Cisco TrustSec Support for IOS

Cisco TrustSec (CTS) is a system that provides security for CTS-enabled network devices at each routing hop. In this system, each network device works to authenticate and authorize its neighbor devices and next applies some level of security (group tagging, role-based access control lists (ACLs), encryption, and so on) to traffic between the devices.

The Cisco TrustSec Support for IOS feature involves using Secure RADIUS to prescribe a process of authentication, authorization, session association, encryption, and traffic filtering. Secure RADIUS uses automatic Protected Access Credential (PAC) provisioning as a low overhead method to send PAC metadata and control information to clients. PAC provisioning is used with Extensible Authentication Protocol-Flexible Authentication through Secure Tunneling (EAP-FAST) to establish a Transport Layer Security (TLS) tunnel in which client credentials are verified.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Prerequisites for Cisco TrustSec Support for IOS

To use the Cisco TrustSec functionality on your existing router, ensure that you have purchased a Cisco TrustSec security license. If the router is being ordered and needs the Cisco TrustSec functionality, ensure that this license is preinstalled on your router before it is shipped to you.

The Cisco Identity Services Engine 1.0 is required for authentication. The Secure Access Control Server (ACS) Express Appliance server can also be used for authentication; however, not all ACS features are supported by CTS.

Restrictions for Cisco TrustSec Support for IOS

- The Cisco TrustSec Support for IOS feature is supported on the Cisco Integrated Services Router Generation 2 (ISR G2) only.
- EAP-FAST only supports Phase 0 where the PAC is initially distributed to the client. EAP-FAST Phase 1 (the PAC is used to establish a secure tunnel) and Phase 2 (client is authenticated through the secure tunnel) are not supported.

Information About Cisco TrustSec Support for IOS

Cisco TrustSec Device Enrollment

Any device that participates in the CTS network requires it to be authenticated and trusted. New devices that connect to the CTS network use an enrollment process to obtain CTS authentication credentials and receive general information about the CTS environment to facilitate the authentication process. Device enrollment can happen either directly with an Authentication Server (AS) provided the device has L3 connectivity to AS or through a peer Authenticator (AT) device, such as a switch or router that facilitates enrollment with an AS.

Access switches or routers are the authentication points in typical branch access scenarios and have direct connectivity to the AS. They authenticate endpoints through EAP-FAST Phase 0 for dynamic PAC provisioning or RADIUS and EAP exchange. When endpoints are successfully authenticated, they receive user-specific AAA attributes that include the SGT, which in turn is relayed to a router using SXP. The router initiates EAP-FAST Phase 0 exchange with the available AS and obtains a PAC. This is accomplished by a local PAC-provisioning driver, which acts as a pass-through authenticator to the supplicant EAP-FAST engine running on the router.

Secure RADIUS

The RADIUS protocol requires a secret to be shared between a client and a server. Shared secrets are used to verify that RADIUS messages are sent by a RADIUS enabled device that is configured with the same shared secret. Shared secrets also verify that the RADIUS message has not been modified in transit (message integrity). The message integrity is checked by including the Message Authenticator attribute in the RADIUS messages. This attribute is a Hash-based Message Authentication Code-Message Digest 5 (HMAC-MD5) of the entire radius message using the shared secret as the key. The shared secret is also used to encrypt some RADIUS attributes, such as User-Password and Tunnel-Password.

EAP-FAST

EAP-FAST is a publicly accessible IEEE 802.1X extensible authentication protocol type that is used to support customers who cannot enforce a strong password policy. EAP-FAST is used for the following reasons:

- Digital certificates are not required.
- A variety of database types for usernames and passwords are supported.
- Password expiration and change are supported.
- EAP-FAST is flexible, easy to deploy and manage.

Note Lightweight Directory Access Protocol (LDAP) users cannot be automatically PAC provisioned and must be manually provisioned.

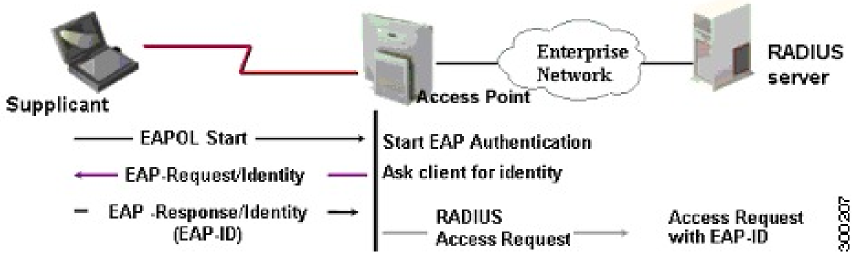
EAP-FAST comprises three basic phases, but only Phase 0 is supported. Phase 0 initially distributes the PAC to the client device.

Note Unsupported EAP-FAST Phase 1 uses the PAC to establish a secure tunnel and Phase 2 authenticates the client through a secure tunnel.

Phase 0 or auto-provisioning (also called in-band provisioning) component of EAP-FAST permits the secure distribution of the user PAC to each device. With some other authentication protocols, it is necessary to establish a network connection or manually install a file in order to distribute credentials to the device. Phase 0 in EAP-FAST permits a PAC to be distributed to the device during an encrypted session after the device's credentials are authenticated. This device authentication uses a challenge-handshake protocol to authenticate the device and to validate the server response. This authentication mechanism guards against potential interception and reforwarding of provisioning requests for the purpose of intercepting a user PAC.

The end result of Phase 0 is PAC distribution. After successful PAC distribution, the server issues an authentication failure to the access point and the device is disassociated from the network. Then the device reinitiates an EAP-FAST authentication with the network using the newly provisioned PAC and the device's credentials.

The figure below shows an overview of EAP-FAST authentication.



Protected Access Credential (PAC)

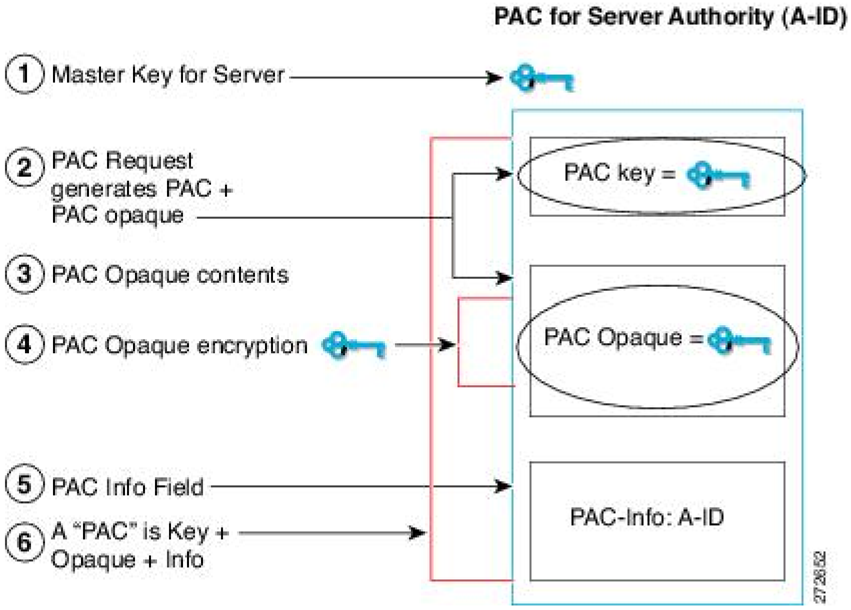
The PAC is a unique shared credential used to mutually authenticate client and server. It is associated with a specific client username and a server authority identifier (A-ID). A PAC removes the need for Public Key Infrastructure (PKI) and digital certificates.

Creating a PAC consists of the following steps:

1. Server A-ID maintains a local key (master key) that is only known by the server.
2. When a client, which is referred to in this context as an initiator identity (I-ID), requests a PAC from the server, the server generates a randomly unique PAC key and PAC-Opaque field for this client.
3. The PAC-Opaque field contains the randomly generated PAC key along with other information such as an I-ID and key lifetime.
4. PAC Key, I-ID, and Lifetime in the PAC-Opaque field are encrypted with the master key.
5. A PAC-Info field that contains the A-ID is created.
6. The PAC is distributed or imported to the client automatically.

Note The server does not maintain the PAC or the PAC key, enabling the EAP-FAST server to be stateless.

The figure below describes the PAC's construction. A PAC consists of the PAC-Opaque, PAC Key, and PAC-Info fields. The PAC-Info field contains the A-ID.



PAC Provisioning

In Secure RADIUS, the PAC key is provisioned into each device during authentication to derive the shared secret. Since the RADIUS ACS does not store the PAC key for each device, the clients must also send an additional RADIUS attribute containing the PAC-Opaque field, which is a variable length field that can only be interpreted by the server to recover the required information and validate the peer's identity and authentication. For example, the PAC-Opaque field may include the PAC key and the PAC's peer identity.

The PAC-Opaque field format and contents are specific to the PAC server on which it is issued. The RADIUS server obtains the PAC Key from the PAC-Opaque field and derives the shared secret the same way clients do. Secure RADIUS only modifies the way shared secret is derived and not its usage.

EAP-FAST Phase 0 is used to automatically provision a client with a PAC.

Deploying Devices in High Availability Setup

Perform the following steps when deploying devices in an HA setup:

1. Clear the credentials from all the devices which are part of the HA setup.
2. Boot the stack setup and establish the device roles (active, standby, and members).
3. Configure the credentials on the active device. Use the **cts credentials id** *id* **password** *password* command to configure the credentials.

Note While adding a new device to an existing stack, ensure that you clear the credentials on the fresh device and then add it to the existing stack setup.

How to Provide Cisco TrustSec Support for IOS

Installing the Cisco TrustSec Security License

To use the Cisco TrustSec functionality on your existing router, ensure that you have purchased a Cisco TrustSec security license. If the router is being ordered and needs the Cisco TrustSec functionality, ensure that this license is preinstalled on your router before it is shipped to you.

Perform this task to manually install the Cisco TrustSec security license:

SUMMARY STEPS

1. **enable**
2. **license install** *stored-location-url*
3. **license boot module** *module-name* **technology-package** *package-name*
4. **reload**
5. **show license udi**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**license install** *stored-location-url* **Example:** `Router# license install tftp://mytftpserver/mylicensefile.lic`	Installs the license on the router.
Step 3	**license boot module** *module-name* **technology-package** *package-name* **Example:** `Router# license boot module c2900 technology-package securityk9`	Specifies the security software license to boot. • The *module-name* argument is the router or module to be configured. • The **technology-package** keyword and *package-name* argument upgrades the security software license package from which the router should boot. • Accept the end-user license agreement when prompted.
Step 4	**reload** **Example:** `Router# reload`	Restarts the router to enable the new software with the securityk9 license containing the Cisco TrustSec license.
Step 5	**show license udi** **Example:** `Router# show license udi`	Displays all the UDI values that are licensed in the system, and verifies that your Cisco TrustSec security license has installed successfully.

What to Do Next

See the “Configuring Cisco TrustSec Credentials” section to configure the basic parameters needed to make Cisco TrustSec operational on your router.

Configuring Cisco TrustSec Credentials

Perform this task for CTS to work on your router.

SUMMARY STEPS

1. **enable**
2. **cts credentials id** *cts-id* **password** *password*
3. **configure terminal**
4. **aaa new-model**
5. **aaa authentication dot1x default group radius**
6. **cts authorization list network** *list-name*
7. **aaa authorization network** *list-name* **group radius**
8. **exit**
9. **show cts server-list**
10. **show cts credentials**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**cts credentials id** *cts-id* **password** *password* **Example:** `Router# cts credentials id ctsid password abcd`	Specifies the CTS device ID for this device to use when authenticating with other CTS devices with EAP-FAST because CTS requires each device in the network to identity itself uniquely. • The *cts-id* argument has a maximum length of 32 characters and is case sensitive. • The *password* argument is the password for this device to use when authenticating with other CTS devices with EAP-FAST.
Step 3	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 4	**aaa new-model** **Example:** `Router(config)# aaa new-model`	Enables new RADIUS and AAA access control commands and functions and disables old commands.

	Command or Action	Purpose
Step 5	**aaa authentication dot1x default group radius** **Example:** `Router(config)# aaa authentication dot1x default group radius`	Specifies that RADIUS servers are used for authentication on interfaces running IEEE 802.1X.
Step 6	**cts authorization list network** *list-name* **Example:** `Router(config)# cts authorization list network cts-mlist`	Specifies a list of AAA servers for the CTS seed device to use.
Step 7	**aaa authorization network** *list-name* **group radius** **Example:** `Router(config)# aaa authorization network cts-mlist group radius`	Specifies the CTS authorization list name for all network-related service requests from RADIUS servers.
Step 8	**exit** **Example:** `Router(config)# exit`	Exits global configuration mode.
Step 9	**show cts server-list** **Example:** `Router# show cts server-list`	Displays the RADIUS the server configurations for CTS seed devices.
Step 10	**show cts credentials** **Example:** `Router# show cts credentials`	Displays the CTS device ID. The stored password is never displayed.

Configuring Secure RADIUS Automatic PAC Provisioning

In seed devices, the PAC-Opaque field has to be provisioned so that all RADIUS exchanges can use the PAC-Opaque field to make the server it communicates with capable of automatic PAC provisioning. All non-seed devices obtain the PAC-Opaque field during the authentication phase of a link initialization.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **aaa new-model**
4. **radius server** *name*
5. **address ipv4** *hostname* [**acct-port** *port* | **alias** *name* | **auth-port** *port* [**acct-port** *port*]]
6. **pac key** *encryption-key*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**aaa new-model** **Example:** `Router(config)# aaa new-model`	Enables new RADIUS and AAA access control commands and functions and disables old commands.
Step 4	**radius server** *name* **Example:** `Router(config)# radius server myserver`	Specifies a name for the RADIUS server PAC provisioning configuration and enters RADIUS server configuration mode.
Step 5	**address ipv4** *hostname* [**acct-port** *port* | **alias** *name* | **auth-port** *port* [**acct-port** *port*]] **Example:** `Router(config-radius-server)# address ipv4 10.0.0.1 acct-port 1813 auth-port 1812`	Configures the RADIUS server accounting and authentication parameters for PAC provisioning. • The *hostname* argument is the RADIUS server IPv4 address or Domain Name System (DNS) name. • The **acct-port** keyword and *port* argument specify the UDP port for the RADIUS accounting server for accounting requests. The default port is 1646. • The **alias** keyword and *name* argument specify an alias for this server. The alias can be an IPv4 address or host name. Up to 8 aliases can be configured for this server.

	Command or Action	Purpose
		• The **auth-port** keyword and *port* argument specify the UDP port for RADIUS authentication server. The default port is 1645.
Step 6	**pac key** *encryption-key* **Example:** `Router(config-radius-server)# pac key 7 mypackey`	Specifies the PAC encryption key (overrides the default). • The *encryption-key* can be **0** (specifies that an unencrypted keys follows), **7** (specifies that a hidden key follows), or a line specifying the unencrypted (clear-text) server key.

What to Do Next

Note Automatic PAC Provisioning can also be triggered by Secure RADIUS when the server has no PAC or when an Access-Reject message is received from the Autonomous System (AS) says “PAC Expired”.

Configuration Examples for Cisco TrustSec Support for IOS

Configuring the CTS Device ID and Password: Example

The following example configures himalaya and cisco as the CTS device ID and password:

```
Router# cts credentials id himalaya password cisco

CTS device ID and password have been inserted in the local keystore. Please make sure that
 the same ID and password are configured in the server database.
```

The following example changes the CTS device ID and password to atlas and cisco123:

```
Router# cts credentials id atlas password cisco123
A different device ID is being configured.
This may disrupt connectivity on your CTS links.
Are you sure you want to change the Device ID? [confirm] y
TS device ID and password have been inserted in the local keystore. Please make sure that
the same ID and password are configured in the server database.
```

The following example displays the CTS device ID and password state:

```
Router# show cts credentials
CTS password is defined in keystore, device-id = atlas
```

Configuring AAA for a CTS Seed Device and Automatic PAC Provisioning: Example

The following example configures the AAA configuration for a CTS seed device and automatic PAC provisioning on the router:

```
Router# configure terminal
Router(config)# aaa new-model
Router(config)# aaa authentication dot1x default group radius
Router(config)# aaa authorization network cts-mlist group radius
Router(config)# cts authorization list cts-mlist
Router(config)# aaa accounting dot1x default start-stop group radius
Router(config)# radius-server host 10.20.3.1 auth-port 1812 acct-port 1813 pac key AbCe1234
Router(config)# radius-server vsa send authentication
Router(config)# dot1x system-auth-control
Router(config)# exit
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
Security commands	Cisco IOS Security Command Reference: Commands A to C Cisco IOS Security Command Reference: Commands D to L Cisco IOS Security Command Reference: Commands M to R Cisco IOS Security Command Reference: Commands S to Z
EAP Flexible Authentication via Secured Tunnel (EAP-FAST) authentication protocol deployment in wireless networks	EAP-FAST Deployment Guide
Cisco TrustSec switches	Cisco TrustSec Switch Configuration Guide

MIBs

Description	Link
CISCO-TRUSTSEC-SXP-MIB	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for Cisco TrustSec Support for IOS

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 1: Feature Information for Cisco TrustSec Support for IOS

Feature Name	Releases	Feature Information
Support for Cisco TrustSec Solution on ISR Platforms.	12.2(33)SXI 15.2(2)T	This feature involves using secure RADIUS to prescribe a process of authentication, authorization, session association, encryption, and traffic filtering. Secure RADIUS uses automatic PAC provisioning as a low overhead method to send PAC metadata and control information to clients. PAC provisioning is used with EAP-FAST to establish a TLS tunnel in which client credentials are verified. In Cisco IOS Release 12.2(33)SXI, this feature was introduced on Cisco IOS software. This feature was integrated into Cisco IOS Release 15.2(2)T software. The following commands were introduced or modified: **address ipv4 (config-radius-server)**, **cts authorization list network**, **pac keyradius-server host**, **show cts credentials**, **show cts server-list**.