Cisco Application Policy Infrastructure Controller Enterprise Module Deployment Guide, Release 1.2.x

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Preface

Audience

This publication is for experienced network administrators who will deploy the Cisco Application Policy Infrastructure Controller Enterprise Module (Cisco APIC-EM) in their network. Use this guide to deploy, make secure, access, verify, and troubleshoot the Cisco APIC-EM.

For information about using the controller's GUI for the first time, see the *Cisco APIC-EM Quick Start Guide*.

Note The Cisco Application Policy Infrastructure Controller Enterprise Module (Cisco APIC-EM) is also referred to within this deployment guide as a controller.

Document Conventions

This document uses the following conventions:

Convention	Description
^ or Ctrl	Both the ^ symbol and Ctrl represent the Control (Ctrl) key on a keyboard. For example, the key combination **^D** or **Ctrl-D** means that you hold down the Control key while you press the D key. (Keys are indicated in capital letters but are not case sensitive.)
bold font	Commands and keywords and user-entered text appear in **bold** font.
Italic font	Document titles, new or emphasized terms, and arguments for which you supply values are in *italic* font.

Convention	Description
`Courier` font	Terminal sessions and information the system displays appear in `courier` font.
`Bold Courier` font	**`Bold Courier`** font indicates text that the user must enter.
[x]	Elements in square brackets are optional.
...	An ellipsis (three consecutive nonbolded periods without spaces) after a syntax element indicates that the element can be repeated.
|	A vertical line, called a pipe, indicates a choice within a set of keywords or arguments.
[x | y]	Optional alternative keywords are grouped in brackets and separated by vertical bars.
{x | y}	Required alternative keywords are grouped in braces and separated by vertical bars.
[x {y | z}]	Nested set of square brackets or braces indicate optional or required choices within optional or required elements. Braces and a vertical bar within square brackets indicate a required choice within an optional element.
string	A nonquoted set of characters. Do not use quotation marks around the string or the string will include the quotation marks.
< >	Nonprinting characters such as passwords are in angle brackets.
[ ]	Default responses to system prompts are in square brackets.
!, #	An exclamation point (!) or a pound sign (#) at the beginning of a line of code indicates a comment line.

Reader Alert Conventions

This document may use the following conventions for reader alerts:

Note Means *reader take note*. Notes contain helpful suggestions or references to material not covered in the manual.

Tip Means *the following information will help you solve a problem.*

Caution Means *reader be careful*. In this situation, you might do something that could result in equipment damage or loss of data.

Timesaver Means *the described action saves time.* You can save time by performing the action described in the paragraph.

Warning IMPORTANT SAFETY INSTRUCTIONS

This warning symbol means danger. You are in a situation that could cause bodily injury. Before you work on any equipment, be aware of the hazards involved with electrical circuitry and be familiar with standard practices for preventing accidents. Use the statement number provided at the end of each warning to locate its translation in the translated safety warnings that accompanied this device. Statement 1071

SAVE THESE INSTRUCTIONS

Related Documentation

- Cisco APIC-EM Documentation:
  - *Release Notes for the Cisco Application Policy Infrastructure Controller Enterprise Module*
  - *Supported Platforms for the Cisco Application Policy Infrastructure Controller Enterprise Module*
  - *Cisco APIC-EM Quick Start Guide* (directly accessible from the controller's GUI)
  - *Cisco Application Policy Infrastructure Controller Enterprise Module Deployment Guide*
  - *Cisco Application Policy Infrastructure Controller Enterprise Module Upgrade Guide*
  - *Cisco Application Policy Infrastructure Controller Enterprise Module Configuration Guide*
  - *Cisco Application Policy Infrastructure Controller Enterprise Module Hardware Installation Guide*
  - *Cisco Application Policy Infrastructure Controller Enterprise Module Troubleshooting Guide*
  - *Open Source Used In Cisco APIC-EM*
- Cisco IWAN Documentation for the Cisco APIC-EM:
  - *Release Notes for Cisco IWAN*
  - *Release Notes for Cisco Intelligent Wide Area Network (Cisco IWAN)*
  - *Software Configuration Guide for Cisco IWAN on APIC-EM*
  - *Open Source Used in Cisco IWAN and Cisco Network Plug and Play*
- Cisco Network Plug and Play Documentation for the Cisco APIC-EM:
  - *Release Notes for Cisco Network Plug and Play*

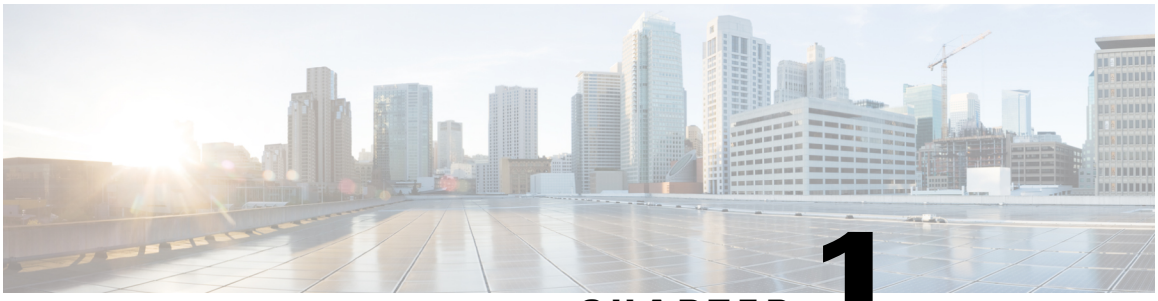
- *Solution Guide for Cisco Network Plug and Play*
- *Configuration Guide for Cisco Network Plug and Play on Cisco APIC-EM*
- *Cisco Open Plug-n-Play Agent Configuration Guide*
- *Mobile Application User Guide for Cisco Network Plug and Play*

Note For information about developing your own application that interacts with the controller by means of the northbound REST API, see the developer.cisco.com/site/apic-em Web site.

Obtaining Documentation and Submitting a Service Request

For information on obtaining documentation, using the Cisco Bug Search Tool (BST), submitting a service request, and gathering additional information, see What's New in Cisco Product Documentation.

To receive new and revised Cisco technical content directly to your desktop, you can subscribe to the What's New in Cisco Product Documentation RSS feed. RSS feeds are a free service.



CHAPTER 1

New and Changed Information

This chapter provides release-specific information for each new and changed feature in the .

New and Changed Information

The table below summarizes the new and changed features for the Cisco APIC-EM Release 1.2.0.x that are covered in this document. For information about all of the features in the release, see the Release Notes.

Feature	Description	Where Documented
New **Home** page view with system health data displayed	New **Home** page view, with **Home** and **System Health** tabs.	See Chapter 6, Configuring the Cisco APIC-EM Settings.
New TLS version support for the controller.	You can configure the TLS version for communications for northbound API connections to the controller using a CLI command run on the host.	See Chapter 3, Cisco APIC-EM Security.

Feature	Description	Where Documented
New configuration options available for inter-host communications within a multi-host cluster.	You can configure IPSec tunneling for communications between the hosts using the configuration wizard during a deployment or an upgrade. You can also configure IPSec tunneling for communications between hosts with a new CLI command. The default for inter-host communications is GRE. **Note** You can configure IPSec tunneling for Cisco APIC-EM using either the CLI or the configuration wizard. The recommended method of configuring IPSec tunneling is by using the configuration wizard. .	See Chapter 3, Cisco APIC-EM Security and Chapter 5, Deploying the Cisco APIC-EM.
New external authentication support for the controller.	You can configure the controller to access and communicate with an AAA server using the RADIUS protocol. This enables a user to login into the controller using the credentials on an AAA server.	See Chapter 6, Configuring the Cisco APIC-EM Settings.
New Cisco APIC-EM evaluation version is available.	An evaluation version of the Cisco APIC-EM is provided for a host with 16 to 25 GB of memory.	See Cisco APIC-EM Evaluation Version, on page 2.

Cisco APIC-EM Evaluation Version

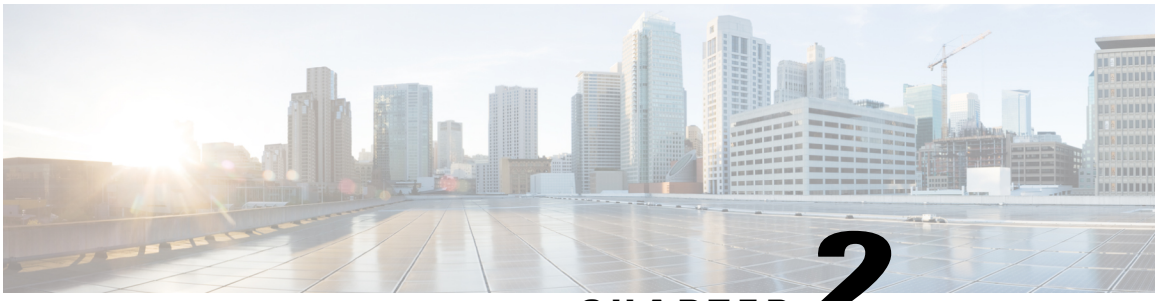
An evaluation version of the Cisco APIC-EM is provided with this release. The Cisco APIC-EM evaluation version can be deployed on a host (appliance, server, or virtual machine) that has only 16 GB of memory. The Cisco APIC-EM evaluation version provides all of the features of the standard version, with the following limitations:

- Telemetry is not supported.
- Logging has reduced functionality.
- Maximum number of devices supported for the controller is 20.

Cisco APIC-EM will discover your host's available memory during the deployment process and will provide the following responses and options:

- When deploying the controller on a host with 64 GB or more of memory (meets the memory requirements), the configuration wizard will proceed with the installation.
- When deploying the controller on a host with 25 to 64 GB of memory, you are prompted to add another host or increase memory on the host to meet the requirements.
- When deploying the controller on a host with 16 to 25 GB or memory, you are prompted to install a low-memory, evaluation version of the controller.
- When deploying the controller on a host with less than 16 GB of memory, you are prompted to add more memory and cannot proceed with the installation.

Note The deployment process for the evaluation version is the same as the deployment process for the standard single host.



CHAPTER 2

Overview

About the Cisco Application Policy Infrastructure Controller Enterprise Module

The Cisco Application Policy Infrastructure Controller - Enterprise Module (APIC-EM) is Cisco's SDN Controller for Enterprise Networks (Access, Campus, WAN and Wireless).

The platform hosts multiple applications (SDN apps) that use open northbound REST APIs that drive core network automation solutions. The platform also supports a number of south-bound protocols that enable it to communicate with the breadth of network devices that customers already have in place, and extend SDN benefits to both greenfield and brownfield environments.

The Cisco APIC-EM platform supports both wired and wireless enterprise networks across the Campus, Branch and WAN infrastructures. It offers the following benefits:

- Creates an intelligent, open, programmable network with open APIs
- Saves time, resources, and costs through advanced automation
- Transforms business intent policies into a dynamic network configuration
- Provides a single point for network wide automation and control

The following table describes the features and benefits of the Cisco APIC-EM.

Table 1: Cisco APIC Enterprise Module Features and Benefits

Feature	Description
Network Information Database (NIDB)	The Cisco APIC-EM periodically scans the network to create a "single source of truth" for IT. This inventory includes all network devices, along with an abstraction for the entire enterprise network.
Network topology visualization	The Cisco APIC-EM automatically discovers and maps network devices to a physical topology with detailed device-level data. You can use this interactive feature to troubleshoot your network.
EasyQoS	The EasyQoS feature enables you to configure quality of service on the devices in your network that have been discovered by the Cisco APIC-EM. Using EasyQoS, you can group devices and then define the business relevance of applications that are used in your network. The Cisco APIC-EM takes your QoS selections, translates them into the proper command line interface (CLI) commands, and deploys them onto the selected devices.
Cisco Network Plug and Play application	The Cisco Network Plug and Play solution is a converged solution that extends across Cisco's enterprise portfolio. It provides a highly secure, scalable, seamless, and unified zero-touch deployment experience for customers across Cisco routers, switches and wireless access points.
Cisco Intelligent WAN (IWAN) application	The separately licensed IWAN application for APIC-EM simplifies the provisioning of IWAN network profiles with simple business policies. The IWAN application defines business-level preferences by application or groups of applications in terms of the preferred path for hybrid WAN links. Doing so improves the application experience over any connection and saves telecom costs by leveraging cheaper WAN links.
Public Key Infrastructure (PKI) server	The Cisco APIC-EM provides an integrated PKI service that acts as Certificate Authority (CA) to automate X.509 SSL certificate lifecycle management. Applications, such as IWAN and PnP, use the capabilities of the imbedded PKI service for automatic SSL certificate management.
Path Trace application	The path trace application helps to solve network problems by automating the inspection and interrogation of the flow taken by a business application in the network.
High Availability (HA)	HA is provided in N+ 1 redundancy mode with full data persistence for HA and Scale. All the nodes work in Active-Active mode for optimal performance and load sharing.
Back Up and Restore	The Cisco APIC-EM supports complete back up and restore of the entire database from the controller GUI.

Feature	Description
Audit Logs (IWAN)	The Cisco APIC-EM provides a direct link to the IWAN Audit Logs, which allows you to view Cisco APIC-EM- and IWAN-related log entries.

Primary Components

The following are the primary components required for a Cisco APIC-EM deployment:

- The Cisco APIC-EM software provided as an ISO image downloaded from the Cisco website
- Supported Cisco routing and switching platforms

The Cisco APIC-EM ISO image consists of the following components:

- Ubuntu 14.04 LTS 64-bit
- Open-VM-Tools
- Cisco APIC-EM services
- Grapevine Elastic Services Platform, consisting of a Grapevine root and client template

Note Open-VM-Tools is only installed if the ISO image is installed within a virtual machine running on vSphere. The tools will not be installed if the ISO image is installed on a bare-metal or on a hypervisor from another vendor.

For this release, you can deploy and run the Cisco APIC-EM on the following:

- Server (bare-metal hardware)—This is the recommended platform. The Cisco APIC-EM ISO image is installed directly on a server (bare-metal hardware) rather than within a host operating system (OS).

  Note Cisco also offers physical appliances that can be purchased with the Cisco APIC-EM ISO image pre-installed and tested.

- Virtual machine—Cisco APIC-EM ISO image is installed within a virtual machine within a VMware vSphere environment.

The Cisco APIC-EM makes use of the Ubuntu operating system environment and Linux containers (LXC). The Grapevine root runs within the host's operating system. The Grapevine clients run in LXCs within the host. The Cisco APIC-EM services that run on the Grapevine Elastic Services Platform provide the controller with its core functionality. See Chapter 3, *Cisco APIC-EM Services* for additional information about the services.

IP Connectivity

The Cisco APIC-EM communicates with its supported platforms using the following protocols:

- SNMPv2c or SNMPv3
- Telnet or SSH

Note Currently, the Cisco APIC-EM supports IPv4 only. IPv6 support is planned for a future release.

System Requirements

System Requirements—Server (Bare-Metal hardware)

The following table lists the minimum system requirements for a successful Cisco APIC-EM server (bare-metal hardware) installation. Review the minimum system requirements for a server installation. The minimum system requirements for each server in a multi-host deployment are the same as in a single host deployment, except that the multi-host deployment requires two or three servers and less memory for each individual server. Three servers are required for high availability and redundancy. All three servers must reside in the same subnet.

Caution You must dedicate the entire server for the Cisco APIC-EM. You cannot use the server for any other software programs, packages, or data. During the Cisco APIC-EM installation, any other software programs, packages or data on the server will be deleted.

Table 2: Minimum System Requirements—Server

Server Option	Image Format	Bare metal/ISO
Hardware Specifications	CPU (cores)	6 (minimum) **Note** 6 CPUs is the minimum number required for your server. For better performance, we recommend using 12 CPUs.
	Memory	64 GB **Note** For a multi-host hardware deployment (2 or 3 hosts) only 32 GB of RAM is required for each host.

	Disk Capacity	500 GB of available/usable storage after hardware RAID
	RAID Level	Hardware-based RAID at RAID Level 10
	CPU Speed	2.4 GHz
	Disk I/O Speed	200 MBps
	Network Adapter	1
Networking	Web Access	Required
	Browser	The following browsers are supported when viewing and working with the Cisco APIC-EM: • Google Chrome, version 50.0 or later • Mozilla Firefox, version 46.0 or later

System Requirements—Virtual Machine

The following table lists the minimum system requirements for a successful Cisco APIC-EM VMware vSphere installation.

In addition to the minimum system requirements listed below, we recommend that you also configure specific resource pools for the virtual machine(s). For information about these additional recommended configurations, see Preparing a VMware System for Cisco APIC-EM Deployment.

Note You must configure at a minimum 64 GB RAM for the virtual machine that contains the Cisco APIC-EM when a single host is being deployed. The single host server that contains the virtual machine must have this much RAM physically available. For a multi-host deployment (2 or 3 hosts), only 32 GB of RAM is required for each of the virtual machines that contains the Cisco APIC-EM. Three servers are required for high availability and redundancy. All three servers must reside in the same subnet.

Table 3: Minimum System Requirements—Virtual Machine

Virtual Machine	VMware ESXi Version	5.1/5.5/6.0
	Image Format	ISO

	Virtual CPU (vCPU)	6 (minimum) **Note** 6 vCPUs is the minimum number required for your virtual machine configuration. For better performance, we recommend using 12 vCPUs.
	Datastores	We recommend that you do not share a datastore with any defined virtual machines that are not part of the designated Cisco APIC-EM cluster. If the datastore is shared, then disk I/O access contention may occur and cause a significant reduction of disk bandwidth throughput and a significant increase of I/O latency to the cluster.
Hardware Specifications	Memory	64 GB **Note** For a multi-host deployment (2 or 3 hosts) only 32 GB of RAM is required for each host.
	Disk Capacity	500 GB
	CPU Speed	2.4 GHz
	Disk I/O Speed	200 MBps
	Network Adapter	1
Networking	Web Access	Required
	Browser	The following browsers are supported when viewing and working with the Cisco APIC-EM: • Google Chrome, version 50.0 or later • Mozilla Firefox, version 46.0 or later

	Network Timing	To avoid conflicting time settings, we recommend that you disable the time synchronization between the guest VM running the Cisco APIC-EM and the ESXi host. Instead, configure the timing of the guest VM to a NTP server. **Important** Ensure that the time settings on the ESXi host are also synchronized to the NTP server. This is especially important when upgrading the Cisco APIC-EM. Failure to ensure synchronization will cause the upgrade to fail.

Related Topics

Configuring Resource Pools Using vSphere Web Client, on page 119
Configuring a Virtual Machine Using vSphere Web Client, on page 122
Preparing a VMware System for Cisco APIC-EM Deployment, on page 117
Virtual Machine Configuration Recommendations, on page 118

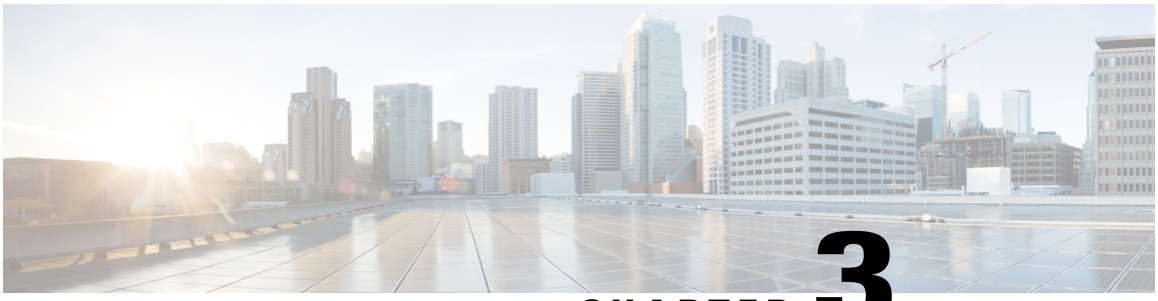
Supported Cisco Platforms and Software Releases

For information about the supported Cisco platforms and software releases:

- See the *Supported Platforms for the Cisco Application Policy Infrastructure Controller Enterprise Module, Release 1.2.0.x* for the list of supported platforms and software releases for the base controller applications (Discovery, Inventory, Topology,EasyQoS and Path Trace).
- See the *Release Notes for Cisco IWAN on APIC-EM* for the list of supported platforms and software releases for the IWAN application.
- See the *Release Notes for Cisco Network Plug and Play* for the list of supported platforms and software releases for the Cisco Network Plug and Play application.

Supported Northbound REST APIs

The Cisco APIC-EM provides northbound REST APIs that you can use to that you can use to issue requests to the controller and exchange data with the controller in a platform-agnostic way. For detailed information about supported northbound REST APIs, see the internal, interactive documentation located within the GUI itself. Click the **API** button at the top right of the GUI to view this documentation.



CHAPTER 3

Cisco APIC-EM Security

Information about Cisco APIC-EM Security

The Cisco APIC-EM requires a multi-layered architecture to support its basic functionality. This multi-layered architecture consists of the following components:

- External network or networks—The external network exists between administrators and applications on one side of the network, and the Grapevine root and clients within an internal network or cloud on the other side. Both administrators and applications access the Grapevine root and clients using this external network.
- Internal network—The internal network consists of both the Grapevine root and clients.
- Device management network—This network consists of the devices that are managed and monitored by the controller. Note that the device management network is essentially the same as the external network described above. This may be physically or logically segmented from the admins or northbound applications.

Important Any inter-communications between the layers and intra-communications within the layers are protected through encryption, authentication, and segmentation.

Note For information about the different services running on the clients within the internal network, see Chapter 3, *Cisco APIC-EM Services*.

External Network Security

The Cisco APIC-EM provides its service over HTTPS and presents its X.509 server public certificate to client communications arriving at any of the external interfaces (eth0, eth1, eth2, etc.). The external clients (for example, northbound REST API consumer applications, devices performing file downloads from the controller, DMVPN certificate renewal, or certificate revocation list (CRL), etc.) may reach the controller via a NAT, proxy gateway, or directly.

The external X.509 certificate that is presented by the controller is one that has been either dynamically generated and self-signed by the controller itself, or one that has been imported (user's X.509 certificate) with a private key into the controller using the GUI. You have the option to either use the a self-signed X.509 certificate from the controller or to import and use your own X.509 certificate and private key. By default, the self-signed X.509 certificate presented to an API request is signed by Grapevine's internal Certificate Authority (CA). This self-signed X.509 certificate may not be recognized and accepted by your host. To proceed with your API request, you must ignore any warning and trust the certificate to proceed.

Note We recommend against using and importing a self-signed certificate into the controller. Importing a valid X.509 certificate from a well-known, certificate authority (CA) is recommended.

Northbound REST API requests from the external network to the Cisco APIC-EM are made secure using the Transport Layer Security (TLS) protocol. Although the controller supports several TLS versions, the default setting for the controller is TLS, version 1.0. You can restrict TLS support to a later and more secure version using the CLI. For additional information, see Configuring the TLS Version Using the CLI, on page 21 .

Related Topics

Configuring the TLS Version Using the CLI, on page 21

Internal Network Security

Several key intra-Grapevine communications using HTTP are sent over SSL using the internal public key infrastructure (PKI). All the internal Grapevine services, database servers, and the Cisco APIC-EM services themselves listen only on the internal network in order to keep these services segmented and secured.

Related Topics

Configuring IPSec Tunneling for Multi-Host Communications, on page 23

Device Management Network Security

Device management network security involves both controller-initiated communications and device-initiated communications.

For controller-initiated communications (discovery or pushing policy to the devices), the Cisco APIC-EM uses the following protocols to access and program network devices:

- SSH version 2
- Telnet
- SNMP versions 2c and 3

Note If supported by the network devices, we strongly recommend using SNMP version v3c with authentication and privacy enabled. The controller does not connect to devices that are SSH version 1. HTTP and HTTPS are not supported for device discovery by the controller.

For device-initiated communications, network devices can use the following protocols to communicate and interact with the controller:

- HTTP
- HTTPS
- SNMP versions 2c

The use of HTTP or HTTPS is not up to the device itself; it is determined by the NB REST API that the device is calling. HTTP is supported for less sensitive communications.

Related Topics

Configuring the TLS Version Using the CLI, on page 21

Information about PKI

The Cisco APIC-EM relies on Public Key Infrastructure (PKI) to provide secure communications. PKI consists of certificate authorities, digital certificates, and public and private keys.

Certificate authorities (CAs) manage certificate requests and issue digital certificates to participating entities such as hosts, network devices, or users. The CAs provide centralized key management for the participating entities.

Digital signatures, based on public key cryptography, digitally authenticate the hosts, devices and/or individual users. In public key cryptography, such as the RSA encryption system, each entity has a key pair that contains both a private key and a public key. The private key is kept secret and is known only to the owning host, device or user. However, the public key is known to everyone. Anything encrypted with one of the keys can be decrypted with the other. A signature is formed when data is encrypted with a sender's private key. The receiver verifies the signature by decrypting the message with the sender's public key. This process relies on the receiver having a copy of the sender's public key and knowing with a high degree of certainty that it really does belong to the sender and not to someone pretending to be the sender.

Digital certificates link the digital signature to the sender. A digital certificate contains information to identify a user or device, such as the name, serial number, company, department, or IP address. It also contains a copy of the entity's public key. The CA that signs the certificate is a third party that the receiver explicitly trusts to validate identities and to create digital certificates.

To validate the signature of the CA, the receiver must first know the CA's public key. Typically this process is handled out of band or through an operation done at installation. For instance, most web browsers are configured with the public keys of several CAs by default.

Supported Cisco APIC-EM PKI Planes

The Cisco APIC-EM maintains two completely separate PKI planes that do not share certificates, keys, or CAs. Each PKI plane secures a particular set of connections:

- **Controller connections**

  The controller's server certificate secures client-initiated connections (communications) to the controller.

  The controller will present its server certificate in response to HTTPS connection requests from NB REST API callers, such as third-party applications that interact with the controller by means of its use of the NB REST API. Additionally, when a router, switch, or other control-plane device initiates an HTTPS connection to the controller to invoke a NB REST API or to download a file (such as a device image, a configuration, etc.) the server presents its certificate to the device that requested the connection.

  Device interactions initiated by the controller, including actions that the controller takes on behalf of a REST caller (for example, discovering devices, managing tags. or pushing policy to devices) do not currently use HTTPS.

  Note The security content and discussion in this deployment guide concerns itself solely with this specific PKI plane.

- **Device-to-device DMVPN connections**

  IWAN-managed devices form Dynamic Multipoint VPN (DMVPN) connections between themselves to fulfill the IWAN QoS policy. An embedded private CA in the Cisco APIC-EM provisions the certificates and keys that secure these DMVPN connections. The PKI broker embedded in the Cisco APIC-EM manages these certificates and keys as directed by an admin in the IWAN GUI or a REST caller that uses the pki-broker NB REST API. An external CA cannot manage these certificates and keys.

  Currently, only the IWAN application and the DMVPN connection use the internal CA issued certificates. In future, there may be other services that obtain certificates from the Cisco APIC-EM internal CA.

  Note This deployment guide does not discuss the IWAN Dynamic Multipoint VPN (DMVPN) connections. For information about this topic, see the appropriate Cisco IWAN documentation.

Important The internal CA embedded in the Cisco APIC-EM cannot be a sub/intermediate CA to any external CA. Until the Cisco APIC-EM adds such support, these two PKI planes (one for the controller connections and the other for the device-to-device DMVPN connections) remain completely independent of each another. In the current release, the IWAN devices' mutual interaction certificates are managed only by the CA that is embedded in the Cisco APIC-EM. External CAs cannot manage the IWAN-specific certificates that devices present to each other for DMVPN tunnel-creation and related operations.

PKI Device Notifications

The Cisco APIC-EM provides PKI device notifications to assist the user with both troubleshooting and serviceability.

Important The PKI device notifications described in this section are only activated from device-to-device DMVPN connections and not the controller connections.

The following PKI device notifications are available:

- System Notifications—Notifications indicating that user action is required. These notifications are visible from the **Systems Notifications** view that is accessible from the **Global** toolbar in the GUI.
- Audit Log Notifications—Notifications in system logs that are visible using the controller's **Audit Log** GUI.

The following PKI *System* notification types are supported:

- Information
  - New trust point creation
  - New PKCS12 file creation
  - Successful enrollment of a device certificate
  - Successful renewal of a device certificate
  - Revocation of a device certificate
- Warning
  - Partial revocation—Device unreachable or trust point is in use
  - Enrollment delay after 80 percent of a certificate's lifetime
  - Service launch delay
- Critical
  - Certificate Authority handshake failed
  - Enrollment failed
  - Revocation failed

- Renew failed

The following *audit log* notifications are available in the system logs:

- Device enrollment
- Certificate push to the device
- Renewal of a device certificate
- Revocation of a device certificate

Cisco APIC-EM Certificate and Private Key Support

The Cisco APIC-EM supports a PKI certificate management feature that is used to authenticate sessions (HTTPS). These sessions use commonly recognized trusted agents called certificate authorities (CAs). The Cisco APIC-EM uses the PKI certificate management feature to import, store, and manage an X.509 certificate from well-known CAs. The imported certificate becomes an identity certificate for the controller itself, and the controller presents this certificate to its clients for authentication. The clients are the NB API applications and network devices.

The Cisco APIC-EM can import the following files (in either PEM or PKCS file format) using the controller's GUI:

- X.509 certificate
- Private key

Note For the private key, Cisco APIC-EM supports the importation of RSA keys. You should not import DSA, DH, ECDH, and ECDSA key types; they are not supported. You should also keep the private key secure in your own key management system.

Prior to import, you must obtain a valid X.509 certificate and private key from a well-known, certificate authority (CA) or create your own self-signed certificate. After import, the security functionality based upon the X.509 certificate and private key is automatically activated. The Cisco APIC-EM presents the certificate to any device or application that requests them. Both the northbound API applications and network devices can use these credentials to establish a trust relationship with the controller.

In an IWAN configuration and for the Network PnP functionality, an additional procedure involving a PKI trustpool is used to ensure trust between devices within the network. See the following *Cisco APIC-EM Trustpool Support* section for information about this procedure.

Note We recommend against using and importing a self-signed certificate into the controller. Importing a valid X.509 certificate from a well-known, certificate authority (CA) is recommended. Additionally, you must replace the self-signed certificate (installed in the Cisco APIC-EM by default) with a certificate that is signed by a well-known certificate authority for the Network PnP functionality to work properly.

The Cisco APIC-EM supports only one imported X.509 certificate and private key at a time. When you import a second certificate and private key, it overwrites the first (existing) imported certificate and private key values.

Note If the external IP address changes for your controller for any reason, then you need to re-import a new certificate with the changed or new IP address.

Related Topics

Importing a Certificate, on page 80

Cisco APIC-EM Certificate Chain Support

The Cisco APIC-EM is able to import certificates and private keys into the controller through its GUI. The Cisco APIC-EM also supports the importation of subordinate certificates (intermediate certificates) from a subordinate Certificate Authority (CA) through its GUI.

If there are subordinate certificates involved in the certificate chain leading to the certificate that is imported into the controller (controller certificate), then both the subordinate certificates as well as the root certificate of these subordinate CAs must be appended together into a single file to be imported. When appending these certificates, you must append them in the same order as the actual chain of certification.

For example, assume that a well-known and trusted CA with a root certificate (CA root) signed an intermediate CA certificate (CA1). Next, assume that this certificate, CA1 signs another intermediate CA certificate (CA2). Finally, assume that the CA certificate (CA2) was the CA that signed the controller certificate (Controller_Certificate). In this example, the PEM file that needs to be created and imported into the controller should have the following order from the top (beginning) of the file to the bottom of the file (end):

1. Controller_Certificate (top of file)
2. CA2 certificate
3. CA1 certificate

The requirement to append the root and subordinate certificates to the controller certificate to create a single file only applies to a PEM file. The requirement for appending a root and intermediate certificates to a root certificate for import is not required for a PKCS file.

Related Topics

Importing a Certificate, on page 80

Cisco APIC-EM Trustpool Support

The Cisco APIC-EM and Cisco IOS devices support a special PKI certificate store known as the trustpool. The trustpool holds X.509 certificates that identify trusted certificate authorities (CAs). The Cisco APIC-EM and the devices in the network use the trustpool bundle to manage trust relationships with each other and with these CAs. The controller manages this PKI certificate store and has the ability to update it through its GUI when certificates in the pool are due to expire, are reissued, or must be changed for other reasons.

Note The Cisco APIC-EM also uses the trustpool functionality to determine whether any certificate file that is uploaded via its GUI is a valid CA signed certificate or not.

The Cisco APIC-EM contains a pre-installed, default, Cisco-signed trustpool bundle named ios.p7b. This trustpool bundle is trusted by supported Cisco network devices natively, since it is signed with a Cisco digital signing certificate. This trustpool bundle is critical for the Cisco network devices to establish trust with services and applications that are genuine. This Cisco PKI trustpool bundle file is available on the Cisco website (Cisco InfoSec).

The link is located at:http://www.cisco.com/security/pki/

For the controller's Network PnP functionality, the supported Cisco devices that are being managed and monitored by the controller need to import this file. When the supported Cisco devices first boot-up, they contact the controller to import this file.

Note At times, you may need to update this trustpool bundle to a newer version due to certificates in the trustpool expiring, being reissued, or for other reasons. Whenever the trustpool bundle that exists on the controller needs to be updated, you can update it by using the controller's GUI. The controller can access the Cisco cloud (where the Cisco approved trustpool bundles are located) and download the latest trustpool bundle. After download, the controller then overwrites the current, older trustpool bundle file. As a practice, you may want to update the trustpool bundle before a new certificate from a CA is to be imported using the **Certificate** window or the **Proxy Gateway Certificate** window, or whenever the **Update** button is active and not grayed out.

The Cisco APIC-EM trustpool management feature operates in the following way:

1. You boot-up the Cisco devices within your network that supports the Network PnP functionality.

   Note that **not** all Cisco devices support the Network PnP functionality. See the *Release Notes for Cisco Network Plug and Play* for a list of the supported Cisco devices.
2. As part of initial PnP flow, these supported Cisco devices download a trustpool bundle directly from the Cisco APIC-EM using HTTP.
3. The Cisco devices are now ready to interact with the Cisco APIC-EM to obtain further device configuration and provisioning per the Network PnP traffic flows.

Important If an HTTP proxy gateway exists between the controller and these Cisco devices, then perform an additional procedure to import the proxy gateway certificate into the controller. See Importing a Proxy Gateway Certificate, on page 85.

Related Topics

Importing a Trustpool Bundle, on page 83

Security and Cisco Network Plug and Play

With the Cisco Network Plug and Play (PnP) application, the Cisco APIC-EM responds to HTTPS requests from supported Cisco network devices and permits these devices to download and install an image and desired configuration. Before a device can download these files from the controller, the initial interaction between the controller and device involves the establishment of a trust relationship.

At first interaction with a PnP enabled device, that PnP enabled device is provisioned by the controller with trust information that includes a CA root certificates bundle or at the least the certificate of the CA that issued the server side certificate. Note that in latter case, the CA may or may not be a well known CA.

In certain Cisco Network Plug and Play scenarios, your network configuration may have a proxy gateway present between the controller and PnP enabled devices. For example, in an IWAN deployment a branch router may communicate with the Cisco APIC-EM through a proxy gateway at the DMZ at initial provisioning. Depending upon whether there is a proxy gateway present or not, the trust information provided by the controller at the initial transaction with the devices may correspond to the proxy gateway's or to the controller's certificate issuer (if the corresponding server certificates are not valid CA signed). On the other hand, in either proxy or non-proxy cases, if the certificate is a simple self-signed certificate, then that certificate will be downloaded by the device into its trust store.

Note Using a self-signed certificate for either the Cisco APIC-EM or the proxy gateway is strongly discouraged. We strongly recommend using a publicly verifiable CA issued certificate to be installed on the controller, as well as the proxy gateway if one is present.

With a valid CA issued certificate for the controller or the proxy gateway (if present), the PnP enabled devices can download the trustpool bundle (ios.p7b) containing all the well known CA root certificates. This permits the devices to establish secure connections to the controller or to the proxy gateway for further provisioning and operation of those devices. If such a certificate is not a valid CA issued or self-signed, then the devices will have to download the issuing CA's or self-signed certificate to proceed further with a secure connection to the controller or a proxy gateway in front of the controller. The Cisco APIC-EM facilitates automatic downloads of the relevant trusted certificates on the devices, depending on the nature of the certificate installed on it. However; when a proxy gateway is present, the controller provides a provisioning GUI to facilitate similar pre-provisioning.

Related Topics

Importing a Proxy Gateway Certificate, on page 85

Configuring the TLS Version Using the CLI

Northbound REST API requests from the external network to the Cisco APIC-EM (from northbound REST API based apps, browsers, and network devices connecting to the controller using HTTPS) are made secure using the Transport Layer Security protocol (TLS). The Cisco APIC-EM supports TLS versions 1.0, 1.1, and 1.2.

The minimum TLS version that a client (either a northbound application client such as the controller GUI browser or a network device) can communicate with the controller by default is TLS 1.0. If your network device IOS/XE versions can support a higher version than TLS 1.0, then it is strongly recommended to configure the minimum TLS version of the controller to the higher version (be sure that all of your network devices under Cisco APIC-EM control can support this higher TLS version).

Note Any versions lower than TLS 1.0 (such as SSLv3 and SSLv2) are not supported by Cisco APIC-EM.

Important With the controller TLS version set to 1.2, a client initiating a TLS version 1.0 or 1.1 connection will be rejected and any communications from this client will fail. With the controller TLS version set to 1.0, a client initiating a TLS version 1.1 or 1.2 connection will be permitted.

You configure the TLS version for the controller by logging into the host (physical or virtual) and using the CLI.

Note This security feature applies only to port 443 on the Cisco APIC-EM .

Before You Begin

You must have successfully deployed the Cisco APIC-EM and it must be operational.

You must have grapevine SSH access privileges to perform this procedure.

Step 1 Using a Secure Shell (SSH) client, log into the host (physical or virtual) with the IP address that you specified using the configuration wizard.

Note The IP address to enter for the SSH client is the IP address that you configured for the network adapter. This IP address connects the host to the external network.

Step 2 When prompted, enter your Linux username ('grapevine') and password for SSH access.

Step 3 Enter the **grape config display** command at the prompt to display the default TLS minimum version.

```
$ grape config display

PROPERTY                          VALUE
------------------------------------------------------------------------
client_grow_timeout               150
client_heartbeat_timeout          120
client_idle_timeout               60
enable_policy                     True
enable_secure_tunnel              True
enable_service_rollback           False
host_cpu_threshold                0.9
host_datastore_threshold          1.0
host_heartbeat_timeout            120
host_memory_threshold             0.00999999977648
https_proxy
https_proxy_password
https_proxy_username
load_multiplier                   1.0
max_spare_capacity                1
policy_startup_delay              120
tls_minimum                       1_0

(grapevine)
```

Step 4 Enter the **grape config update tls_minimum 1_2** command at the prompt to update to TLS version 1.2

```
$ grape config update tls_minimum 1_2
```

```
Config updated successfully

(grapevine)
```

Step 5 Enter the **grape config display** command at the prompt a second time to view the new TLS minimum version.

```
$ grape config display

PROPERTY                          VALUE
------------------------------------------------------------------------
client_grow_timeout               150
client_heartbeat_timeout          120
client_idle_timeout               60
enable_policy                     True
enable_secure_tunnel              True
enable_service_rollback           False
host_cpu_threshold                0.9
host_datastore_threshold          1.0
host_heartbeat_timeout            120
host_memory_threshold             0.00999999977648
https_proxy
https_proxy_password
https_proxy_username
load_multiplier                   1.0
max_spare_capacity                1
policy_startup_delay              120
tls_minimum                       1_2

(grapevine)
```

The TLS minimum version should display *1_2*, which indicates the TLS 1.2 version.

Related Topics

External Network Security, on page 14

Device Management Network Security , on page 14

Configuring IPSec Tunneling for Multi-Host Communications

The default tunneling protocol used for inter-host communications in a multi-host cluster is Generic Routing Encapsulation (GRE). Communications between the hosts in a multi-host cluster can be made more secure using Internet Protocol Security (IPsec). You can enable secure tunneling with IPSec for the Cisco APIC-EM using the configuration wizard, as described in this procedure.

Important If you are upgrading from a prior Cisco APIC-EM release version, to release version 1.2.x, then follow the upgrade procedure as described in the *Release Notes for the Cisco Application Policy Infrastructure Controller Enterprise Module, Release 1.2.0.x*. This procedure describes the process for configuring IPSec tunneling on a fresh installed 1.2.x multi-host cluster.

Follow the steps described below to enhance security for communications between the hosts. The steps are organized as follow:

1. Break up or disassemble your multi-host cluster (steps 1-5).
2. Enable IPSec tunneling on the last host that was in your cluster (steps 6-10).
3. Reassembly your multi-host cluster around that host where you enabled IPSec tunneling. (steps 10-20).

Note You should not enable or disable the secure tunnel mode (IPSec tunneling) while the Cisco APIC-EM is in a multi-host cluster. The configuration wizard does not support such a change while in a multi-host cluster.

Before You Begin

You must have successfully deployed the Cisco APIC-EM and it must be operational.

You must have grapevine SSH access privileges to perform this procedure.

Step 1 Using a Secure Shell (SSH) client, log into one of the hosts in your cluster.
When prompted, enter your Linux username ('grapevine') and password for SSH access.

Step 2 Enter the following command to access the configuration wizard.

```
$ config_wizard
```

Step 3 Review the **Welcome to the APIC-EM Configuration Wizard!** screen and choose the option to remove the host from the cluster:

- **Remove this host from its APIC-EM cluster**

Step 4 A message appears with an option to **[proceed]** and remove this host from the cluster.
Choose **proceed>>** to begin. After choosing **proceed>>**, the configuration wizard begins to remove this host from the cluster.
At the end of this process, this host is removed from the cluster.

Step 5 Repeat the above steps (steps 1-4) on a second host in the cluster.

Note You must repeat the above steps on each host in your cluster, until you have broken up the multi-host cluster.

Important Make a note of the final host in the cluster that you have just broken up or disassembled. You must perform the next steps (enabling IPSec tunneling) on that specific host. For example, if you have 3 hosts in a cluster (A, B , C) and you first remove host A, then remove host B, then you must enable IPSec on host C.

Step 6 Using a Secure Shell (SSH) client, log into the last host in your cluster and run the **config_wizard** command.

```
$ config_wizard
```

Step 7 Review the current configuration values in the configuration wizard and click **next>>**, until you access the **INTER-HOST COMMUNICATION** screen.

Step 8 Configure IPSec tunneling for communications between the hosts in a multi-host cluster by selecting *yes*.

The default tunneling protocol used for communications between the hosts in a multi-host cluster is Generic Routing Encapsulation (GRE). By entering 'yes', you are configuring IPSec tunneling with this step.

Step 9 Click **next>>** until the last step of the configuration wizard process is reached.

Step 10 Click **proceed>>** to have the configuration wizard save and apply your configuration changes to your Cisco APIC-EM deployment.
At the end of the configuration process, a **CONFIGURATION SUCCEEDED!** message appears.

Next, proceed to log into the other hosts previously in your multi-host cluster and use the configuration wizard to reassemble the cluster (with IPSec tunneling configured between the hosts).

Step 11 Using a Secure Shell (SSH) client, log into one of the other hosts in your cluster.
When prompted, enter your Linux username ('grapevine') and password for SSH access.

Step 12 Enter the following command to access the configuration wizard.

```
$ config_wizard
```

Step 13 Review the **Welcome to the APIC-EM Configuration Wizard!** screen and choose the **Create a new APIC-EM cluster** option.

Note Joining this other (second) host to the host with the enabled IPSec tunneling, automatically configures IPSec tunneling on this other (second) host.

Step 14 Proceed to recreate the cluster using the configuration wizard.
For additional information about this step and process, see Configuring Cisco APIC-EM as a Multi-Host Cluster Using the Wizard, on page 48.

Step 15 At the end of the configuration process, click **proceed>>** to have the configuration wizard save and apply your configuration changes.
A **CONFIGURATION SUCCEEDED!** message appears.

Step 16 Using a Secure Shell (SSH) client, log into the third host and use the configuration wizard to join the new multi-host cluster.
When prompted, enter your Linux username ('grapevine') and password for SSH access.

Step 17 Enter the following command to access the configuration wizard.

```
$ config_wizard
```

Step 18 Review the **Welcome to the APIC-EM Configuration Wizard!** screen and choose the **Add this host to an existing APIC-EM cluster** option.

Note Adding this host to the new multi-host cluster with the enabled IPSec tunneling, automatically configures IPSec tunneling on this host.

Step 19 Proceed to add this host to the cluster using the configuration wizard.
For additional information about this step and process, see Configuring Cisco APIC-EM as a Multi-Host Cluster Using the Wizard, on page 48..

Step 20 At the end of the configuration process, click **proceed>>** to have the configuration wizard save and apply your configuration changes.
A **CONFIGURATION SUCCEEDED!** message appears.

At the end of this step, you have updated your cluster and configured IPSec tunneling. Repeat the above steps to add any additional hosts to your multi-host cluster.

Related Topics

Internal Network Security, on page 14

Password Requirements

The Cisco APIC-EM password policy governs password values in logins to the controller GUI, SSH logins to the Grapevine root, northbound API requests, and logins to the Grapevine console for troubleshooting. The Cisco APIC-EM rejects a password that does not conform to the password policy. If a password is rejected, the controller provides an error message that describes the reason for the rejection.

A new or changed password must meet the following criteria:

- Eight character minimum length.
- Does NOT contain a tab or a line break.
- Does contain characters from at least three of the following categories:
  - Uppercase alphabet
  - Lowercase alphabet
  - Numeral
  - Special characters

    Special characters include the space character or any of the following characters or character combinations:

    ```
    ! @ # $ % ^ & * ( ) - =  + _ { } [ ] \\ | ; : " ' , < . > ? /
    :: #! ./ ;; >> << () **
    ```

For example, `Splunge!` is a valid password because it meets the eight-character minimum length, contains at least one uppercase alphabetic character, contains at least one lowercase alphabetic character, and contains at least one special character (`!`).

Related Topics

Configuring Password Policies, on page 108

Cisco APIC-EM Ports Reference

The following tables list the Cisco APIC-EM ports that permit incoming traffic, as well as the Cisco APIC-EM ports that are used for outgoing traffic. You should ensure that these ports on the controller are open for both incoming and outgoing traffic flows.

The following table lists Cisco APIC-EM ports that permit *incoming* traffic into the controller.

Note Ensure proper protections in your network for accessing ports 22 and 14141.

Table 4: Cisco APIC-EM Incoming Traffic Port Reference

Port Number	Permitted Traffic	Protocol (TCP or UDP)
22	SSH	TCP
67	bootps	UDP
80	HTTP	TCP
123	NTP	UDP
162	SNMP	UDP
443 [1]	HTTPS	TCP
500	ISAKMP In order for deploying multiple hosts across firewalls in certain deployments, the IPSec ISAKMP (Internet Security Association and Key Management Protocol) UDP port 500 has to be allowed to be traversed.	UDP
14141	Grapevine console	TCP
16026	SCEP	TCP

1 You can configure the TLS version for this port using the Cisco APIC-EM. For more information, see Configuring the TLS Version Using the CLI, on page 21

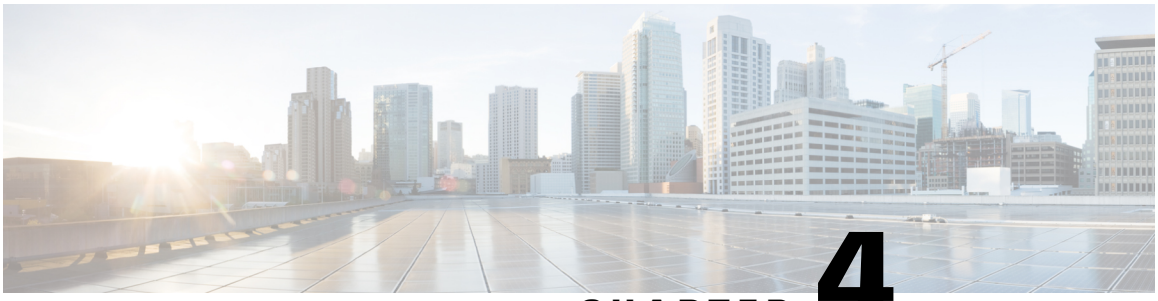
The following table lists Cisco APIC-EM ports that are used for *outgoing* traffic from the controller.

Table 5: Cisco APIC-EM Outgoing Traffic Port Reference

Port Number	Permitted Traffic	Protocol (TCP or UDP)
22	SSH (to the network devices)	TCP
23	Telnet (to the network devices)	TCP
53	DNS	UDP

Port Number	Permitted Traffic	Protocol (TCP or UDP)
80	Port 80 may be used for an outgoing proxy configuration. Additionally, other common ports such as 8080 may also be used when a proxy is being configured by the Cisco APIC-EM configuration wizard (if a proxy is already in use for your network). **Note** To access Cisco supported certificates and trust pools, you can configure your network to allow for outgoing IP traffic from the controller to Cisco addresses at the following URL: http://www.cisco.com/security/pki/	TCP
123	NTP	UDP
161	SNMP agent	UDP
443 [2]	HTTPS	TCP
500	ISAKMP In order for deploying multiple hosts across firewalls in certain deployments, the IPSec ISAKMP ((Internet Security Association and Key Management Protocol) UDP port 500 has to be allowed to be traversed.	UDP

2 You can configure the TLS version for this port using the Cisco APIC-EM. For more information, see Configuring the TLS Version Using the CLI, on page 21



CHAPTER 4

Cisco APIC-EM Services

About Cisco APIC-EM Services

The Cisco APIC-EM creates a Platform as a Service (PaaS) environment for your network, using Grapevine as an Elastic Services platform to support the controller's infrastructure and services. A service in this PaaS environment is a horizontally scalable application that adds instances of itself when demand increases, and frees instances of itself when demand decreases.

The Cisco APIC-EM controls elasticity at the service level, rather than at the Grapevine client level.

Service Managers and Monitors

The Cisco APIC-EM services that run on the Grapevine Elastic Services Platform provide the controller with its functionality. The Grapevine Elastic Services Platform consists the following components:

- Grapevine root—Handles all policy management in regards to service updates, as well as the service lifecycle for both itself and the Grapevine client.
- Grapevine client—Location where the supported services run.

After installation, service functionality is enabled using the following managers and monitors:

- Grapevine Root
  - Service manager—Starts, stops, and monitors service instances across the Grapevine clients.
  - Capacity manager—Provides on-demand capacity to run the services.
  - Load monitor—Monitors the load and health of services across the Grapevine clients.
  - Service catalog—Repository of service bundles that can be deployed on the Grapevine clients.

- Grapevine Client
  - Service manager—Starts, stops, and monitors service instances on the Grapevine client.
  - Service instance manager—Deploys the service.

Service Features

The Cisco APIC-EM provides the following service features:

- Adding capacity on an existing client—When a service load exceeds a specified threshold on a client, the controller can request another service instance to start on a second, preexisting client.
- Adding capacity on a newly instantiated client—When a service load exceeds a specified threshold on a client, the controller can request a new client to be instantiated and then start another service instance on this client.
- Allows automatic scaling of services—As the service load increases, the controller instantiates additional service instances in response. As the service load decreases, the controller tears down the number of instances in response.
- Resiliency for services—When a service fails, the controller starts a replacement instance. The controller then ensures that the service's minimum instance count requirements are maintained.

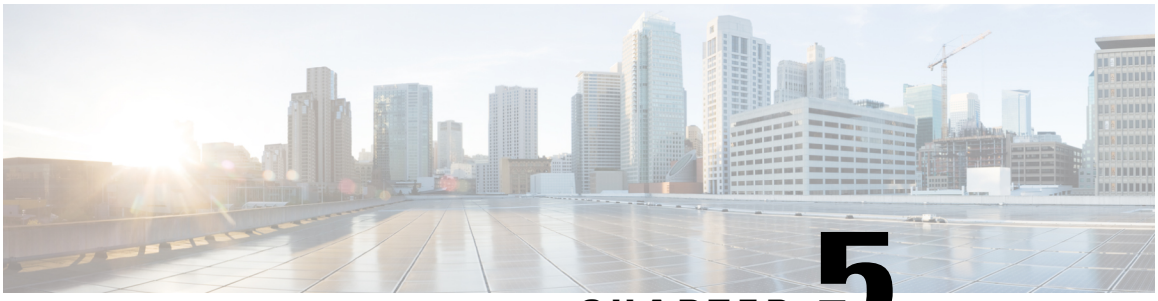
Services

The following are the supported Cisco APIC-EM services for this release.

Note For information about troubleshooting services, see the *Cisco Application Policy Infrastructure Controller Enterprise Module Troubleshooting Guide*.

- access-policy-programmer-service
- apic-em-event-service
- apic-em-inventory-manager-service
- apic-em-jboss-ejbca
- apic-em-network-programmer-service
- apic-em-pki-broker-service
- app-vis-policy-programmer-service
- cas-service
- election-service
- file-service
- identity-manager-pxgrid-service

- ip-pool-manager-service
- ipgeo-service
- log-aggregator
- nbar-policy-programmer-service
- network-poller-service
- node-ui
- pfr-policy-programmer-service
- pnp-service
- policy-analysis-service
- policy-manager-service
- postgres
- qos-lan-policy-programmer-service
- qos-policy-programmer-service
- rbac-service
- remote-ras
- reverse-proxy
- router
- scheduler-service
- task-service
- telemetry-service
- topology-service
- visibility-service



CHAPTER 5

Deploying the Cisco APIC-EM

Information about the Cisco APIC-EM Deployment

You can deploy the Cisco APIC-EM on either a server (bare-metal hardware) or within a virtual machine in a VMware vSphere environment. You can also deploy the Cisco APIC-EM as either a single host or in a multi-host environment.

Note We recommend that you deploy the Cisco APIC-EM in a multi-host environment for enhanced scalability and redundancy.

Related Topics

Configuring Cisco APIC-EM as a Single Host Using the Wizard, on page 41

Configuring Cisco APIC-EM as a Multi-Host Cluster Using the Wizard, on page 48

Pre-Deployment Checklists

Single Host Checklists

Review the following checklists before beginning your single-host Cisco APIC-EM deployment.

Note A host is defined as physical server or virtual machine with instances of a Grapevine root and clients running. The Grapevine root is located in the host OS and the clients are located within Linux containers. The clients run the services within the Linux containers. You can set up either a single host deployment or multi-host deployment (2 or 3 hosts) for your network. For high availability and scale, your multi-host deployment must contain three hosts. All inbound traffic to the controller in a single host deployment is through the host IP address that you configure using the configuration wizard. All inbound traffic to the controller in a multi-host deployment is through a Virtual IP that you configure using the configuration wizard.

Networking Requirements

This Cisco APIC-EM deployment requires that the network adapters (NICs) on the host (physical or virtual) are connected to the following networks:

- Internet (network access required for **Make A Wish** requests and telemetry collection)
- Network with NTP server(s)
- Network with devices that are to be managed by the Cisco APIC-EM

Note The Cisco APIC-EM should never be directly connected to the Internet. It should not be deployed outside of a NAT configured or protected datacenter environment.

IP Address Requirements

Ensure that you have available at least one IP address for the network adapter (NIC) on the host.

The IP address is used as follows:

- Direct access to the Grapevine root
- Direct access to the Cisco APIC-EM controller (for GUI access)

Note If your host has 2 NICs, then you might want to have two IP addresses available and configure one IP address for each NIC.

Multi-Host Checklists

Review the following checklist before beginning your multi-host Cisco APIC-EM deployment.

- You must satisfy the requirements for the single host deployment as described in the previous section for each host.

Note For a multi-host configuration, 32 GB of RAM is required for each host in contrast to 64 GB of RAM requirement for a single host configuration.

- Additionally, you must establish a network connection between each of the hosts using either a switch or a router. Each host must be routable with the other two hosts.
- You must configure a virtual IP (VIP).

  You configure one or more NICs on each host using the configuration wizard. Each NIC that you configure must point to a non-routable network (if all your networks are routable, then you only need one NIC). A VIP is required per non-routable network. For example, if you configure 2 NICs on all 3 hosts in a multi-host cluster and each NIC points to a separate, non-routable network, then you need to configure 2 VIPs. The VIP provides an interface redundancy feature for your multi-host deployment. With a VIP, the IP address can float between the hosts.

  When deploying the controller in a multi-host configuration:

  - You provide a VIP address when configuring the controller using the wizard.
  - On startup, the controller will bring up the VIP on one of the hosts.
  - All inbound requests into controller from the external network are made via this VIP (instead of the host IP address), and the requests are routed to the services running on different hosts via the reverse-proxy service.
  - If the host on which has the VIP fails, then Grapevine will bring up the VIP on one of the remaining two hosts.
  - The VIP must reside in the same subnet as the three hosts.
  - If you are planning to obtain a certificate issued for a multi-host environment, then it is important to get the certificate issued against the virtual IP or the host name resolvable to the virtual IP.

Multi-Host Deployment Virtual IP

A multi-host deployment has three physical IP addresses and one virtual IP that floats across the IP addresses by design in order to provide high availability. This capability to float also means that any SSH client that wants to connect to the virtual IP address will see different host-identity public SSH keys each time the virtual IP moves its residence from one host to another host. Most SSH clients will complain that the new host is not trusted, since an entry already exists (as you might have accepted the key earlier for the older host which owned that virtual IP address before). To prevent this inconvenience, you may want to add the host keys of all the three hosts to your known hosts list as described below.

For example on a Linux or Apple Mac OS client machine, run the **ssh-keyscan** command on each of the three host physical IP addresses as follows:

```
$ ssh-keyscan -t rsa 209.165.200.30
# 209.165.200.30 SSH-2.0-OpenSSH_6.6.1p1 Ubuntu-2ubuntu2.3
209.165.200.30 ssh-rsa AAAAB3NzaC1yc2EAAAADAQABAAABAQDA1B6/1JpKPFOmG3S82eE8OKZkGYmRd
SYnuCHfDiY5Pptt3BmaPgC6OlER4wwDL8VP2Rx2kxj3diIzFpUOyDqTbFxIRKVzlwtHHZdhO6G93MyLLGsWq
```

```
XSMWs4xVcqpembKeCrdjakPaPAXqiAeKW9oimdv.....
```

```
$ ssh-keyscan -t rsa 209.165.200.31
# 209.165.200.31 SSH-2.0-OpenSSH_6.6.1p1 Ubuntu-2ubuntu2.3
209.165.200.31 ssh-rsa AAAAB3NzaC1yc2EAAAADAQABAAABAQDF57F90z2His86tEj4s75pTc7h0nfzF
2c3QweHCNN2ov474HJJcPrnWTw4DAoPpPCU6zWvR0QLxunURDb+pMeZrIIyd49xn9+OBSmBpzrnety7UB2uP
XzL1RvVxayw8mkXkj779LhFh9vkXR4DtX7XLjg.....
```

```
$ ssh-keyscan -t rsa 209.165.200.32
# 209.165.200.32 SSH-2.0-OpenSSH_6.6.1p1 Ubuntu-2ubuntu2.3
209.165.200.32 ssh-rsa AAAAB3NzaC1yc2EAAAADAQABAAABAQC9kwzodGzGkh/UFXVa9fptGe+sa3CBR
6SNerXxpCmfT9AOXH8xuk3/CBX+DDUQgGJVmqw6maCYKOy0RtAhGxdsNdPL6ETTKzxYB5uzw3KhcDJ6D6ob6
jdzkR6yRuXVFi2OE+u1Aqs7J8GO66FfdavU8.....
```

Next, change the IP address in the SSH key line of each output to the virtual IP address of the following and append all three key lines to the `~/.ssh/known_hosts` file and save it.

Assuming that 209.165.200.33 is the virtual IP address in the above multi-host example, you would add three lines in the `~/.ssh/known_hosts` file of your client machine as follows:

```
209.165.200.33 ssh-rsa

AAAAB3NzaC1yc2EAAAADAQABAAABAQDA1B6/1JpKPFOmG3S82eE8OKZkGYmRdSYnuCHfDiY5Pptt3BmaPgC6OlER4
wwDL8VP2Rx2kxj3diIzFpUOyDqTbFxIRKVzlwtHHZdhO6G93MyLLGsWqXSMWs4xVcqpembKeCrdjakPaPAXqiAeKW9
oimdvPbrQPua7Zg9oblDxaBPn0Fqj00YDjKqTkp/IkZHEfHbDM996GLEbWlOvoHeCCqeZ1nWgFIqzAF+ty8+X5Z/fh
hmGe+w2tQlMfrs9pcZDaEEmq/w1W+uRohxLKs+OHnHYAbMzC6O+5fLEr2BwaZf8W016eo1WpPsxUVK6StbXBOQZrcH0
bPsUbIjKJkzafpft9Dp73pSd/vwaoB3DrvNec/PiEJYk+R.....
```

After the above change, the client will have no trouble performing uninterrupted SSH into the virtual IP address of the hosts even with the IP address floating.

Verifying the Cisco ISO Image

Prior to deploying the Cisco APIC-EM, you can verify that the ISO image that you downloaded is a genuine Cisco image.

Note If you are deploying the Cisco APIC-EM from an ISO image that you downloaded, then perform this procedure. This procedure is not required, if deploying the controller with the Cisco APIC-EM Controller Appliance (Cisco APIC-EM ISO image pre-installed and tested).

Before You Begin

You must have received notification of the location of the Cisco APIC-EM ISO image or contacted Cisco support for the location of the Cisco APIC-EM ISO image.

Step 1 Download the ISO image from the location specified by Cisco.

Step 2 Download the Cisco public key for signature verification from the location specified by Cisco.
The Cisco public key is named:

`cisco_image_verification_key.pub`

Step 3 Download the secure hash algorithm (SHA512) checksum file for the ISO image from the location specified by Cisco.

Step 4 Obtain the specific release ISO image's signature file from Cisco support via email or by download from the secure Cisco website (if available).
For example, `apic-em-CA-0.8.2.4704-0.1.0.15.dev1300-gaafbb68.sig`.

Step 5 (Optional) Perform a SHA verification to determine whether the ISO image was corrupted due to a partial download. For example, run one of the following commands (depending upon your operating system):

- On a system running MAC OS X version:

```
shasum -a 512 apic-em-CA-0.8.2.4704-0.1.0.15.dev1300-gaafbb68.iso
```

- On a Linux system:

```
sha512sum apic-em-CA-0.8.2.4704-0.1.0.15.dev1300-gaafbb68.iso
```

Microsoft Windows does not include a built-in checksum utility, but you can install a utility from Microsoft at this link: http://www.microsoft.com/en-us/download/details.aspx?id=11533

Compare the output of the above command (or Microsoft Windows utility) to the SHA512 checksum file downloaded earlier in step 3. If the command output fails to match, download the ISO image again and run the appropriate command a second time. If the output still fails to match, contact Cisco support.

Step 6 Verify that the ISO image is genuine and from Cisco by verifying the signature. Run the following command on the ISO image:

```
openssl dgst -sha512 -verify cisco_image_verification_key.pub -signature
apic-em-CA-0.8.2.4704-0.1.0.15.dev1300-gaafbb68.sig apic-em-CA-0.8.2.4704-0.1.0.15.dev1300-gaafbb68.iso
```

If the ISO image is genuine, then running this command should result in a **Verified OK** message. If this message fails to appear, then do not install the ISO image and contact Cisco support.

Note The image name and the signature names used here are only examples. Use the exact names of these files that you downloaded from the Cisco website.

This command will work in both MAC and Linux environments. For Windows, you need to download and implement OpenSSL from www.openssl.org, if you have not already done so.

What to Do Next

After you verify that the ISO image is genuine and from Cisco, install the Cisco ISO image.

Installing the Cisco ISO Image

Perform the steps in the following procedure to install the Cisco ISO image on the host (server or virtual machine).

Note If you are deploying the Cisco APIC-EM from an ISO image that you downloaded, then perform this procedure. This procedure is not required, if deploying the controller with the Cisco APIC-EM Controller Appliance (Cisco APIC-EM ISO image pre-installed and tested).

Before You Begin

You must review the system requirements before beginning this procedure.

You must review the Cisco APIC-EM pre-deployment checklist before beginning this procedure.

You must have downloaded and verified the Cisco ISO image by performing the tasks in the previous procedure.

For installing the Cisco APIC-EM ISO image into a virtual machine using VMware, you must create an empty virtual machine that you will attach the Cisco APIC-EM ISO image to and then boot up. When creating this virtual machine, do not accept the VMware default settings but configure the settings as per the system requirements previously listed in this guide.

Note See the VMware documentation for information about creating and configuring new virtual machines.

Perform one of the following procedures:

- For installing the Cisco APIC-EM ISO image on a server and from local media:
  - Burn the ISO image onto a DVD or a bootable USB flash drive.
  - Insert the DVD into the DVD drive of the physical appliance.

    If your physical appliance does not come with a DVD drive, you can connect an external USB DVD drive to the appliance and insert the disk into that external drive.
  - You can also connect a bootable USB flash drive where you burnt the ISO image to into the appliance.

    Note Cisco UCS servers provide an additional method of installing a remote ISO using a Virtual KVM console. See your Cisco UCS server documentation for information about this procedure. Note that installing the ISO image using a Virtual KVM console may take longer than the above methods.
- For installing the Cisco APIC-EM ISO image on a virtual machine:
  - Upload the Cisco APIC-EM ISO image directly to the virtual machine's datastore.
  - Attach the Cisco APIC-EM ISO image as a virtual CD-ROM drive of the virtual machine.

What to Do Next

Boot up the host (server or virtual machine) and run the wizard to configure the Cisco APIC-EM.

Cisco APIC-EM Configuration Wizard Parameters

When the Cisco APIC-EM software configuration begins, an interactive configuration wizard prompts you to enter required parameters to configure the controller.

Note Ensure that the DNS and NTP servers are reachable before you run the configuration wizard and whenever a Cisco APIC-EM host reboots in the deployment.

Table 6: Cisco APIC-EM Configuration Wizard Parameters

Configuration Wizard Prompt	Description	Example
Host IP address	Must be a valid IPv4 address for the host. This IP address is used for the network adapter (eth0) on the host and connects to the external network or networks. For multiple network adapters, have several IP addresses available.	10.0.0.12
(Optional) Virtual IP address	Must be a valid IPv4 address. This virtual IP address is used for the network adapter (eth0) on the host. You should only configure a virtual IP address, if you are setting up a multi-host deployment.	10.12.13.14
Netmask IP address	Must be a valid IPv4 netmask.	255.255.255.0
Default Gateway IP address	Must be a valid IPv4 address for the default gateway.	10.12.13.1
Primary server	Must be a valid IPv4 address for the primary server.	10.15.20.25 **Note** Enter either a single IP address for a single primary server, or multiple IP addresses separated by spaces for DNS servers.
Primary NTP server	Must be a valid IPv4 address or hostname of a Network Time Protocol (NTP) server.	10.12.13.10 Enter either a single IP address for a single NTP primary server, or multiple IP addresses separated by spaces for several NTP servers. We recommend that you configure three NTP servers for your deployment.

Configuration Wizard Prompt	Description	Example
Add/Edit another NTP server	Must be a valid NTP domain.	10.12.13.11 Allows you to configure multiple NTP servers. **Note** We recommend that you configure three NTP servers for your deployment.
HTTPS proxy server	Must be a valid IPv4 address for the HTTPS proxy with port number.	https://209.165.200.11:3128
Admin Username	Identifies the administrative username used for GUI access to the Cisco APIC-EM controller. We recommend that the username be three to eight characters in length and be composed of valid alphanumeric characters (A–Z, a–z, or 0–9).	admin2780
Admin Password	Identifies the administrative password that is used for GUI access to the Cisco APIC-EM controller. You must create this password because there is no default. The password meet the following requirements: • Eight character minimum length. • Does NOT contain a tab or a line break. • Does contain characters from at least three of the following categories: ◦ Uppercase alphabet ◦ Lowercase alphabet ◦ Numeral ◦ Special characters (for example, ! or #)	MyIseYPass2

Configuration Wizard Prompt	Description	Example
Linux Username	Identifies the Linux (Grapevine) username used for CLI access to the Grapevine root and clients.	The default is 'grapevine' and cannot be changed.
Linux Password	Identifies the Linux (Grapevine) password that is used for CLI access to the Grapevine roots and clients. You must create this password because there is no default. The password meet the following requirements: • Eight character minimum length. • Does NOT contain a tab or a line break. • Does contain characters from at least three of the following categories: ◦ Uppercase alphabet ◦ Lowercase alphabet ◦ Numeral ◦ Special characters (for example, ! or #)	MyGVPass01

Configuring Cisco APIC-EM as a Single Host Using the Wizard

Perform the steps in the following procedure to configure Cisco APIC-EM as a single host using the wizard.

Note If you attempt to install Cisco APIC-EM on a host that does not meet the minimum system requirements, then a warning appears notifying you of the option to install a limited, low-memory evaluation version of the controller. You can either install this evaluation version or proceed to upgrade your host's system with additional memory and run the configuration wizard again. The evaluation version of the controller will permit you to try out the controller's basic functionality, including discovery, EasyQoS, and Path Trace. The maximum number of devices supported for the evaluation version is 20.

Before You Begin

You must have either received the Cisco APIC-EM Controller Appliance with the Cisco APIC-EM pre-installed or you must have downloaded, verified, and installed the Cisco ISO image onto a server or virtual machine as described in the previous procedures.

Step 1 Boot up the host.

Step 2 Review the **APIC-EM License Agreement** screen that appears and choose either **<view license agreement>** to review the license agreement or **accept>>** to accept the license agreement and proceed.

Note You will not be able to proceed without accepting the license agreement.

After accepting the license agreement, you are then prompted to select a configuration option.

Step 3 Review the **Welcome to the APIC-EM Configuration Wizard!** screen and choose the **Create a new APIC-EM cluster** option to begin.
You are then prompted to enter values for the **NETWORK ADAPTER #1 (eth0)**.

Step 4 Enter configuration values for the **NETWORK ADAPTER #1 (eth0)** on the host.
The configuration wizard discovers and prompts you to confirm values for the network adapter or adapters on your host. For example, if your host has three network adapters you are prompted to confirm configuration values for network adapter #1 (eth0), network adapter #2 (eth1), and network adapter #3 (eth2) respectively.

Note The primary interface for the controller is eth0 and it is best practice to ensure that this interface is made highly available.

On Cisco UCS servers, the NIC labeled with number 1 would be the physical NIC. The NIC labeled with the number 2 would be eth1.

Host IP address	Enter the host IP address to use for the network adapter. This host IP address (and network adapter) connects to the external network or networks. These external network(s) consists of the network devices, NTP servers, as well as providing access to the northbound REST APIs. The external network(s) also provides access to the controller GUI. **Note** The configuration wizard validates the value entered and issues an error message if incorrect. If you receive an error message for the host IP address, then check to ensure that eth0 (ethernet interface) is connected to the correct network adapter.
Virtual IP	(Optional) Enter a virtual IP address to use for this network adapter. You should only configure a virtual IP address, if you are setting up a multi-host deployment. **Note** For additional information about virtual IP, see Multi-Host Deployment Virtual IP, on page 35
Netmask	Enter the netmask for the network adapter's IP address.

Default Gateway IP address	Enter a default gateway IP address to use for the network adapter. **Note** If no other routes match the traffic, traffic will be routed through this IP address.
DNS Servers	Enter the DNS server or servers IP addresses (separated by spaces) for the network adapter.
Static Routes	If required for your network, enter a space separated list of static routes in this format: <network>/<netmask>/<gateway> Static routes, which define explicit paths between two routers, cannot be automatically updated; you must manually reconfigure static routes when network changes occur. You should use static routes in environments where network traffic is predictable and where the network design is simple. You should not use static routes in large, constantly changing networks because static routes cannot react to network changes.

Once satisfied with the controller network adapter settings, enter **next>>** to proceed. After entering **next>>**, the configuration wizard proceeds to validate the values you entered. After validation and if your host has two network adapters, you are prompted to enter values for **NETWORK ADAPTER #2 (eth1)**. If your host has three network adapters, you are prompted to enter values for **NETWORK ADAPTER #2 (eth1)** and **NETWORK ADAPTER #3 (eth2)**. If you do not have any additional network adapters or if you do not have more than one non-routable network, then proceed directly to the next step.

Step 5 If the controller is being deployed in your network behind a proxy server and the controller's access to the Internet is through this proxy server, then enter configuration values for the **HTTPS PROXY**.

Note If there is no proxy server between the controller and access to the Internet, then this step will not appear. Instead, you will be prompted to enter values for **CLOUD CONNECTIVITY**.

HTTPS Proxy	Enter the protocol (HTTP or HTTPS), IP address, and port number of the proxy. For example, enter **https://209.165.200.11:3128**
HTTPS Proxy Username	Enter the username, if authentication is required for the proxy.
HTTPS Proxy Password	Enter the password, if authentication is required for the proxy.

After configuring the **HTTPS PROXY**, enter **next>>** to proceed. After entering **next>>**, you are then prompted to enter values for **CLOUD CONNECTIVITY**.

Step 6 Enter configuration values for **CLOUD CONNECTIVITY**.

CCO Username	Enter a Cisco Connection Online (CCO) username for cloud connectivity. For example, enter the username that you use to log into the Cisco website to access restricted locations as either a Cisco customer or partner.
CCO Password	Enter a Cisco Connection Online (CCO) password for the CCO *username*. For example, enter the password that you use to log into the Cisco website to access restricted locations as either a Cisco customer or partner.
Company Name	Enter the company or organization's name with which you are affiliated.

Once satisfied with the cloud connectivity settings, enter **next>>** to proceed. After entering **next>>**, the configuration wizard proceeds to validate the values entered. After validation, you are then prompted to enter values for the **LINUX USER SETTINGS**.

Step 7 Enter configuration values for the **LINUX USER SETTINGS**.

Linux Password	Enter a Linux password. The Linux password is used to ensure security for both the Grapevine root and clients located on the host (appliance, server, or virtual machine). Access to the Grapevine root and clients by you or the controller requires this password. The default username is grapevine. For information about the requirements for a Linux password, see the Password Policy section, in Chapter 3, Cisco APIC-EM Security. **Note** The Linux password is encrypted and hashed in the controller database.
Re-enter Linux Password	Confirm the Linux password by entering it a second time.
Seed Phrase Password Generation	(Optional) Instead of creating and entering your own password in the above **Linux Password** fields, you can enter a seed phrase and have the configuration wizard generate a random and secure password using that seed phrase. Enter a seed phrase and then press <**Generate Password**> to generate the password.

Auto Generated Password	(Optional) The seed phrase appears as part of a random and secure password. If desired, you can either use this password "as is", or you can further edit this auto generated password. **Note** When finished with the password, be sure to save it to a secure location for future reference. Press <**Use Generated Password**> to save the password.

After configuring the Linux password, enter **next>>** to proceed. After entering **next>>**, you are then prompted to enter values for the **APIC-EM ADMIN USER SETTINGS**.

Step 8 Enter configuration values for the **APIC-EM ADMIN USER SETTINGS**.

Administrator Username	Enter an administrator username. Your administrator username and password are used to ensure security for the controller itself. Access to the controller's GUI requires that you enter this username and password.
Administrator Password	Enter an administrator password. For information about the requirements for an administrator password, see the Password Policy section, in Chapter 3, Cisco APIC-EM Security. **Note** The administrator password is encrypted and hashed in the controller database.
Re-enter Administrator Password	Confirm the administrator password by entering it a second time.
Seed Phrase Password Generation	(Optional) Instead of creating and entering your own password in the above **Administrator Password** fields, you can enter a seed phrase and have the configuration wizard generate a random and secure password using that seed phrase. Enter a seed phrase and then press <**Generate Password**> to generate the password.
Auto Generated Password	(Optional) The seed phrase appears as part of a random and secure password. If desired, you can either use this password "as is", or you can further edit this auto generated password. **Note** When finished with the password, be sure to save it to a secure location for future reference. Press <**Use Generated Password**> to save the password.

After configuring the administrator password, enter **next>>** to proceed.

After entering **next>>**, you are then prompted to enter values for either the **NTP SERVER SETTINGS**.

Step 9 Enter configuration values for **NTP SERVER SETTINGS**.

NTP servers	Enter a single NTP server address or a list of NTP servers each separated by a space. The Elastic Services Platform (Grapevine) manages a Network Time Protocol (NTP) server to provide time synchronization for the Grapevine clients. You must configure the NTP server for the clients. The NTP server is external to the cluster. **Note** We recommend that for redundancy purposes, you configure at least three NTP servers for your Cisco APIC-EM deployment.

Note Cisco routers can also be configured as NTP servers.

After configuring the NTP server(s), enter **next>>** to proceed. After entering **next>>**, you are then prompted to enter values for **INTER-HOST COMMUNICATION**.

Step 10 Enter configuration values for **INTER-HOST COMMUNICATION**.

Enable IPSec Encryption	You can configure IPSec tunneling for communications between the hosts in a multi-host cluster. By selecting *yes*, you configure IPSec tunneling. The default is GRE and the default option is set to *no*.

Once satisfied with the inter-host communication setting, enter **next>>** to proceed. After entering **next>>**, the configuration wizard proceeds to validate the values you entered.

Step 11 Enter configuration values for **CONTROLLER CLEAN-UP**.

Harvest All Virtual Disks	Entering **yes** will delete all Grapevine virtual disks that belong to the controller for this specific deployment. For an initial configuration, enter **no**.
Delete All Clients	Entering **yes** will delete all Grapevine clients that belong to the controller for this specific deployment. For an initial configuration, enter **no**.

For an initial configuration, enter **no** for both options.

After configuring the controller clean-up, enter **next>>** to proceed. After entering **next>>**, you are then prompted to enter values to finish the configuration and begin the configuration wizard installation.

Step 12 A final message appears stating that the wizard is now ready to proceed with applying the configuration.

The following options are available:

- **[back]—**Review and verify your configuration settings.
- **[cancel]—**Discard your configuration settings and exit the configuration wizard.
- **[save & exit]—**Save your configuration settings and exit the configuration wizard.
- **[proceed]—**Save your configuration settings and begin applying them.

Enter **proceed>>** to complete the installation. After entering **proceed>>**, the configuration wizard applies the configuration values that you entered above.

Note

At the end of the configuration process, a **CONFIGURATION SUCCEEDED!** message appears.

Step 13 Open your browser and enter the host IP address to access the Cisco APIC-EM GUI.
You can use the displayed IP address of the Cisco APIC-EM GUI at the end of the configuration process.

Step 14 After entering the IP address in the browser, a message stating that "Your connection is not private" appears.
Ignore the message and click the **Advanced** link.

Step 15 After clicking the **Advanced** link, a message stating that the site's security certificate is not trusted appears.
Ignore the message and click the link.

Note This message appears because the controller uses a self-signed certificate. You will have the option to upload a trusted certificate using the controller GUI after installation completes.

Step 16 In the **Login** window, enter the administrator username and password that you configured above and click the **Log In** button.

What to Do Next

For a multi-host deployment, perform the following procedure to configure another host and join it with this host to create a cluster.

For a single-host deployment, begin to use the Cisco APIC-EM to manage and configure your network.

Note You can send feedback about the Cisco APIC-EM by clicking the Feedback icon ("I wish this page would....") at the lower right of each window in the GUI. Clicking on this icon opens a comments field. Use this field to make a comment on the current window or to make a request to the Cisco APIC-EM development team.

Related Topics

Information about the Cisco APIC-EM Deployment, on page 33

Configuring Cisco APIC-EM as a Multi-Host Cluster Using the Wizard

Perform the steps in this procedure to configure Cisco APIC-EM on your host and to join it to another, pre-existing host to create a cluster. Configuring the Cisco APIC-EM on multiple hosts to create a cluster is best practice for both high availability and scale.

Caution

- When joining a host to a cluster as described in the procedure below, there is no merging of the data on the two hosts. The data that currently exists on the host that is joining the cluster is erased and replaced with the data that exists on the cluster that is being joined to.
- When joining the additional hosts to form a cluster be sure to join only a single host at a time. You should not join multiple hosts at the same time, as doing so will result in unexpected behavior.
- You should also expect some service downtime when the adding or removing hosts to a cluster, since the services are then redistributed across the hosts. Be aware that during the service redistribution, there will be downtime.

Before You Begin

You must have either received a Cisco APIC-EM Controller Appliance with the Cisco APIC-EM pre-installed or you must have downloaded, verified, and installed the Cisco ISO image onto a second server or virtual machine.

You must have already configured Cisco APIC-EM on the first host (server or virtual machine) in your planned multi-host cluster following the steps in the previous procedure. This procedure must be run on the second host that you are joining to the cluster. When joining the new host to the cluster, you must specify an existing host in the cluster to connect to.

Note The Cisco APIC-EM multi-host configuration supports the following two workflows:

- You first configure a single host running Cisco APIC-EM in your network. After performing this procedure, you then use the wizard to configure and join two additional hosts to form a cluster.
- If you already have several single hosts configured with Cisco APIC-EM, you can use the configuration wizard to join two additional hosts to a single host to form a cluster.

Step 1 Boot up the host.

Step 2 Review the **APIC-EM License Agreement** screen that appears and choose either **<view license agreement>** to review the license agreement or **accept>>** to accept the license agreement and proceed with the deployment.

Note You will not be able to proceed without accepting the license agreement.

After accepting the license agreement, you are then prompted to select a configuration option.

Step 3 Review the **Welcome to the APIC-EM Configuration Wizard!** screen and choose one of the two displayed options to begin.

- **Create a new APIC-EM cluster**
- **Add this host to an existing APIC-EM cluster**

For the multi-host deployment, click the **Add this host to an existing APIC-EM cluster** option.

Step 4 Enter configuration values for the **NETWORK ADAPTER #1 (eth0)** on the host.
The configuration wizard discovers and prompts you to confirm values for the network adapter or adapters on your host. For example, if your host has two network adapters you are prompted to confirm configuration values for network adapter #1 (eth0) and network adapter #2 (eth1).

Note On Cisco UCS servers, the NIC labeled with number 1 would be the physical NIC. The NIC labeled with the number 2 would be eth1.

Host IP address	Enter a host IP address to use for the network adapter. This host IP address connects to the external network or networks. **Note** The network adapter(s) connect to the external network or networks. These external network(s) consists of the network devices, NTP servers, as well as providing access to the northbound REST APIs. The external network(s) also provides access to the controller GUI.
Netmask	Enter the netmask for the network adapter's IP address.

Later in this procedure, the following information will be discovered and copied from the cluster to the configuration file of this host:

- Default Gateway IP address
- DNS Servers
- Static Routes

Once satisfied with the controller network adapter settings, enter **next>>** to proceed. After entering **next>>**, the configuration wizard proceeds to validate the values you entered. After validation, you are then prompted to enter values for the **APIC-EM CLUSTER SETTINGS**.

Step 5 Enter configuration values for the **APIC-EM CLUSTER SETTINGS**.

Remote Host IP	Enter the eth0 IP address of the pre-configured host that you are now joining to form a cluster. **Note** If a virtual IP address has already been configured on another host for a multi-host cluster, you may also enter that IP address value. This field accepts either the IP address of a pre-configured host to the cluster or the virtual IP address of the cluster.

Administrator Username	Enter an administrator username. This is the administrator username on the pre-configured host that you are now joining to form a cluster.
Administrator Password	Enter an administrator password. This is the administrator password on the pre-configured host that you are now joining to form a cluster. For information about the requirements for an administrator password, see the Password Policy section, in Chapter 3, Cisco APIC-EM Security. **Note** The administrator password is encrypted and hashed in the controller database.

After configuring the administrator cluster settings, enter **next>>** to proceed. After entering **next>>**, the configuration wizard then proceeds to prepare the host to join the cluster.

You will receive a message to please wait, while the remote cluster is being queried and data is retrieved.

Step 6 Enter configuration values for the **Virtual IP**.

Note If you are joining the host to a cluster where the virtual IP has already been configured, then you will not be prompted for virtual IP configuration values. If you are joining the host to a cluster where a virtual IP has not yet been configured, then you will be prompted for virtual IP configuration values.

Virtual IP	Enter the virtual IP address to use for the network that the controller is directed to. **Note** For additional information about virtual IP, see Multi-Host Deployment Virtual IP, on page 35

Once satisfied with the virtual IP address settings, enter **next>>** to proceed. After entering **next>>**, the configuration wizard proceeds to validate the values you entered.

Step 7 (Optional) Enter additional configuration values for the **Virtual IP**.

The configuration wizard proceeds to continue its discovery of any pre-existing configuration values on the hosts in the cluster. Depending upon what the configuration wizard discovers, you may be prompted to enter additional configuration values. For example:

- If eth1 was configured on a pre-existing host in the cluster, then you are prompted to enter the host IP address that was configured for eth1. You are also prompted for a VIP, if it has not yet been configured for this NIC.
- If eth2 was configured on a pre-existing host in the cluster, then you are prompted to enter the host IP address that was configured for eth2. You are also prompted for a VIP, if it has not yet been configured for this NIC.
- If eth3 was configured on a pre-existing host in the cluster, then you are prompted to enter the host IP address that was configured for this eth3. You are also prompted for a VIP, if it has not yet been configured for this NIC.

Note This configuration wizard discovery process and prompting continues for the number of configured Ethernet ports in the cluster.

Virtual IP	Enter the virtual IP address to use for the network that the controller is directed to.
IP address	Enter an IP address to use for this network adapter. This IP address connects to the external network or networks. **Note** The network adapter(s) connect to the external network or networks. These external network(s) consists of the network devices, NTP servers, as well as providing access to the northbound REST APIs. The external network(s) also provides access to the controller GUI.

Once satisfied with the virtual IP address settings, enter **next>>** to proceed. After entering **next>>**, the configuration wizard proceeds to validate the values you entered.

Step 8 A final message appears stating that the wizard is now ready to proceed to join the host to the cluster.
The following options are available:

- **[back]—**Review and verify or modify your configuration settings.
- **[cancel]—**Discard your configuration settings and exit the configuration wizard.
- **[proceed]—**Save your configuration settings and begin the process to join this host to the specified Cisco APIC-EM.

Enter **proceed>>** to proceed. After entering **proceed>>**, the configuration wizard applies the configuration values that you entered above.

Note

At the end of the configuration process, a successful configuration message appears.

Step 9 Open your browser and enter an IP address to access the Cisco APIC-EM GUI.
You can use the first displayed IP address of the Cisco APIC-EM GUI at the end of the configuration process.

Note The first displayed IP address can be used to access the Cisco APIC-EM GUI. The second displayed IP address accesses the network where the devices reside.

Step 10 After entering the IP address in the browser, a message stating that "Your connection is not private" appears.
Ignore the message and click the **Advanced** link.

Step 11 After clicking the **Advanced** link, a message stating that the site's security certificate is not trusted appears.
Ignore the message and click the link.

Note This message appears because the controller uses a self-signed certificate. You will have the option to upload a trusted certificate using the controller GUI after installation completes.

Step 12 In the **Login** window, enter the administrator username and password that you configured above and click the **Log In** button.

What to Do Next

Proceed to follow the same procedure described here to join the third and final host to the multi-host cluster.

Note You can send feedback about the Cisco APIC-EM by clicking the Feedback icon ("I wish this page would....") at the lower right of each window in the GUI. Clicking on this icon opens a comments field. Use this field to make a comment on the current window or to make a request to the Cisco APIC-EM development team.

Related Topics

Information about the Cisco APIC-EM Deployment, on page 33

Powering Down and Powering Up the Cisco APIC-EM

Under certain circumstances such as troubleshooting, you might want to power down and then power up the Cisco APIC-EM. This procedure describes how to gracefully power down and then power up the Cisco APIC-EM.

Before You Begin

You should have deployed the Cisco APIC-EM following the procedures in this guide.

Step 1 Using a Secure Shell (SSH) client, log into the host (appliance, server, or virtual machine) with the IP address that you specified using the configuration wizard.

Note The IP address to enter for the SSH client is the IP address that you configured for the network adapter. This IP address connects the host to the external network.

Step 2 When prompted, enter your Linux username ('grapevine') and password for SSH access.

Step 3 Enter the **grape host display** command to review the command output and determine the *host_id* of the host that you want to power off.

Step 4 Enter the **grape host evacuate** command to harvest (gracefully shut down) the services on the host. Use the *host_id* for this command that you determined in the previous step.

```
$ grape host evacuate host_id
```

This command harvests all services running on the specified host (*host_id*) using the **grape host evacuate** command. In a multi-host cluster, the services on the specified host are harvested and transferred to the other two hosts in the cluster.

Step 5 Power down the host, by entering the following command:

```
$ sudo shutdown -h now
```

Note Enter your password a second time when prompted.

Step 6 Review the command output as the host shuts down.

Note The **sudo shutdown** command also powers off the host.

Step 7 Power up the Grapevine root process by turning the host back on.

Step 8 Using a Secure Shell (SSH) client, log back into the host with the IP address that you specified using the configuration wizard.

Note The IP address to enter for the SSH client is the IP address that you configured for the network adapter. This IP address connects the host to the external network.

Step 9 When prompted, enter your Linux username ('grapevine') and password for SSH access.

Step 10 Enable Grapevine, by entering the following command on the Grapevine root:

```
$ grape host enable host_id
```

The host ID to enter for this command must be the same as the host ID used in the **grape host evacuate** command in step 4.

Wait a few minutes for the Cisco APIC-EM services to start up again.

What to Do Next

Log back into the controller's GUI and begin working with the Cisco APIC-EM to manage and monitor the devices within your network.

Uninstalling the Cisco APIC-EM

The following procedure describes how to uninstall the Cisco APIC-EM.

Note If you plan to reinstall the Cisco APIC-EM after uninstalling it, then you must follow the procedure described below to avoid any possible problems. You should have also contacted Cisco support for the link to download the latest Cisco APIC-EM ISO image. Be aware that this procedure shuts down both the Cisco APIC-EM and the host (physical or virtual) on which it resides. At the end of this procedure and if you are reinstalling the Cisco APIC-EM, then you will need to access the host and restart it.

Step 1 Using a Secure Shell (SSH) client, log into the host (appliance, server, or virtual machine) with the IP address that you specified using the configuration wizard.

Note The IP address to enter for the SSH client is the IP address that you configured for the network adapter. This IP address connects the appliance to the external network.

Step 2 Enter the Linux username ('grapevine') and password when prompted.

Step 3 Enter the **reset_grapevine factory** command at the prompt.

```
$ reset_grapevine factory
```

Step 4 Enter your Linux grapevine password a second time to start the reset process.

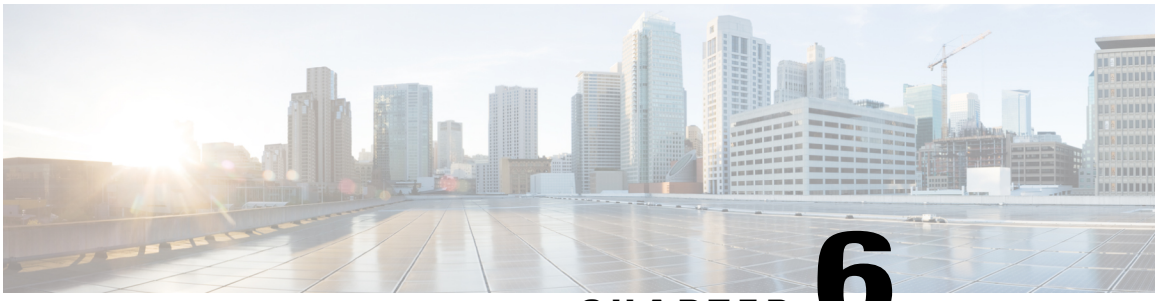
```
$ sudo password for grapevine *********
```

After entering this command a warning appears that the **reset_grapevine factory** command will shut down the controller.

You are then prompted to confirm your intent to run the **reset_grapevine factory** command.

Step 5 Enter **Yes** to confirm that you want to run the **reset_grapevine factory** command.
The controller then performs the following tasks:

- Stops all running clients and services
- Stops and shuts down any Linux containers
- Deletes all cluster data
- Deletes all user data
- Deletes the configuration files including secrets and private keys
- Shuts down the controller
- Shuts down the host (physical or virtual)



CHAPTER 6

Configuring the Cisco APIC-EM Settings

Logging into the Cisco APIC-EM

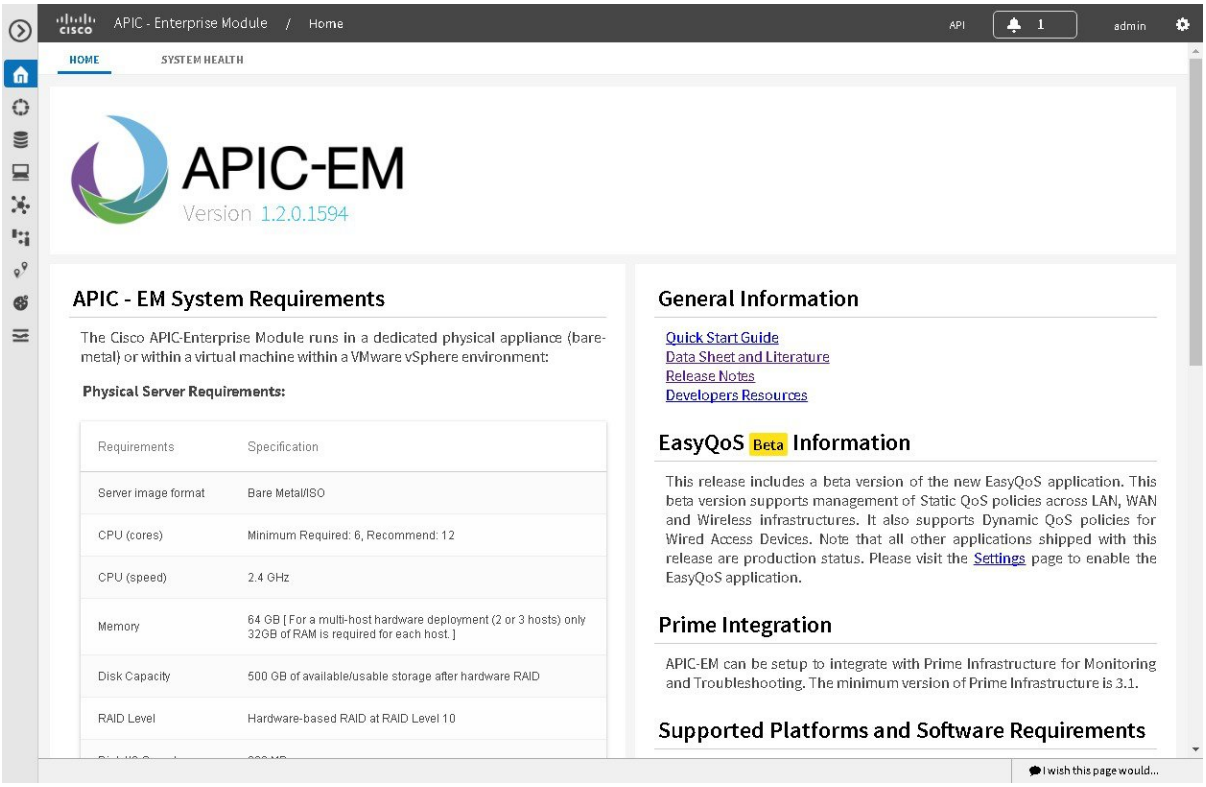
You access the Cisco APIC-EM GUI by entering the IP address that you configured for the network adapter using the configuration wizard. This IP address connects to the external network. Enter the IP address in your browser in the following format:

https://*IP address*

Step 1 From your browser, enter the IP address of the Cisco APIC-EM in the address bar.

Step 2 On the launch page, enter your username and password that you configured during the deployment procedure. The **Home** page of the APIC-EM controller appears. The **Home** page consists of the following two tabs:

- **Home**
- **System Health**



What to Do Next

Click on each tab and review the information provided in the GUI.

Reviewing the Cisco APIC-EM Home Page

The Cisco APIC-EM **Home** page consists of the following two tabs:

- **Home**
- **System Health**

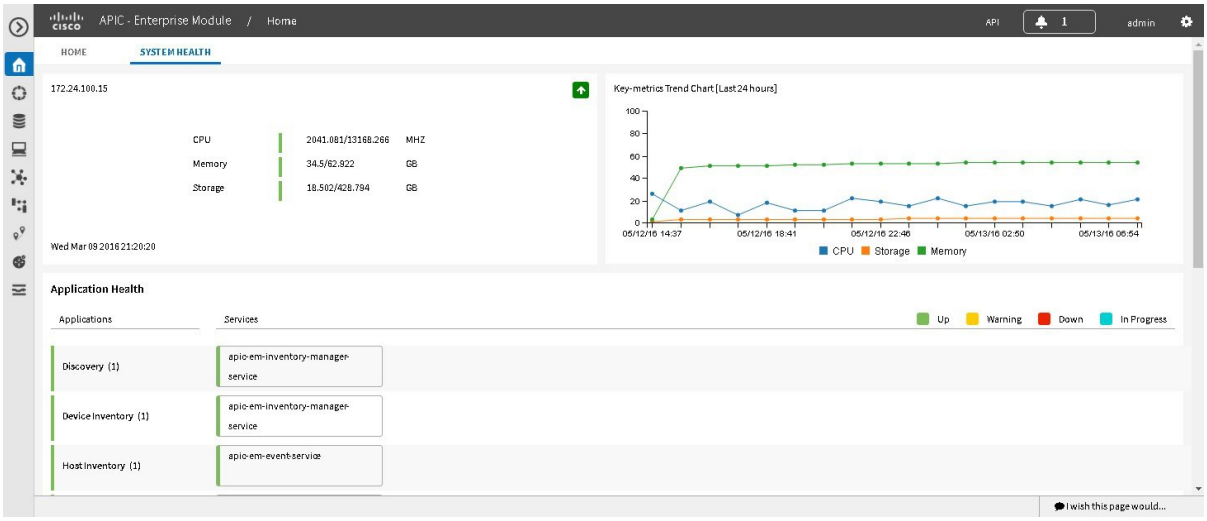
The **Home** tab provides you with the following features:

- Direct access to the **Quick Start Guide**
- List of System Requirements
- Information about Prime Integration
- Information and links to other controller resources

The **System Health** tab provides you with the following features:

- System health data
- Application health data

Figure 1: Home Page - System Health Tab



Before You Begin

You must have successfully deployed the Cisco APIC-EM and it must be operational.

All users can access the contents of the **Home** tab. However, only administrators (users with ROLE_ADMIN privileges) can access the **System Health** tab.

For information about the user permissions required to perform tasks using the Cisco APIC-EM, see the chapter, "Managing Users and Roles," in the *Cisco Application Policy Infrastructure Controller Enterprise Module Configuration Guide*.

Log into the Cisco APIC-EM **Home** page, as described in the previous procedure.

Step 1 Click the **Home** tab to view information about the installed controller applications.
Proceed to perform any of the following actions:

- Click the link to open the **Quick Start Guide**
- Review the information about the supported platforms and devices
- Review the information about Prime Infrastructure support
- Click the datasheet links or Cisco DevNet links for additional information about the controller and access to Cisco DevNet, respectively

Step 2 Click the **System Health** tab to view information about the controller's health.
Note

The following information is displayed in the **System Health** tab.

System (Host) Health Data	Data displayed include: • Host IP address • CPU—Host CPU usage is displayed in MHZ. Both the currently used and available host CPU is displayed. • Memory—Host memory usage is displayed in GB. Both the currently used and available host memory is displayed. • Storage—Host storage usage is displayed in GB. Both the currently used and available host storage is displayed. **Note** If you have configured a multi-host cluster, then each host's data (CPU, memory, and storage) will be displayed in the UI. Color indicates status for the above host data: • Green—Indicates proper usage and support. • Blue—Indicates usage is approaching improper levels and triggers this warning (color change). • Orange—Indicates a failure based upon the usage exceeding the maximum supported value. Additionally, a graphical representation of the above data over the last 24 hours is displayed in this tab. Moving your cursor or mousing over the graph displays a data summation for specific date and time. **Note** By placing your cursor over (mouse over) a color warning in the window, further information about the warning or failure message appears.

Application Health Data	Displays applications available from the **Navigation** pane, and the services that support each application. For example, the **Topology** application accessible in the GUI is supported by topology-service. Color bars indicate the status for the applications and the supporting service(s): • Green —Indicates that an application instance is starting. An application instance is the aggregation of the service instances. You can configure a minimum or maximum number of service instances, as well as grow and harvest these service instances (spin up or spin down the services). • Yellow—Indicates application instance and its supporting service instance(s) are experiencing issues and triggers this warning (color change). • Red—Indicates a failure of the application instance and its supporting service instance(s). You can harvest a service instance and then regrow it using the GUI. If the service instance does not regrow using the GUI, then you can manually regrow it. When you harvest a service instance, the controller will determine which instance is regrown (load balancing among them). • Blue—Indicates an in-progress state for the application or service instance (growing or harvesting).

Step 3 Place your cursor over a specific service to view additional information about it.
The following additional information is displayed about the service:

- Service name
- Service status (indicated by color code)
- Number of instances of the service currently running
- IP address or addresses of host where service instances are running
- Service version

Step 4 (Optional) Click the green-colored addition icon (+) within the service to grow (start up) an instance of that service for an application.

Caution Growing or harvesting services can be done for troubleshooting a service that is performing erratically. Be sure that you understand the possible effects of growing and harvesting services, because doing so could have unexpected results. For detailed information about growing and harvesting services for troubleshooting purposes, see the *Cisco Application Policy Infrastructure Controller Enterprise Module Troubleshooting Guide*.

Step 5 (Optional) Click the red-colored subtraction icon (-) within the service to harvest (shut down) an instance of the service for an application.

Caution Growing or harvesting services can be done for troubleshooting a service that is performing erratically. Be sure that you understand the possible effects of growing and harvesting the services, because doing so could have unexpected results. For detailed information about growing and harvesting services for troubleshooting purposes, see the *Cisco Application Policy Infrastructure Controller Enterprise Module Troubleshooting Guide*.

What to Do Next

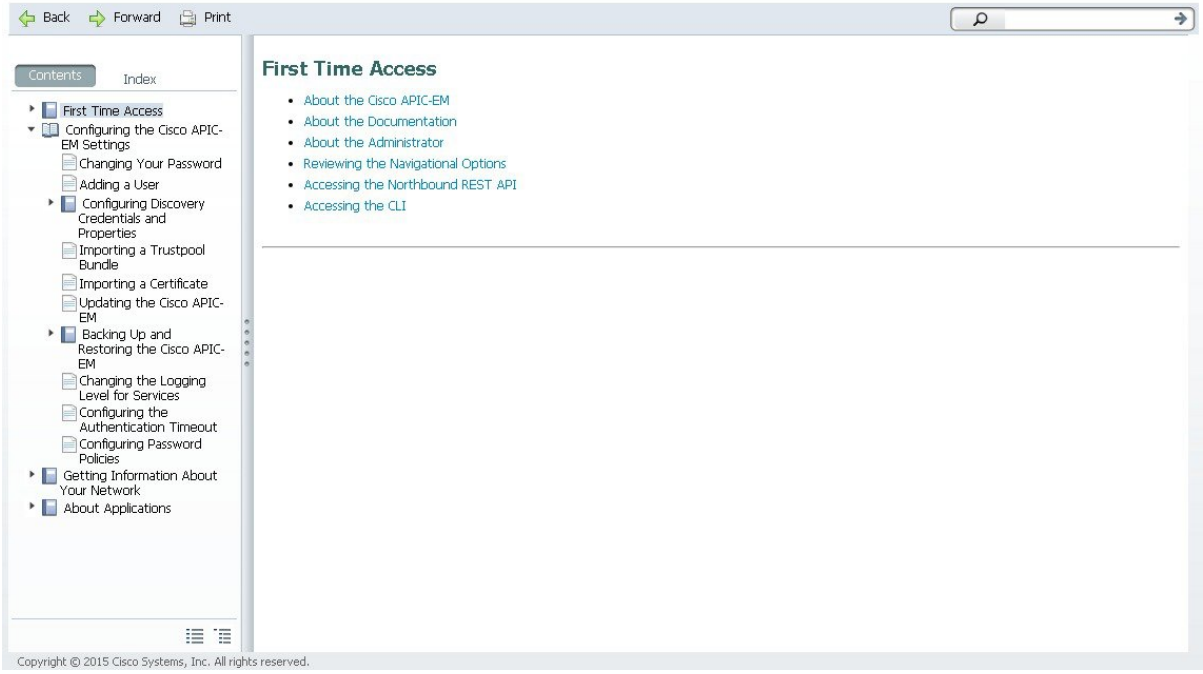
Proceed to take a quick tour of the controller by clicking the **Quick Start Guide** link that appears on the **Home** tab.

Quick Tour of the APIC-EM Graphical User Interface (GUI)

For a quick introduction to the Cisco APIC-EM GUI, log into the Cisco APIC-EM controller as an administrator and follow the procedure below.

Step 1 Click the **Quick Start Guide** link that appears on the Cisco APIC-EM **Home** page.
The *Quick Start Guide* opens in a separate window.

Figure 2: Quick Start Guide



Step 2 Take a few moments to review the contents of the *Quick Start Guide*, which provides a short introduction to the main components of the Cisco APIC-EM graphical user interface and briefly describes how to configure some of the Cisco APIC-EM settings.

What to Do Next

If you are using the IWAN application with Cisco Prime Infrastructure for your network, then proceed to configure your Prime credentials. If you are not using the IWAN application with Cisco Prime Infrastructure, then proceed to configure the discovery credentials for your network.

User Settings

Configuring Passwords and User Profiles

You can use the following configuration tools to manage passwords and user profiles:

- **Passwords—**You can change your own password using the **Change Password** option in **Settings**. You cannot change another user's password unless you have administrator privileges (ROLE_ADMIN). Changing the password of another user involves deleting the user from the controller database and then recreating it with a new password. For security reasons, passwords are not displayed to any user, not even those with administrator privileges. For more information, see the *Cisco Application Policy Infrastructure Controller Enterprise Module Configuration Guide*.
- **Internal User Profiles—**When you deploy the Cisco APIC-EM for the first time, the configuration wizard prompts for a username and password. This first-time user is given full administrative (read and write) permissions for the controller and is able to create user accounts for other users.

  You can create internal user profiles using the **Internal Users** option in **Settings**. Available roles are Administrator (ROLE_ADMIN), Policy Administrator (ROLE_POLICY_ADMIN), Observer (ROLE_OBSERVER), and Installer (ROLE_INSTALLER). Only users with the administrative role (ROLE_ADMIN) can create user profiles and assign user roles. For more information, see the *Cisco Application Policy Infrastructure Controller Enterprise Module Configuration Guide*.
- **External User Profiles—**Cisco APIC-EM supports both internal and external users. An internal user is created when you deploy Cisco APIC-EM for the first time (administrator) or is subsequently created on the controller using the GUI. In contrast, an external user is created on an external AAA server. Cisco APIC-EM can use the user credentials stored in AAA server to manage access to the controller. For information about configuring the controller to interact with the external AAA server, see Configuring External Authentication, on page 63. After you have configured external authentication for the Cisco APIC-EM, you can view external users and their roles in the **External Users** window, by logging out and then logging back into the controller using the external authentication credentials.

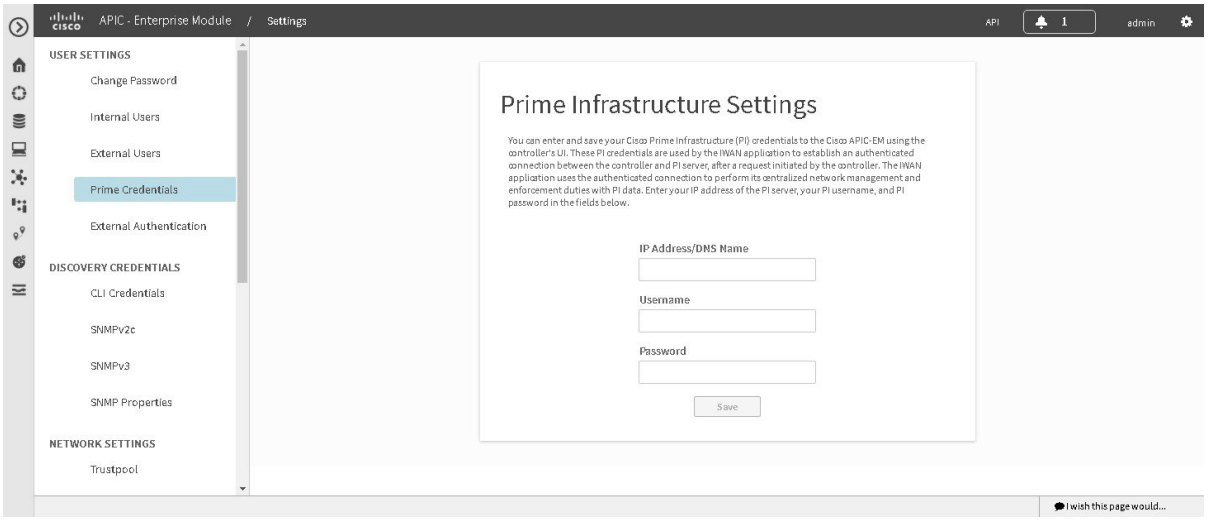
Note You can only view external users and their roles in the **External Users** window. You cannot create, edit, or delete external users on the controller. These tasks must be performed on the external AAA server.

Configuring the Prime Infrastructure Settings

You can enter and save your Cisco Prime Infrastructure (PI) settings to the Cisco APIC-EM using the controller's UI. These PI settings are used by the IWAN application to establish an authenticated connection between the controller and PI server, after a request initiated by the controller. The IWAN application uses the authenticated connection to perform its centralized network management and enforcement duties with PI data.

You can configure the PI settings using the **Prime Infrastructure Settings** window in the Cisco APIC-EM GUI.

Figure 3: Prime Infrastructure Settings Window



Before You Begin

You must have successfully deployed the Cisco APIC-EM and it must be operational.

You must have administrator (ROLE_ADMIN) permissions to perform this procedure.

For information about the user permissions required to perform tasks using the Cisco APIC-EM, see the chapter, *Managing Users and Roles* in the *Cisco Application Policy Infrastructure Controller Enterprise Module Configuration Guide*.

Step 1 In the **Home** window, click either **admin** or the **Settings** icon (gear) at the top right corner of the screen.

Step 2 Click the **Settings** link from the drop-down menu.

Step 3 In the **Settings** navigation pane, click **Prime Credentials** to view the **Prime Infrastructure Settings** window.

Step 4 Enter either the IP address of the PI server or the DNS domain name of the PI server.

Step 5 Enter the PI credentials username.

Step 6 Enter the PI credentials password.

Step 7 Click the **Save** button to save the PI credentials to the Cisco APIC-EM database.

What to Do Next

Proceed to configure the discovery credentials for your network.

Configuring External Authentication

The Cisco APIC-EM supports external authentication and authorization for users from an AAA server. The external authentication and authorization is based upon usernames, passwords, and attributes that already exist on a pre-configured AAA server. With external authentication and authorization, you can log into the controller with credentials that already exist on the AAA server. The RADIUS protocol is used to connect the controller to the AAA server.

The controller attempts to authenticate and authorize the user in the following order:

1. Authenticate/authorize with the user's credentials on a primary AAA server.
2. Authenticate/authorize with the user's credentials on a redundant or secondary AAA server.
3. Authenticate/authorize with the user's credentials managed by the Cisco APIC-EM.

A user is granted access to the controller only if both authentication and authorization is successful.

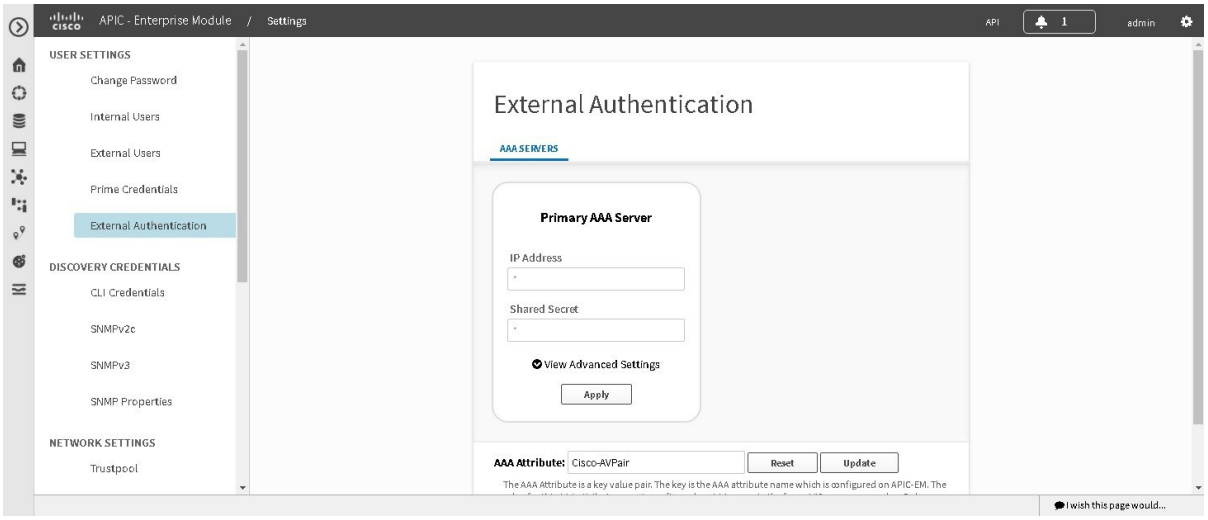
When authentication/authorization is attempted using an AAA server, the response from that AAA server may be either a timeout or rejection:

- A timeout occurs when there is no response received from the AAA server within a specific period of time. If the AAA server times out for the authentication/authorization request on the first configured AAA server, then there is a failover to the secondary AAA server. If the secondary AAA server also times out for the authentication/authorization request, then a fall back to local authentication/authorization occurs.
- A rejection is an explicit denial of credentials. If the AAA server rejects an authentication/authorization attempt made from the controller, then there is a fall back to local authentication/authorization.

You configure parameters for the controller to connect to and communicate with an external AAA server, using the **External Authentication** window in the Cisco APIC-EM GUI.

Note External authentication is only supported for the Cisco APIC-EM UI and not the Grapevine console UI.

Figure 5: External Authentication Window



Before You Begin

You must have successfully deployed the Cisco APIC-EM and it must be operational.

You must have administrator (ROLE_ADMIN) permissions to perform this procedure.

For information about the user permissions required to perform tasks using the Cisco APIC-EM, see the chapter, Managing Users and Roles in the *Cisco Application Policy Infrastructure Controller Enterprise Module Configuration Guide*.

You must have the AAA server already preconfigured, set up, and running. You must also configure the AAA server to interact with the Cisco APIC-EM. When configuring the AAA server to interact with the Cisco APIC- EM, perform the following additional steps:

- Register the Cisco APIC-EM with the AAA server.

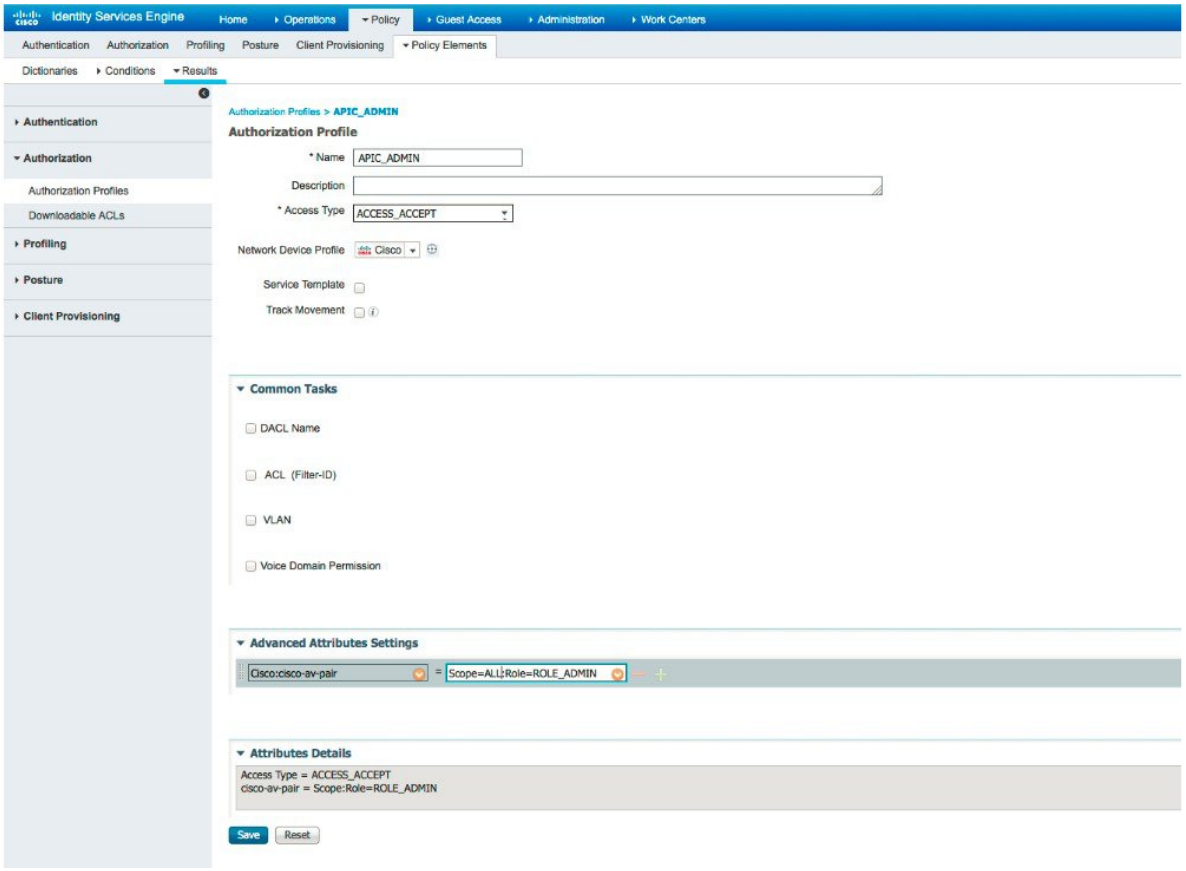
  Note This could also involve configuring a shared-secret on both the AAA server and Cisco APIC-EM controller.

- Configure an attribute name with a value on the AAA server (the attribute name must match on both the AAA server and controller, see step 10 in the following procedure).
- For a Cisco APIC-EM multi-host configuration, configure all individual host IP addresses and the Virtual IP address for the multi-host cluster on the AAA server.

As an example of using the Cisco Identity Services Engine (ISE) GUI to configure values on an AAA server, you select **Authorization Profiles** in the Cisco ISE GUI navigation pane and proceed to configure an authorization profile. When configuring an authorization profile, you enter the following values:

- **Description**: Enter a description for the profile
- **Access Type**: ACCESS_ACCEPT
- **Network Device Profile**: Cisco
- **Advance Attribute Settings**:
  - **Attribute Name**: cisco-av-pair (default value)
  - **Scope**: Scope=ALL:Role=ROLE_ADMIN

Figure 4: AAA Server Configuration Example (Cisco ISE GUI)



Step 1 In the **Home** window, click either **admin** or the **Settings** icon (gear) at the top right corner of the screen.

Step 2 Click the **Settings** link from the drop-down menu.

Step 3 In the **Settings** navigation pane, click **External Authentication** to view the **External Authentication** window.

Step 4 Click the **AAA Server** tab to configure the controller with AAA server credential authentication values.

Step 5 Configure access to the AAA server for the controller by entering the following *required* information:

- **IP address—**Enter the IP address of your AAA server

- **Shared Secret—**Enter the AAA server's shared secret.

Click either **View Advanced Settings** to enter additional information for the configuration or **Apply** to save and apply your configuration.

Step 6 (Optional) Configure access to the AAA server for the controller by entering the following information:

- **Protocol—**RADIUS

  The Protocol field is grayed out, since RADIUS is the default protocol.

- **Authentication Port—**The default value for this field is 1812. Enter a different value if you do not use this common value for your AAA server.
- **Account Port—**The default value for this field is 1813. Enter a different value if you do not use this common value for your AAA server.

  Note Accounting is not supported in this controller release.

- **Retries—**Enter the number of times for the controller to attempt authentication, or accept the default value of 1.
- **Timeout (seconds)—**Enter the time interval for the controller to attempt authentication, or accept the default value of 2 seconds.

Click **Apply** to save and apply your configuration.

Step 7 Click the **Add AAA Server** tab to configure a *secondary* AAA server for the controller.
The *secondary* AAA server is the backup AAA server that is used for high availability.

Step 8 Configure access to the *secondary* AAA server for the controller by entering the following *required* information:

- **IP address—**Enter the IP address of your second AAA server
- **Shared Secret—**Enter the second AAA server's shared secret.

Important We recommend that the secondary AAA server has the same configuration as the primary AAA server, otherwise results are unpredictable.

Click either **View Advanced Settings** to enter additional information for the configuration or **Apply** to save and apply your configuration.

Step 9 (Optional) Configure access to the *secondary* AAA server for the controller by entering the following information:

- **Protocol—**RADIUS

  The Protocol field is grayed out, since RADIUS is the default protocol.

- **Authentication Port—**The default value for this field is 1812. Enter a different value if you do not use this common value for your AAA server.
- **Account Port—**The default value for this field is 1813. Enter a different value if you do not use this common value for your AAA server.
- **Retries—**Enter the number of times for the controller to attempt authentication, or accept the default value of 1.
- **Timeout (seconds)—**Enter the time interval for the controller to attempt authentication, or accept the default value of 2 seconds.

Click **Apply** to save and apply your configuration.

Step 10 Enter the **AAA Attribute**.
As part of the required, earlier AAA server configuration, you must have already configured an AAA attribute on the AAA server. The AAA attribute is a key value pair that consists of both a key and its value. The key is the AAA attribute name. On the Cisco APIC-EM, you register this AAA attribute name in the controller's GUI in this field. By doing so, you are instructing the controller to search for this key (AAA attribute name) in the AAA server response, after logging in with your AAA credentials.

Important The default AAA attribute name on the controller is Cisco-AVPair.

On the AAA server, you configure *both* the key (AAA attribute name) and its value. The key must be the same as that being configured on the Cisco APIC-EM. The value (which is only configured on the AAA server) supports the following format: Scope=*scope_value*:Role=*role_value*

For example: Scope=ALL:Role=ROLE_ADMIN

Once finished, click **Update** to save the **AAA Attribute** name.

What to Do Next

Log out of the Cisco APIC-EM.

Using your AAA server credentials, log back into the Cisco APIC-EM.

Access the **External Users** window on the controller's GUI to view the AAA server users, roles, and scope.

Note If the authentication/authorization is successful and access is granted, then the user's external authentication/authorization is saved in the controller's database. All users successfully granted access can be viewed in the **External Users** window.

Discovery Credentials

The Cisco APIC-EM supports two different types of discovery credentials: global and discovery request-specific (request-specific). Both types of discovery credentials can consist of CLI or SNMP credentials that are configured using the controller's GUI.

The global credentials (CLI and SNMP) are configured in the **Discovery Credentials** windows as described in this chapter. These global credentials are used in addition to any request-specific credentials that are configured in the **Discovery** window. For information about the procedure to configure request-specific credentials in the **Discovery** window, see the *Cisco Application Policy Infrastructure Controller Enterprise Module Configuration Guide*.

Both CLI and SNMP credentials are required for a successful discovery. The SNMP credentials (either global or request-specific) are used for *device* discovery. The CLI credentials (either global or request-specific) are used for capturing *device configurations* for the controller's inventory.

You should enter at least one set of SNMP credentials, either SNMPv2c or SNMPv3, for your device discovery. If you are going to configure SNMPv2 settings in your network, then SNMP Read Only (RO) community string values should be entered in the controller to assure a successful discovery and populated inventory. However, if an SNMP RO community string is not entered into the controller, as a *best effort*, discovery will run with the default SNMP RO community string "public."

Note You can enter values for both SNMP versions (SNMPv2c and SNMPv3) for a single discovery. The controller supports multiple SNMP credential configurations. Altogether, you can enter a maximum of 5 global device credentials (SNMP or CLI) using the **Discovery Credentials** windows as described in this chapter, with an additional credentials set being created in the **Discovery** window. Therefore, for a single discovery scan request, you can configure a total of 6 credential sets of each type (CLI or SNMP).

Global Credentials

Global credentials are defined as preexisting credentials that are common to the devices in a network. Global credentials (CLI and SNMP) are configured on the devices using the GUI (**Discovery Credentials**) and permit successful login to the devices. Global credentials are used by the Cisco APIC-EM to authenticate and access the devices in a network that share this device credential when performing network discoveries.

You configure the global CLI credentials in the **CLI Credentials** window. You access this window, by clicking either **admin** or the **Settings** icon (gear) on the menu bar at the upper right of the screen. You then click the **Settings** link from the drop-down menu and then click **CLI Credentials** on the Setting Navigation pane.

You configure the global SNMP credentials in the **SNMPv2c** or **SNMPv3** window . You access these windows, by clicking either **admin** or the **Settings** icon (gear) on the menu bar at the upper right of the screen. You then click the **Settings** link from the drop-down menu and then click one of the SNMP window links on the Setting Navigation pane.

Note Multiple credentials can be configured in the **CLI Credentials** window.

Discovery Request-Specific Credentials

Discovery request-specific credentials (request-specific credentials) are defined as preexisting *device* credentials for a specific network device or set of devices that do not share the global credentials.

You configure the request-specific credentials in the **Discovery** window prior to performing a discovery that is exclusive for that set of network devices. You access this window by clicking **Discovery** on the Navigation pane.

Discovery Credentials Example

The following example describes how a user would configure and run a series of discoveries to authenticate and access all of the devices in a network by the Cisco APIC-EM.

Assume a network of 20 devices that form a CDP neighborship. In this network, 15 devices share a global credential (Credential-0) and the 5 remaining devices each have their own unique or discovery request-specific credentials (Credential 1- 5).

To properly authenticate and access the devices in this network by the Cisco APIC-EM, you perform the following tasks:

1 Configure the CLI global credentials as Credential-0 for the controller.

   You configure the global credentials in the **CLI Credentials** window. You access this window, by clicking either **admin** or the **Settings** icon (gear) on the menu bar at the upper right of the screen. You then click the **Settings** link from the drop-down menu and then click **CLI Credentials** on the Setting Navigation pane.

2 Configure the SNMP (v2c or v3) global credentials.

   You configure these global credentials in the two SNMP windows. You access these GUI windows by clicking the **Settings** button at the top right and then clicking **SNMPv2c** or **SNMPv3** on the Setting Navigation pane.

3 Run a **CDP** discovery using one of the 15 device IP addresses (15 devices that share the global credentials) and selecting the global credentials in the GUI. You run a **CDP** discovery in the **Discovery** window. You access this window, by clicking **Discovery** on the Navigation pane.

4 Run 5 separate **Range** discoveries for each of the remaining 5 devices using the appropriate discovery request-specific credentials and SNMP values (for example, Credential-1, Credential-2-5, etc.).

   You configure the discovery request-specific credentials in the **Discovery** window. You access this window, by clicking **Discovery** on the Navigation pane.

5 Review the **Device Inventory** table in the **Device Inventory** window to check the discovery results.

Discovery Credentials Rules

Discovery credentials (global and discovery request-specific) operate under rules as described in the bullet list and table below.

Discovery request-specific credentials rules:

- These credentials can be provided when creating a new network discovery, but only a single set of these credentials is allowed per network discovery.
- These credentials take precedence over any configured global credentials.
- If the discovery request-specific credentials cause an authentication failure, then discovery is attempted a second time with the configured global credentials (if explicitly selected in the **Discovery** window). If discovery fails with the global credentials then the device discovery status will result in an authentication failure.
- If the discovery request-specific credentials (both CLI and SNMP) are not provided as part of network discovery, then the global credentials (both CLI and SNMP) are used to authenticate devices.

Global credentials rules:

Table 7: Global Credentials Rules

Global Credentials	Discovery Request-Specific Credentials	Result
Not configured	Not configured	The default SNMP read community string (public) is used for the discovery scan, but the device discovery will fail since both CLI and SNMP credentials must be configured for a successful device discovery.
Not configured	Configured	The specified discovery request-specific credentials will be used for discovery.
Configured	Not configured	All the configured global credentials will be used.
Configured but not selected	Configured	Only the request-specific credentials will be used.
Configured and selected	Not configured	Only selected global credential will be used.
Configured and selected	Configured	Both specified credentials (global and discovery request-specific) will be used for discovery.
Configured, but wrong global credential IDs are mentioned in the discovery POST REST API.	Correct request-specific credentials configured	Discovery fails. **Note** This scenario is only possible by API not from the controller GUI.
Configured, but wrong global credential IDs are mentioned in the discovery POST REST API.	Not configured	Discovery fails. **Note** This scenario is only possible by API not from the controller GUI.

Discovery Credentials Caveats

The following are caveats for the Cisco APIC-EM discovery credentials:

- If a device credential changes in a network device or devices after Cisco APIC-EM discovery is completed for that device or devices, any subsequent polling cycles for that device or devices will fail. To correct this situation, an administrator has following options:
    - Start a new discovery scan with changed discovery request-specific credentials that matches the new device credential.

- Update the global credentials with the new device credential. Execute a new discovery scan with the new global credentials.

- If the ongoing discovery fails due to a device authentication failure (for example, the provided discovery credential is not valid for the devices discovered by current discovery), then the administrator has following options:
  - Stop or delete the current discovery. Create one or more new network discovery jobs (either a **CDP** or **Range** discovery type) with a discovery request-specific credential that matches the device credential.
  - Create a new global credential or modify one of the global credentials, and execute a new discovery selecting the correct global credential.
- Deleting a global credential does not affect already discovered devices. These already discovered devices will not report an authentication failure.
- The Cisco APIC-EM provides a REST API which allows the retrieval of the list of managed network devices in the Cisco APIC-EM inventory, including certain administrative credentials (SNMP community strings and CLI usernames). The purpose of this API is to allow an external application to synchronize its own managed device inventory with the devices that have been discovered by the Cisco APIC-EM. For example, for Cisco IWAN scenarios, Prime Infrastructure makes use of this API in order to populate its inventory with the IWAN devices contained in the Cisco APIC-EM inventory in order to provide monitoring of the IWAN solution. Any user account with a ROLE_ADMIN has access to this API.

Note Only the username is provided in clear text. SNMP community strings and passwords are not provided in cleartext for security reasons.

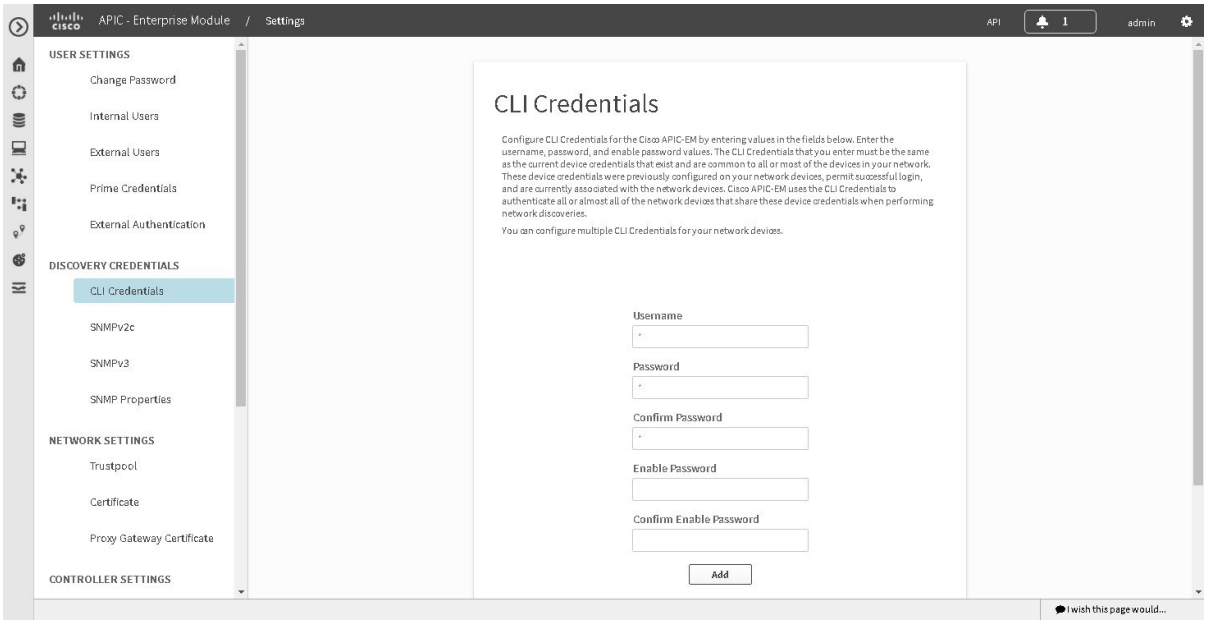
Configuring CLI Credentials—Global

CLI credentials are defined as preexisting *device* credentials that are common to most of the devices in a network. CLI credentials are used by the Cisco APIC-EM to authenticate and access the devices in a network that share this CLI credential when performing devices discoveries.

You configure the CLI global credentials in the **CLI Credentials** window.

Note You can configure up to five CLI credentials.

Figure 6: CLI Credentials Window



Before You Begin

You must have successfully deployed the Cisco APIC-EM and it must be operational.

You must have either administrator (ROLE_ADMIN) or policy administrator (ROLE_POLICY_ADMIN) permissions to perform this procedure.

For information about the user permissions required to perform tasks using the Cisco APIC-EM, see the chapter, "Managing Users and Roles," in the *Cisco Application Policy Infrastructure Controller Enterprise Module Configuration Guide*.

Step 1 In the **Home** window, click either **admin** or the **Settings** icon (gear) at the top right corner of the screen.

Step 2 Click the **Settings** link from the drop-down menu.

Step 3 In the **Settings** navigation pane, click **CLI Credentials** to view the **CLI Credentials** window.
In the **CLI Credentials** window, enter the appropriate CLI global credentials for the devices within your network or networks.

Step 4 Enter the CLI Credentials username in the **Username** field.

Step 5 Enter the CLI Credentials password in the **Password** field.

Step 6 Reenter the CLI Credentials password in the **Confirm Password** field to confirm the value that you just entered.

Step 7 If your network devices have been configured with an enable password, then enter the CLI Credentials for the enable password in the **Enable Password** field.

Note Both the CLI credentials password and enable password are saved in the device's configuration in encrypted form. You cannot view these original passwords after you enter them.

Step 8 If you entered an enable password in the **Enable Password** field, reenter it in the **Confirm Enable Password** field to confirm the value that you just entered.

Step 9 In the **CLI Credentials** window, click **Add** to save the credentials to the Cisco APIC-EM database.

What to Do Next

Proceed to configure SNMP values for your network device discovery.

For a successful device discovery (with all the device information to be collected), CLI credentials (global and/or discovery request-specific) should be configured using the controller. The global credentials for CLI and SNMP (v2c or v3) are configured in the **Discovery Credentials** windows as described in this chapter, and are used in addition to any discovery request-specific credentials (for CLI and SNMP) that are configured in the **Discovery** window.

Configuring SNMP

You configure SNMP for device discovery using the following **Discovery Credentials** windows in the Cisco APIC-EM GUI:

- **SNMPv2c**
- **SNMPv3**
- **SNMP Properties**

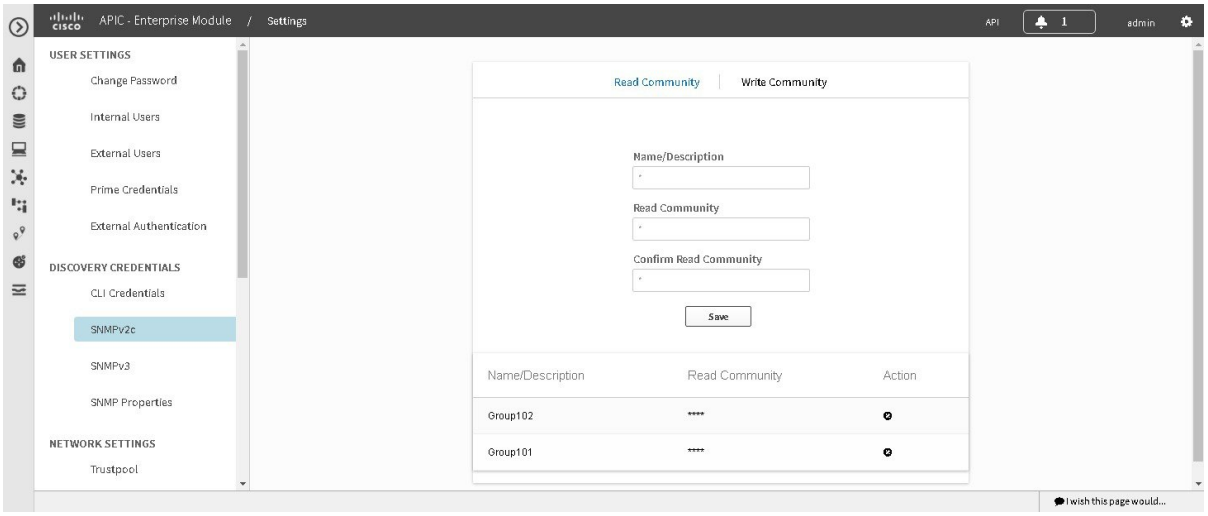
Note You can use SNMP and the existing security features in SNMP v3 to secure communications between the controller and the devices in your network. SNMP v3 provides both privacy (encryption) and authentication capabilities for these communications. If possible for your network, we recommend that you use SNMPv3 with both privacy and authentication enabled.

Configuring SNMPv2c

You configure SNMPv2c for device discovery in the **SNMPv2c** window in the Cisco APIC-EM GUI. The SNMP values that you configure for SNMPv2c for the controller must match the SNMPv2c values that have been configured for your network devices.

Note You can configure up to five read community strings and five write community strings.

Figure 7: Configuring SNMPv2c



SNMP is an application-layer protocol that provides a message format for communication between SNMP managers and agents. SNMP provides a standardized framework and a common language used for the monitoring and management of devices in a network. The different versions of SNMP are SNMPv1, SNMPv2, SNMPv2c, and SNMPv3.

SNMPv2c is the community string-based administrative framework for SNMPv2. Community string is a type of password, which is transmitted in clear text. SNMPv2c does not provide authentication or encryption (noAuthNoPriv level of security).

Note In addition to configuring SNMPv2c for device discovery in the controller, a "best effort" Cisco APIC-EM discovery is in place, meaning that devices having SNMP with Read-Only (RO) community string set to "public" will be discovered all the time irrespective of the configured SNMP Read/Write community string.

Before You Begin

You must have successfully deployed the Cisco APIC-EM and it must be operational.

You must have your network's SNMP information available for this configuration procedure.

You must have either administrator (ROLE_ADMIN) or policy administrator (ROLE_POLICY_ADMIN) permissions to perform this procedure.

For information about the user permissions required to perform tasks using the Cisco APIC-EM, see the chapter, "Managing Users and Roles," in the *Cisco Application Policy Infrastructure Controller Enterprise Module Configuration Guide*.

Step 1 In the **Home** window, click either **admin** or the **Settings** icon (gear) at the top right corner of the screen.

Step 2 Click the **Settings** link from the drop-down menu.

Step 3 In the **Settings** navigation pane, click **SNMPv2c** to view the **SNMPv2c** window.

Step 4 In the **SNMPv2c** window, click **Read Community**.
Enter your **Read Community** values:

- **Name/Description—**Description of the Read-Only (RO) community string value and/or the device or devices that are configured with it.
- **Read Community—**Read-Only community string value configured on devices that you need the controller to connect to and access. This community string value must match the community string value pre-configured on the devices that the controller will connect to and access.
- **Confirm Read Community—**Reenter the Read-Only community string to confirm the value that you just entered.

Note If you are configuring SNMPv2c for your discovery, then configuring **Read Community** values is mandatory.

Step 5 Click **Save** to save your **Read Community** values.
The **Read Community** values will appear in the table below.

Step 6 (Optional) In the **SNMPv2c** window, click **Write Community**.
Enter your **Write Community** values:

- **Name/Description—**Description of the Write community string value and/or the device or devices that are configured with it.
- **Write Community—**Write community string value configured on devices that you need the controller to connect to and access. This community string value must match the community string value pre-configured on the devices that the controller will connect to and access.
- **Confirm Write Community—**Reenter the Write community string to confirm the value that you just entered.

Step 7 (Optional) Click **Save** to save your **Write Community** values.
The **Write Community** values will appear in the table below.

What to Do Next

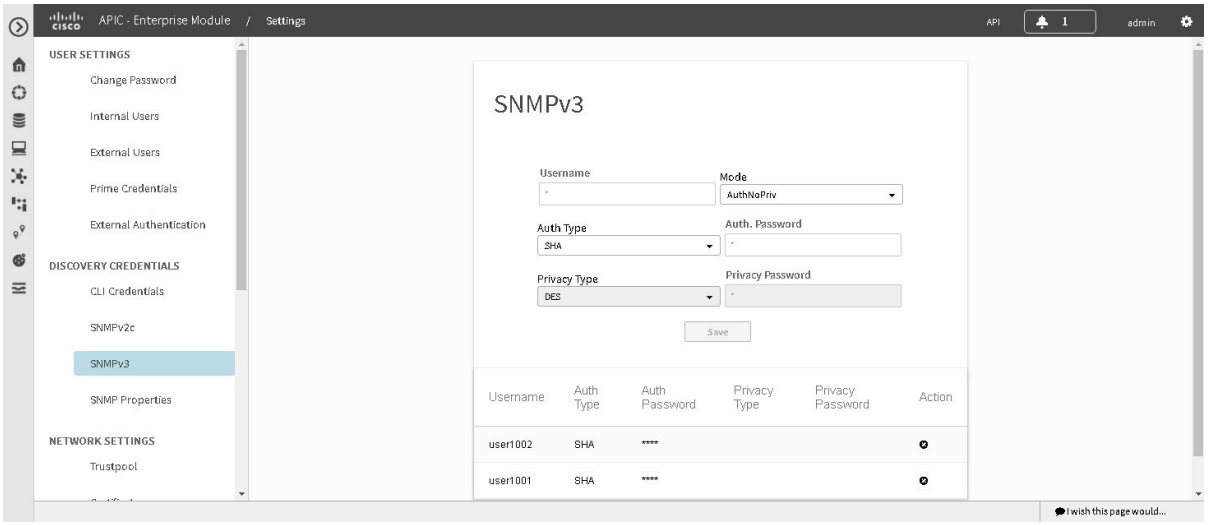
If required for your SNMP configuration, proceed to configure either **SNMPv3** or **SNMP Properties** using the GUI.

If you are finished with your SNMP configuration, then proceed to import an X.509 certificate and private key into the controller, if necessary for your network configuration.

Configuring SNMPv3

You configure SNMPv3 for device discovery in the **SNMPv3** window in the Cisco APIC-EM GUI. The SNMP values that you configure for SNMPv3 for the controller must match the SNMPv3 values that have been configured for your network devices. You can configure up to five SNMPv3 settings.

Figure 8: Configuring SNMPv3



SNMP is an application-layer protocol that provides a message format for communication between SNMP managers and agents. SNMP provides a standardized framework and a common language used for the monitoring and management of devices in a network. The different versions of SNMP are SNMPv1, SNMPv2, SNMPv2c, and SNMPv3.

SNMPv3 provides secure access to devices by a combination of authenticating and encrypting frames over the network. The following are supported SNMPv3 security models:

- Message integrity—Ensures that a packet has not been tampered with in-transit.
- Authentication—Determines the message is from a valid source
- Encryption—Scrambles the packet contents to prevent it from being seen by unauthorized sources

SNMPv3 provides for both security models and security levels. A security model is an authentication strategy that is set up for a user and the role in which the user resides. A security level is the permitted level of security within a security model. A combination of a security model and a security level determines which security mechanism is employed when handling an SNMP packet.

The security level determines if an SNMP message needs to be protected from disclosure and if the message needs to be authenticated. The various security levels that exist within a security model are as follows:

- noAuthNoPriv—Security level that does not provide authentication or encryption
- AuthNoPriv—Security level that provides authentication but does not provide encryption
- AuthPriv—Security level that provides both authentication and encryption

The following table identifies what the combinations of security models and levels mean:

Table 8: SNMP Security Models and Levels

Model	Level	Authentication	Encryption	What Happens
v2c	noAuthNoPriv	Community String	No	Uses a community string match for authentication.
v3	noAuthNoPriv	User Name	No	Uses a username match for authentication.
v3	AuthNoPriv	Either: • HMAC-MD5 • HMAC-SHA	No	Provides authentication based on the Hash-Based Message Authentication Code (HMAC) Message Digest 5 (MD5) algorithm or the HMAC Secure Hash algorithm (SHA)
v3	AuthPriv	Either: • HMAC-MD5 • HMAC-SHA	Either: • CBC-DES • CBC-AES-128	Provides authentication based on the HMAC-MD5 or HMAC-SHA algorithms. Provides Data Encryption Standard (DES) 56-bit encryption in addition to authentication based on the Cipher Block Chaining (CBC) DES (DES-56) standard or CBC-mode AES for encryption.

Before You Begin

You must have successfully deployed the Cisco APIC-EM and it must be operational.

You must have your network's SNMP information available for this configuration procedure.

You must have either administrator (ROLE_ADMIN) or policy administrator (ROLE_POLICY_ADMIN) permissions to perform this procedure.

For information about the user permissions required to perform tasks using the Cisco APIC-EM, see the chapter, *Managing Users and Roles* in the *Cisco Application Policy Infrastructure Controller Enterprise Module Configuration Guide*.

Step 1 In the **Home** window, click either **admin** or the **Settings** icon (gear) at the top right corner of the screen.

Step 2 Click the **Settings** link from the drop-down menu.

Step 3 In the **Settings** navigation pane, click **SNMPv3** to view the **SNMPv3** window.
If you use SNMPv3 in your network to monitor and manage devices, then configure the SNMPv3 values for discovery for your network.

Step 4 In the **SNMPv3** window, enter a **Username** value and choose a **Mode** from the drop down menu.
The following **Mode** options are available:

- **AuthPriv**
- **AuthNoPriv**
- **NoAuthNoPriv**

Note Subsequent **SNMPv3** configuration options might or might not be available depending upon your selection for this step.

Step 5 If you selected **AuthPriv** or **AuthNoPriv** as a **Mode** option, then choose an **Authentication** type from the drop down menu and enter an authentication password.
The following **Authentication** options are available:

- **SHA—**Authentication based on the Hash-Based Message Authentication Code (HMAC), Secure Hash algorithm (SHA) algorithm
- **MD5—**Authentication based on the Hash-Based Message Authentication Code (HMAC), Message Digest 5 (MD5) algorithm

Step 6 If you selected **AuthPriv** as a **Mode** option, then choose a **Privacy** type from the drop down menu and enter a SNMPv3 privacy password.
The SNMPv3 privacy password is used to generate the secret key used for encryption of messages exchanged with devices that support DES or AES128 encryption.

The following **Privacy** type options are available:

- **DES—**Data Encryption Standard (DES) 56-bit encryption in addition to authentication based on the Cipher Block Chaining (CBC) DES (DES-56) standard.
- **AES128—**Cipher Block Chaining (CBC) mode AES for encryption.

Step 7 Click **Save** to save your SNMPv3 configuration values.
The **SNMPv3** configured values will appear in the table below.

What to Do Next

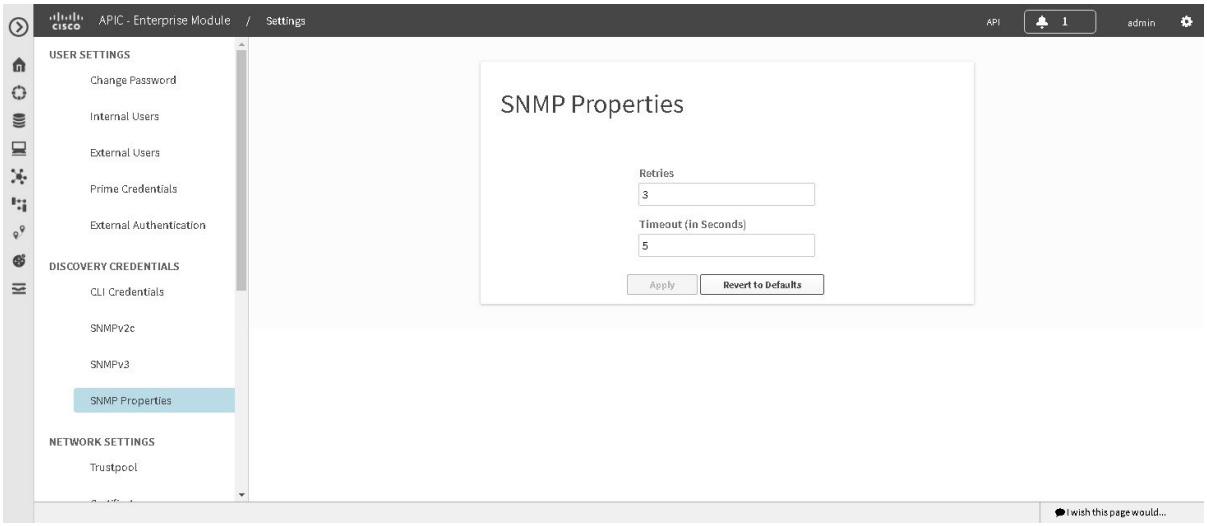
If required for your SNMP configuration, proceed to configure either **SNMPv2c** or **SNMP Properties** using the GUI.

If you are finished with your SNMP configuration, then proceed to import an X.509 certificate and private key into the controller, if necessary for your network configuration.

Configuring SNMP Properties

You configure SNMP properties for device discovery in the **SNMP Properties** window in the Cisco APIC-EM GUI.

Figure 9: Configuring SNMP Properties



Before You Begin

You must have successfully deployed the Cisco APIC-EM and it must be operational.

You must have your network's SNMP information available for this configuration procedure.

You must have either administrator (ROLE_ADMIN) or policy administrator (ROLE_POLICY_ADMIN) permissions to perform this procedure.

For information about the user permissions required to perform tasks using the Cisco APIC-EM, see the chapter, *Managing Users and Roles* in the *Cisco Application Policy Infrastructure Controller Enterprise Module Configuration Guide*.

Step 1 In the **Home** window, click either **admin** or the **Settings** icon (gear) at the top right corner of the screen.

Step 2 Click the **Settings** link from the drop-down menu.

Step 3 In the **Settings** navigation pane, click **SNMP Properties** to view the **SNMP Properties** window.
Configure the SNMP property settings for discovery in your network.

Step 4 In the **SNMP Properties** window, enter a value in the **Retries** field.
The value entered in this field is the number of attempts the controller attempts to use SNMP to communicate with your network devices.

Step 5 In the **SNMP Properties** window, enter a value in the **Timeout** field.

The value entered in this field is the length of time in seconds the controller attempts to use SNMP to communicate with your network devices.

Step 6 Click **Apply** to save your SNMP configuration values.
You can also click **Revert to Defaults** to revert to the SNMP property default values. The following are the SNMP property default values:

- **Retries—**3
- **Timeout—**5

What to Do Next

If required for your SNMP configuration, proceed to configure either **SNMPv2c** or **SNMPv3** using the GUI.

If you are finished with your SNMP configuration, then proceed to import an X.509 certificate and private key into the controller, if necessary for your network configuration.

Network Settings

Importing a Certificate

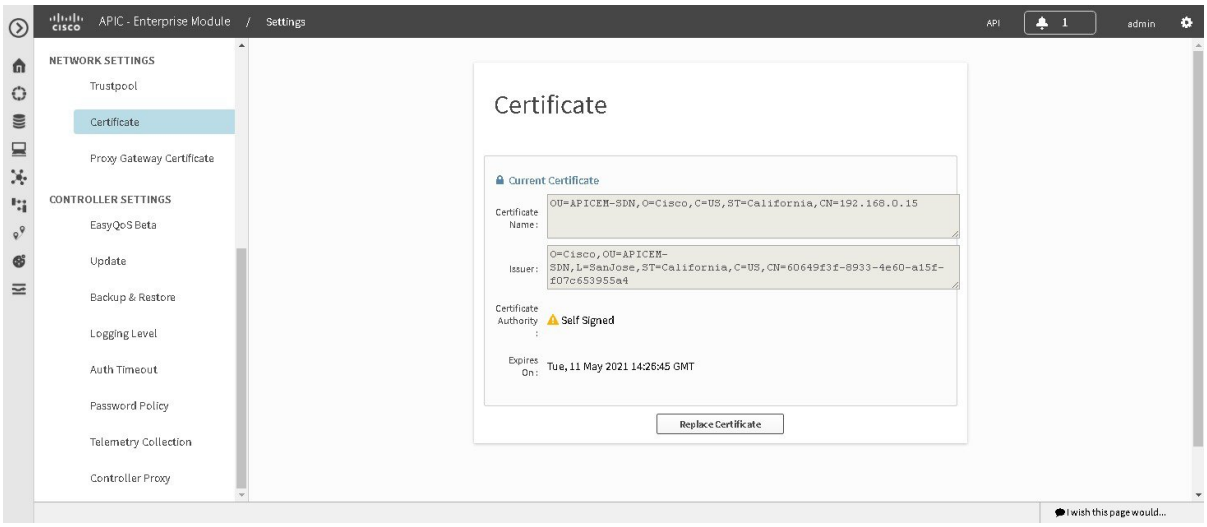
The Cisco APIC-EM supports the import and storing of an X.509 certificate and private key into the controller. After import, the certificate and private key can be used to create a secure and trusted environment between the Cisco APIC-EM, NB API applications, and network devices.

Note If you have a multi-host deployment and you plan to acquire a valid CA-issued certificate for your controller HTTPS server, then use the virtual IP address that you assigned to the multi-hosts as the Common Name for the certificate when you order. If you are using a host name instead, make sure the host name is DNS-resolvable to the virtual IP address of the multi-host deployment.

If you already have a single host Cisco APIC-EM with a previously purchased CA-issued certificate for its external IP address, then it is ideal to use that original physical IP address of the single host as the virtual IP address of the multi-host deployment. This way you can save your investment in the CA-issued certificate and also keep the external client applications, using your Cisco APIC-EM services to continue using the same IP address.

You import a certificate and private key using the **Certificate** window in the Cisco APIC-EM GUI.

Figure 10: Certificate Configuration Window



Important The Cisco APIC-EM itself does NOT interact with any external CA directly; therefore, it does not check any Certificate Revocation Lists and it has no way to learn of revocation of its server certificate by an external CA. Note, also, that the controller does not automatically update its server certificate. Replacement of an expired or revoked server certificate requires explicit action on the part of a ROLE_ADMIN user. Although the controller has no direct means of discovering the revocation of its server certificate by an external CA, it does notify the admin of expiration of its server certificate as well as self-signed key being operational.

Before You Begin

You must have successfully deployed the Cisco APIC-EM and it must be operational.

You must have acquired an X.509 certificate and private key from a well-known certificate authority (CA) for the import.

You must have administrator (ROLE_ADMIN) permissions to perform this procedure.

For information about the user permissions required to perform tasks using the Cisco APIC-EM, see the chapter, *Managing Users and Roles* in the *Cisco Application Policy Infrastructure Controller Enterprise Module Configuration Guide*.

Step 1 In the **Home** window, click either **admin** or the **Settings** icon (gear) at the top right corner of the screen.

Step 2 Click the **Settings** link from the drop-down menu.

Step 3 In the **Settings** navigation pane, click **Certificate** to view the **Certificate** window.

Step 4 In the **Certificate** window, view the current certificate data.
When first viewing this window, the current certificate data that is displayed is the controller's self-signed certificate. The self-signed certificate's expiration is set for several years in the future.

Note The **Expiration Date and Time** is displayed as a Greenwich Mean Time (GMT) value. A system notification will appear in the controller's GUI 2 months before the expiration date and time of the certificate.

Additional displayed fields in the **Certificate** window include:

- Certificate Name—The name of the certificate.
- Issuer—The issuer name identifies the entity that has signed and issued the certificate.
- Certificate Authority—Either self-signed or name of the CA.
- Expires On—Expiration date of the certificate.

Step 5 To replace the current certificate, click the **Replace Certificate** button.
The following new fields appear:

- **Certificate—**Fields to enter certificate data
- **Private Key—**Fields to enter private key data

Step 6 In the **Certificate** fields, choose the file format type of the certificate:

- **PEM—**Privacy enhanced mail file format
- **PKCS—**Public-key cryptography standard file format

Choose one of the above file types for the certificate that you are importing into the Cisco APIC-EM.

Step 7 If you choose **PEM**, then perform the following tasks:

- For the **Certificate** field, import the **PEM** file by dragging and dropping this file into the **Drag n' Drop a File Here** field.

  Note For a PEM file, it must have a valid PEM format extension (.pem, .cert, .crt). The maximum file size for the certificate is 10KB

- For the **Private Key** field, import the private key by dragging and dropping this file into the **Drag n' Drop a File Here** field.
  - Choose the encryption option from the **Encrypted** drop-down menu for the private key.
  - If encryption is chosen, enter the passphrase for the private key in the **Passphrase** field.

    Note For the private keys, they must have a valid private key format extension (.pem or .key).

Step 8 If you choose **PKCS**, then perform the following tasks:

- For the **Certificate** field, import the **PKCS** file by dragging and dropping this file into the **Drag n' Drop a File Here** field.

  Note For a PKCS file, it must have a valid PKCS format extension (.pfx, .p12). The maximum file size for the certificate is 10KB

- For the **Certificate** field, enter the passphrase for the certificate using the **Passphrase** field.

  Note For PKCS, the imported certificate also requires a passphrase.

- For the **Private Key** field, choose the encryption option for the private key using the drop-down menu.
- For the **Private Key** field, if encryption is chosen, enter the passphrase for the private key in the **Passphrase** field.

Step 9 Click the **Upload/Activate** button.

Step 10 Return to the **Certificate** window to view the updated certificate data.
The information displayed in the **Certificate** window should have changed to reflect the new certificate name, issuer, and certificate authority.

Related Topics

Cisco APIC-EM Certificate and Private Key Support, on page 18
Cisco APIC-EM Certificate Chain Support, on page 19

Importing a Trustpool Bundle

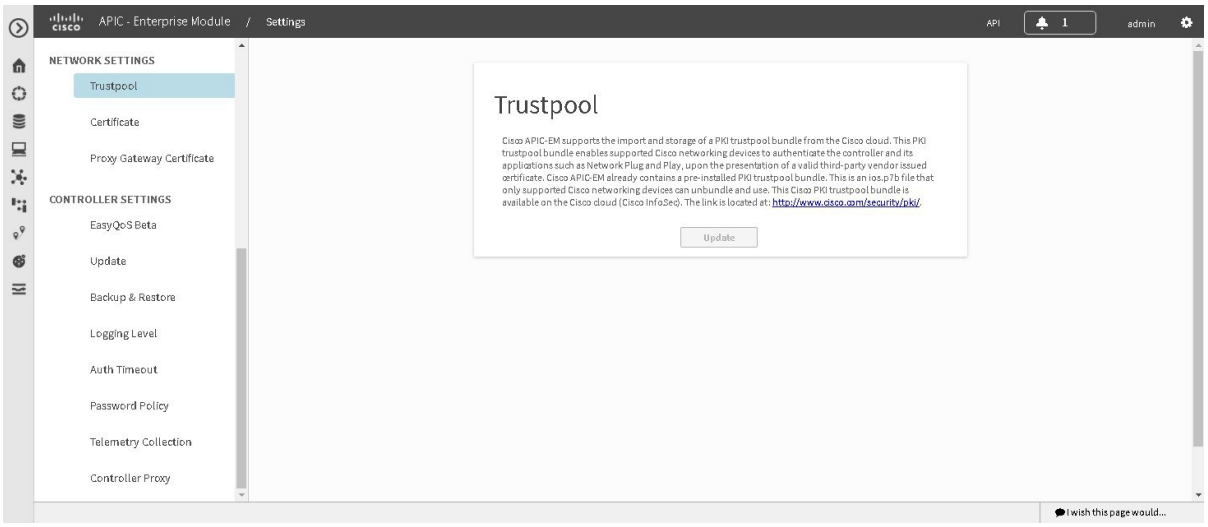
The Cisco APIC-EM contains a pre-installed Cisco trustpool bundle (Cisco Trusted External Root Bundle). The Cisco APIC-EM also supports the import and storage of an updated trustpool bundle from Cisco. The trustpool bundle is used by supported Cisco networking devices to authenticate the controller and its applications, such as Network PnP upon the presentation of its CA signed certificate, as well as any other third party that presents a valid CA signed certificate.

Note The Cisco trustpool bundle is an ios.p7b file that only supported Cisco devices can unbundle and use. This ios.p7b file contains root certificates of valid certificate authorities including Cisco itself. This Cisco trustpool bundle is available on the Cisco cloud (Cisco InfoSec). The link is located at: http://www.cisco.com/security/pki/.

The trustpool bundle provides you with a safe and convenient way to use the same CA to manage all your network device certificates, as well as your controller certificate. The trustpool bundle is used by the controller to validate its own certificate as well as a proxy gateway certificate (if any), to determine whether it is valid CA signed certificate or not. Additionally, the trustpool bundle is available to be uploaded to the Network PnP enabled devices at the beginning of their PnP workflow so that they can trust the controller for subsequent HTTPS-based connections.

You import the Cisco trust bundle using the **Trustpool** window in the Cisco APIC-EM GUI.

Figure 11: Trustpool Window



Before You Begin

You must have successfully deployed the Cisco APIC-EM and it must be operational.

You must have administrator (ROLE_ADMIN) permissions to perform this procedure.

For information about the user permissions required to perform tasks using the Cisco APIC-EM, see the chapter, *Managing Users and Roles* in the *Cisco Application Policy Infrastructure Controller Enterprise Module Configuration Guide*.

Step 1 In the **Home** window, click either **admin** or the **Settings** icon (gear) at the top right corner of the screen.

Step 2 Click the **Settings** link from the drop-down menu.

Step 3 In the **Settings** navigation pane, click **Trustpool** to view the **Trustpool** window.

Step 4 In the **Trustpool** window, click the **Update** button.
After clicking this button, the following actions occur:

- The controller checks to see if a new trustpool bundle exists in the Cisco cloud URL location.
- If the trustpool bundle in the Cisco cloud is the same as the installed trustpool bundle on the controller, then the controller does not initiate a new download and install.
- If the trustpool bundle in the Cisco cloud is a new version of the trustpool bundle, then the controller initiates a new download and install of the trustpool bundle.
- After a new trustpool bundle is downloaded and installed on the controller, the controller makes this trustpool bundle available to the supported Cisco devices to download.

Note The **Update** button in the controller's **Trustpool** window will become active when an updated version of ios.p7b file is available and Internet access is present. The **Update** button will remain inactive if there is no Internet access.

Related Topics

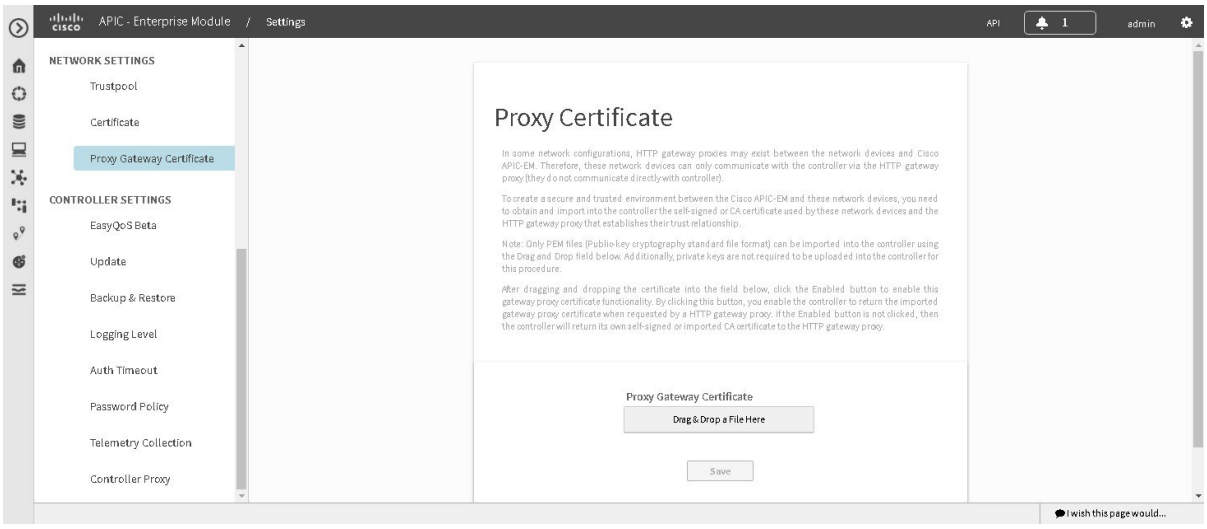
Cisco APIC-EM Trustpool Support, on page 19

Importing a Proxy Gateway Certificate

In some network configurations, proxy gateways may exist between the Cisco APIC-EM and network devices. Common ports such as 80 and 443 pass through the gateway proxy in the DMZ, and for this reason SSL sessions from the network devices meant for the controller terminate at the proxy gateway. Therefore, these network devices can only communicate with the controller via the proxy gateway. In order for the network devices to establish secure and trusted connections with the controller, or if present, a proxy gateway, then the network devices should have their PKI trust stores appropriately provisioned with the relevant CA root certificates or the server's own certificate under certain circumstances.

In network topologies where there is a proxy gateway present between controller and PnP enabled devices, follow the procedure below to import a proxy gateway certificate into the controller.

Figure 12: Proxy Gateway Certificate Window



Before You Begin

You have successfully deployed the Cisco APIC-EM and it is operational.

In your network, an HTTP proxy gateway exists between the controller and PnP enabled network devices. The PnP enabled network devices will use the proxy gateway's IP address to reach the Cisco APIC-EM controller and its services.

You have the certificate file currently being used by the proxy gateway. The certificate file contents can consist any of the following:

- The proxy gateways's certificate in PEM format, with the certificate being self-signed.

- The proxy gateway's certificate in PEM format, with the certificate being issued by a valid, well-known CA, such as the Comodo Group, Symantec, or DigiCert.
- The proxy gateway's certificate and the issuing CA root certificate.

Note The certificate file is structured in the above order as a chain and in PEM format. This is required if the CA is not a valid, well-known CA. For example, a CA not present in the Cisco ios.p7b trust pool bundle.

- The proxy gateways's certificate and a Sub CA certificate.

Note The certificate file is structured in the above order and as a chain in PEM format. This is required if the issuing Root CA, Sub CA is a well-known valid CA such as the Comodo Group, Symantec, or DigiCert.

The certificate used by the devices and proxy gateway must be imported into the controller by following this procedure.

You must have administrator (ROLE_ADMIN) permissions to perform this procedure.

For information about the user permissions required to perform tasks using the Cisco APIC-EM, see the chapter, *Managing Users and Roles* in the *Cisco Application Policy Infrastructure Controller Enterprise Module Configuration Guide*.

Step 1 In the **Home** window, click either **admin** or the **Settings** icon (gear) at the top right corner of the screen.

Step 2 Click the **Settings** link from the drop-down menu.

Step 3 In the **Settings** navigation pane, click **Proxy Gateway Certificate** to view the **Proxy Certificate** window.

Step 4 In the **Proxy Gateway Certificate** window, view the current proxy gateway certificate data (if this exists).

Note The **Expiration Date and Time** is displayed as a Greenwich Mean Time (GMT) value. A system notification will appear in the controller's GUI 2 months before the expiration date and time of the certificate.

Step 5 To add a proxy gateway certificate, drag and drop the self-signed or CA certificate to the **Drag n' Drop a File Here** field.

Note Only PEM files (Public-key cryptography standard file format) can be imported into the controller using this field. Additionally, private keys are neither required nor uploaded into the controller for this procedure.

Step 6 Click the **Save** button.

Step 7 Refresh the **Proxy Gateway Certificate** window to view the updated proxy gateway certificate data.
The information displayed in the **Proxy Gateway Certificate** window should have changed to reflect the new certificate name, issuer, and certificate authority.

Related Topics

Security and Cisco Network Plug and Play, on page 20

Logs and Logging

The Cisco APIC-EM generates the following log types that are accessible through the GUI:

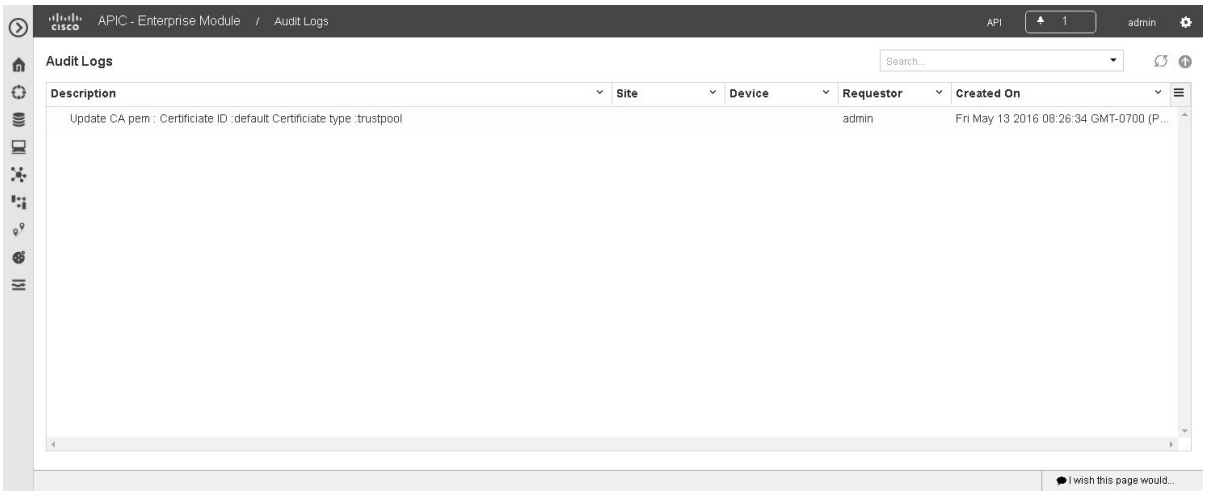
- Audit Logs—Logs used primarily to monitor policy creation and application.
- Service Logs—Logs used to monitor the controller services.

Viewing Audit Logs

Cisco APIC-EM audit logs are used primarily to keep track of policies for the EasyQoS and iWAN applications.

You can view audit logs using the **Audit Logs** window in the Cisco APIC-EM GUI. The Cisco APIC-EM also supports the ability to export the audit logs to a local system.

Figure 13: Audit Logs



Before You Begin

You must have successfully deployed the Cisco APIC-EM and it must be operational.

You must have either administrator (ROLE_ADMIN) or policy administrator (ROLE_POLICY_ADMIN) permissions to perform this procedure.

For information about the user permissions required to perform tasks using the Cisco APIC-EM, see the chapter, "Managing Users and Roles," in the *Cisco Application Policy Infrastructure Controller Enterprise Module Configuration Guide*.

Step 1 In the **Home** window, click either **admin** or the **Settings** icon (gear) at the top right corner of the screen.

Step 2 Click the **Audit Logs** link from the drop-down menu.
The **Audit Logs** window appears. In the **Audit Logs** window, you view current policies that exist in your network. These are policies applied by either the IWAN or EasyQoS applications.

The following information is displayed for each policy in the window:

- **Description—**Application or policy audit log description
- **Site—**Name of site for the specific audit log
- **Device—**Device or devices for the audit log
- **Requestor—**User requesting audit log
- **Created On—**Date application or policy audit log was created.

Step 3 Click on the addition icon (+) next to an audit log to view the children audit logs in the **Audit Logs** window.
Each audit log is a parent to several child audit logs. By clicking on this icon, you can view a series of additional audit logs.

Step 4 Perform a search of the audit logs by clicking on the **Search** field in the **Audit Logs** window, entering a specific parameter, and then clicking the **Submit** button.
You can search for a specific audit log by the following parameters:

- Description
- Requestor
- Device
- Site
- Start Date
- End Date

Step 5 Click on the dual arrow icon to refresh the data displayed in the window.
The data displayed in the window is refreshed with the latest audit log data.

Step 6 Click on the down arrow icon to download a local copy of the audit log in .csv file format.
A .csv file containing audit log data is downloaded locally to your system. You can use the .csv file for additional review of the audit log or archive it as a record of activity on the controller.

What to Do Next

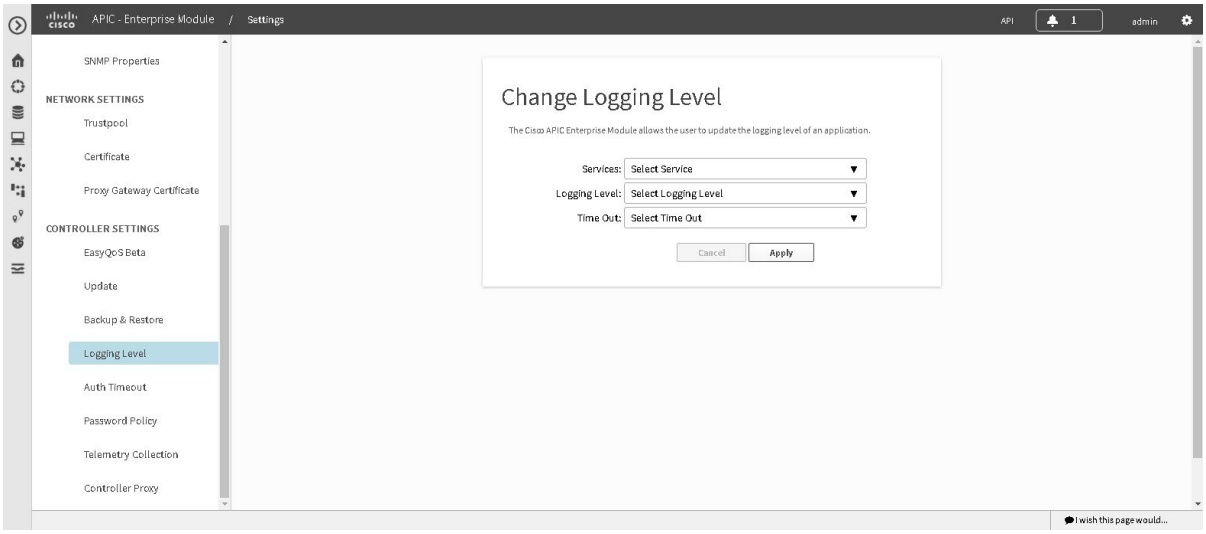
Proceed to review any additional log files using the controller's GUI, or download individual audit logs as .csv files for further review or for archiving purposes.

Changing the Logging Level for Services

You can change the logging level for the Cisco APIC-EM services by using the **Changing the Logging Level** window in the Cisco APIC-EM GUI.

A logging level determines the amount of data that is captured to the log files. Each logging level is cumulative, that is, each level contains all the data generated by the specified level and any higher levels. For example, setting the logging level to **Info** also captures **Warn** and **Error** logs.

Figure 14: Service Logging Level Window



The default logging level for services in the controller is informational (**Info**). You can change the logging level with the GUI to set it to debug or trace to capture more information.

Caution Any logs collected at the **Debug** level or higher should be handled with restricted access.

Note The log files are created and stored in a centralized location on your controller. From this location, the controller can query and display them in the GUI The total compressed size of the log files is 2GB. If log files created are in excess of 2GB, then the pre-existing log files are overwritten with the newer log files.

Before You Begin

You must have successfully deployed the Cisco APIC-EM and it must be operational.

You must have administrator (ROLE_ADMIN) permissions to perform this procedure.

For information about the user permissions required to perform tasks using the Cisco APIC-EM, see the chapter, *Managing Users and Roles* in the *Cisco Application Policy Infrastructure Controller Enterprise Module Configuration Guide*.

Step 1 In the **Home** window, click either **admin** or the **Settings** icon (gear) at the top right corner of the screen.

Step 2 Click the **Settings** link from the drop-down menu.

Step 3 In the **Settings** navigation pane, click **Changing the Logging Level** to view the **Changing Logging Level** window. The **Logging Level** table appears with the following fields:

- **Services**
- **Logging Level**
- **Timeout**

Step 4 In the **Changing Logging Level** window, choose a service from the **Services** field to adjust its logging level.

Note The **Services** field displays any services that are currently configured and running on the controller.

Step 5 In the **Changing Logging Level** window, choose the new logging level for the service from the **Logging Level** field.
The following logging levels are supported on the controller:

- **Trace—**Trace messages
- **Debug—**Debugging messages
- **Info—**Normal but significant condition messages
- **Warn—**Warning condition messages
- **Error—**Error condition messages

Step 6 In the **Changing Logging Level** window, choose the time period for the logging level from the **Timeout** field for the logging level adjustment.
You configure logging level time periods in increments of 15 minutes up to an unlimited time period.

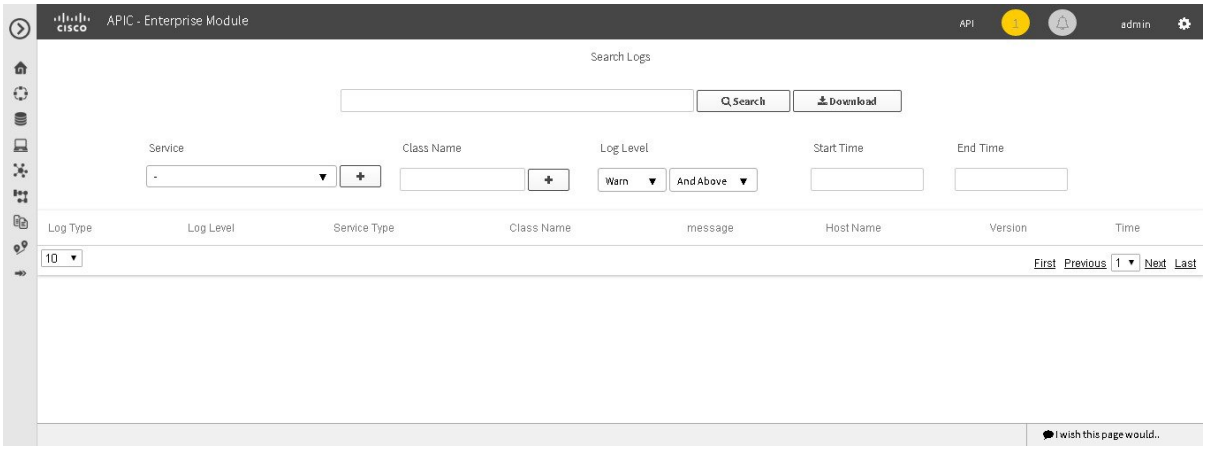
Step 7 Review your selection and click the **Apply** button.
To cancel your selection click the **Cancel** button.

The logging level for the specified service is set.

Searching the Service Logs

You can search various controller service logs using the **Search Logs** window in the Cisco APIC-EM GUI.

Figure 15: Search Logs



The following log files are reviewed during a search:

- Linux logs
- Grapevine logs
- Grapevine service logs
- Database logs

Before You Begin

You must have successfully deployed the Cisco APIC-EM and it must be operational.

You must have either administrator (ROLE_ADMIN) or policy administrator (ROLE_POLICY_ADMIN) permissions to perform this procedure.

For information about the user permissions required to perform tasks using the Cisco APIC-EM, see the chapter, "Managing Users and Roles," in the *Cisco Application Policy Infrastructure Controller Enterprise Module Configuration Guide*.

Step 1 In the **Home** window, click either **admin** or the **Settings** icon (gear) at the top right corner of the screen.

Step 2 Click the **Logs** link from the drop-down menu.
The **Search Logs** window appears. In the **Search Logs** window, you can search the controller service logs by performing the following tasks:

- Search service logs by entering text in the **Search** field.
- Search service logs by configuring the GUI drop-down fields and menus.

- Search service logs by both entering search text and by using the GUI drop-down fields and menus as filters to that text.

Note There are no mandatory fields in the GUI that must have a value entered to conduct a search. You do not have to configure any specific field to run a search.

Step 3 (Optional) Enter a string value in the **Search Logs** field at the top of the **Search Log** window and click the **Search** button.
The log search results are displayed at the bottom of the **Search Logs** window in a table. You can view the following information from the search:

- **Log Level—**Log level (Error, Warn, Trace, Debug, Info)
- **Service Type—**Type of service (also including Grapevine and Linux services)
- **Class Name—**Java class that executed the request.
- **Message—**Actual detail of message that was sent to the log file. For example, "File not found" or "Resource xxx not found".
- **Host Name—**Grapevine host name that generated the request.
- **Version—**Version of the service.
- **Time—**Time message was sent to the log file.

Below the table are numerical filters. Adjust these filters to limit the number of logs displayed in the table (10, 25, 50, 100) or to view groups of a logs at a time (First, Previous, Next, Last, or 1-3).

Step 4 (Optional) In the **Search Logs** window, choose a service from the **Services** drop-down menu for the search and click the plus sign (+).
You can add several different services to your search, by choosing from the drop-down menu and then clicking the plus sign(+).

Note The **Services** drop-down menu displays any services that are currently configured and running on the controller.

Step 5 (Optional) In the **Search Log** window, type in a Java class in the **Class Name** field and click the plus sign (+).
You can add several different Java classes to your search, by choosing from the drop-down menu and then clicking the plus sign(+).

Step 6 (Optional) In the **Search Logs** window, choose a logging level from the **Log Level** drop-down menu.
The following logging levels are supported:

- **Trace—**Trace messages
- **Debug—**Debugging messages
- **Info—**Normal but significant condition messages
- **Warn—**Warning condition messages
- **Error—**Error condition messages

Step 7 (Optional) Adjust the logging level by choosing an appropriate condition in the second **Log Level** drop-down menu.
The following logging level adjustments are supported:

- **And Below—**Search for the specified logging level and any other logging level that has a lower level. For example, a **Trace** has a lower logging level than a **Warn**.
- **Only—**Search only for the specified logging level. Ignore any other logging levels in the results.
- **And Above—**Search for the specified logging level and any other logging level with a higher level. For example, a **Warn** has a higher logging level than a **Debug**.

Step 8 (Optional) In the **Search Logs** window, enter a start time for the logs in the **Start Time** field for the search or use the calendar icon.
If entering a date and time directly, use the following formats:

- Hour: Minutes, AM or PM
- MM/DD/YYYY

Step 9 (Optional) In the **Search Logs** window, enter an end time for the logs in the **End Time** field for the search or use the calendar icon.
If entering a date and time directly, use the following formats:

- Hour: Minutes, AM or PM
- MM/DD/YYYY

Step 10 Review your log search settings and then click the **Search** button.
The log search results are displayed at the bottom of the **Search Log** window in a table.

Below the table are numerical filters. Adjust these filters to limit the number of logs displayed in the table (10, 25, 50, 100) or to view groups of a logs at a time (First, Previous, Next, Last, or 1-3).

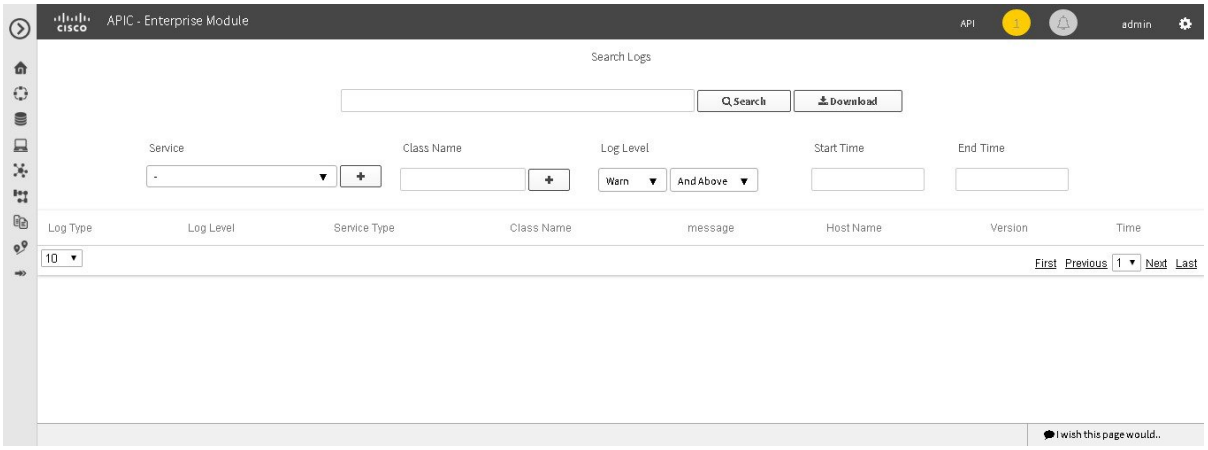
What to Do Next

Proceed with any additional service log searches.

Downloading the Service Logs

You can download various controller service logs using the **Search Logs** window in the Cisco APIC-EM GUI.

Figure 16: Downloading Logs



The following log files are reviewed during a search and download:

- Linux logs
- Grapevine logs
- Grapevine service logs
- Database logs

Before You Begin

You must have successfully deployed the Cisco APIC-EM and it must be operational.

You must have either administrator (ROLE_ADMIN) or policy administrator (ROLE_POLICY_ADMIN) permissions to perform this procedure.

For information about the user permissions required to perform tasks using the Cisco APIC-EM, see the chapter, "Managing Users and Roles," in the *Cisco Application Policy Infrastructure Controller Enterprise Module Configuration Guide*.

Step 1 In the **Home** window, click either **admin** or the **Settings** icon (gear) at the top right corner of the screen.

Step 2 Click the **Logs** link from the drop-down menu.
The **Search Logs** window appears. In the **Search Logs** window, you can download the controller service logs by performing the following tasks:

- Download service logs by entering a string value.
- Download service logs by configuring the GUI drop-down menus and fields.

- Download service logs by both entering a string value and by configuring the GUI drop-down menus and fields as filters to that string value.

Step 3 (Optional) Enter a string value in the **Search Logs** field at the top of the **Search Logs** window and click the **Download** button.
The log download results are displayed at the bottom of the **Search Logs** window.

Step 4 (Optional) In the **Search Log** window, choose a service from the **Services** drop-down menu for the download and click the plus sign (+).
You can add several different services to your download, by choosing from the drop-down menu and then clicking the plus sign(+).

Note The **Services** drop-down menu displays any services that are currently configured and running on the controller.

Step 5 (Optional) In the **Search Log** window, choose a Java class from the **Class** drop-down menu for the download and click the plus sign (+).
You can add several different Java classes to your download, by choosing from the drop-down menu and then clicking the plus sign(+).

Step 6 (Optional) In the **Search Logs** window, choose a logging level from the **Log Level** drop-down menu.
The following logging levels are supported:

- **Trace—**Trace messages
- **Debug—**Debugging messages
- **Info—**Normal but significant condition messages
- **Warn—**Warning condition messages
- **Error—**Error condition messages

Step 7 (Optional) Adjust the logging level by choosing an appropriate condition in the second **Log Level** drop-down menu.
The following logging level adjustments are supported:

- **And Below—**Search for the specified logging level and any other logging level that has a lower level. For example, a **Trace** has a lower logging level than a **Warn**.
- **Only—**Search only for the specified logging level. Ignore any other logging levels in the results.
- **And Above—**Search for the specified logging level and any other logging level with a higher level. For example, a **Warn** has a higher logging level than a **Debug**.

Step 8 (Optional) In the **Search Logs** window, enter a start time for the logs in the **Start Time** field for the download or use the calendar icon.
If entering a date and time directly, use the following formats:

- Hour: Minutes, AM or PM
- MM/DD/YYYY

Step 9 (Optional) In the **Search Logs** window, enter an end time for the logs in the **End Time** field for the download or use the calendar icon.
If entering a date and time directly, use the following formats:

- Hour: Minutes, AM or PM
- MM/DD/YYYY

Step 10 Review your log search settings and then click the **Download** button.
The log download results are displayed at the bottom right of the **Search Log** window as a page icon displaying the number of logs using the following format: `Search Results (5).log`.

Step 11 Click on the icon for the log download results.
A new window opens that displays the log download data. This data is organized using the following parameters:

- **Timestamp—**Time message was sent to the log file
- **Service type—**Service
- **Class—**Java class that executed the request.
- **Log level—**Log level
- **Message—**Actual detail of message that was sent to the log file. For example, "File not found" or "Resource xxx not found".
- **Version Number—**Version of the service.

What to Do Next

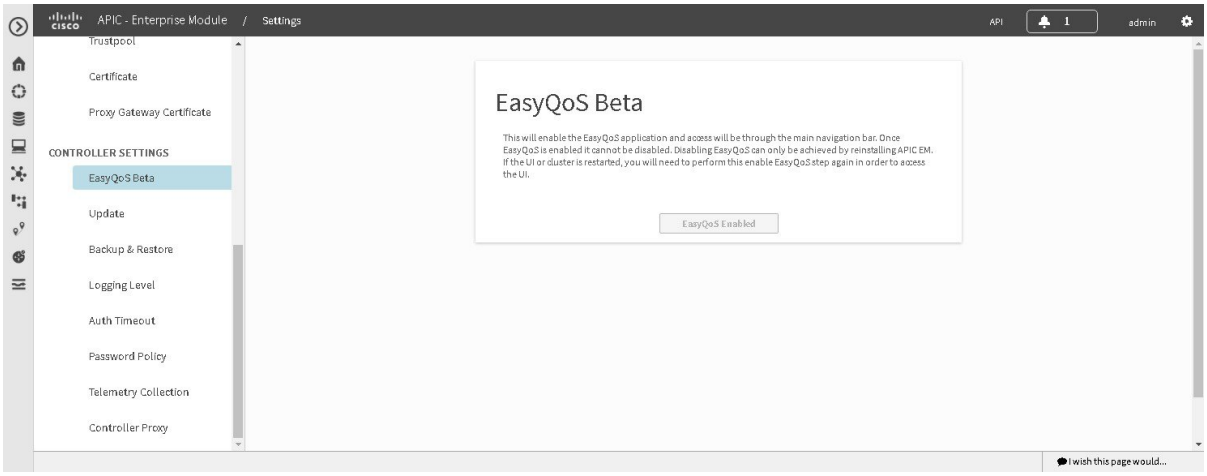
Proceed with any additional service log downloads.

Controller Settings

Enabling EasyQoS

You can enable and activate the EasyQoS application on the controller using the **EasyQoS Beta** window in the Cisco APIC-EM GUI.

Figure 17: Enable EasyQoS



Before You Begin

You must have successfully deployed the Cisco APIC-EM and it must be operational.

You must have administrator (ROLE_ADMIN) permissions to perform this procedure.

For information about the user permissions required to perform tasks using the Cisco APIC-EM, see the chapter, *Managing Users and Roles* in the *Cisco Application Policy Infrastructure Controller Enterprise Module Configuration Guide*

Step 1 In the **Home** window, click either **admin** or the **Settings** icon (gear) at the top right corner of the screen.

Step 2 Click the **Settings** link from the drop-down menu.

Step 3 In the **Settings** navigation pane, click **EasyQoS Beta** to view the **EasyQoS Beta** window.

Step 4 Click the **Enable EasyQoS** button to activate EasyQoS on the controller.

Note Once enabled, you can only disable EasyQoS by uninstalling and then reinstalling the controller. Any QoS configurations applied to devices using EasyQoS will remain on those devices.

Step 5 Click the **EasyQoS** icon in the main Navigation pane to open the EasyQoS application.
For detailed information about EasyQoS, see the *Cisco Application Policy Infrastructure Controller Enterprise Module Configuration Guide*.

What to Do Next

Proceed to apply QoS to your network devices using the EasyQoS application.

Updating the Cisco APIC-EM Software

You can update the Cisco APIC-EM to the latest version using the controller's software update procedure. This procedure requires that you perform the following tasks:

1. Download the release upgrade pack from the secure Cisco cloud.
2. Run a checksum against the release upgrade pack.
3. Upload the release upgrade pack to the controller using the GUI.
4. Update the controller's software with the release upgrade pack.

Important This procedure should be read in conjunction with the latest version of the Cisco APIC-EM release notes, as there may be specific additional requirements for that release's upgrade. The latest release for Cisco APIC-EM is release 1.2.0.x. You should first review the *Release Notes for Cisco Application Policy Infrastructure Controller Enterprise Module*, Release 1.2.0.x before beginning this procedure.

Note In a multi-host cluster, you only need to update a single host. After updating that single host, the other two hosts are automatically updated with the release upgrade pack.

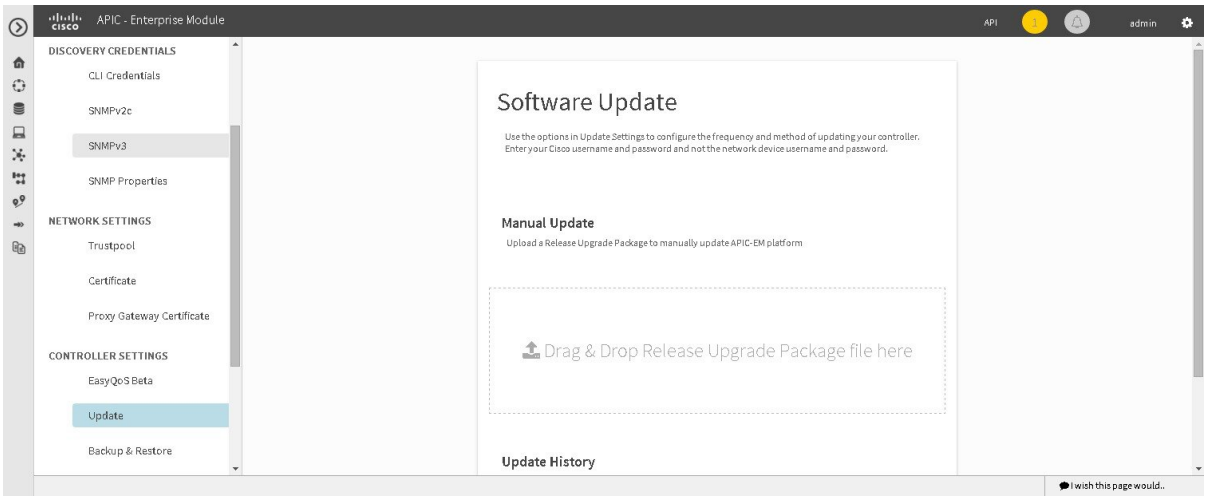
The release upgrade pack is available for download as a tar file that is also compressed, so the release upgrade pack has a .tar.gz extension. The release upgrade pack itself may consist of any or all of the following update files:

- Service files
- Grapevine files
- Linux files

Note Each release upgrade pack contains an encrypted Cisco signature for security purposes, as well as release version metadata that validates the package.

You perform the upload and update procedure using the **Software Update** window in the Cisco APIC-EM GUI.

Figure 18: Software Update Window



Note After a successful upload and software update, you are not permitted to rollback to an earlier Cisco APIC-EM version.

Before You Begin

You must have successfully deployed the Cisco APIC-EM and it must be operational.

You must have administrator (ROLE_ADMIN) permissions to perform this procedure.

For information about the user permissions required to perform tasks using the Cisco APIC-EM, see the chapter, *Managing Users and Roles* in the *Cisco Application Policy Infrastructure Controller Enterprise Module Configuration Guide*.

Note When updating or upgrading the Cisco APIC-EM in a virtual machine within a VMware vSphere environment, you must ensure that the time settings on the ESXi host are also synchronized to the NTP server. Failure to ensure synchronization will cause the upgrade to fail.

You must have received notification from Cisco that the Cisco APIC-EM software update is available for you to download from the secure Cisco website.

You can be notified about the availability of a Cisco APIC-EM software update in the following ways:

- Email notification from Cisco support and/or updated release notes.
- System notification through the controller GUI.

Note Notification about available release upgrade packs can be viewed by clicking the **System Notifications** icon on the menu bar.

Step 1 Review the information in the Cisco notification about the Cisco APIC-EM update file and checksum.
The Cisco notification specifies the location of the release upgrade pack and verification values for either a Message Digest 5 (MD5) or Secure Hash Algorithm (SHA) 512 bits (SHA512) checksum.

Note The Cisco APIC-EM release upgrade pack is a bit file that varies in size based upon the requirements of the specific update. The release upgrade pack can be as large as several Gigabits.

Step 2 Download the release upgrade pack from the secure Cisco website to your laptop or to a location within your network.

Step 3 Run a checksum against the release upgrade pack using your own checksum verification tool or utility (either MD5 or SHA512).

Step 4 Review the displayed checksum verification value from your checksum verification tool or utility.
If the output from your checksum verification tool or utility matches the appropriate checksum value in the Cisco notification or from the Cisco secure website, then proceed to the next step. If the output does not match the checksum value, then download the release upgrade pack and perform another checksum. If checksum verification issues persist, contact Cisco support.

Step 5 In the **Home** window, click either **admin** or the **Settings** icon (gear) at the top right corner of the screen.

Step 6 Click the **Settings** link from the drop-down menu.

Step 7 In the **Settings** navigation pane, click **Software Update** to view the **Software Update** window.

Step 8 If the release upgrade pack is acceptable to use for updating the controller (checksum value match in step 4), then drag and drop the release upgrade pack from the download location on your laptop or in your network onto the **Manual Update** field in the **Software Update** window.
After dropping the release upgrade pack onto the **Manual Update** field, the upload process begins.

The upload process may take several minutes depending upon the size of the release upgrade pack and your network connection. During the upload process, you can continue to work with the controller. Once the upload process ends and the update process begins, you will not be able to work with the controller.

Note If you close the **Software Update** window for any reason, then the upload process stops. To start the upload process again, open the **Software Update** window and drag and drop the release upgrade pack onto the **Manual Update** field again. The upload process starts where it previously stopped. To avoid any interruptions to the upload process while working with the controller, open additional windows in the GUI for any other tasks. Keep the **Software Update** window open during the upload process.

Step 9 Once the upload process finishes, the update process automatically begins. A message appears in the GUI stating that the update process has started and is in progress.
You should refrain from working with the controller during the update process. During the update process, the controller may shut down and restart. The shut down process may last for several minutes.

Note At the beginning of the update process, the controller performs a second verification test on the release upgrade pack. The release upgrade pack itself contains an encrypted security value (signature) that will be decrypted and reviewed by the controller. This second verification test ensures that the release upgrade pack that has been uploaded is from Cisco. The release upgrade pack must pass this second verification test before the update process can continue.

Step 10 Once the update process finishes, you will receive a success or failure notification.

If the update was successful, you will receive a successful update notification and can then proceed working with the controller. If the update was unsuccessful, you will receive an unsuccessful update notification with suggested remedial actions to take.

After the update (or attempted update), information about it will also appear in the **Update History** field of the **Software Update** window. The following update data is displayed in this field:

- **Date—**Local date and time of the update
- **User—**Username of the person initiating the update
- **Update Version—**Update path of release upgrade pack version represented with an arrow.
- **Update Status—**Success or failure status of the update.

  Note If you place your cursor over (mouseover) a failure status in this field, then additional details about the failure is displayed.

Backing Up and Restoring the Cisco APIC-EM

As with any other system upon which your company or organization relies, you need to ensure that the Cisco APIC-EM is backed up regularly, so that it can be restored in case of hardware or other failure.

Caution For the IWAN solution application, you must review the *Software Configuration Guide for Cisco IWAN on APIC-EM* before attempting a back up and restore. There is important and detailed information about how these processes work for the IWAN solution application that includes what is not backed up, what is not backed up, recommendations, limitations, and caveats.

Information about Backing Up and Restoring the Cisco APIC-EM

The back up and restore procedure for the Cisco APIC-EM can be used for the following purposes:

- To create a single backup file to support disaster recovery on the controller
- To create a single backup file on one controller to restore to a different controller (if required for your network configuration)

When you perform a back up using the controller's GUI, you copy and export the controller's database and files as a single file to a specific location on the controller. When you perform a restore, you copy over the existing database and files on the controller using this single backup file.

Note The Cisco APIC-EM uses PostgreSQL as the preferred database engine for all network data. PostgreSQL is an open source object-relational database system.

The following files and data are copied and restored when performing a back up and restore:

- Cisco APIC-EM database
- Cisco APIC-EM file system and files
- X.509 certificates and trustpools
- Usernames and passwords
- Any user uploaded files (for example, any Network Plug and Play image files)

The database and files are compressed into a single *.backup* file when performing the back up and restore. The maximum size of the *.backup* file is 30GB. This number consists of a permitted 20GB maximum size for a file service back up and a 10GB permitted maximum size for the database back up.

Note The .backup file should not be modified by the user.

Only a single back up can be performed at a time. Performing multiple back ups at once are not permitted. Additionally, only a full back up is supported. Other types of back ups (for example, incremental back ups) are not supported.

Note After saving the backup file, you can also download it to another location in your network. You can restore the backup file from its default location in the controller or drag and drop the backup file from its location in your network to restore.

When performing a backup and restore, we recommend the following:

- Perform a back up everyday to maintain a current version of your database and files.
- Perform a back up and restore after making any changes to your configuration. For example, when changing or creating a new policy on a device.
- Only perform a back up and restore during a low impact or maintenance time period.

When a back up is being performed, you will be unable to delete any files that have been uploaded to the file service and any changes you make to any files may not be captured by the back up process. When a restore is being performed, the controller is unavailable.

Note You cannot schedule nor automate a back up and restore at this time. Additionally, once started you cannot manually cancel either the back up or restore process.

Multi-Host Cluster Back Up and Restore

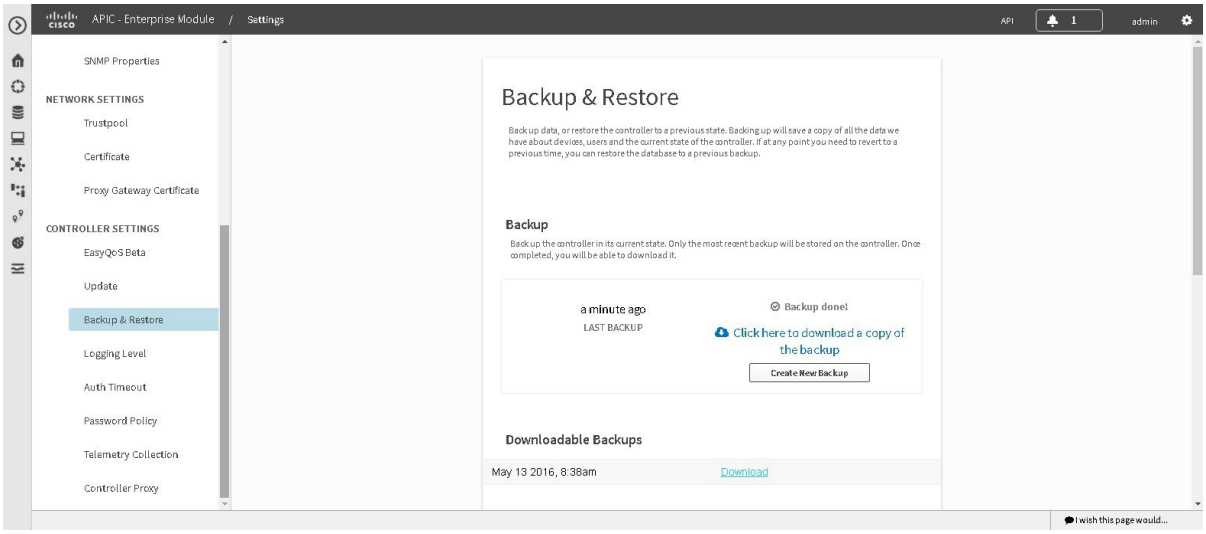
In a multi-host cluster, the database and files are replicated and shared across three hosts. When backing up and restoring in a multi-host cluster, you need to first back up on one of the three hosts in the cluster. You can then use that backup file to restore all three hosts in the cluster. However, you need not perform the restore operation on each of the hosts. You simply restore one of the hosts in the cluster. The controller replicates the restored data to the other hosts automatically.

Note The back up and restore process in a multi-host cluster requires that the Cisco APIC-EM software and version must be the same for all three hosts.

Backing Up the Cisco APIC-EM

You can back up your controller using the **Backup & Restore** window.

Figure 19: Backup & Restore Window



Before You Begin

You must have successfully deployed the Cisco APIC-EM and it must be operational.

You must have administrator (ROLE_ADMIN) permissions to perform this procedure.

For information about the user permissions required to perform tasks using the Cisco APIC-EM, see the chapter, *Managing Users and Roles* in the *Cisco Application Policy Infrastructure Controller Enterprise Module Configuration Guide*.

Step 1 In the **Home** window, click either **admin** or the **Settings** icon (gear) at the top right corner of the screen.

Step 2 Click the **Settings** link from the drop-down menu.

Step 3 In the **Settings** navigation pane, click **Backup & Restore** to view the **Backup & Restore** window.

Step 4 In the **Backup & Restore** window, create a backup file by clicking on the **Create New Backup** button. After clicking the **Create New Backup** button, a **Backup in Progress** window appears in the GUI.

During this process, the Cisco APIC-EM creates a compressed *.backup* file of the controller database and files. This backup file is also given a time and date stamp that is reflected in its file name. The following file naming convention is used: *yyyy-mm-dd-hh-min-seconds* (year-month-day-hour-seconds).

For example:

backup_2015_08_14-08-35-10

Note If necessary, you can rename the backup file instead of using the default time and date stamp naming convention.

This backup file is then saved to a default location within the controller. You will receive a **Backup Done!** notification, once the back up process is finished. Only a single backup file at a time is stored within the controller.

Note If the back up process fails for any reason, there is no impact to the controller and its database. Additionally, you will receive an error message stating the cause of the back up failure. The most common reason for a failed back up is insufficient disk space. If your back up process fails, you should check to ensure that there is sufficient disk space on the controller and attempt another back up.

Step 5 (Optional) Create a copy of the backup file to another location.
After a successful back up, a **Download** link appears in the GUI. Click the link to download and save a copy of the backup file to a location on your laptop or network.

What to Do Next

When necessary and at an appropriate time, proceed to restore the backup file to the Cisco APIC-EM.

Restoring the Cisco APIC-EM

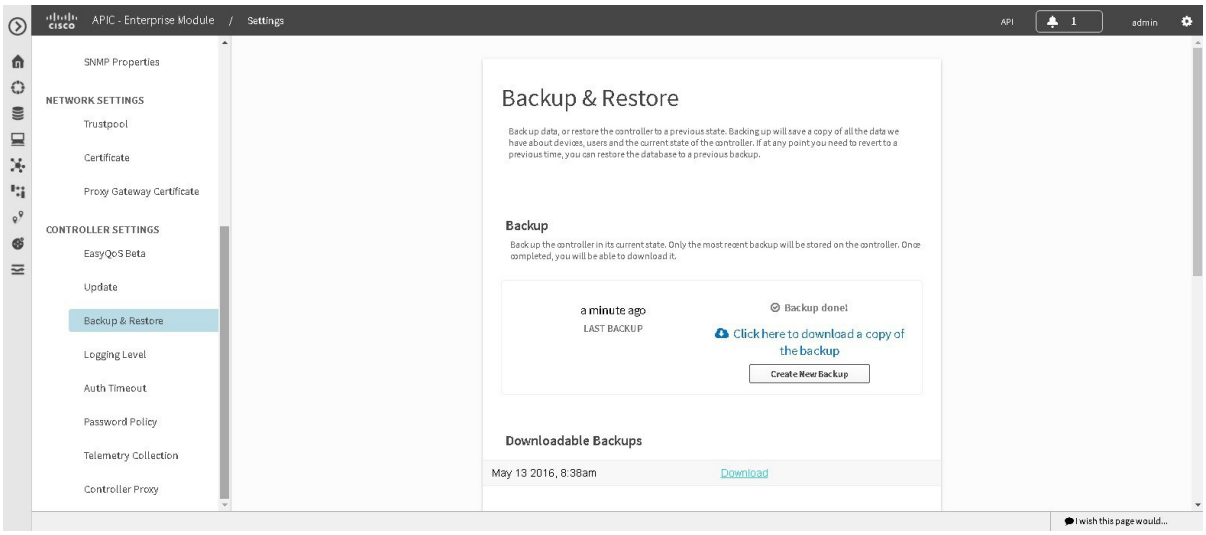
You can restore your controller using the **Backup & Restore** window.

The following restore options are available:

- You can restore from the last know backup file on the controller.
- You can also restore from an archived backup file that was saved and moved to another location on your network.

Caution The Cisco APIC-EM restore process restores the controller's database and files. The restore process does not restore your network state and any changes made by the controller since the last backup, including any new network policies that have been created, any new or updated passwords, or any new or updated certificates/trustpool bundles.

Figure 20: Backup & Restore Window



Note You can only restore a backup from a controller that is the same software version as the controller where the backup was originally taken from.

Before You Begin

You must have successfully deployed the Cisco APIC-EM and it must be operational.

You must have administrator (ROLE_ADMIN) permissions to perform this procedure.

For information about the user permissions required to perform tasks using the Cisco APIC-EM, see the chapter, *Managing Users and Roles* in the *Cisco Application Policy Infrastructure Controller Enterprise Module Configuration Guide*.

You must have successfully performed a back up of the Cisco APIC-EM database and files following the steps in the previous procedure.

Step 1 In the **Home** window, click either **admin** or the **Settings** icon (gear) at the top right corner of the screen.

Step 2 Click the **Settings** link from the drop-down menu.

Step 3 In the **Settings** navigation pane, click **Backup & Restore** to view the **Backup & Restore** window.

Step 4 To restore the backup file, click on the **Restore from last Backup** button.

You can also drag and drop the backup file from its location in your network onto the **Drag and Drop a backup file** field in this window.

During a restore, the backup file copies over the current database.

Note When a restore is in progress, you are not be able to open and access any windows in the GUI.

Step 5 After the restore process completes, log back into the controller's GUI.
If the restore process was successful, you will be logged out of the controller and its GUI. You will need to log back in.

Note The Cisco APIC-EM restore process restores the controller's database and files. The restore process does not restore your network state and any changes made by the controller since the last backup, including any new network policies that have been created, any new or updated passwords, or any new or updated certificates/trustpool bundles.

To check whether the restore process was successful, you can either review the **Backup History** field of the **Backup & Restore** window or access the Grapevine root and to run the **grape backup display** command.

Caution

If the restore process was unsuccessful, you will receive an unsuccessful restore notification. Since the database may be in an inconsistent state, we recommend that you do not use the database and contact technical support for additional actions to take.

Step 6 (Optional) Using a Secure Shell (SSH) client, log into the host (physical or virtual) with the IP address that you specified using the configuration wizard.

Note The IP address to enter for the SSH client is the IP address that you configured for the network adapter. This IP address connects the appliance to the external network.

Step 7 (Optional) When prompted, enter your Linux username ('grapevine') and password for SSH access.

Step 8 (Optional) Enter the **grape backup display** command at the prompt to confirm that the restore process was completed and successful.

```
$ grape backup display
```

Check the command output to ensure that the restore process was completed and successful. Look for the property operation marked "restore" in the command output, with the latest start_time and ensure that the status is marked as a "success".

Step 9 (Optional) Using the Secure Shell (SSH) client, log out of the appliance.

Step 10 Return to the controller's GUI and review the **Backup History** field of the **Backup & Restore** window.
After the restore, information about it appears in the **Backup History** field of the **Backup & Restore** window. The following update data is displayed in this field:

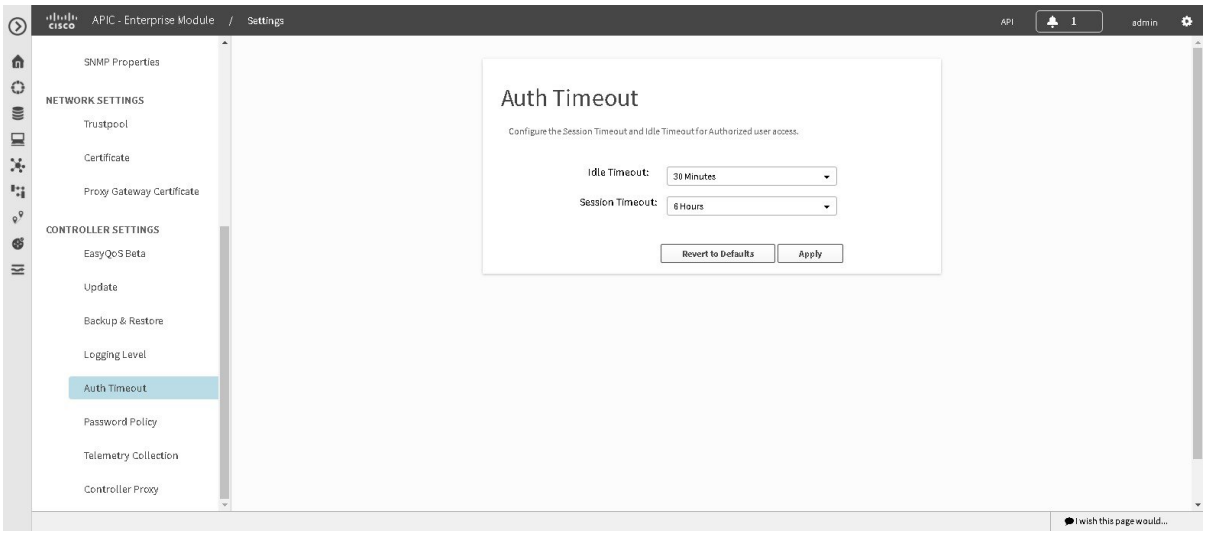
- **Date—**Local date and time of the restore
- **ID—**Controller generated identification number of the backup file
- **Operation—**Type of operation, either backup or restore
- **Update Status—**Success or failure status of the operation.

  Note If you place your cursor over (mouseover) a failure status in this field, then additional details about the failure is displayed.

Configuring the Authentication Timeout

You can configure authentication timeouts that require the user to log back into the controller with their credentials (username and password) using the **Authentication Timeout** window in the Cisco APIC-EM GUI.

Figure 21: Authentication Timeout Window



The following authentication timeout values can be configured:

- Idle timeout—Time interval that you can configure before the controller requires re-authentication (logging back in with appropriate credentials) due to Cisco APIC-EM inactivity. Idle timeouts are API-based, meaning that idle timeout is the time the controller is idle between API usages and not GUI mouse clicks or drags.
- Session timeout—Time interval that you can configure before the controller requires re-authentication (logging back in with appropriate credentials). This is a forced re-authentication.

Note Approximately 2-3 minutes before your session is about to idle timeout, a pop-up warning appears in the GUI stating that your session is about to idle timeout and asking if you wish to continue with the current session. Click **Cancel** to ignore the warning and idle timeout of the session within approximately 2-3 minutes. Click **OK** to continue the session for another 30 minutes.

Before You Begin

You must have successfully deployed the Cisco APIC-EM and it must be operational.

You must have administrator (ROLE_ADMIN) permissions to perform this procedure.

For information about the user permissions required to perform tasks using the Cisco APIC-EM, see the chapter, *Managing Users and Roles* in the *Cisco Application Policy Infrastructure Controller Enterprise Module Configuration Guide*

Step 1 In the **Home** window, click either **admin** or the **Settings** icon (gear) at the top right corner of the screen.

Step 2 Click the **Settings** link from the drop-down menu.

Step 3 In the **Settings** navigation pane, click **Authentication Timeout** to view the **Authentication Timeout** window.

Step 4 (Optional) Configure the idle timeout value using the **Idle Timeout** drop-down menu.
You can configure the idle timeout value in increments of 5 minutes, up to an hour. The default value is 30 minutes.

Step 5 (Optional) Configure the session timeout value using the **Session Timeout** drop-down menu.
You can configure the session timeout value in increments of 30 minutes, up to 24 hours. The default value is six hours.

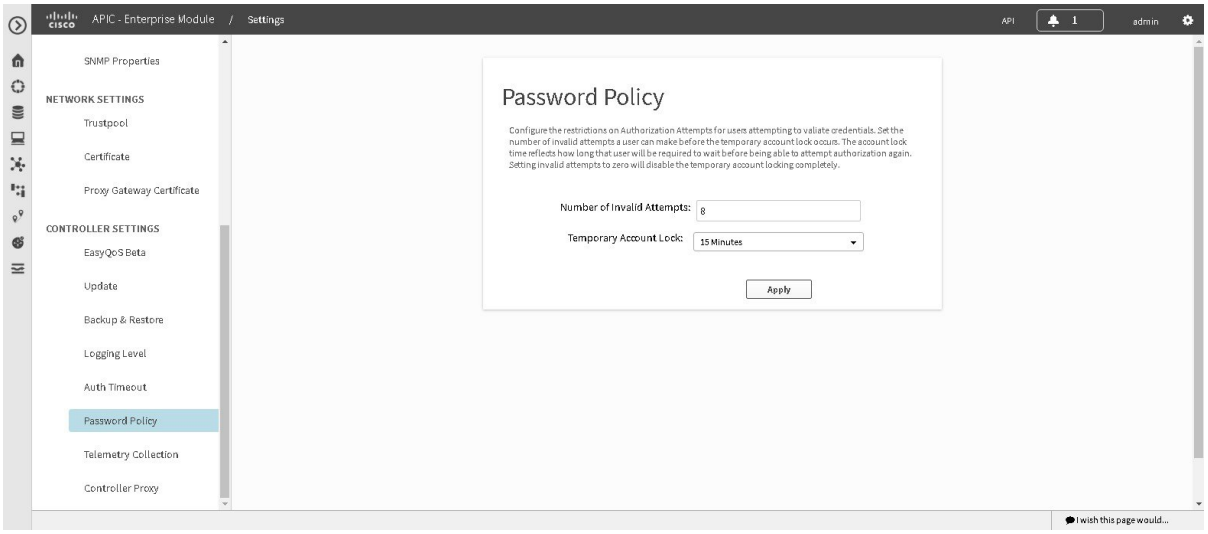
Step 6 Click the **Apply** button to apply your configuration to the controller.
To restore the authentication timeout defaults to the controller, click the **Revert to Defaults** button.

Configuring Password Policies

As an administrator, you can control the number of consecutive, invalid user login attempts to the Cisco APIC-EM. Once a user crosses the threshold set by you as administrator, the user's account is locked and access is refused. Additionally, as an administrator, you can also configure the length of time that the user account is locked. The user account will remain locked until the configured time period expires.

You configure these controller access parameters for the Cisco APIC-EM using the **Password Policy** window.

Figure 22: Password Policy Window



The following password policy functionality is supported:

- As an administrator, you can set the number of consecutive, invalid user login attempts to the controller. These consecutive, invalid user login attempts can be set from 0 to 10 attempts, with 8 attempts being the default value. Setting invalid attempts to 0 will disable the feature of locking a user with invalid password attempts.
- As an administrator, you can set the length of time a user account is locked. Permitted lock time intervals for a user account range from 1-3600 seconds, with 900 seconds being the default value.
- When a user account is locked due to the number of consecutive, invalid login attempts, entering correct credentials will still result in a login failure until the expiration of the configured lock out time period.
- An administrator can unlock the user account at any time.

  We recommend that you create at least two administrator accounts for your deployment. With two administrator accounts, if one account is locked for whatever reason then the other account can be used to unlock that locked account.

Note For information about how to unlock a user account, see the Chapter 4, *Managing Users and Roles* in the *Cisco Application Policy Infrastructure Controller Enterprise Module Configuration Guide*.

- A locked user account is unlocked when the configured lock out time period expires.
- A user account can never be permanently locked, but to deny access permanently, an administrator can delete the account.

Before You Begin

You must have successfully deployed the Cisco APIC-EM and it must be operational.

You must have administrator (ROLE_ADMIN) permissions to perform this procedure.

For information about the user permissions required to perform tasks using the Cisco APIC-EM, see the chapter, *Managing Users and Roles* in the *Cisco Application Policy Infrastructure Controller Enterprise Module Configuration Guide*.

Step 1 In the **Home** window, click either **admin** or the **Settings** icon (gear) at the top right corner of the screen.

Step 2 Click the **Settings** link from the drop-down menu.

Step 3 In the **Settings** navigation pane, click **Password Policy** to view the **Password Policy** window.

Step 4 (Optional) Configure the number of permitted consecutive, invalid password attempts by choosing from the **Number of Invalid Attempts** drop-down menu.

Step 5 (Optional) Configure the time interval for locking a user account by choosing from the **Temporary Account Lock** drop-down menu.

Step 6 Click the **Apply** button to apply your configuration to the controller.

Related Topics

Password Requirements, on page 26

Telemetry Collection

The Cisco APIC-EM uses telemetry to collect information about the user experience with the controller. This information is collected for the following reasons:

- To proactively identify any issues with the controller
- To better understand the controller features that are most frequently used
- To improve and enhance the overall user experience

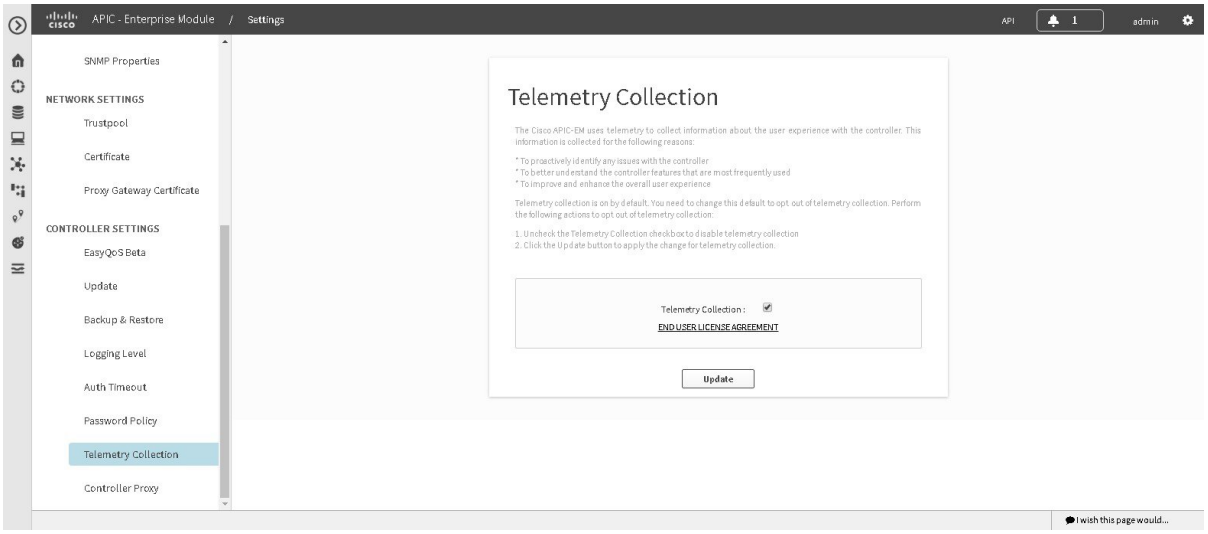
You are able to view the some of the collected telemetry data using the following methods:

- View the logs using the Cisco APIC-EM GUI—For information about this method, see *Searching the Services Logs* in Chapter 5, Configuring the Cisco APIC-EM Settings.
- View the logs using the Grapevine console— For information about this method, see *Troubleshooting Services* in Chapter 6, Troubleshooting the Cisco APIC-EM.

Telemetry is enabled with a telemetry service that collects data from the many other controller services. The telemetry service supports Data Access Service (DAS). The telemetry service uploads data to the Cisco Clean Access Agent (CAA) infrastructure on the Cisco cloud using HTTPS.

Telemetry collection is on by default. If you wish to opt out of telemetry collection, then perform the steps in the following procedure.

Figure 23: Telemetry Collection Window



Before You Begin

You must have successfully deployed the Cisco APIC-EM and it must be operational.

You must have administrator (ROLE_ADMIN) permissions to perform this procedure.

For information about the user permissions required to perform tasks using the Cisco APIC-EM, see the chapter, *Managing Users and Roles* in the *Cisco Application Policy Infrastructure Controller Enterprise Module Configuration Guide*.

Step 1 In the **Home** window, click either **admin** or the **Settings** icon (gear) at the top right corner of the screen.

Step 2 Click the **Settings** link from the drop-down menu.

Step 3 In the **Settings** navigation pane, click **Telemetry Collection** to view the **Telemetry Collection** window.
When accessing the **Telemetry Collection** window for the first time, the GUI displays a blue box with a check that indicates that telemetry collection is enabled.

Step 4 (Optional) Click the **End User License Agreement** to review the agreement for telemetry collection.

Step 5 (Optional) Uncheck the **Telemetry Collection** blue box to disable telemetry collection.

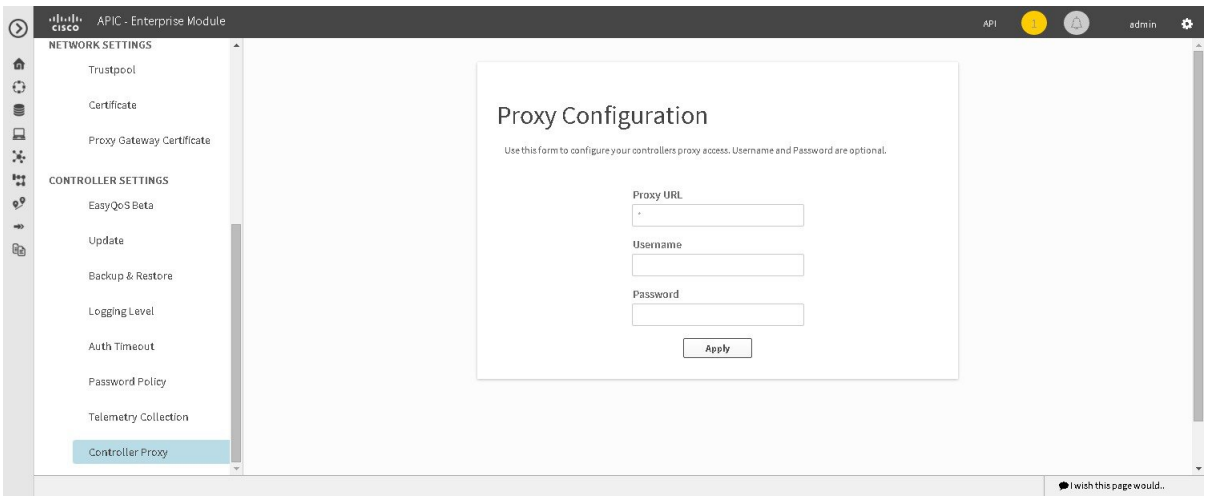
Step 6 (Optional) Click the **Update** button to apply the change for telemetry collection.

Configuring the Proxy

If the Cisco APIC-EM is unable to communicate directly with the telemetry server in the Cisco cloud, then a message will appear in the controller GUI (for an admin user) requesting that you configure access to the proxy. This message will contain a direct link to the **Proxy Configuration** window where you can configure this access. To configure access, enter the appropriate settings for the proxy server that exists between the controller and the telemetry server.

You configure these settings using the **Proxy Configuration** window in the Cisco APIC-EM GUI.

Figure 24: Proxy Configuration Window



Before You Begin

You must have successfully deployed the Cisco APIC-EM and it must be operational.

You must have administrator (ROLE_ADMIN) permissions to perform this procedure.

For information about the user permissions required to perform tasks using the Cisco APIC-EM, see the chapter, *Managing Users and Roles* in the *Cisco Application Policy Infrastructure Controller Enterprise Module Configuration Guide*.

Step 1 In the **Home** window, click either **admin** or the **Settings** icon (gear) at the top right corner of the screen.

Step 2 Click the **Settings** link from the drop-down menu.

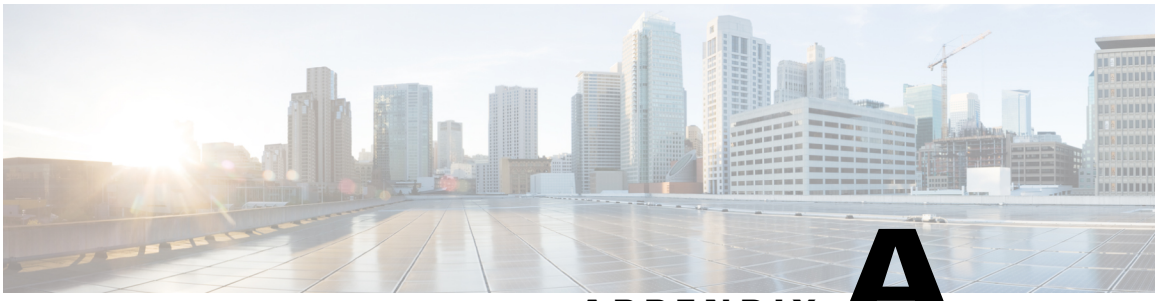
Step 3 In the **Settings** navigation pane, click **Controller Proxy** to view the **Proxy Configuration** window.

Step 4 Enter the proxy server's URL address.

Step 5 (Optional) If the proxy server requires authentication, then enter the username for access to the proxy server.

Step 6 (Optional) If the proxy server requires authentication, then enter the password that is required for access to the proxy server.

Step 7 Click the **Apply** button to apply your proxy configuration settings to the controller.



APPENDIX A

Cisco APIC-EM Multi-Host Support

Multi-Host Support

A host is defined as an appliance, physical server, or virtual machine with Linux containers running instances of the Grapevine clients. The Grapevine root itself runs directly on the host's operating system and not in the Linux containers. You can set up either a single host or multi-host deployment. A multi-host deployment with three hosts is best practice for both high availability and scale. Each Grapevine root in a multi-host configuration maintains an Active/Active status with the other Grapevine roots and is therefore able to coordinate with the other Grapevine roots the overall management of the cluster.

Note Active/Active is defined as all Grapevine roots being operational and active.

Each host must be running the same controller software in the multi-host configuration. You are able to mix and match physical and virtual appliances in the multi-host configuration.

The multi-host configuration has the following requirements and features:

- Each host requires a minimum of 32 GB of memory.
- A multi-host cluster comprised of 3 hosts is able to tolerate the loss of one of the hosts and supports a single fail-over (although with only two hosts, there is no HA).

  Note If a second host also fails in the three host cluster, the remaining host in the cluster will become inoperable and the cluster will go down. Therefore, in the event of the loss of one of the hosts, we recommend that you remove this host from the cluster using the configuration wizard and then either repair and rejoin this host to the cluster or join a new host to the cluster.

- As each host is configured with 32 GB of memory, if a host failure occurs then the remaining hosts would have a total 64 GB of memory which is sufficient to run the controller.
- All three hosts must reside in the same subnet.

Clustering and Database Replication

The clustering feature of the Cisco APIC-EM provides a mechanism for distributing processing and database replication among multiple hosts that run the exact same version of the controller. Clustering provides both a sharing of resources and features, and enables system high availability and scalability.

Security Replication

In a multi-host environment, the security features of a single host are replicated among the other two hosts, including any X.509 certificates or trustpools. Once you join a host to another host or to a cluster, the Cisco APIC-EM credentials are shared and become the same as that of the host you are joining or the pre-existing cluster. The Cisco APIC-EM credentials are cluster-wide (across hosts) and not per-host.

Note We strongly suggest that any multi-host cluster that you set up be located within a secure network environment. For this release, privacy is not enabled for all of the communications between the hosts.

Service Redundancy

The Cisco APIC-EM provides high availability (HA) support using service redundancy. A Cisco APIC-EM cluster can be set up across multiple Linux containers within multiple hosts. On each host, the Grapevine root is an application running on the host and the Grapevine clients are created and reside in the containers. Both the Cisco APIC-EM services and database are then instantiated across the clients within the Linux containers:

- Cisco APIC-EM Services:
  - For service high availability, if a service fails then Grapevine (the Elastics Service Platform) spins up a new instance to replace it. If Grapevine is unable to spin up the new instance on the same container after a sole instance fails, then it spins up a new container and then spins up the new instance on this container.
  - Cisco APIC-EM supports a replacement service instance model. For example, assume that one of the roots on a single host spins up an instance. If that host and its root goes down, then another host on another root spins up an instance to ensure continuity of that service.
- Cisco APIC-EM Database:
  - The Cisco APIC-EM services use a PostgreSQL database management system. PostgreSQL has a built-in master-slave model for synchronizing data across replicated databases to respond to any failover situation.
  - The master and slave postgres instances are grown across different Linux containers and across different hosts. The data of these postgresSql instances are synchronized using PostgresSQL's built-in data streaming replication mechanism. With three hosts, there is one master (with a master postgres instances) and two slaves (each with a slave postgres instance).
  - If the master fails, then the slave seamlessly takes over.

- In the event of a failure by the master, an election process occurs among the remaining hosts to determine which becomes the new master. This election process can also be triggered by resetting the controller using the CLI or rebooting the host.

Caution To protect against any hardware failure, you need to deploy the Cisco APIC-EM on a cluster with three hosts.

Multi-Host Synchronization

Whenever there is a configuration change on one of the hosts, Grapevine synchronizes the change with the other two hosts. The supported types of synchronization include:

- Database—Synchronization includes any database updates related to the configuration, performance, and monitoring data.
- File—Synchronization includes any changes to the configuration files.

Multi-Host Monitor Process

Grapevine is the main component that manages HA operations in a cluster. To ensure proper cluster HA operation, Grapevine uses both health checks and heart beats.

Health checks are used to monitor processes that are low performing and not running properly. Services that run on Grapevine have health checks that are periodically invoked. If there is any indication of an unhealthy service, Grapevine will harvest and regrow that service.

In addition to the health checks, Grapevine also uses heart beats between the services, clients, and roots to monitor the status of the cluster. Grapevine monitors these heart beats for any processes that may have failed. If there is no heart beat, then this indicates that a process has failed and to correct for this situation, Grapevine regrows the service.

Grapevine also uses a heart beat to monitor for adequate memory and storage capability for the cluster. If a heart beat indicates that the cluster's memory or storage fails below an appropriate level necessary for successful operations, then Grapevine will not grow any new services.

Split Brain and Network Partition

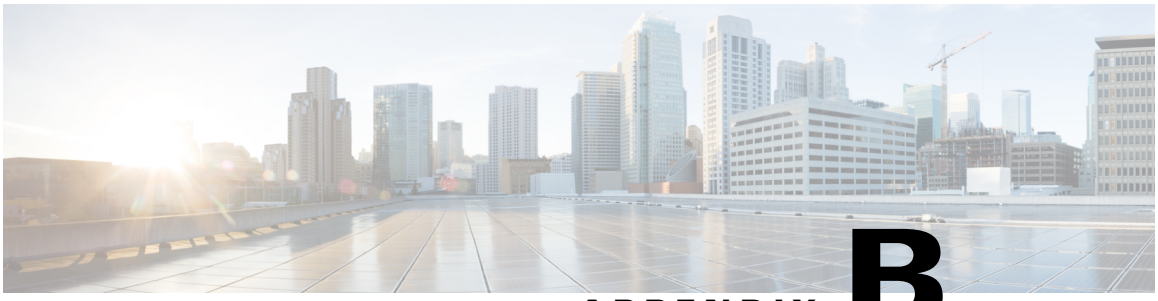
When Cisco APIC-EM is configured as a multi-host cluster, a private network connection is set up between the hosts. This private network connection is used by each host to monitor the health and status of the other cluster hosts. A split brain occurs when there is a temporary failure of the network connection between the hosts, for example, due to any of the following occurrences:

- Physical disconnection of the network connection from a host
- Loss of power to one or more hosts
- Cisco APIC-EM appliance failure

During a split brain occurrence, situations can arise where each separate host is sending commands to a given network device without any coordination with the other hosts, and the results can be problematic.

To correct for a split brain event, when the private network connection fails between one of the hosts, the other two hosts create a quorum and establish a network partition between themselves and the failed host with the following results:

- The split brain or network partition scenarios are be handled by ensuring quorum (majority reads and rights) to the controller database.
- The side of the partition with the "minority" stops operating, since it is be unable to perform quorum (majority reads and rights) to the controller database.
- The side of the partition with the "majority" continues to operate, since they are *able* to perform quorum (majority reads and rights) to the controller database.



APPENDIX B

Preparing Virtual Machines for Cisco APIC-EM

Preparing a VMware System for Cisco APIC-EM Deployment

To ensure that the Cisco APIC-EM works well within a virtual environment, configure the virtual machine with recommended resource pool values. A resource pool is a logical abstraction for the virtual machines that can be used to manage resources. Resource pools can be grouped into hierarchies and then used to partition CPU and memory resources.

You can configure and prepare the virtual machine using either the VMware vSphere Client or Web Client. We recommend that you use the VMware vSphere Web Client, since the **Latency Sensitivity** setting for resource pools must be configured as **High**. The **Latency Sensitivity** setting can only be configured using the VMware vSphere Web Client

Note When deploying the Cisco APIC-EM in a virtual environment, you must first configure the VMware system before installing Cisco APIC-EM. To install Cisco APIC-EM, you need to download the ISO image containing the controller from Cisco.com and then map the ISO image to the VMware system and boot from it.

Related Topics

Configuring Resource Pools Using vSphere Web Client, on page 119

Configuring a Virtual Machine Using vSphere Web Client, on page 122

System Requirements—Virtual Machine, on page 9

Virtual Machine Configuration Recommendations

The following table lists the recommended configuration settings for a successful Cisco APIC-EM VMware vSphere installation, including resource pools. When installing Cisco APIC-EM on a supported virtual machine, we recommend that the following configuration settings are used.

Note When preparing the virtual machine for the Cisco APIC-EM, the configuration settings terminology may differ depending upon the VMware application and GUI that your are using.

Table 9: Virtual Machine Configuration Recommendations (Including Resource Pools)

Resource Pool: CPU Resources	Reservation—14400 MHz is minimum configuration setting for this value Limit—Unlimited Shares—Normal
vCPU	6 (minimum) **Note** 6 vCPUs is the minimum number required for your virtual machine configuration. For better performance, we recommend using 12 CPUs.
Resource Pool: Memory	Memory—32 GB or 64 GB is the minimum configuration setting for this value, depending upon your hardware. Reserve all guest memory—Enable
SCSI controller value	VMware Paravirtual
New network value	New network value—Enter the network that the controller will connect to. Status—Connect at power on Adapter type—VMXNET3
Advanced	Choose High for the Latency sensitivity

Related Topics

Configuring Resource Pools Using vSphere Web Client, on page 119
Configuring a Virtual Machine Using vSphere Web Client, on page 122
System Requirements—Virtual Machine, on page 9

Configuring Resource Pools Using vSphere Web Client

To ensure that the Cisco APIC-EM works well within a virtual environment, you should configure resource pools with the recommended values. A resource pool is a logical abstraction for the virtual machines that can be used to manage resources. Resource pools can be grouped into hierarchies and then used to partition CPU and memory resources.

Note You should first create a new resource pool with the recommended configuration values as described in this procedure, and then subsequently create a virtual machine (where the Cisco APIC-EM will be installed) on that resource pool.

Before You Begin

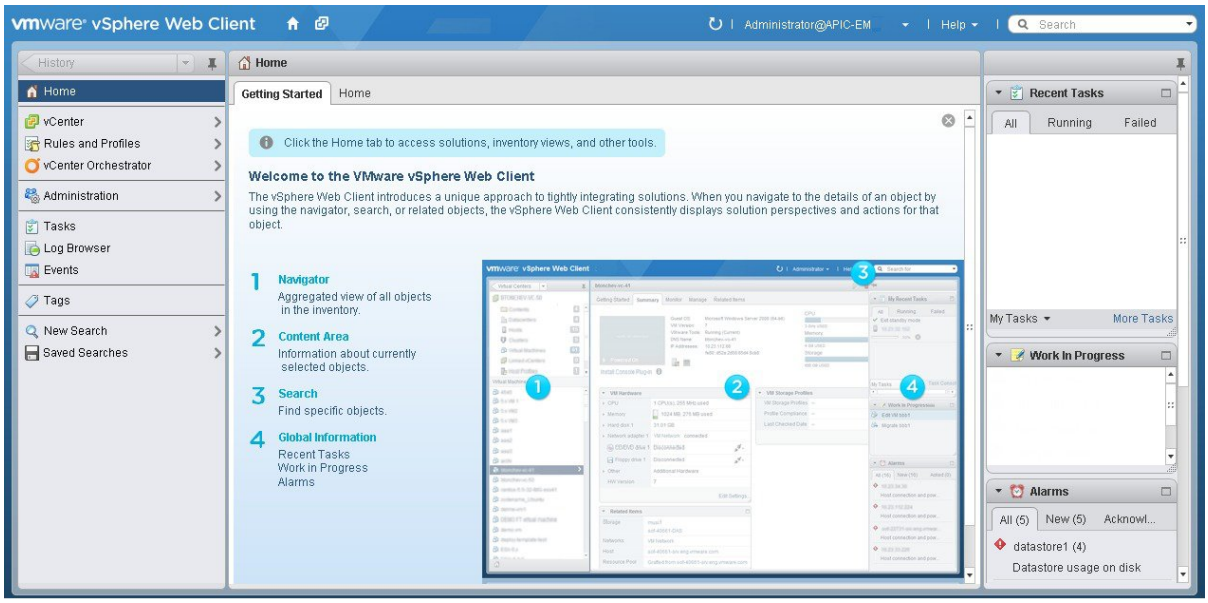
You have reviewed your VMware documentation concerning resource pools and their configuration.

You are familiar with the VMware vSphere Web Client and have a basic knowledge of how to create, manage and troubleshoot virtual machines using it.

You have your host and virtual datastores already set up and accessible in vSphere Web Client for this procedure.

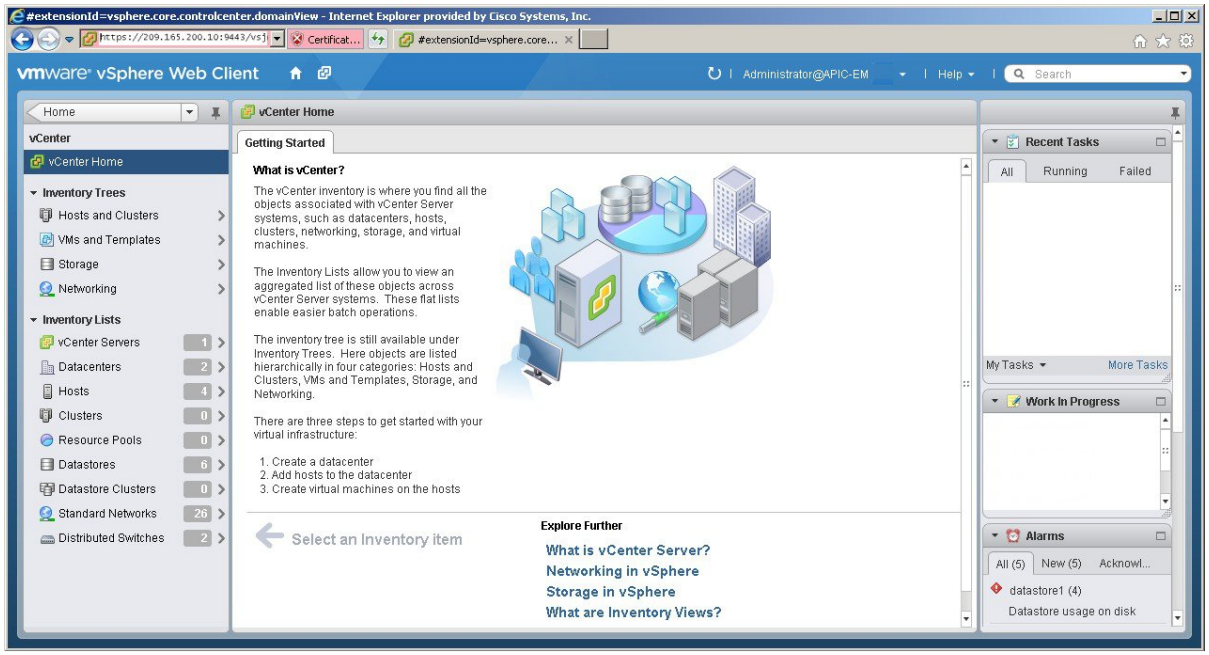
Step 1 Open the VMware vSphere Web Client to perform the procedure.

Figure 25: VMware vSphere Web Client



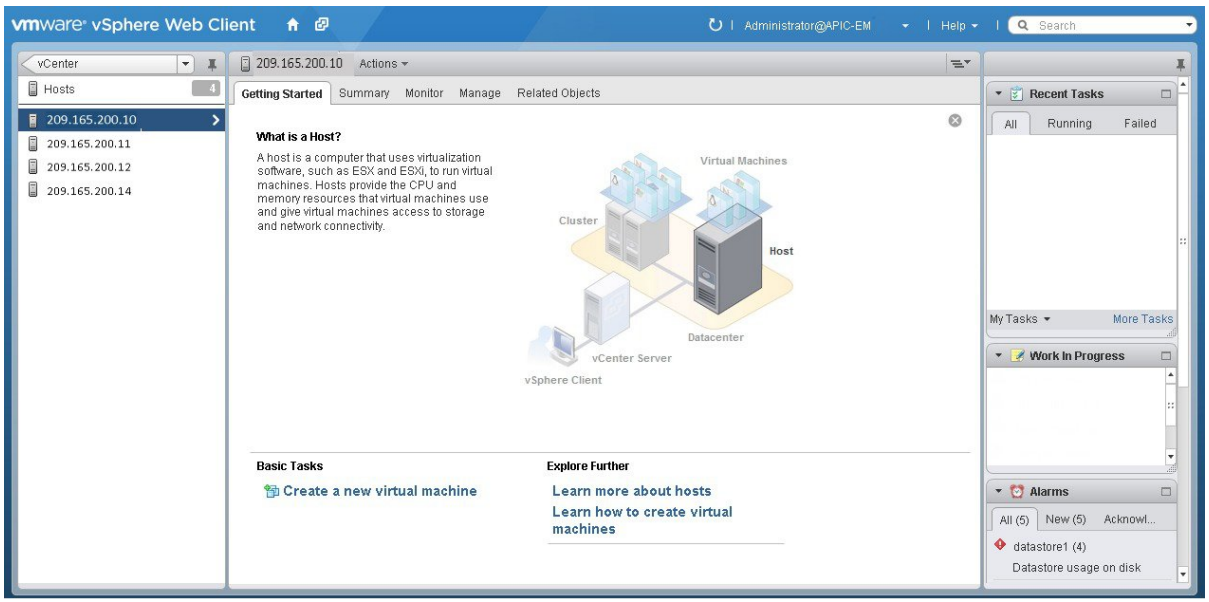
Step 2 Click **vCenter** in the **Navigator**.

Figure 26: vCenter Home



Step 3 Click on **Hosts**.

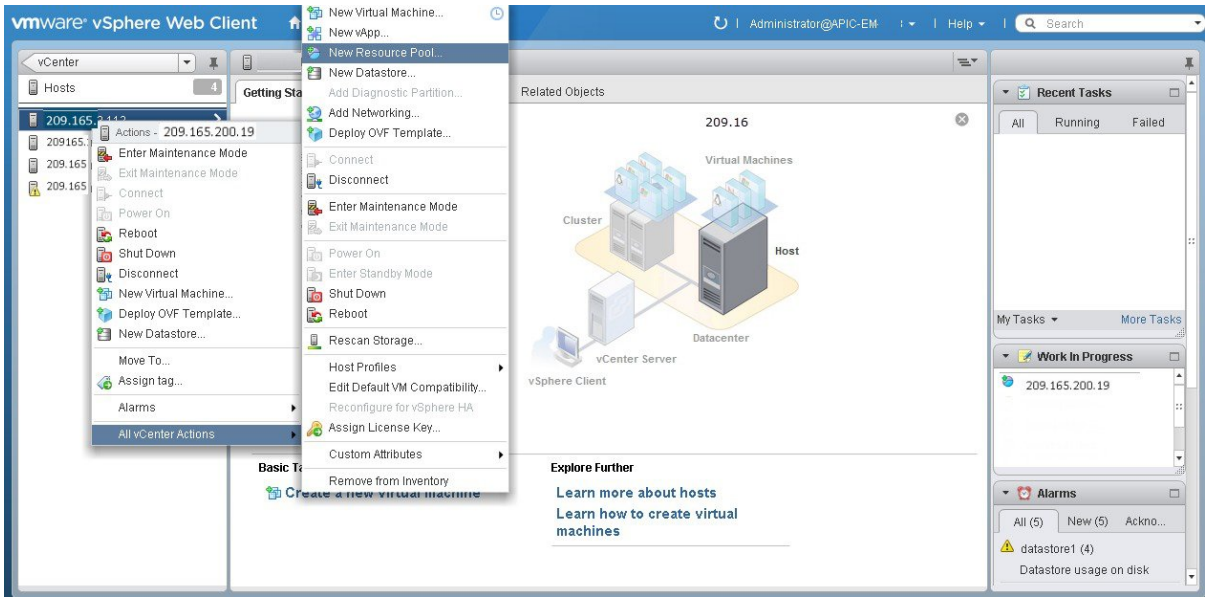
Figure 27: Hosts



Choose a host where you will create the resource pool.

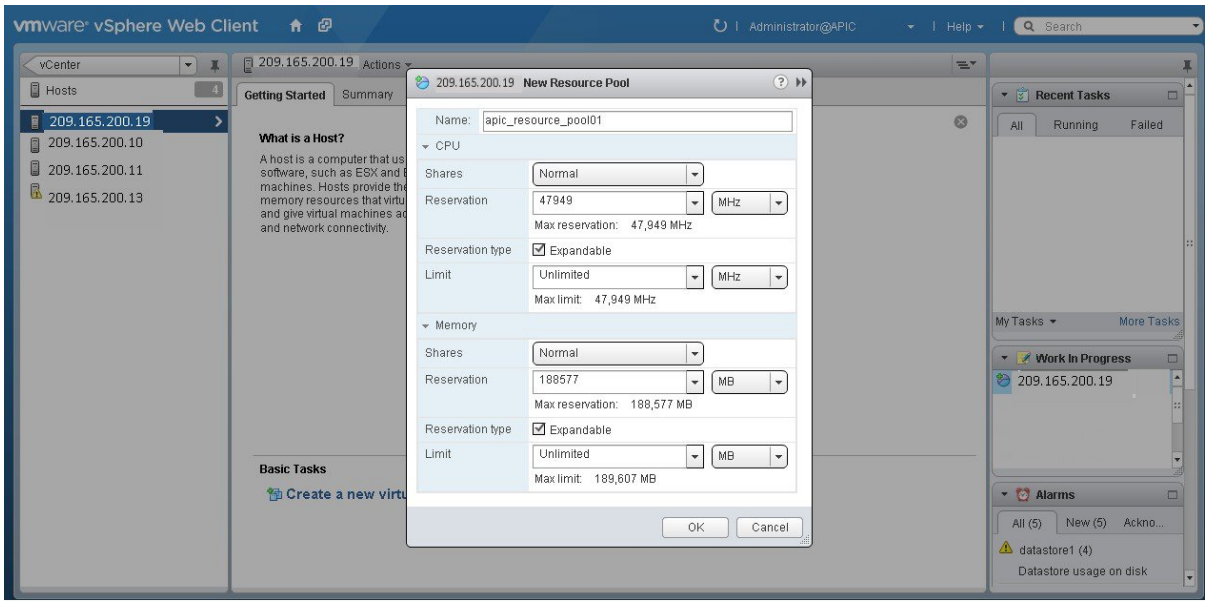
Step 4 Right-click on the selected host and click **All vCenter Actions** | **New Resource Pool**.

Figure 28: New Resource Pool



Step 5 Enter a name and specify values for the resource pool in the **New Resource Pool** dialog box.

Figure 29: New Resource Pool



We recommend entering the following resource pool values in this dialog box:

- **CPU Resources**
  - **Shares—**Choose **Normal** from the drop-down menu
  - **Reservation—**14400 MHz is minimum configuration setting for this value
  - **Reservation Type—**Check box for Expandable
  - **Limit—**Set to Maximum Limit
- **Memory Resources**
  - **Shares—**Choose **Normal** from the drop-down menu
  - **Reservation—**32 GB or 64 GB is the minimum configuration setting for this value, depending upon your hardware.
  - **Reservation Type—**Check box for Expandable
  - **Limit—**Set to Maximum Limit

Step 6 Click **OK** to save the configured resource pool values.

What to Do Next

Proceed to create a new virtual machine on this resource pool. For assistance with this procedure, see the following procedure, Configuring a VMware Server Using vSphere Web Client.

Related Topics

Preparing a VMware System for Cisco APIC-EM Deployment, on page 117
Virtual Machine Configuration Recommendations, on page 118
System Requirements—Virtual Machine, on page 9

Configuring a Virtual Machine Using vSphere Web Client

To ensure that the Cisco APIC-EM properly functions in a virtual environment, create the virtual machine(s) following the procedure described below with the recommended settings.

Note You must create this virtual machine on the resource pool that you earlier configured, as described in the previous procedure.

Before You Begin

You have reviewed the minimum system requirements for a successful Cisco APIC-EM VMware vSphere installation, as previously described in this guide.

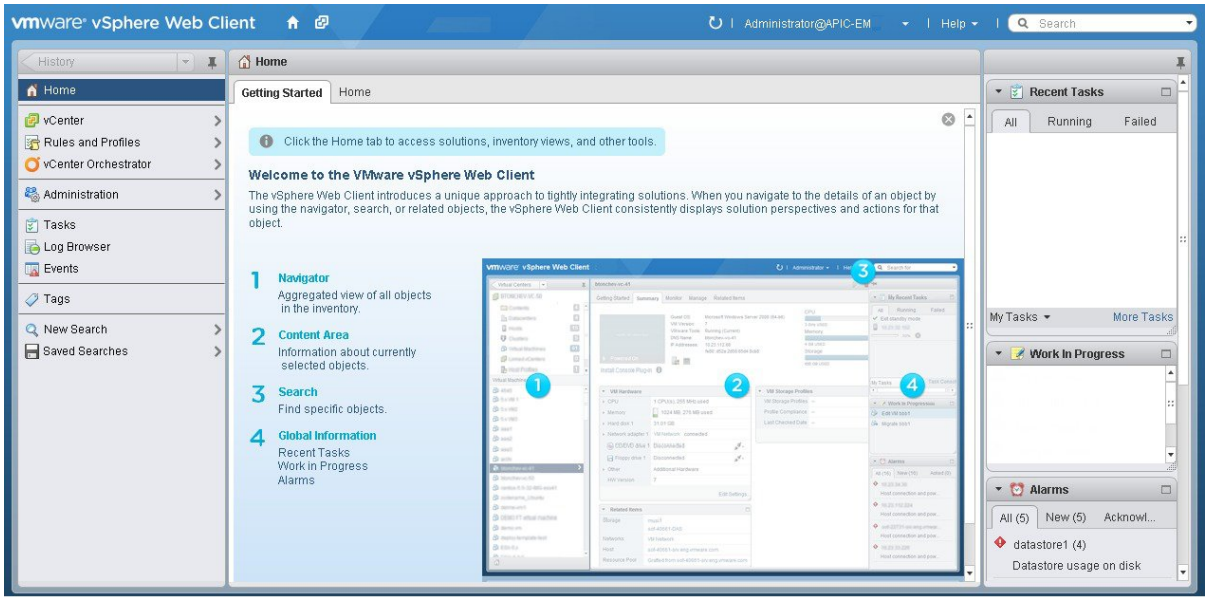
You are familiar with the VMware vSphere Web Client and have a basic knowledge of how to create, manage and troubleshoot virtual machines using the Web Client.

You have your host and virtual datastores already set up and accessible in vSphere Web Client for this procedure.

You have already created a resource pool on the host, following the steps described in the previous procedure, Configuring Resource Pools Using vSphere Web Client.

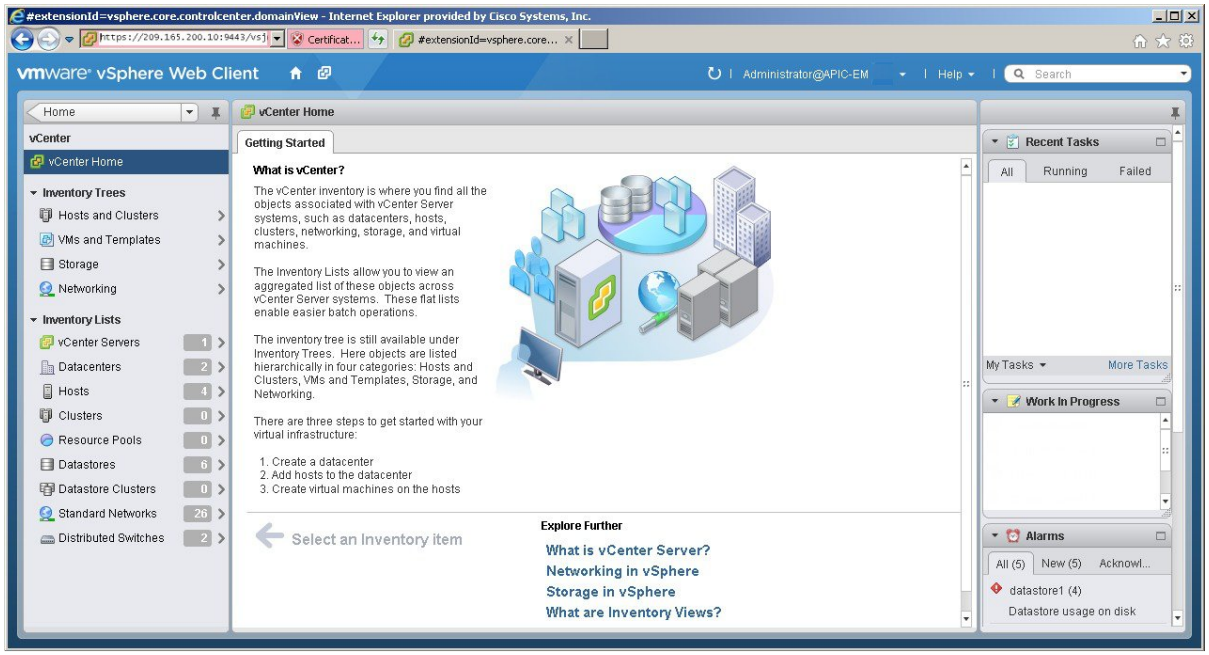
Step 1 Open the VMware vSphere Web Client to perform the procedure.

Figure 30: VMware vSphere Web Client



Step 2 Click **vCenter** in the **Navigator**.

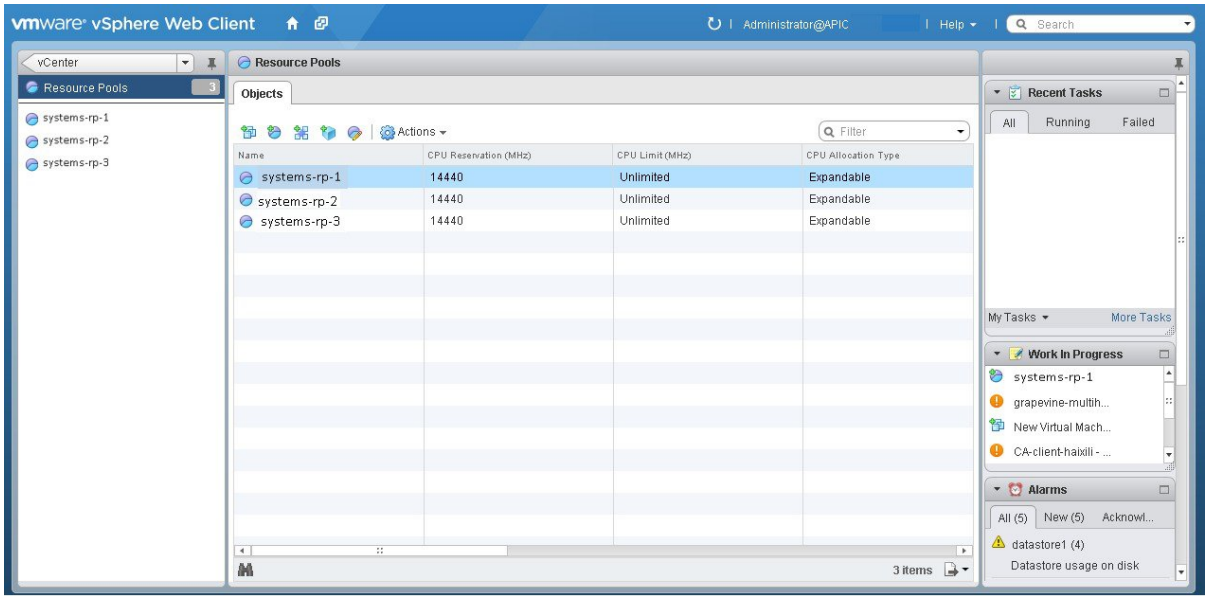
Figure 31: vCenter



Step 3 Click **Resource Pools** in the **Inventory Lists** in **vCenter**.

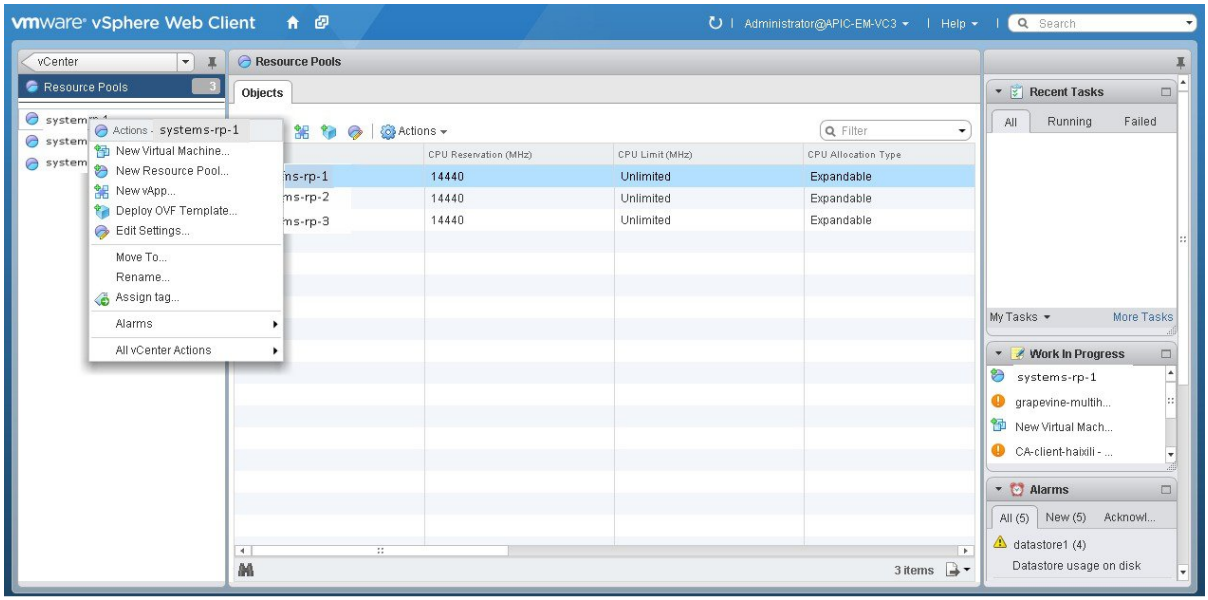
Step 4 Choose the resource pool where you will install the virtual machine from the list.

Figure 32: Resource Pools



Step 5 Right click on the resource pool and select **New Virtual Machine** from the menu.

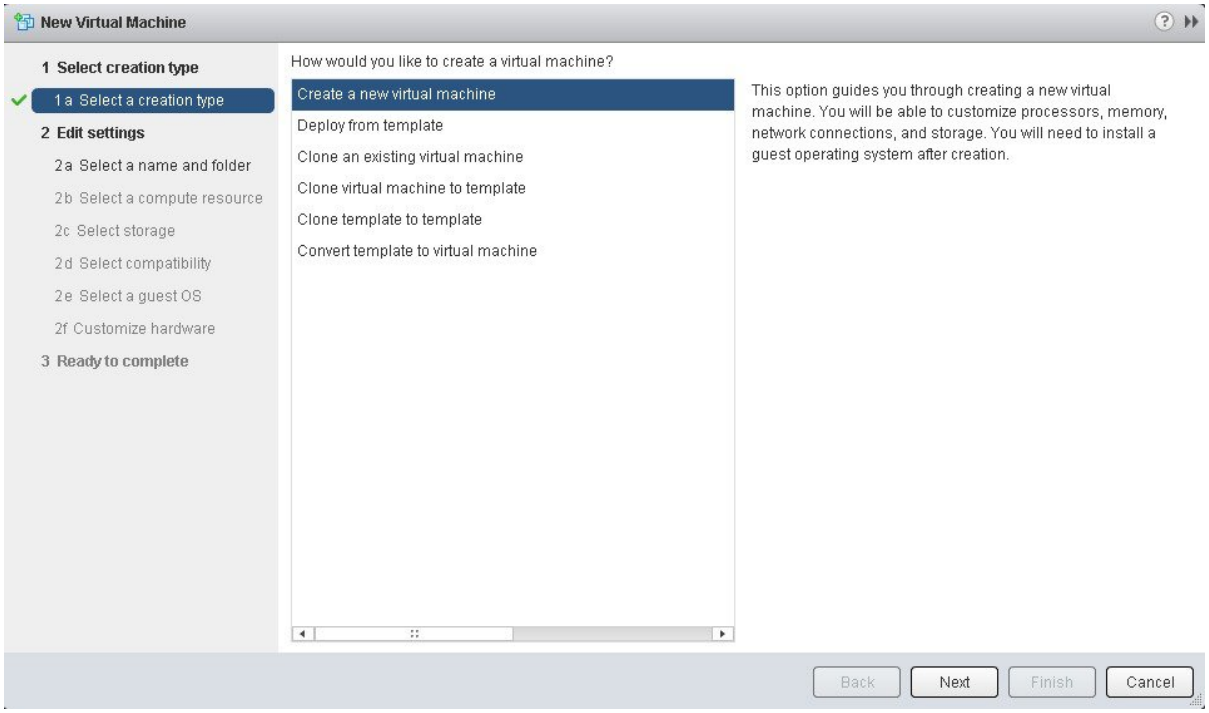
Figure 33: New Virtual Machine



Note We strongly recommend that only a single virtual machine be created under the resource pool.

Step 6 Click **Create a new virtual machine** in the **New Virtual Machine** dialog box under **1a Select creation type**.

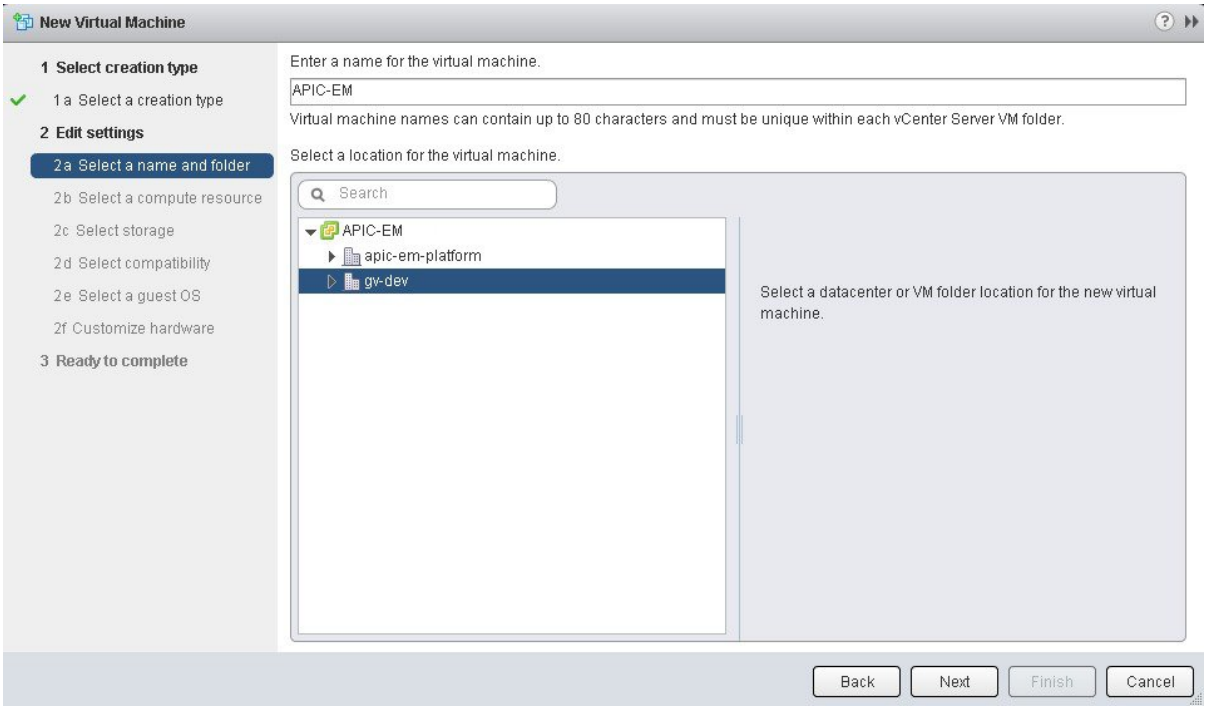
Figure 34: Select Creation Type



Click **Next** to proceed to the next step.

Step 7 In the **New Virtual Machine** dialog box under **2 Edit Settings**, click **2a Select a name and folder**. Enter a name for the virtual machine and a location for the virtual machine.

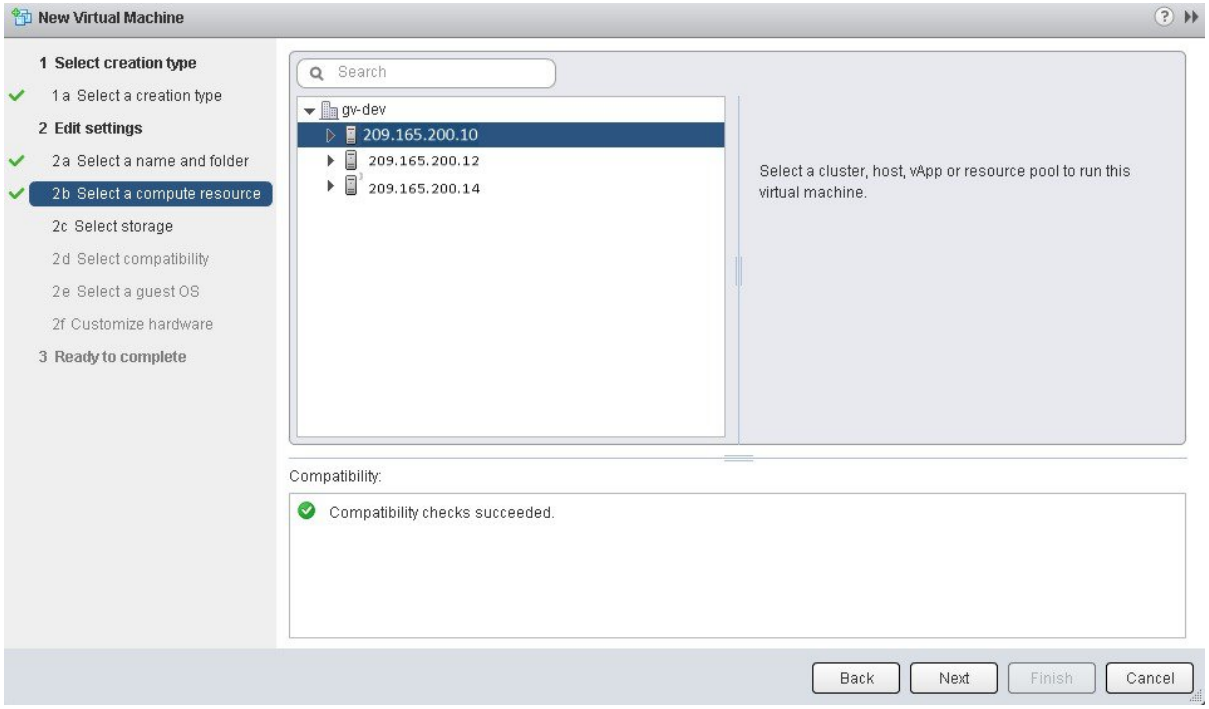
Figure 35: Select Name and Folder



Click **Next** to proceed to the next step.

Step 8 Click **2b Select a computer resource**.
Select the resource pool that was created in the previous procedure.

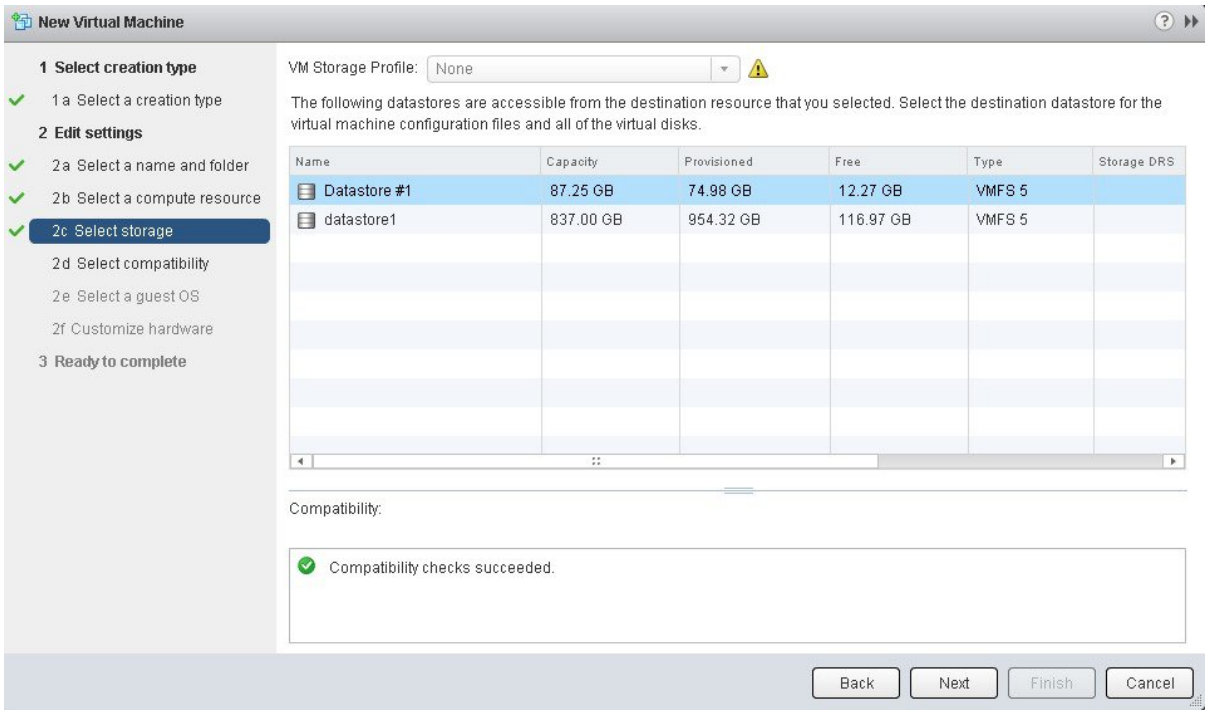
Figure 36: Select Computer Resource



Click **Next** to proceed to the next step.

Step 9 Click **2c Select storage**.
Select a datastore for your virtual machine.

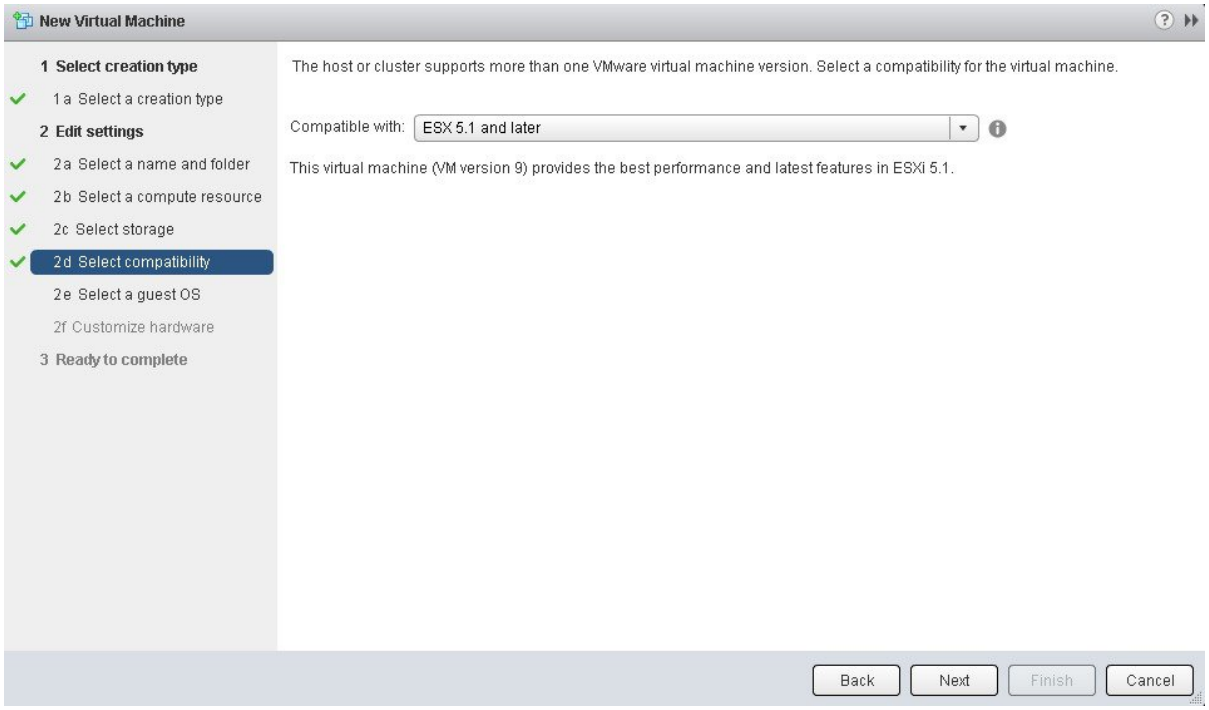
Figure 37: Select Storage



Click **Next** to proceed to the next step.

Step 10 Click **2d Select compatibility**.
Select **ESX 5.1 and later** from the drop down menu.

Figure 38: Select Compatibility

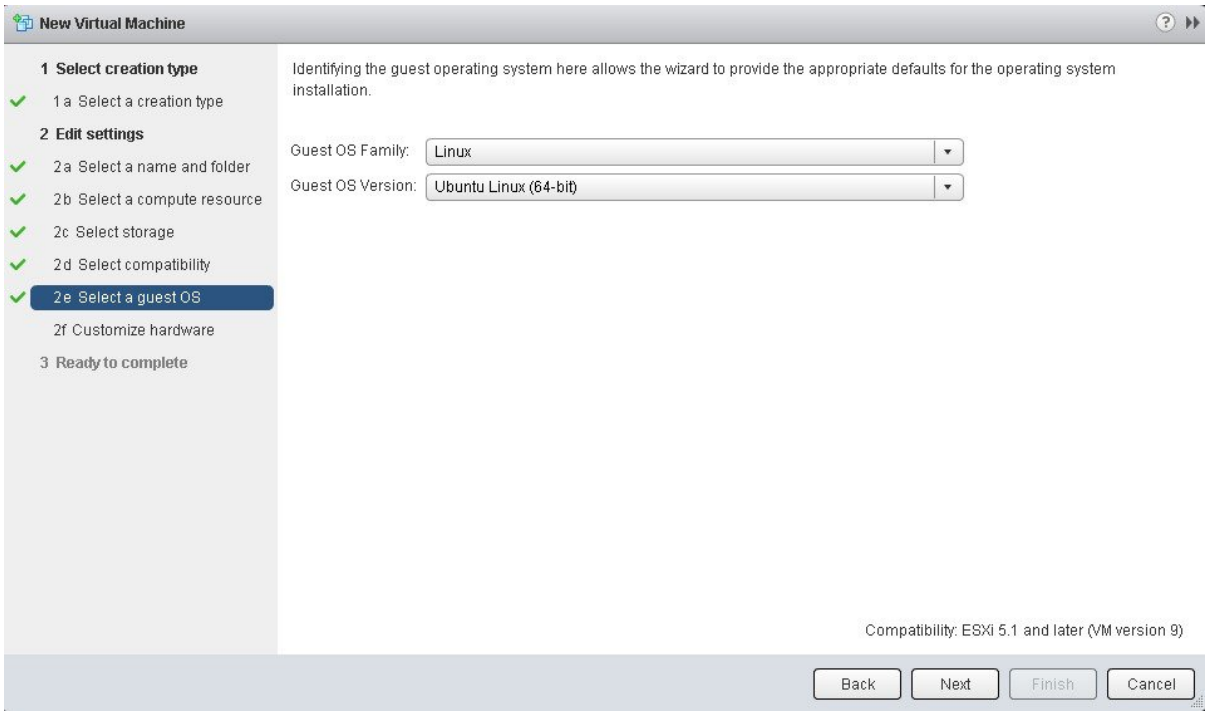


Click **Next** to proceed to the next step.

Step 11 Click **2e Select a guest OS**.
Select the following values from the drop down menus:

- **Guest OS Family**: Linux
- **Guest OS Version**: Ubuntu Linux (64-bit)

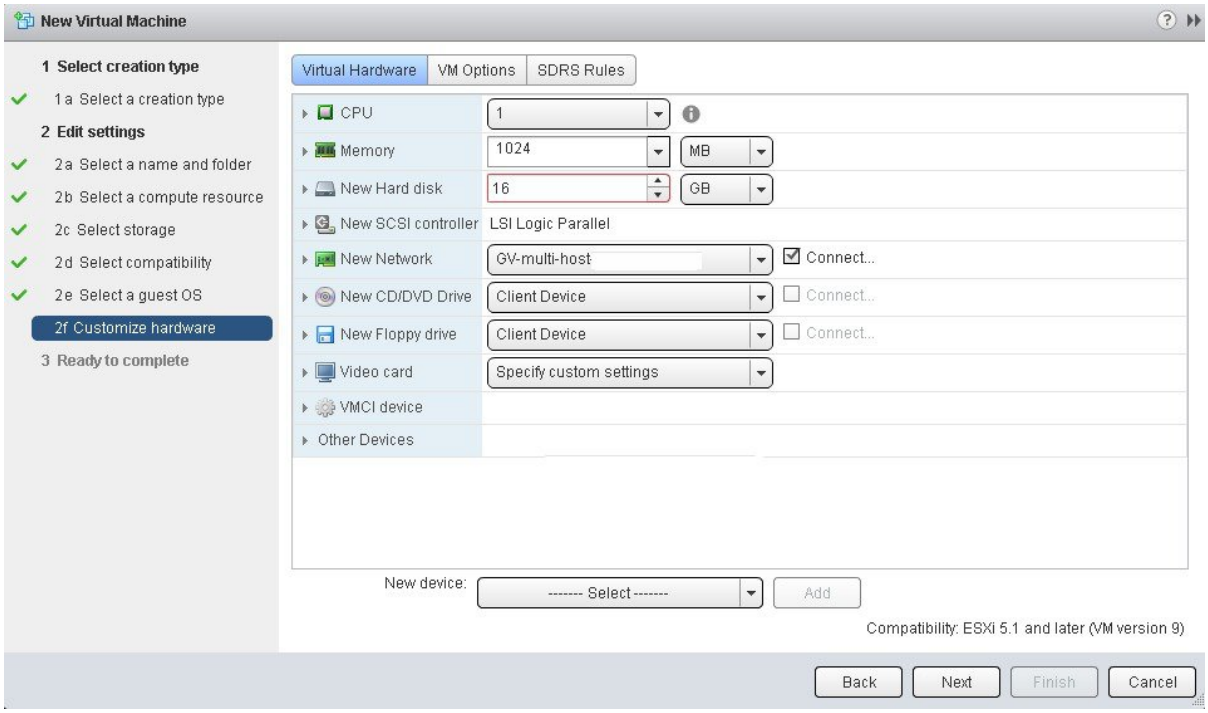
Figure 39: Select Guest OS



Click **Next** to proceed to the next step.

Step 12 Click **2f Customize hardware**.

Figure 40: Customize Hardware



Step 13 In the **Virtual Hardware** tab, ensure that the following **CPU** values are selected.

CPU	Enter a value of 6 cores. **Note** 6 cores is the minimum number to enter for your virtual machine configuration. For better performance, we recommend entering and using 12 cores.
Reservation	Enter a minimum value of at least 14400 MHz.
Limit	Select **Unlimited** from the drop down menu
Shares	Select **Normal** from the drop down menu.

Note The above dedicated CPU resources for the host are required for the Cisco APIC-EM.

Step 14 In the **Virtual Hardware** tab, ensure that the following **Memory** values are selected.

Memory	Enter a minimum value of 32 GB or 64 GB, depending on your hardware.
Reserve all guest memory (all locked)	Check this box.

Note The above dedicated memory resources for the host are required for the Cisco APIC-EM.

Step 15 In the **Virtual Hardware** tab, ensure that the following **New Hard disk** value is entered.

New Hard disk	Increase to at least 500 GB minimum.

Step 16 In the **Virtual Hardware** tab, ensure that the following **New SCSI controller** value is entered.

New SCSI controller	Select **VMware Paravirtual** from the drop down menu.

Step 17 In the **Virtual Hardware** tab, ensure that the following **New Network** values are entered.

New network value	Enter the network that the controller will connect to for this value.
Status	Check the box for **Connect at Power On**.
Adapter type	Select **VMXNET3** from the drop down menu.

Step 18 In the **Virtual Hardware** tab, ensure that the following **New CD/DVD Drive** value is entered.

New CD/DVD Drive	Select **Datastore ISO file** from the drop down and the configure the location of the ISO file in the **File** window.

Step 19 Click the **VM Options** tab to open it and ensure that the following values are entered.

Advanced	Choose **High for Latency sensitivity** from the drop down menu.

Click **Ok** to save your configuration and to proceed to the next step.

Step 20 Click **3 Ready to complete**.
Click **Finish** to finish the virtual machine configuration.

Step 21 In the virtual machine, map the Cisco APIC-EM ISO image onto the local drive (CD/DVD).

Step 22 Boot up the virtual machine and choose the **CD-ROM** option from the **Boot Menu**.

Step 23 Choose **Install Grapevine Appliance** from the **Ubuntu** window that appears in the virtual machine.

What to Do Next

Proceed to deploy the controller by following the configuration wizard prompts.

For information about the deployment process and configuration wizard options, see Chapter 4 in the *Cisco Application Policy Infrastructure Controller Enterprise Module Deployment Guide*, and the following sections:

- Configuring Cisco APIC-EM as a Single Host Using the Wizard
- Configuring Cisco APIC-EM as a Multi-Host Cluster Using the Wizard

Related Topics

Preparing a VMware System for Cisco APIC-EM Deployment, on page 117

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