects get lost forever if you decommission or replace that Cisco APIC.

Procedure

Step 1 On the menu bar, choose **System** > **Controllers**.

Step 2 In the **Navigation** pane, expand **Controllers** > **apic_name** > **Cluster as Seen by Node**.

You must choose an **apic_name** that is within the cluster and not the controller that is being decommissioned.

The **Cluster as Seen by Node** window appears in the **Work** pane with the controller details and the **APIC Cluster** and **Standby APIC** tabs.

Step 3 In the **Work** pane, verify in the **APIC Cluster** tab that the **Health State** in the **Active Controllers** summary table indicates the cluster is **Fully Fit** before continuing.

Step 4 In the **Active Controllers** table located in the **APIC Cluster** tab of the **Work** pane, right-click on the controller you want to decommission and choose **Decommission**.
The **Confirmation** dialog box displays.

Step 5 Click **Yes**.

The decommissioned controller displays **Unregistered** in the **Operational State** column. The controller is then taken out of service and no longer visible in the **Work** pane.

Note
- After decommissioning a Cisco APIC from the cluster, power the controller down and disconnect it from the fabric. Before returning the Cisco APIC to service, perform a factory reset on the controller.
- The operation cluster size shrinks only after the last appliance is decommissioned, and not after the administrative size is changed. Verify after each controller is decommissioned that the operational state of the controller is unregistered, and the controller is no longer in service in the cluster.
- After decommissioning the Cisco APIC, you must reboot the controller for Layer 4 to Layer 7 services. You must perform the reboot before re-commissioning the controller.

Shutting Down the APICs in a Cluster

Shutting Down all the APICs in a Cluster

Before you shutdown all the APICs in a cluster, ensure that the APIC cluster is in a healthy state and all the APICs are showing fully fit. Once you start this process, we recommend that no configuration changes are done during this process. Use this procedure to gracefully shut down all the APICs in a cluster.

Procedure

Step 1 Log in to Cisco APIC with appliance ID 1.

Step 2 On the menu bar, choose **System** > **Controllers**.

Step 3 In the Navigation pane, expand **Controllers** > **apic_controller_name**.

You must select the third APIC in the cluster.

Step 4 Right-click the controller and click **Shutdown**.

Step 5 Repeat the steps to shutdown the second APIC in the cluster.

Step 6 Log in to Cisco IMC of the first APIC in the cluster to shutdown the APIC.

Step 7 Choose **Server** > **Server Summary** > **Shutdown Server**.

You have now shutdown all the three APICs in a cluster.

Bringing Back the APICs in a Cluster

Use this procedure to bring back the APICs in a cluster.

Procedure

Step 1 Log in to Cisco IMC of the first APIC in the cluster.

Step 2 Choose **Server** > **Server Summary** > **Power On** to power on the first APIC.

Step 3 Repeat the steps to power on the second APIC and then the third APIC in the cluster.

After all the APICs are powered on, ensure that all the APICs are in a fully fit state. Only after verifying that the APICs are in a fully fit state, you must make any configuration changes on the APIC.

Cold Standby

About Cold Standby for a Cisco APIC Cluster

The Cold Standby functionality for a Cisco Application Policy Infrastructure Controller (APIC) cluster enables you to operate the Cisco APICs in a cluster in an Active/Standby mode. In a Cisco APIC cluster, the designated active Cisco APICs share the load and the designated standby Cisco APICs can act as a replacement for any of the Cisco APICs in the active cluster.

As an admin user, you can set up the Cold Standby functionality when the Cisco APIC is launched for the first time. We recommend that you have at least three active Cisco APICs in a cluster, and one or more standby Cisco APICs. As an admin user, you can initiate the switch over to replace an active Cisco APIC with a standby Cisco APIC.

Guidelines and Limitations for Standby Cisco APICs

The following are guidelines and limitations for standby Cisco Application Policy Infrastructure Controllers (APICs):

- There must be three active Cisco APICs to add a standby Cisco APIC.
- The standby Cisco APIC need to run with the same firmware version of the cluster when the standby Cisco APICs join the cluster during the initial setup.
- During an upgrade process, after all the active Cisco APICs are upgraded, the standby Cisco APICs are also upgraded automatically.
- During the initial setup, IDs are assigned to the standby Cisco APICs. After a standby Cisco APIC is switched over to an active Cisco APIC, the standby Cisco APIC (new active) starts using the ID of the replaced (old active) Cisco APIC.
- The admin login is not enabled on the standby Cisco APICs. To troubleshoot a Cold Standby Cisco APIC, you must log in to the standby using SSH as *rescue-user*.
- During the switch over, the replaced active Cisco APIC needs to be powered down to prevent connectivity to the replaced Cisco APIC.
- Switch over fails under the following conditions:
  - If there is no connectivity to the standby Cisco APIC.
  - If the firmware version of the standby Cisco APIC is not the same as that of the active cluster.
- After switching over a standby Cisco APIC to be active, you can setup another standby Cisco APIC, if needed.
- If **Retain OOB IP address for Standby (new active)** is checked, the standby (new active) Cisco APIC will retain its original standby out-of-band management IP address.
- If **Retain OOB IP address for Standby (new active)** is not checked:
  - If only one active Cisco APIC is down: The standby (new active) Cisco APIC will use the old active Cisco APIC's out-of-band management IP address.
  - If more than one active Cisco APICs are down: The standby (new active) Cisco APIC will try to use the active Cisco APIC's out-of-band management IP address, but it may fail if the shard of out-of-band management IP address configuration for the active Cisco APIC is in the minority state.
- For Cisco ACI Multi-Pod, if the old active Cisco APIC and the standby Cisco APIC use different out-of-band management IP subnets, you must check the option to have the standby (new active) Cisco APIC retain its original standby out-of-band management IP address. Otherwise, you will lose out-of-band management IP connectivity to the standby (new active) Cisco APIC. This situation might happen if the old active Cisco APIC and the standby Cisco APIC are in the different pods.

  If out-of-band management IP connectivity is lost because of this reason or if more than one active Cisco APICs are down, you must create a new Static Node Management OOB IP Address to change the new active (previously standby) Cisco APIC out-of-band management IP address. You must have the cluster out of the minority state to make the configuration change.
- The standby Cisco APIC does not participate in policy configuration or management.

- No information is replicated to the standby Cisco APICs, not even the administrator credentials.
- A standby Cisco APIC does not retain the in-band management IP address when you promote the Cisco APIC to be active. You must manually reconfigure the Cisco APIC to have the correct in-band management IP address.

Verifying Cold Standby Status Using the GUI

1. On the menu bar, choose **System** > **Controllers**.
2. In the **Navigation** pane, expand **Controllers** > **apic_controller_name** > **Cluster as Seen by Node**.
3. In the **Work** pane, the standby controllers are displayed under **Standby Controllers**.

Switching Over an Active APIC with a Standby APIC Using the GUI

Use this procedure to switch over an active APIC with a standby APIC.

Procedure

Step 1 On the menu bar, choose **System** > **Controllers**.

Step 2 In the **Navigation** pane, expand **Controllers** > ***apic_controller_name*** > **Cluster as Seen by Node**.

The ***apic_controller_name*** should be other than the name of the controller that you are replacing.

Step 3 In the **Work** pane, verify that the **Health State** in the **Active Controllers** summary table indicates the active controllers other than the one being replaced are **Fully Fit** before continuing.

Step 4 Click an ***apic_controller_name*** that you want to switch over.

Step 5 In the **Work** pane, click **...** in the row of the contoller that you are replacing, then choose **Replace**.
The **Replace** dialog box displays.

Step 6 Choose the **Backup Controller** from the drop-down list and click **Submit**.

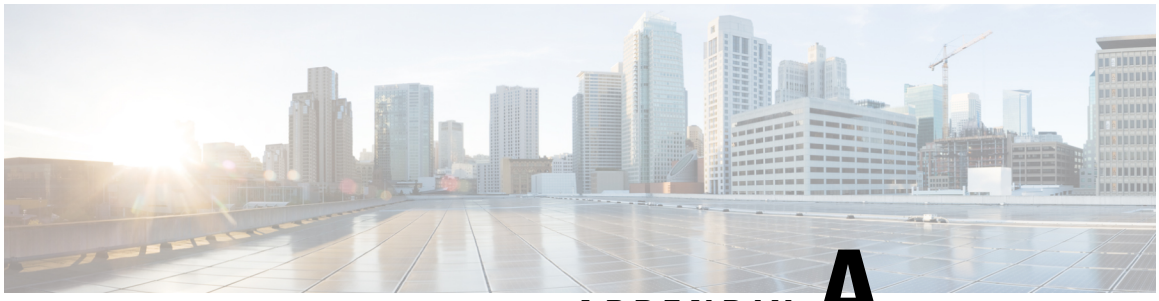
It may take several minutes to switch over an active APIC with a standby APIC and for the system to be registered as active.

Step 7 Verify the progress of the switch over in the **Failover Status** field in the **Active Controllers** summary table.

Note We recommend that you use a standby APIC in the same pod to replace an active APIC because each pod might use a different out of band management IP subnet.

If you can't use the recommended approach (for example, if active APIC (ID:2) in Pod1 is replaced by standby APIC (ID:21) in Pod2), and the out of band management IP subnets are different between pods, an additional procedure is required to have the standby Cisco APIC (new active) retain its original out of band management IP address after the failover.

- Check the **Retain OOB IP address for Standby (new active)** box at Step 6, on page 65.
- After the failover, delete the static Node Management Address configuration for the replaced (old active) Cisco APIC and read the static Node Management Address configuration for the new active (previously standby) Cisco APIC.



APPENDIX A

Configuring the Cisco APIC Using the CLI

Cluster Management Guidelines

The Cisco Application Policy Infrastructure Controller (APIC) cluster comprises multiple Cisco APICs that provide operators a unified real time monitoring, diagnostic, and configuration management capability for the Cisco Application Centric Infrastructure (ACI) fabric. To assure optimal system performance, use the following guidelines when making changes to the Cisco APIC cluster:

- Prior to initiating a change to the cluster, always verify its health. When performing planned changes to the cluster, all controllers in the cluster should be healthy. If one or more of the Cisco APICs' health status in the cluster is not "fully fit," remedy that situation before proceeding. Also, assure that cluster controllers added to the Cisco APIC are running the same version of firmware as the other controllers in the Cisco APIC cluster.
- We recommend that you have at least 3 active Cisco APICs in a cluster, along with additional standby Cisco APICs. In most cases, we recommend a cluster size of 3, 5, or 7 Cisco APICs. We recommend 4 Cisco APICs for a two site multi-pod fabric that has between 80 to 200 leaf switches.
- Disregard cluster information from Cisco APICs that are not currently in the cluster; they do not provide accurate cluster information.
- Cluster slots contain a Cisco APIC `ChassisID`. Once you configure a slot, it remains unavailable until you decommission the Cisco APIC with the assigned `ChassisID`.
- If a Cisco APIC firmware upgrade is in progress, wait for it to complete and the cluster to be fully fit before proceeding with any other changes to the cluster.

- When moving a Cisco APIC, first ensure that you have a healthy cluster. After verifying the health of the Cisco APIC cluster, choose the Cisco APIC that you intend to shut down. After the Cisco APIC has shut down, move the Cisco APIC, re-connect it, and then turn it back on. From the GUI, verify that the all controllers in the cluster return to a fully fit state.

Note Only move one Cisco APIC at a time.

- When moving a Cisco APIC that is connected to a set of leaf switches to another set of leaf switches or when moving a Cisco APIC to different port within the same leaf switch, first ensure that you have a healthy cluster. After verifying the health of the Cisco APIC cluster, choose the Cisco APIC that you intend to move and decommission it from the cluster. After the Cisco APIC is decomissioned, move the Cisco APIC and then commission it.
- Before configuring the Cisco APIC cluster, ensure that all of the Cisco APICs are running the same firmware version. Initial clustering of Cisco APICs running differing versions is an unsupported operation and may cause problems within the cluster.
- Unlike other objects, log record objects are stored only in one shard of a database on one of the Cisco APICs. These objects get lost forever if you decommission or replace that Cisco APIC.
- When you decommission a Cisco APIC, the Cisco APIC loses all fault, event, and audit log history that was stored in it. If you replace all Cisco APICs, you lose all log history. Before you migrate a Cisco APIC, we recommend that you manually backup the log history.

Replacing a Cisco APIC in a Cluster Using the CLI

Note
- For more information about managing clusters, see Cluster Management Guidelines.
- When you replace an APIC, the password will always be synced from the cluster. When replacing APIC 1, you will be asked for a password but it will be ignored in favor of the existing password in the cluster. When replacing APIC 2 or 3, you will not be asked for a password.

Before you begin

Before replacing an APIC, ensure that the replacement APIC is running the same firmware version as the APIC to be replaced. If the versions are not the same, you must update the firmware of the replacement APIC before you begin. Initial clustering of APICs running differing versions is an unsupported operation and may cause problems within the cluster.

Procedure

Step 1 Identify the APIC that you want to replace.

Step 2 Note the configuration details of the APIC to be replaced by using the **acidiag avread** command.

Step 3 Decommission the APIC using the **controller** *controller-id* **decommission** command.

Note Decommissioning the APIC removes the mapping between the APIC ID and Chassis ID. The new APIC typically has a different APIC ID, so you must remove this mapping in order to add a new APIC to the cluster.

Step 4 To commission the new APIC, follow these steps:

a) Disconnect the old APIC from the fabric.
b) Connect the replacement APIC to the fabric.

The new APIC controller appears in the APIC GUI menu **System > Controllers > apic_controller_name > Cluster as Seen by Node** in the **Unauthorized Controllers** list.

c) Commission the new APIC using the **controller** *controller-id* **commission** command.
d) Boot the new APIC.
e) Allow several minutes for the new APIC information to propagate to the rest of the cluster.

The new APIC controller appears in the APIC GUI menu **System > Controllers > apic_controller_name > Cluster as Seen by Node** in the **Active Controllers** list.

Switching Over Active APIC with Standby APIC Using CLI

Use this procedure to switch over an active APIC with a standby APIC.

Procedure

Step 1 **replace-controller replace** *ID number Backup serial number*

Replaces an active APIC with an standby APIC.

Example:

```
apic1#replace-controller replace 2 FCH1804V27L
Do you want to replace APIC 2 with a backup? (Y/n): Y
```

Step 2 **replace-controller reset** *ID number*

Resets fail over status of the active controller.

Example:

```
apic1# replace-controller reset 2
Do you want to reset failover status of APIC 2? (Y/n): Y
```

Verifying Cold Standby Status Using the CLI

Procedure

To verify the Cold Standby status of APIC, log in to the APIC as admin and enter the command **show controller**.

```
apic1# show controller
Fabric Name          : vegas
Operational Size     : 3
Cluster Size         : 3
Time Difference      : 496
Fabric Security Mode : strict

 ID    Pod   Address          In-Band IPv4     In-Band IPv6                OOB IPv4
 OOB IPv6                   Version             Flags  Serial Number     Health
 ----  ----  ---------------  ---------------  -------------------------  ---------------
 -------------------------  ------------------  -----  ----------------  ------------------

 1*    1     10.0.0.1         0.0.0.0          fc00::1                    172.23.142.4
 fe80::26e9:b3ff:fe91:c4e0  2.2(0.172)          crva-  FCH1748V0DF       fully-fit
 2     1     10.0.0.2         0.0.0.0          fc00::1                    172.23.142.6
 fe80::26e9:bf8f:fe91:f37c  2.2(0.172)          crva-  FCH1747V0YF       fully-fit
 3     1     10.0.0.3         0.0.0.0          fc00::1                    172.23.142.8
 fe80::4e00:82ff:fead:bc66  2.2(0.172)          crva-  FCH1725V2DK       fully-fit
 21~         10.0.0.21
                                                -----  FCH1734V2DG

Flags - c:Commissioned | r:Registered | v:Valid Certificate | a:Approved | f/s:Failover
fail/success
(*)Current (~)Standby
```

Registering an Unregistered Switch Using the CLI

Use this procedure to register a switch from the **Nodes Pending Registration** tab on the **Fabric Membership** work pane using the CLI.

Note This procedure is identical to "Adding a Switch Before Discovery Using the CLI". When you execute the command, the system determines if the node exists and, if not, adds it. If the node exists, the system registers it.

Procedure

	Command or Action	Purpose
Step 1	[**no**] **system switch-id** *serial-number switch-id name* **pod** *id* **role leaf node-type tier-2-leaf**	Adds the switch to the pending registration list.

Adding a Switch Before Discovery Using the CLI

Use this procedure to add a switch to the **Nodes Pending Registration** tab on the **Fabric Membership** work pane using the CLI.

Note This procedure is identical to "Registering an Unregistered Switch Using the CLI". When you execute the command, the system determines if the node exists and, if not, adds it. If the node does exist, the system registers it.

Procedure

[**no**] **system switch-id** *serial-number switch-id name* **pod** *id* **role leaf node-type tier-2-leaf**

Adds the switch to the pending registration list.

Removing a Switch to Maintenance Mode Using the CLI

Use this procedure to remove a switch to maintenance mode using the CLI.

Note While the switch is in maintenance mode, CLI 'show' commands on the switch show the front panel ports as being in the up state and the BGP protocol as up and running. The interfaces are actually shut and all other adjacencies for BGP are brought down, but the displayed active states allow for debugging.

Procedure

[**no**]**debug-switch** *node_id or node_name*

Removes the switch to maintenance mode.

Inserting a Switch to Operation Mode Using the CLI

Use this procedure to insert a switch to operational mode using the CLI.

Procedure

[**no**]**no debug-switch** *node_id or node_name*

Inserts the switch to operational mode.

Configuring a Remote Location Using the NX-OS Style CLI

In the ACI fabric, you can configure one or more remote destinations for exporting techsupport or configuration files.

Procedure

	Command or Action	Purpose
Step 1	**configure** **Example:** `apic1# configure`	Enters global configuration mode.
Step 2	[**no**] **remote path** *remote-path-name* **Example:** `apic1(config)# remote path myFiles`	Enters configuration mode for a remote path.
Step 3	**user** *username* **Example:** `apic1(config-remote)# user admin5`	Sets the user name for logging in to the remote server. You are prompted for a password.
Step 4	**path** {**ftp** | **scp** | **sftp**} *host*[*:port*] [**remote-directory**] **Example:** `apic1(config-remote)# path sftp filehost.example.com:21 remote-directory /reports/apic`	Sets the path and protocol to the remote server. You are prompted for a password.

Examples

This example shows how to configure a remote path for exporting files.

```
apic1# configure
apic1(config)# remote path myFiles
apic1(config-remote)# user admin5
You must reset the password when modifying the path:
Password:
Retype password:
apic1(config-remote)# path sftp filehost.example.com:21 remote-directory /reports/apic
You must reset the password when modifying the path:
```

```
Password:
Retype password:
```

Finding Your Switch Inventory Using the NX-OS CLI

This section explains how to find your switch model and serial numbers using the NX-OS CLI.

Procedure

Find your switch inventory as follows:

Example:

```
switch# show hardware
Cisco Nexus Operating System (NX-OS) Software
TAC support: http://www.cisco.com/tac
Documents: http://www.cisco.com/en/US/products/ps9372/tsd_products_support_series_home.html
Copyright (c) 2002-2014, Cisco Systems, Inc. All rights reserved.
The copyrights to certain works contained in this software are
owned by other third parties and used and distributed under
license. Certain components of this software are licensed under
the GNU General Public License (GPL) version 2.0 or the GNU
Lesser General Public License (LGPL) Version 2.1. A copy of each
such license is available at
http://www.opensource.org/licenses/gpl-2.0.php and
http://www.opensource.org/licenses/lgpl-2.1.php

Software
  BIOS:      version 07.56
  kickstart: version 12.1(1h) [build 12.1(1h)]
  system:    version 12.1(1h) [build 12.1(1h)]
  PE:        version 2.1(1h)
  BIOS compile time:       06/08/2016
  kickstart image file is: /bootflash/aci-n9000-dk9.12.1.1h.bin
  kickstart compile time:  10/01/2016 20:10:40 [10/01/2016 20:10:40]
  system image file is:    /bootflash/auto-s
  system compile time:     10/01/2016 20:10:40 [10/01/2016 20:10:40]


Hardware
  cisco N9K-C93180YC-EX ("supervisor")
   Intel(R) Xeon(R) CPU  @ 1.80GHz with 16400384 kB of memory.
  Processor Board ID FDO20101H1W

  Device name: ifav41-leaf204
  bootflash:    62522368 kB

Kernel uptime is 02 day(s), 21 hour(s), 42 minute(s), 31 second(s)

Last reset at 241000 usecs after Sun Oct 02 01:27:25 2016
  Reason: reset-by-installer
  System version: 12.1(1e)
  Service: Upgrade

plugin
  Core Plugin, Ethernet Plugin
--------------------------------
Switch hardware ID information
```

```
--------------------------------

Switch is booted up
Switch type is : Nexus C93180YC-EX Chassis
Model number is N9K-C93180YC-EX
H/W version is 0.2010
Part Number is 73-15298-01
Part Revision is 1
Manufacture Date is Year 20 Week 10
Serial number is FDO20101H1W
CLEI code is 73-15298-01

--------------------------------
Chassis has one slot
--------------------------------

Module1 ok
  Module type is : 48x10/25G
  1 submodules are present
  Model number is N9K-C93180YC-EX
  H/W version is 0.2110
  Part Number is 73-17776-02
  Part Revision is 11
  Manufacture Date is Year 20 Week 10
  Serial number is FDO20101H1W
  CLEI code is 73-17776-02

GEM ok
  Module type is : 6x40/100G Switch
  1 submodules are present
  Model number is N9K-C93180YC-EX
  H/W version is 0.2110
  Part Number is 73-17776-02
  Part Revision is 11
  Manufacture Date is Year 20 Week 10
  Serial number is FDO20101H1W
  CLEI code is 73-17776-02

---------------------------------------
Chassis has  2 PowerSupply Slots
---------------------------------------

PS1 shut
  Power supply type is : 54.000000W 220v AC
  Model number is NXA-PAC-650W-PE
  H/W version is 0.0
  Part Number is 341-0729-01
  Part Revision is A0
  Manufacture Date is Year 19 Week 50
  Serial number is LIT19500ZEK
  CLEI code is 341-0729-01

PS2 ok
  Power supply type is : 54.000000W 220v AC
  Model number is NXA-PAC-650W-PE
  H/W version is 0.0
  Part Number is 341-0729-01
  Part Revision is A0
  Manufacture Date is Year 19 Week 50
  Serial number is LIT19500ZEA
  CLEI code is 341-0729-01

---------------------------------------
Chassis has  4 Fans
```

```
--------------------------------------

FT1 ok

 Fan1(sys_fan1)(fan_model:NXA-FAN-30CFM-F)                                    is inserted
but info is not available

FT2 ok

 Fan2(sys_fan2)(fan_model:NXA-FAN-30CFM-F)                                    is inserted
but info is not available

FT3 ok

 Fan3(sys_fan3)(fan_model:NXA-FAN-30CFM-F)                                    is inserted
but info is not available

FT4 ok

 Fan4(sys_fan4)(fan_model:NXA-FAN-30CFM-F)                                    is inserted
but info is not available


================================================================================
```

Verifying the Cisco APIC Cluster Using the CLI

Cisco Application Policy Infrastructure Controller (APIC) release 4.2.(1) introduces the **cluster_health** command, which enables you to verify the Cisco APIC cluster status step-by-step. The following output example demonstrates a scenario where everything is fine except for one node (ID 1002), which is inactive.

Note To use the **cluster_health** command, you must be logged in as admin.

Procedure

To verify the cluster status:

```
F1-APIC1# cluster_health
Password:

Running...

Checking Wiring and UUID: OK
Checking AD Processes: Running
Checking All Apics in Commission State: OK
Checking All Apics in Active State: OK
Checking Fabric Nodes: Inactive switches: ID=1002(IP=10.1.176.66/32)
Checking Apic Fully-Fit: OK
Checking Shard Convergence: OK
Checking Leadership Degration: Optimal leader for all shards
Ping OOB IPs:
APIC-1: 172.31.184.12 - OK
APIC-2: 172.31.184.13 - OK
```

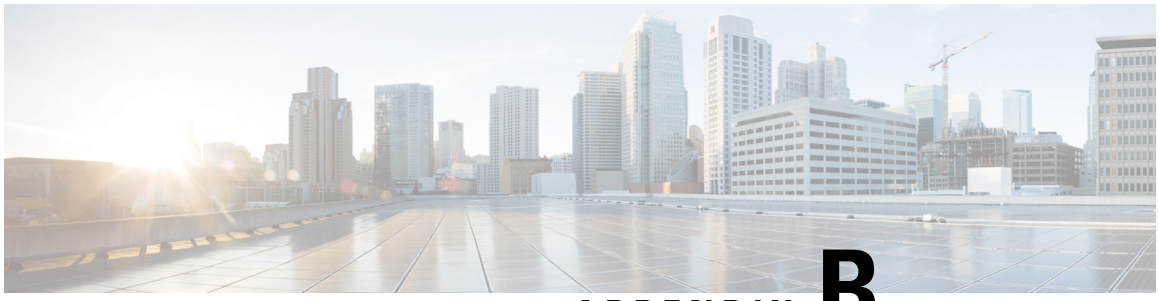
```
APIC-3: 172.31.184.14 - OK
Ping Infra IPs:
APIC-1: 10.1.0.1 - OK
APIC-2: 10.1.0.2 - OK
APIC-3: 10.1.0.3 - OK
Checking APIC Versions: Same (4.2(0.261a))
Checking SSL: OK

Done!
```

Table 10: Cluster_Health Verification Steps

Step	Description
Checking Wiring and UUID	Leaf switches provide infra connectivity between each Cisco APIC by detecting the Cisco APICs using LLDP. This step checks wiring issues between a leaf and a Cisco APIC that is detected during LLDP discovery. Any issues in here implies a leaf switch cannot provide infra connectivity for a Cisco APIC as it doesn't have a valid information. For example, a Cisco APIC UUID mismatch means the new APIC2 has a different UUID than the previously known APIC2. UUID – Universally Unique ID, or chassis ID in some outputs
Checking AD Processes	Cisco APIC clustering is handled by the Appliance Director process on each Cisco APIC. This step checks if the process is running correctly.
Checking All APICs in Commission State	To complete the Cisco APIC clustering, all Cisco APICs need to be commissioned.
Checking All APICs in Active State	To complete the Cisco APIC clustering, all commissioned Cisco APICs need to be active. If it is not active, the Cisco APIC may not be up yet.
Checking Fabric Nodes: Inactive switches	The Cisco APIC's communication are through infra connectivity provided by leaf and spine switches. This step checks inactive switches to ensure switches are providing infra connectivity.
Checking APIC Fully-Fit	When Cisco APICs have established IP reachability to each other through infra network, it will synchronize its database to each other. When the synchronization completes, the status of all Cisco APICs become "Fully-Fit." Otherwise, the status will be "Data Layer Partially Diverged," and so on.

Step	Description
Checking Shard Convergence	When Cisco APICs are not fully-fit, database shards need to be checked to see which service is not fully synchronized. If there is any service that has problems in synchronization, you may reach out to Cisco TAC for further troubleshooting.
Checking Leadership Degration	In ACI, each database shard has one leader shard distributed to each Cisco APIC in the cluster. This step shows if all shards have an optimal leader. If there is an issue in here when all Cisco APICs are up, you may reach out to Cisco TAC for further troubleshooting.
Ping OOB IPs	This step is to check if all Cisco APICs are up and operational by pinging the OOB IP which is configured separately from clustering.
Ping Infra IPs	This step is to check if there is infra connectivity between each Cisco APIC. Cisco APIC clustering is performed through infra connectivity instead of OOB.
Checking APIC Versions	All Cisco APICs should be on a same version to complete clustering.
Checking SSL	All Cisco APICs need to have a valid SSL that should be built-in when a Cisco APIC is shopped as an appliance. Without a valid SSL, the server cannot operate the Cisco APIC OS correctly.

Configuring the Cisco APIC Using the CLI



APPENDIX B

Configuring the Cisco APIC Using the REST API

Expanding the APIC Cluster Using the REST API

The cluster drives its actual size to the target size. If the target size is higher than the actual size, the cluster size expands.

Procedure

Step 1 Set the target cluster size to expand the APIC cluster size.

Example:

```
POST
https://<IP address>/api/node/mo/uni/controller.xml
<infraClusterPol name='default' size=3/>
```

Step 2 Physically connect the APIC controllers that you want to add to the cluster.

Contracting the APIC Cluster Using the REST API

The cluster drives its actual size to the target size. If the target size is lower than the actual size, the cluster size contracts.

Procedure

Step 1 Set the target cluster size so as to contract the APIC cluster size.

Example:

```
POST
https://<IP address>/api/node/mo/uni/controller.xml
<infraClusterPol name='default' size=1/>
```

Step 2 Decommission APIC3 on APIC1 for cluster contraction.

Example:

```
POST
https://<IP address>/api/node/mo/topology/pod-1/node-1/av.xml
<infraWiNode id=3 adminSt='out-of-service'/>
```

Step 3 Decommission APIC2 on APIC1 for cluster contraction.

Example:

```
POST
https://<IP address>/api/node/mo/topology/pod-1/node-1/av.xml
<infraWiNode id=2 adminSt='out-of-service'/>
```

Reducing the APIC Cluster Size

Follow these guidelines to reduce the APIC cluster size and decommission the APIC controllers that are removed from the cluster:

Note Failure to follow an orderly process to decommission and power down APIC controllers from a reduced cluster can lead to unpredictable outcomes. Do not allow unrecognized APIC controllers to remain connected to the fabric.

- Reducing the cluster size increases the load on the remaining APIC controllers. Schedule the APIC controller size reduction at a time when the demands of the fabric workload will not be impacted by the cluster synchronization.
- If one or more of the APIC controllers' health status in the cluster is not "fully fit", remedy that situation before proceeding.
- Reduce the cluster target size to the new lower value. For example if the existing cluster size is 6 and you will remove 3 controllers, reduce the cluster target size to 3.
- Starting with the highest numbered controller ID in the existing cluster, decommission, power down, and disconnect the APIC controller one by one until the cluster reaches the new lower target size.

  Upon the decommissioning and removal of each controller, the APIC synchronizes the cluster.

Note After decommissioning an APIC controller from the cluster, power it down and disconnect it from fabric. Before returning it to service, do a wiped clean back to factory reset.

- Cluster synchronization stops if an existing APIC controller becomes unavailable. Resolve this issue before attempting to proceed with the cluster synchronization.
- Depending on the amount of data the APIC must synchronize upon the removal of a controller, the time required to decommission and complete cluster synchronization for each controller could be more than 10 minutes per controller.

Note Complete the entire necessary decommissioning steps, allowing the APIC to complete the cluster synchronization accordingly before making additional changes to the cluster.

Switching Over Active APIC with Standby APIC Using REST API

Use this procedure to switch over an active APIC with standby APIC using REST API.

Procedure

Switch over active APIC with standby APIC.

```
URL for POST: https://ip
address/api/node/mo/topology/pod-initiator_pod_id/node-initiator_id/av.xml
Body: <infraWiNode id=outgoing_apic_id targetMbSn=backup-serial-number/>
where initiator_id = id of an active APIC other than the APIC being replaced.
pod-initiator_pod_id = pod ID of the active APIC
backup-serial-number = serial number of standby APIC
```

Example:

```
https://ip address/api/node/mo/topology/pod-1/node-1/av.xml
<infraWiNode id=2 targetMbSn=FCH1750V00Q/>
```

Registering an Unregistered Switch Using the REST API

Use this procedure to register a switch from the **Nodes Pending Registration** tab on the **Fabric Membership** work pane using the REST API.

Note This procedure is identical to "Adding a Switch Before Discovery Using the REST API". When you apply the code, the system determines if the node exists and, if not, adds it. If the node does exist, the system registers it.

Procedure

Add a switch description.

Example:

```
POST
https://<IP address>/api/policymgr/mo/uni.xml

<!-- /api/policymgr/mo/uni.xml -->
<polUni>
<ctrlrInst>
    <fabricNodeIdentPol>
        <fabricNodeIdentP  nodeType="tier-2-leaf" podId="1" serial="XXXXXXXXX"
        name="tier-2-leaf-leaf1" nodeId="101"/>

    </fabricNodeIdentPol>
</ctrlrInst>
</polUni>
```

Adding a Switch Before Discovery Using the REST API

Use this procedure to add a switch to the **Nodes Pending Registration** tab on the **Fabric Membership** work pane using the REST API.

Note This procedure is identical to "Registering an Unregistered Switch Using the REST API". When you apply the code, the system determines if the node exists and, if not, adds it. If the node does exist, the system registers it.

Procedure

Add a switch description.

Example:

```
POST
https://<IP address>/api/policymgr/mo/uni.xml

<!-- /api/policymgr/mo/uni.xml -->
<polUni>
<ctrlrInst>
    <fabricNodeIdentPol>
        <fabricNodeIdentP  nodeType="tier-2-leaf" podId="1" serial="XXXXXXXXX"
        name="tier-2-leaf1" nodeId="101"/>

    </fabricNodeIdentPol>
</ctrlrInst>
```

```
</polUni>
```

Removing a Switch to Maintenance Mode Using the REST API

Use this procedure to remove a switch to maintenance mode using the REST API.

Procedure

Remove a switch to maintenance mode.

Example:

```
POST
https://<IP address>/api/node/mo/uni/fabric/outofsvc.xml

<fabricOOServicePol
    descr=""
    dn=""
    name="default"
    nameAlias=""
    ownerKey=""
    ownerTag="">
  <fabricRsDecommissionNode
      debug="yes"
      dn=""
      removeFromController="no"
      tDn="topology/pod-1/node-102"/>
</fabricOOServicePol>
```

Inserting a Switch to Operational Mode Using the REST API

Use this procedure to insert a switch to operational mode using the REST API.

Procedure

Insert a switch to operational mode.

Example:

```
POST
https://<IP address>/api/node/mo/uni/fabric/outofsvc.xml

<fabricOOServicePol
    descr=""
    dn=""
    name="default"
    nameAlias=""
    ownerKey=""
```

```
    ownerTag="">
  <fabricRsDecommissionNode
      debug="yes"
      dn=""
      removeFromController="no"
      tDn="topology/pod-1/node-102"
      status="deleted"/>
</fabricOOServicePol>
```

Configuring a Remote Location Using the REST API

This procedure explains how to create a remote location using the REST API.

```
<fileRemotePath name="local" host="host or ip" protocol="ftp|scp|sftp" remotePath="path to
 folder" userName="uname" userPasswd="pwd" />
```

Sending an On-Demand Tech Support File Using the REST API

Procedure

Step 1 Set the remote destination for a technical support file using the REST API, by sending a POST with XML such as the following example:

Example:

```
<fileRemotePath userName="" remotePort="22" remotePath="" protocol="sftp" name="ToSupport"
 host="192.168.200.2"
dn="uni/fabric/path-ToSupport" descr="">

<fileRsARemoteHostToEpg tDn="uni/tn-mgmt/mgmtp-default/oob-default"/>

</fileRemotePath>
```

Step 2 Generate an on-demand technical support file using the REST API by sending a POST with XML such as the following:

Example:

```
<dbgexpTechSupOnD upgradeLogs="no" startTime="unspecified" name="Tech_Support_9-20-16"
  exportToController="no" endTime="unspecified" dn="uni/fabric/tsod-Tech_Support_9-20-16"
descr=""
  compression="gzip" category="forwarding" adminSt="untriggered">
    <dbgexpRsExportDest tDn="uni/fabric/path-ToSupport"/>
    <dbgexpRsTsSrc tDn="topology/pod-1/node-102/sys"/>
    <dbgexpRsTsSrc tDn="topology/pod-1/node-103/sys"/>
    <dbgexpRsTsSrc tDn="topology/pod-1/node-101/sys"/>
    <dbgexpRsData tDn="uni/fabric/tscont"/>
</dbgexpTechSupOnD>
<fabricFuncP>
    <fabricCtrlrPGrp name="default">
        <fabricRsApplTechSupOnDemand tnDbgexpTechSupOnDName=" Tech_Support_9-20-16"/>
```

```
    </fabricCtrlrPGrp>
</fabricFuncP>
```

Finding Your Switch Inventory Using the REST API

This section explains how to find your switch model and serial numbers using the REST API

Procedure

Find your switch inventory as follows:

Example:

```
GET
https://192.0.20.123/api/node/mo/topology/pod-1.json?query-target=children&target-subtree-class=fabricNode
```

The following response is returned:

```
response:
  {
     "totalCount":"8",
     "imdata":
     [{
         "fabricNode":{
           "attributes":{
              "adSt":"on",
              "childAction":"",
              "delayedHeartbeat":"no",
              "dn":"topology/pod-1/node-103",
              "fabricSt":"active",
              "id":"103",
              "lcOwn":"local",
              "modTs":"2016-10-08T14:49:35.665+00:00",
              "model":"N9K-C9396PX",
              "monPolDn":"uni/fabric/monfab-default",
              "name":"leaf3",
              "nameAlias":"",
              "role":"leaf",
              "serial":"TEP-1-103",
              "status":"","uid":"0",
              "vendor":"Cisco Systems, Inc",
              "version":""}
            }
     },{
         "fabricNode":{
           "attributes":{
             "adSt":"on",
             "childAction":"",
             "delayedHeartbeat":"no",
             "dn":"topology/pod-1/node-105",
             "fabricSt":"active",
             "id":"105",
             "lcOwn":"local",
             "modTs":"2016-10-08T14:47:52.011+00:00",
             "model":"N9K-C9508",
             "monPolDn":"uni/fabric/monfab-default",
             "name":"spine2",
```

Configuring the Cisco APIC Using the REST API

```
            "nameAlias":"",
            "role":"spine",
            "serial":"TEP-1-105","status":"",
            "uid":"0",
            "vendor":"Cisco Systems, Inc",
            "version":""
         ...
   [TRUNCATED]
         ...
}
```