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Cisco TrustSec Overview

Cisco TrustSec builds secure networks by establishing domains of trusted network devices. Each device in the domain is authenticated by its peers. Communication on the links between devices in the domain is secured with a combination of encryption, message integrity check, and data-path replay protection mechanisms.

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Restrictions for Cisco TrustSec

- Protected access credential (PAC) provisioning fails and remains in hung state, when an invalid device ID is specified. Even after clearing the PAC, and configuring the correct device ID and password, PAC still fails.

As a workaround, in the Cisco Identity Services Engine (ISE), uncheck the Suppress Anomalous Clients option in the Administration> System> Settings> Protocols> Radius menu for PAC to work.

Information About Cisco TrustSec Architecture

The Cisco TrustSec security architecture builds secure networks by establishing domains of trusted network devices. Each device in the domain is authenticated by its peers. Communication on the links between devices in the domain is secured with a combination of encryption, message integrity check, and data-path replay protection mechanisms. Cisco TrustSec uses the device and user credentials acquired during authentication for classifying the packets by security groups (SGs) as they enter the network. This packet classification is
maintained by tagging packets on ingress to the Cisco TrustSec network so that they can be properly identified for the purpose of applying security and other policy criteria along the data path. The tag, called the security group tag (SGT), allows the network to enforce the access control policy by enabling the endpoint device to act upon the SGT to filter traffic.

**Note**

Cisco TrustSec IEEE 802.1X links are not supported on platforms supported in the Cisco IOS XE Denali, Cisco IOS XE Everest, and Cisco IOS XE Fuji releases, and hence only the Authenticator is supported; the Supplicant is not supported.

The Cisco TrustSec architecture incorporates three key components:

- **Authenticated networking infrastructure**—After the first device (called the seed device) authenticates with the authentication server to begin the Cisco TrustSec domain, each new device added to the domain is authenticated by its peer devices already within the domain. The peers act as intermediaries for the domain’s authentication server. Each newly-authenticated device is categorized by the authentication server and assigned a security group number based on its identity, role, and security posture.

- **Security group-based access control**—Access policies within the Cisco TrustSec domain are topology-independent, based on the roles (as indicated by security group number) of source and destination devices rather than on network addresses. Individual packets are tagged with the security group number of the source.

- **Secure communication**—With encryption-capable hardware, communication on each link between devices in the domain can be secured with a combination of encryption, message integrity checks, and data-path replay protection mechanisms.

The following figure shows an example of a Cisco TrustSec domain. In this example, several networking devices and an endpoint device are inside the Cisco TrustSec domain. One endpoint device and one networking device are outside the domain because they are not Cisco TrustSec-capable devices or because they have been refused access. The authentication server is considered to be outside of the Cisco TrustSec domain; it is either a Cisco Identities Service Engine (Cisco ISE), or a Cisco Secure Access Control System (Cisco ACS).
Each participant in the Cisco TrustSec authentication process acts in one of the following roles:

- **Supplicant**—An unauthenticated device connected to a peer within the Cisco TrustSec domain, and attempting to join the Cisco TrustSec domain.
- **Authentication server**—The server that validates the identity of the supplicant and issues the policies that determine the supplicant’s access to services within the Cisco TrustSec domain.
- **Authenticator**—An authenticated device that is already part of the Cisco TrustSec domain and can authenticate new peer supplicants on behalf of the authentication server.

When the link between a supplicant and an authenticator first comes up, the following sequence of events typically occurs:

1. **Authentication (802.1X)**—The supplicant is authenticated by the authentication server, with the authenticator acting as an intermediary. Mutual authentication is performed between the two peers (supplicant and authenticator).

2. **Authorization**—Based on the identity information of the supplicant, the authentication server provides authorization policies, such as security group assignments and ACLs, to each of the linked peers. The authentication server provides the identity of each peer to the other, and each peer then applies the appropriate policy for the link.

3. **Security Association Protocol (SAP) negotiation**—When both sides of a link support encryption, the supplicant and the authenticator negotiate the necessary parameters to establish a security association (SA).

**Note**

SAP is not supported on 100G interfaces. We recommend that you use MACsec Key Agreement protocol (MKA) with extended packet numbering (XPN) on 100G interfaces.
When all three steps are complete, the authenticator changes the state of the link from the unauthorized (blocking) state to the authorized state, and the supplicant becomes a member of the Cisco TrustSec domain.

Cisco TrustSec uses ingress tagging and egress filtering to enforce access control policy in a scalable manner. Packets entering the domain are tagged with a security group tag (SGT) containing the assigned security group number of the source device. This packet classification is maintained along the data path within the Cisco TrustSec domain for the purpose of applying security and other policy criteria. The final Cisco TrustSec device on the data path, either the endpoint or network egress point, enforces an access control policy based on the security group of the Cisco TrustSec source device and the security group of the final Cisco TrustSec device. Unlike traditional access control lists based on network addresses, Cisco TrustSec access control policies are a form of role-based access control lists (RBACLs) called security group access control lists (SGACLs).

Ingress refers to packets entering the first Cisco TrustSec-capable device encountered by a packet on its path to the destination and egress refers to packets leaving the last Cisco TrustSec-capable device on the path.

## Authentication

### Cisco TrustSec and Authentication

Using Network Device Admission Control (NDAC), Cisco TrustSec authenticates a device before allowing it to join the network. NDAC uses 802.1X authentication with Extensible Authentication Protocol Flexible Authentication via Secure Tunnel (EAP-FAST) as the Extensible Authentication Protocol (EAP) method to perform the authentication. EAP-FAST conversations provide for other EAP method exchanges inside the EAP-FAST tunnel using chains. Administrators can use traditional user-authentication methods, such as Microsoft Challenge Handshake Authentication Protocol Version 2 (MSCHAPv2), while still having security provided by the EAP-FAST tunnel. During the EAP-FAST exchange, the authentication server creates and delivers to the supplicant a unique protected access credential (PAC) that contains a shared key and an encrypted token to be used for future secure communications with the authentication server.

The following figure shows the EAP-FAST tunnel and inner methods as used in Cisco TrustSec.
Cisco TrustSec Enhancements to EAP-FAST

The implementation of EAP-FAST for Cisco TrustSec has the following enhancements:

- Authenticate the authenticator—Securely determines the identity of the authenticator by requiring the authenticator to use its PAC to derive the shared key between itself and the authentication server. This feature also prevents you from configuring RADIUS shared keys on the authentication server for every possible IP address that can be used by the authenticator.

- Notify each device of the identity of its peer—By the end of the authentication exchange, the authentication server has identified both the supplicant and the authenticator. The authentication server conveys the identity of the authenticator, and whether the authenticator is Cisco TrustSec-capable, to the supplicant by using additional type-length-value parameters (TLVs) in the protected EAP-FAST termination. The authentication server also conveys the identity of the supplicant, and whether the supplicant is Cisco TrustSec-capable, to the authenticator.
TrustSec-capable, to the authenticator by using RADIUS attributes in the Access- Accept message. Because each device knows the identity of its peer, it can send additional RADIUS Access-Requests to the authentication server to acquire the policy to be applied on the link.

802.1X Role Selection

In 802.1X, the authenticator must have IP connectivity with the authentication server because it has to relay the authentication exchange between the supplicant and the authenticator using RADIUS over UDP/IP. When an endpoint device, such as a PC, connects to a network, it is obvious that it should function as a supplicant. However, in the case of a Cisco TrustSec connection between two network devices, the 802.1X role of each network device might not be immediately apparent to the other network device.

Instead of requiring manual configuration of the authenticator and supplicant roles for two adjacent switches, Cisco TrustSec runs a role-selection algorithm to automatically determine which switch functions as the authenticator and which functions as the supplicant. The role-selection algorithm assigns the authenticator role to the switch that has IP reachability to a RADIUS server. Both switches start both the authenticator and supplicant state machines. When a switch detects that its peer has access to a RADIUS server, it terminates its own authenticator state machine and assumes the role of the supplicant. If both switches have access to a RADIUS server, the first switch to receive a response from the RADIUS server becomes the authenticator and the other switch becomes the supplicant.

Cisco TrustSec Authentication Summary

By the end of the Cisco TrustSec authentication process, the authentication server has performed the following actions:

• Verified the identities of the supplicant and the authenticator.
• Authenticated the user if the supplicant is an endpoint device.

At the end of the Cisco TrustSec authentication process, both the authenticator and the supplicant know the following:

• Device ID of the peer
• Cisco TrustSec capability information of the peer
• Key used for the SAP

Device Identities

Cisco TrustSec does not use IP addresses or MAC addresses as device identities. Instead, you assign a name (device ID) to each Cisco TrustSec-capable switch to identify it uniquely in the Cisco TrustSec domain. This device ID is used for the following:

• Looking up the authorization policy
• Looking up passwords in the databases during authentication
Device Credentials

Cisco TrustSec supports password-based credentials. Cisco TrustSec authenticates the supplicants through passwords and uses MSCHAPv2 to provide mutual authentication.

The authentication server uses these credentials to mutually authenticate the supplicant during the EAP-FAST phase 0 (provisioning) exchange where a PAC is provisioned in the supplicant. Cisco TrustSec does not perform the EAP-FAST phase 0 exchange again until the PAC expires, and only performs EAP-FAST phase 1 and phase 2 exchanges for future link bringups. The EAP-FAST phase 1 exchange uses the PAC to mutually authenticate the authentication server and the supplicant. Cisco TrustSec uses the device credentials only during the PAC provisioning (or reprovisioning) steps.

When the supplicant first joins the Cisco TrustSec domain, the authentication server authenticates the supplicant and pushes a shared key and encrypted token to the supplicant with the PAC. The authentication server and the supplicant use this key and token for mutual authentication in all future EAP-FAST phase 0 exchanges.

User Credentials

Cisco TrustSec does not require a specific type of user credential for endpoint devices. You can choose any type of user authentication method that is supported by the authentication server, and use the corresponding credentials. For example, the Cisco Secure Access Control System (ACS) version 5.1 supports MSCHAPv2, generic token card (GTC), or RSA one-time password (OTP).

Security Group-Based Access Control

Security Groups and SGTs

A security group is a grouping of users, endpoint devices, and resources that share access control policies. Security groups are defined by the administrator in the Cisco ISE or Cisco Secure ACS. As new users and devices are added to the Cisco TrustSec domain, the authentication server assigns these new entities to appropriate security groups. Cisco TrustSec assigns to each security group a unique 16-bit security group number whose scope is global within a Cisco TrustSec domain. The number of security groups in the device is limited to the number of authenticated network entities. You do not have to manually configure security group numbers.

Once a device is authenticated, Cisco TrustSec tags any packet that originates from that device with a security group tag (SGT) that contains the security group number of the device. The packet carries this SGT throughout the network within the Cisco TrustSec header. The SGT is a single label that determines the privileges of the source within the entire enterprise.

Because the SGT contains the security group of the source, the tag can be referred to as the source SGT. The destination device is also assigned to a security group (the destination SG) that can be referred to for simplicity as the destination group tag (DGT), although the actual Cisco TrustSec packet tag does not contain the security group number of the destination device.

Security Group ACL Support

Security group access control lists (SGACLs) is a policy enforcement through which the administrator can control operations performed by an user, based on security group assignments and destination resources.
Policy enforcement within the Cisco TrustSec domain is represented by a permissions matrix, with source security group number on one axis and destination security group number on the other axis. Each cell in the matrix contains an ordered list of SGACLs, which specifies permissions that should be applied to packets originating from an IP belonging to a source security group and having a destination IP that belongs to the destination security group.

SGACL provides stateless access control mechanism based on the security association or security group tag value instead of IP addresses and filters. There are three ways to provision an SGACL policy:

- **Static policy provisioning:** The SGACL policies are defined by the user using the command `cts role-based permission`.
- **Dynamic policy provisioning:** Configuration of SGACL policies should be done primarily through the policy management function of the Cisco Secure ACS or the Cisco Identity Services Engine.
- **Change of Authorization (CoA):** The updated policy is downloaded when the SGACL policy is modified on the ISE and CoA is pushed to the Cisco TrustSec device.

The device data plane receives the CoA packets from the policy provider (ISE) and applies the policy to the CoA packets. The packets are then forwarded to the device control plane where the next level of policy enforcement happens for the incoming CoA packets. To view the hardware and software policy counter hit information, run the `show cts role-based counters` command in privileged EXEC mode.

**SGACL Policies**

Using security group access control lists (SGACLs), you can control the operations that users can perform based on the security group assignments of users and destination resources. Policy enforcement within the Cisco TrustSec domain is represented by a permissions matrix, with source security group numbers on one axis and destination security group numbers on the other axis. Each cell in the body of the matrix can contain an ordered list of SGACLs which specifies the permissions that should be applied to packets originating from the source security group and destined for the destination security group.

The following figure shows an example of a Cisco TrustSec permissions matrix for a simple domain with three defined user roles and one defined destination resource. Three SGACL policies control access to the destination server based on the role of the user.
By assigning users and devices within the network to security groups and applying access control between the security groups, Cisco TrustSec achieves role-based topology-independent access control within the network. Because SGACLS define access control policies based on device identities instead of IP addresses as in traditional ACLs, network devices are free to move throughout the network and change IP addresses. As long as the roles and the permissions remain the same, changes to the network topology do not change the security policy. When a user is added to the device, you simply assign the user to an appropriate security group and the user immediately receives the permissions of that group.

SGACL policies are applied to traffic that is generated between two host devices, not to traffic that is generated from a device to an end host device.

Using role-based permissions greatly reduces the size of ACLs and simplifies their maintenance. With Cisco TrustSec, the number of access control entries (ACEs) configured is determined by the number of permissions specified, resulting in a much smaller number of ACEs than in a traditional IP network. The use of SGACLS in Cisco TrustSec typically results in a more efficient use of TCAM resources compared with traditional ACLs.

**Ingress Tagging and Egress Enforcement**

Cisco TrustSec access control is implemented using ingress tagging and egress enforcement. At the ingress point to the Cisco TrustSec domain, traffic from the source is tagged with an SGT containing the security group number of the source entity. The SGT is propagated with the traffic across the domain. At the egress point of the Cisco TrustSec domain, an egress device uses the source SGT and the security group number of the destination entity (the destination SG, or DGT) to determine which access policy to apply from the SGACL policy matrix.

The following figure shows how the SGT assignment and the SGACL enforcement operate in a Cisco TrustSec domain.
Determining the Source Security Group

A network device at the ingress of Cisco TrustSec domain must determine the SGT of the packet entering the Cisco TrustSec domain so that it can tag the packet with that SGT when it forwards it into the Cisco TrustSec domain. The egress network device must determine the SGT of the packet in order to apply an SGACL.

The network device can determine the SGT for a packet in one of the following methods:

- Obtain the source SGT during policy acquisition—After the Cisco TrustSec authentication phase, a network device acquires policy information from the authentication server, which indicates whether the peer device is trusted or not. If a peer device is not trusted, then the authentication server can also provide an SGT to apply to all packets coming from the peer device.

- Obtain the source SGT from the packet—If a packet comes from a trusted peer device, the packet carries the SGT. This applies to a network device that is not the first network device in Cisco TrustSec domain for the packet.

- Look up the source SGT based on the source identity—With Identity Port Mapping (IPM), you can manually configure the link with the identity of the connected peer. The network device requests policy information, including SGT and trust state, from the authentication server.

- Look up the source SGT based on the source IP address—In some cases, you can manually configure the policy to decide the SGT of a packet based on its source IP address. The SGT Exchange Protocol (SXP) can also populate the IP-address-to-SGT mapping table.
Determining the Destination Security Group

The egress network device in a Cisco TrustSec domain determines the destination group (DGT) for applying the SGACL. The network device determines the destination security group for the packet using the same methods used for determining the source security group, with the exception of obtaining the group number from a packet tag. The destination security group number is not included in a packet tag.

In some cases, ingress devices or other non-egress devices might have destination group information available. In those cases, SGACLs might be applied in these devices rather than egress devices.

SGACL Enforcement on Routed and Switched Traffic

SGACL enforcement is applied only on IP traffic, but enforcement can be applied to either routed or switched traffic.

For routed traffic, SGACL enforcement is performed by an egress switch, typically a distribution switch or an access switch with a routed port connecting to the destination host. When you enable SGACL enforcement globally, enforcement is automatically enabled on every Layer 3 interface except for SVI interfaces.

For switched traffic, SGACL enforcement is performed on traffic flowing within a single switching domain without any routing function. An example would be SGACL enforcement performed by a data center access switch on server-to-server traffic between two directly connected servers. In this example, the server-to-server traffic would typically be switched. SGACL enforcement can be applied to packets switched within a VLAN or forwarded to an SVI associated with a VLAN, but enforcement must be enabled explicitly for each VLAN.

SGACL Logging and ACE Statistics

When logging is enabled in SGACL, the device logs the following information:

- The source security group tag (SGT) and destination SGT
- The SGACL policy name
- The packet protocol type
- The action performed on the packet

The log option applies to individual ACEs and causes packets that match the ACE to be logged. The first packet logged by the log keyword generates a syslog message. Subsequent log messages are generated and reported at five-minute intervals. If the logging-enabled ACE matches another packet (with characteristics identical to the packet that generated the log message), the number of matched packets is incremented (counters) and then reported.

To enable logging, use the **log** keyword in front of the ACE definition in the SGACL configuration. For example, **permit ip log**.

When SGACL logging is enabled, ICMP Request messages from the device to the client are not logged for IPv4 and IPv6 protocols. However, ICMP Response messages from the client to the device are logged.

The following is a sample log, displaying source and destination SGTs, ACE matches (for a permit or deny action), and the protocol, that is, TCP, UDP, IGMP, and ICMP information:

*Jun 2 08:58:06.489: %C4K_IOSINTF-6-SGACLHIT: list deny_udp_src_port_log-30 Denied udp 24.0.0.23(100) -> 28.0.0.91(100), SGT8 DGT 12
In addition to the existing ‘per cell’ SGACL statistics, which can be displayed using the `show cts role-based counters` command, you can also display ACE statistics, by using the `show ip access-list sgacl_name` command. No additional configuration is required for this.

The following example shows how you can use the `show ip access-list` command to display the ACE count:

```
Device# show ip access-control deny_udp_src_port_log-30
Role-based IP access list deny_udp_src_port_log-30 (downloaded)
10 deny udp src eq 100 log (283 matches)
20 permit ip log (50 matches)
```

When the incoming traffic matches the cell, but does not match the SGACL of the cell, the traffic is allowed and the counters are incremented in the HW-Permit for the cell.

The following example shows how the SGACL of a cell works:

The SGACL policy is configured from 5 to 18 with “deny icmp echo” and there is incoming traffic from 5 to 18 with TCP header. If the cell matches from 5 to 18 but traffic does not match with icmp, traffic will be allowed and HW-Permit counter of cell 5 to 18 will get incremented.

```
Device# show cts role-based permissions from 5 to 18
IPv4 Role-based permissions from group 5:sgt_5_Contractors to group 18:sgt_18_data_user2:sgacl_5_18-01
RBACL Monitor All for Dynamic Policies : FALSE
RBACL Monitor All for Configured Policies : FALSE
Device# show ip access-lists sgacl_5_18-01
Role-based IP access list sgacl_5_18-01 (downloaded)
10 deny icmp echo log (1 match)
Device# show cts role-based counters from 5 to 18
Role-based IPv4 counters
<table>
<thead>
<tr>
<th>From</th>
<th>To</th>
<th>SW-Denied</th>
<th>HW-Denied</th>
<th>SW-Permitt</th>
<th>HW-Permitt</th>
<th>SW-Monitor</th>
<th>HW-Monitor</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>18</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1673202</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
```

**Note**

*Note:

VRF-aware SGACL Logging

The SGACL system logs will include VRF information. In addition to the fields that are currently logged, the logging information will include the VRF name. The updated logging information will be as shown below:

```
*Nov 15 02:18:52.187: %RBM-6-SGACLHIT_V6: ingress_interface='GigabitEthernet1/0/15' sgacl_name='IPV6_TCP_DENY' action='Deny' protocol='tcp' src-vrf='CTS-VRF' src-ip='25::2' src-port='20' dest-vrf='CTS-VRF' dest-ip='49::2' dest-port='30' sgt='200' dgt='500' logging_interval_hits='1'
```

**VRF-aware SGACL Logging**

The SGACL system logs will include VRF information. In addition to the fields that are currently logged, the logging information will include the VRF name. The updated logging information will be as shown below:

```
*Nov 15 02:18:52.187: %RBM-6-SGACLHIT_V6: ingress_interface='GigabitEthernet1/0/15' sgacl_name='IPV6_TCP_DENY' action='Deny' protocol='tcp' src-vrf='CTS-VRF' src-ip='25::2' src-port='20' dest-vrf='CTS-VRF' dest-ip='49::2' dest-port='30' sgt='200' dgt='500' logging_interval_hits='1'
```

**SGACL Monitor Mode**

During the pre-deployment phase of Cisco TrustSec, an administrator will use the monitor mode to test the security policies without enforcing them to make sure that the policies function as intended. If the security policies do not function as intended, the monitor mode provides a convenient mechanism for identifying that and provides an opportunity to correct the policy before enabling SGACL enforcement. This enables
administrators to have increased visibility to the outcome of the policy actions before they enforce it, and confirm that the subject policy meets the security requirements (access is denied to resources if users are not authorized).

The monitoring capability is provided at the SGT-DGT pair level. When you enable the SGACL monitoring mode feature, the deny action is implemented as an ACL permit on the line cards. This allows the SGACL counters and logging to display how connections are handled by the SGACL policy. Since all the monitored traffic is permitted, there is no disruption of service due to SGACLs while in the SGACL monitor mode.

### Authorization and Policy Acquisition

After device authentication ends, both the supplicant and authenticator obtain the security policy from the authentication server. The two peers then perform link authorization and enforce the link security policy against each other based on their Cisco TrustSec device IDs. The link authentication method can be configured as either 802.1X or manual authentication. If the link security is 802.1X, each peer uses a device ID received from the authentication server. If the link security is manual, you must assign the peer device IDs.

The authentication server returns the following policy attributes:

- **Cisco TrustSec trust**—Indicates whether the peer device is to be trusted for the purpose of putting the SGT in the packets.
- **Peer SGT**—Indicates the security group to which the peer belongs. If the peer is not trusted, all packets received from the peer are tagged with this SGT. If the device does not know whether any SGACLs are associated with the peer’s SGT, the device may send a follow-up request to the authentication server to download the SGACLs.
- **Authorization expiry time**—Indicates the number of seconds before the policy expires. A Cisco TrustSec device should refresh its policy and authorization before it times out. The device can cache the authentication and policy data and reuse it after a reboot if the data has not expired.

---

**Note**

Each Cisco TrustSec device should support some minimal default access policy in case it is not able to contact the authentication server to get an appropriate policy for the peer.

The NDAC and SAP negotiation process is shown in the following figure.
Environment Data Download

The Cisco TrustSec environment data is a collection of information or policies that assists a device to function as a Cisco TrustSec node. The device acquires the environment data from the authentication server when the device first joins a Cisco TrustSec domain, although you might also manually configure some of the data on a device. For example, you must configure the seed Cisco TrustSec device with the authentication server information, which can later be augmented by the server list that the device acquires from the authentication server.

The device must refresh the Cisco TrustSec environment data before it expires. The device can also cache the environment data and reuse it after a reboot if the data has not expired.

The device uses RADIUS to acquire the following environment data from the authentication server:

- Server lists: List of servers that the client can use for future RADIUS requests (for both authentication and authorization). PAC refresh happens through these servers.
- Device SG: Security group to which the device itself belongs.
- Expiry timeout: Interval that controls how often the Cisco TrustSec device should refresh its environment data.

RADIUS Relay Functionality

The device that plays the role of the Cisco TrustSec authenticator in the 802.1X authentication process has IP connectivity to the authentication server, allowing the device to acquire the policy and authorization from the authentication server by exchanging RADIUS messages over UDP/IP. The supplicant device may not have IP connectivity with the authentication server. In such cases, Cisco TrustSec allows the authenticator to act as a RADIUS relay for the supplicant.

The supplicant sends a special EAPOL message to the authenticator that contains the RADIUS server IP address and UDP port and the complete RADIUS request. The authenticator extracts the RADIUS request from the received EAPOL message and sends it over UDP/IP to the authentication server. When the RADIUS
response returns from the authentication server, the authenticator forwards the message back to the supplicant, encapsulated in an EAPOL frame.

**Link Security**

When both sides of a link support 802.1AE Media Access Control Security (MACsec), a security association protocol (SAP) negotiation is performed. An EAPOL-Key exchange occurs between the supplicant and the authenticator to negotiate a cipher suite, exchange security parameters, and manage keys. Successful completion of all three tasks results in the establishment of a security association (SA).

Depending on your software version, crypto licensing, and link hardware support, SAP negotiation can use one of the following modes of operation:

- Galois/Counter Mode (GCM)—Specifies authentication and encryption
- GCM authentication (GMAC)—Specifies authentication and no encryption
- No Encapsulation—Specifies no encapsulation (clear text)
- Null—Specifies encapsulation, no authentication and no encryption

All modes except No Encapsulation require Cisco TrustSec-capable hardware.

**Configuring SAP-PMK for Link Security**

**SUMMARY STEPS**

1. enable
2. configure terminal
3. interface type number
4. switchport mode trunk
5. cts manual
6. no propagate sgt
7. sap pmk key [mode-list mode1 [mode2 [mode3 [mode4]]]]
8. end

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>enable Example: Device&gt; enable</td>
<td>Enables privileged EXEC mode. * Enter your password if prompted.</td>
</tr>
<tr>
<td>Step 2</td>
<td>configure terminal Example: Device# configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
<td></td>
</tr>
<tr>
<td>---------------------------------------</td>
<td>-------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> interface type number</td>
<td>Configures an interface and enters interface configuration mode.</td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Device(config)# interface TenGigabitEthernet 1/1/4</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> switchport mode trunk</td>
<td>Specifies a trunking VLAN Layer 2 interface.</td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Device(config-if)# switchport mode trunk</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> cts manual</td>
<td>Enters Cisco TrustSec manual configuration mode.</td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Device(config-if)# cts manual</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong> no propagate sgt</td>
<td>Use the no form of this command when the peer is incapable</td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td>of processing a SGT. The no propagate sgt command prevents the</td>
<td></td>
</tr>
<tr>
<td>Device(config-if-cts-manual)# no propagate sgt</td>
<td>interface from transmitting the SGT to the peer.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong> sap pmk key [mode-list complex options]</td>
<td>Configures the SAP pairwise master key (PMK) and operation mode. SAP</td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td>is disabled by default in Cisco TrustSec manual mode.</td>
<td></td>
</tr>
<tr>
<td>Device(config-if-cts-manual)# sap pmk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0000000000000000000000000000000000000000000000000000001234567890</td>
<td>• key: A hexadecimal value with an even number of characters and a</td>
<td></td>
</tr>
<tr>
<td>mode-list gcm-encrypt gmac</td>
<td>maximum length of 32 characters.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 8</strong> end</td>
<td>Exits Cisco TrustSec manual configuration mode and returns to</td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td>privileged EXEC mode..</td>
<td></td>
</tr>
<tr>
<td>Device(config-if-cts-manual)# end</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Using Cisco TrustSec-Incapable Devices and Networks in a Cisco TrustSec Network

SXP for SGT Propagation Across Legacy Access Networks

Tagging packets with SGTs requires hardware support. You might have devices in your network that, while capable of participating in Cisco TrustSec authentication, lack the hardware capability to tag packets with SGTs. By using the SGT Exchange Protocol (SXP), these devices can pass IP-address-to-SGT mappings to a Cisco TrustSec peer device that has Cisco TrustSec-capable hardware.

SXP typically operates between ingress access layer devices at the Cisco TrustSec domain edge and distribution layer devices within the Cisco TrustSec domain. The access layer device performs Cisco TrustSec authentication of external source devices to determine the appropriate SGTs for ingress packets. The access layer device learns the IP addresses of the source devices using IP device tracking and (optionally) DHCP snooping, then uses SXP to pass the IP addresses of the source devices along with their SGTs to the distribution devices. Distribution devices with Cisco TrustSec-capable hardware can use this IP-to-SGT mapping information to tag packets appropriately and to enforce SGACL policies.

Figure 6: SXP Protocol to Propagate SGT Information

You must manually configure an SXP connection between a peer without Cisco TrustSec hardware support and a peer with Cisco TrustSec hardware support. The following tasks are required when configuring the SXP connection:

- If you require SXP data integrity and authentication, you must configure the same SXP password on both peer devices. You can configure the SXP password either explicitly for each peer connection or globally for the device. Although an SXP password is not required, we recommend its use.

- You must configure each peer on the SXP connection as either an SXP speaker or an SXP listener. The speaker device distributes the IP-to-SGT mapping information to the listener device.

- You can specify a source IP address to use for each peer relationship or you can configure a default source IP address for peer connections where you have not configured a specific source IP address. If you do not specify any source IP address, the device will use the interface IP address of the connection to the peer.

Cisco TrustSec Configuration Guide, Cisco IOS XE Gibraltar 16.10.x (Catalyst 9400 Switches)
SXP allows multiple hops. That is, if the peer of a device lacking Cisco TrustSec hardware support also lacks Cisco TrustSec hardware support, the second peer can have an SXP connection to a third peer, continuing the propagation of the IP-to-SGT mapping information until a hardware-capable peer is reached. A device can be configured as an SXP listener for one SXP connection as an SXP speaker for another SXP connection.

A Cisco TrustSec device maintains connectivity with its SXP peers by using the TCP keepalive mechanism. To establish or restore a peer connection, the device will repeatedly attempt the connection setup using a configurable retry period until the connection is successful or until the connection is removed from the configuration.

Layer 3 SGT Transport for Spanning Non-TrustSec Regions

When a packet leaves the Cisco TrustSec domain for a non-TrustSec destination, the egress Cisco TrustSec device removes the Cisco TrustSec header and SGT before forwarding the packet to the outside network. If, however, the packet is merely traversing a non-TrustSec domain on the path to another Cisco TrustSec domain, as shown in the following figure, the SGT can be preserved by using the Cisco TrustSec Layer 3 SGT Transport feature. In this feature, the egress Cisco TrustSec device encapsulates the packet with an ESP header that includes a copy of the SGT. When the encapsulated packet arrives at the next Cisco TrustSec domain, the ingress Cisco TrustSec device removes the ESP encapsulation and propagates the packet with its SGT.

To support Cisco TrustSec Layer 3 SGT Transport, any device that will act as a Cisco TrustSec ingress or egress Layer 3 gateway must maintain a traffic policy database that lists eligible subnets in remote Cisco TrustSec domains as well as any excluded subnets within those regions. You can configure this database manually on each device if they cannot be downloaded automatically from the Cisco Secure ACS.

A device can send Layer 3 SGT Transport data from one port and receive Layer 3 SGT Transport data on another port, but both the ingress and egress ports must have Cisco TrustSec-capable hardware.
Cisco TrustSec does not encrypt the Layer 3 SGT Transport encapsulated packets. To protect the packets traversing the non-TrustSec domain, you can configure other protection methods, such as IPsec.

### Cisco TrustSec Reflector for Cisco TrustSec-Incapable Switching Modules

A Cisco device in a Cisco TrustSec domain may contain any of these types of switching modules:

- Cisco TrustSec-capable—Hardware supports insertion and propagation of SGT.
- Cisco TrustSec-aware—Hardware does not support insertion and propagation of SGT, but hardware can perform a lookup to determine the source and destination SGTs for a packet.
- Cisco TrustSec-incapable—Hardware does not support insertion and propagation of SGT and cannot determine the SGT by a hardware lookup.

If your switch contains a Cisco TrustSec-capable supervisor engine, you can use the Cisco TrustSec reflector feature to accommodate legacy Cisco TrustSec-incapable switching modules within the same switch. Cisco TrustSec reflector uses SPAN to reflect traffic from a Cisco TrustSec-incapable switching module to the supervisor engine for SGT assignment and insertion.

Two mutually exclusive modes, ingress and egress, are supported for the Cisco TrustSec reflector. The default is pure mode, in which neither reflector is enabled. A Cisco TrustSec ingress reflector is configured on an access switch facing a distribution switch, while a Cisco TrustSec egress reflector is configured on a distribution switch.

#### Ingress Reflector

A Cisco TrustSec ingress reflector is implemented on an access switch, where the Cisco TrustSec-incapable switching module is on the Cisco TrustSec domain edge and the Cisco TrustSec-capable supervisor engine uplink port connects to a Cisco TrustSec-capable distribution switch.

The following conditions must be met before the Cisco TrustSec ingress reflector configuration is accepted:

- The supervisor engine must be Cisco TrustSec-capable.
- Any Cisco TrustSec-incapable DFCs must be powered down.
- A Cisco TrustSec egress reflector must not be configured on the switch.
- Before disabling the Cisco TrustSec ingress reflector, you must remove power from the Cisco TrustSec-incapable switching modules.

#### Egress Reflector

A Cisco TrustSec egress reflector is implemented on a distribution switch with Layer 3 uplinks, where the Cisco TrustSec-incapable switching module faces an access switch. The Cisco TrustSec egress reflector is
supported only on Layer 3 uplinks, and is not supported on Layer 2 interfaces, SVIs, subinterfaces, or tunnels, and is not supported for NAT traffic.

The following conditions must be met before the Cisco TrustSec egress reflector configuration is accepted:

- The supervisor engine or DFC switching module must be Cisco TrustSec-capable.
- Cisco TrustSec must not be enabled on non-routed interfaces on the supervisor engine uplink ports or on the Cisco TrustSec-capable DFC switching modules.
- Before disabling the Cisco TrustSec egress reflector, you must remove power from the Cisco TrustSec-incapable switching modules.
- A Cisco TrustSec ingress reflector must not be configured on the switch.

**VRF-Aware SXP**

The SXP implementation of Virtual Routing and Forwarding (VRF) binds an SXP connection with a specific VRF. It is assumed that the network topology is correctly configured for Layer 2 or Layer 3 VPNs, with all VRFs configured before enabling Cisco TrustSec.

SXP VRF support can be summarized as follows:

- Only one SXP connection can be bound to one VRF.
- Different VRFs may have overlapping SXP peer or source IP addresses.
- IP–SGT mappings learned (added or deleted) in one VRF can be updated only in the same VRF domain. The SXP connection cannot update a mapping bound to a different VRF. If no SXP connection exits for a VRF, IP–SGT mappings for that VRF won’t be updated by SXP.
- Multiple address families per VRF is supported. Therefore, one SXP connection in a VRF domain can forward both IPV4 and IPV6 IP-SGT mappings.
- SXP has no limitation on the number of connections and number of IP–SGT mappings per VRF.

**Layer 2 VRF-Aware SXP and VRF Assignment**

VRF to Layer 2 VLANs assignments are specified with the `cts role-based l2-vrf vrf-name vlan-list` global configuration command. A VLAN is considered a Layer 2 VLAN as long as there is no switch virtual interface (SVI) with an IP address configured on the VLAN. The VLAN becomes a Layer 3 VLAN once an IP address is configured on its SVI.

The VRF assignments configured by the `cts role-based l2-vrf` command are active as long as a VLAN remains a Layer 2 VLAN. The IP–SGT bindings learned while a VRF assignment is active are also added to the Forwarding Information Base (FIB) table associated with the VRF and the IP protocol version. If an SVI becomes active for a VLAN, the VRF to VLAN assignment becomes inactive and all the bindings learned on the VLAN are moved to the FIB table associated with the SVI’s VRF.

The VRF to VLAN assignment is retained even when the assignment becomes inactive. It is reactivated when the SVI is removed or when the SVI IP address is deconfigured. When reactivated, the IP–SGT bindings are moved back from the FIB table associated with the SVI’s VRF to the FIB table associated with the VRF assigned by the `cts role-based l2-vrf` command.
Feature Information for Cisco TrustSec Overview

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 Overview

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Release</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco TrustSec Overview</td>
<td>Cisco IOS XE Everest 16.6.1</td>
<td>Cisco TrustSec builds secure networks by establishing domains of trusted network devices.</td>
</tr>
</tbody>
</table>
Configuring Identities, Connections, and SGTs

• Configuring Identities and Connections, on page 23

Configuring Identities and Connections

This module describes the following features:

• Configuring Credentials and AAA for a Cisco TrustSec Seed Device
• Configuring Credentials and AAA for a Cisco TrustSec Non-Seed Device
• Cisco TrustSec Authentication and MACsec in 802.1X Mode on an Uplink Port
• Cisco TrustSec and MACsec in Manual Mode on an Uplink Port
• Regenerating SAP Key on an Interface
• Configuring a New or Replacement Password with the Authentication Server Automatically

How to Configure Identities and Connections

Configuring Credentials and AAA for a Cisco TrustSec Seed Device

A Cisco TrustSec-capable device that is directly connected to the authentication server, or indirectly connected but is the first device to begin the TrustSec domain, is called the seed device. Other Cisco TrustSec network devices are non-seed devices.

Note

• You must also configure the Cisco TrustSec credentials for the device on the Cisco Identity Services Engine (Cisco ISE) or the Cisco Secure Access Control Server (Cisco ACS).
• The cts authorization list command must be configured to download the Cisco TrustSec environment data and SGACL policy from the Cisco Identity Services Engine (ISE).

To enable NDAC and AAA on the seed device so that it can begin the Cisco TrustSec domain, perform these steps:
SUMMARY STEPS

1. `cts credentials id device-id password password`
2. `enable`
3. `configure terminal`
4. `aaa new-model`
5. `aaa authentication dot1x default group radius`
6. `aaa authorization network mlist group radius`
7. `cts authorization list mlist`
8. `aaa accounting dot1x default start-stop group radius`
9. `radius-server host ip-addr auth-port 1812 acct-port 1813 pac key secret`
10. `radius-server vsa send authentication`
11. `dot1x system-auth-control`
12. `exit`

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> <code>cts credentials id device-id password password</code></td>
<td>Specifies the Cisco TrustSec device ID and password for this device to use when authenticating with other Cisco TrustSec devices with EAP-FAST. The <code>device-id</code> argument has a maximum length of 32 characters and is case sensitive.</td>
</tr>
<tr>
<td>Example: Device# <code>cts credentials id device1 password Cisco123</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> <code>enable</code></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example: Device# <code>enable</code></td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 3</strong> <code>configure terminal</code></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example: Device# <code>configure terminal</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> <code>aaa new-model</code></td>
<td>Enables AAA.</td>
</tr>
<tr>
<td>Example: Device(config)# <code>aaa new-model</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> <code>aaa authentication dot1x default group radius</code></td>
<td>Specifies the 802.1X port-based authentication method as RADIUS.</td>
</tr>
<tr>
<td>Example: Device(config)# <code>aaa authentication dot1x default group radius</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong> <code>aaa authorization network mlist group radius</code></td>
<td>Configures the device to use RADIUS authorization for all network-related service requests.</td>
</tr>
<tr>
<td>Example: Device(config)# <code>aaa authorization network mlist group radius</code></td>
<td>• <code>mlist</code>—The Cisco TrustSec AAA server group.</td>
</tr>
<tr>
<td><strong>Step 7</strong> <code>cts authorization list mlist</code></td>
<td>Specifies a Cisco TrustSec AAA server group. Non-seed devices will obtain the server list from the authenticator.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
</tr>
<tr>
<td><code>Device(config)# cts authorization list mlist</code></td>
<td>Enables 802.1X accounting using RADIUS.</td>
</tr>
<tr>
<td><strong>Step 8</strong> <code>aaa accounting dot1x default start-stop group radius</code></td>
<td>Enables 802.1X accounting using RADIUS.</td>
</tr>
<tr>
<td><strong>Example:</strong> <code>Device(config)# aaa accounting dot1x default start-stop group radius</code></td>
<td>Enables 802.1X accounting using RADIUS.</td>
</tr>
<tr>
<td><strong>Step 9</strong> <code>radius-server host ip-addr auth-port 1812 acct-port 1813 pac key secret</code></td>
<td>Specifies the RADIUS authentication server host address, service ports, and encryption key.</td>
</tr>
<tr>
<td><strong>Example:</strong> <code>Device(config)# radius-server host 10.20.3.1 auth-port 1812 acct-port 1813 pac key AbCe1234</code></td>
<td>Specifies the RADIUS authentication server host address, service ports, and encryption key.</td>
</tr>
<tr>
<td><strong>Step 10</strong> <code>radius-server vsa send authentication</code></td>
<td>Configures the device to recognize and use vendor-specific attributes (VSAs) in RADIUS Access-Requests generated by the device during the authentication phase.</td>
</tr>
<tr>
<td><strong>Example:</strong> <code>Device(config)# radius-server vsa send authentication</code></td>
<td>Configures the device to recognize and use vendor-specific attributes (VSAs) in RADIUS Access-Requests generated by the device during the authentication phase.</td>
</tr>
<tr>
<td><strong>Step 11</strong> <code>dot1x system-auth-control</code></td>
<td>Globally enables 802.1X port-based authentication.</td>
</tr>
<tr>
<td><strong>Example:</strong> <code>Device(config)# dot1x system-auth-control</code></td>
<td>Globally enables 802.1X port-based authentication.</td>
</tr>
<tr>
<td><strong>Step 12</strong> <code>exit</code></td>
<td>Exits configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> <code>Device(config)# exit</code></td>
<td>Exits configuration mode.</td>
</tr>
</tbody>
</table>

### Configuring Credentials and AAA for a Cisco TrustSec Non-Seed Device

**Note**
You must also configure the Cisco TrustSec credentials for the device on the Cisco Identity Services Engine, or the Cisco Secure ACS.

To enable NDAC and AAA on a non-seed device so that it can join the Cisco TrustSec domain, perform these steps:

**SUMMARY STEPS**

1. `cts credentials id device-id password password`
2. `enable`
3. `configure terminal`
4. `aaa new-model`
5. `aaa authentication dot1x default group radius`
6. `aaa authorization network mlist group radius`
7. `aaa accounting dot1x default start-stop group radius`
### DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| 1    | cts credentials id device-id password password | Specifies the Cisco TrustSec device ID and password for this device to use when authenticating with other Cisco TrustSec devices with EAP-FAST. The `device-id` argument has a maximum length of 32 characters and is case sensitive. Example:  
Device# cts credentials id device-id password password |
| 2    | enable            | Enables privileged EXEC mode.  
• Enter your password if prompted. Example:  
Device# enable |
| 3    | configure terminal | Enters global configuration mode. Example:  
Device# configure terminal |
| 4    | aaa new-model     | Enables AAA. Example:  
Device(config)# aaa new-model |
| 5    | aaa authentication dot1x default group radius | Specifies the 802.1X port-based authentication method as RADIUS. Example:  
Device(config)# aaa authentication dot1x default group radius |
| 6    | aaa authorization network mlist group radius | Configures the device to use RADIUS authorization for all network-related service requests.  
• `mlist`— Specifies a Cisco TrustSec AAA server group. Example:  
Device(config)# aaa authorization network mlist group radius |
| 7    | aaa accounting dot1x default start-stop group radius | Enables 802.1X accounting using RADIUS. Example:  
Device(config)# aaa accounting dot1x default start-stop group radius |
| 8    | radius-server vsa send authentication | Configures the device to recognize and use vendor-specific attributes (VSAs) in RADIUS Access-Requests generated by the device during the authentication phase. Example:  
Device(config)# radius-server vsa send authentication |
| 9    | dot1x system-auth-control | Globally enables 802.1X port-based authentication. Example: |
Regenerating SAP Key on an Interface

The ability to manually refresh encryption keys is often part of network administration security requirements. SAP key refresh ordinarily occurs automatically, triggered by combinations of network events and non-configurable internal timers.

**SUMMARY STEPS**

1. `cts rekey interface type slot/port`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>Device(config)# dot1x system-auth-control</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 10</strong></td>
<td></td>
</tr>
<tr>
<td><code>exit</code></td>
<td>Exits configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device(config)# exit</code></td>
<td></td>
</tr>
</tbody>
</table>

Configuring Additional Authentication Server-Related Parameters

To configure the interaction between a device and the Cisco TrustSec server, perform one or more of these tasks:

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `cts server deadtime seconds`
4. `cts server load-balance method least-outstanding [batch-size transactions ] [ignore-preferred-server ]`
5. `cts server test {server-IP-address | all} {deadtime seconds | enable | idle-time seconds }`
6. `exit`
7. `show cts server-list`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td></td>
</tr>
<tr>
<td><code>enable</code></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device# enable</code></td>
<td></td>
</tr>
</tbody>
</table>
### Command or Action

<table>
<thead>
<tr>
<th>Step 2</th>
<th>configure terminal</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td>Device# configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 3</th>
<th>cts server deadtime seconds</th>
<th>(Optional) Specifies how long a server in the group should not be selected for service once it has been marked as dead. The default is 20 seconds; the range is 1 to 864000.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td>Device(config)# cts server deadtime 20</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 4</th>
<th>cts server load-balance method least-outstanding [batch-size transactions ] [ignore-preferred-server ]</th>
<th>(Optional) Enables RADIUS load balancing for the Cisco TrustSec private server group and chooses the server with the least outstanding transactions. By default, no load balancing is applied. The default transactions is 25. The ignore-preferred-server keyword instructs the device not to try to use the same server throughout a session.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td>Device(config)# cts server load-balance method least-outstanding batch-size 50 ignore-preferred-server</td>
<td></td>
</tr>
</tbody>
</table>

| Step 5 | cts server test {server-IP-address | all } {deadtime seconds | enable | idle-time seconds } | (Optional) Configures the server-liveliness test for a specified server or for all servers on the dynamic server list. By default, the test is enabled for all servers. The default idle-time is 60 seconds; the range is from 1 to 14400. |
|---|---|---|
| **Example:** | Device(config)# cts server test 10.15.20.102 idle-time 120 | |

<table>
<thead>
<tr>
<th>Step 6</th>
<th>exit</th>
<th>Exits configuration mode.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td>Device(config)# exit</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 7</th>
<th>show cts server-list</th>
<th>Displays status and configuration details of a list of Cisco TrustSec servers.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td>Device# show cts server-list</td>
<td></td>
</tr>
</tbody>
</table>

---

### Configuration Examples for Identities and Connections

#### Example: Configuring Additional Authentication Server-Related Parameters

To configure the interaction between a switch and the Cisco TrustSec server, perform one or more of these tasks:

This example shows how to configure server settings and how to display the Cisco TrustSec server list:

```
Device# configure terminal
Device(config)# cts server load-balance method least-outstanding batch-size 50 ignore-preferred-server
Device(config)# cts server test all deadtime 20
Device(config)# cts server test all enable
Device(config)# exit
Device# show cts server-list
CTS Server Radius Load Balance = ENABLED
```
Verifying the Cisco TrustSec Interface Configuration

To view the Cisco TrustSec-related interface configuration, use the `show cts interface` command.

<table>
<thead>
<tr>
<th>Device# show cts interface gigabitethernet 1/1/1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global Dot1x feature is Disabled</td>
</tr>
<tr>
<td>Interface GigabitEthernet1/1/1:</td>
</tr>
<tr>
<td>CTS is enabled, mode: MANUAL</td>
</tr>
<tr>
<td>IFC state: OPEN</td>
</tr>
<tr>
<td>Interface Active for 00:54:01.936</td>
</tr>
<tr>
<td>Authentication Status: NOT APPLICABLE</td>
</tr>
<tr>
<td>Peer identity: &quot;unknown&quot;</td>
</tr>
<tr>
<td>Peer's advertised capabilities: &quot;sap&quot;</td>
</tr>
<tr>
<td>Authorization Status: SUCCEEDED</td>
</tr>
<tr>
<td>Peer SGT: 18</td>
</tr>
<tr>
<td>Peer SGT assignment: Trusted</td>
</tr>
<tr>
<td>SAP Status: SUCCEEDED</td>
</tr>
<tr>
<td>Version: 2</td>
</tr>
<tr>
<td>Configured pairwise ciphers:</td>
</tr>
<tr>
<td>gcm-encrypt</td>
</tr>
<tr>
<td>Replay protection: enabled</td>
</tr>
<tr>
<td>Replay protection mode: STRICT</td>
</tr>
<tr>
<td>Selected cipher: gcm-encrypt</td>
</tr>
<tr>
<td>Propagate SGT: Enabled</td>
</tr>
<tr>
<td>Cache Info:</td>
</tr>
<tr>
<td>Expiration: N/A</td>
</tr>
<tr>
<td>Cache applied to link: NONE</td>
</tr>
<tr>
<td>Statistics:</td>
</tr>
<tr>
<td>authc success: 0</td>
</tr>
<tr>
<td>authc reject: 0</td>
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</table>

Verifying the Cisco TrustSec Interface Configuration

To view the Cisco TrustSec-related interface configuration, use the `show cts interface` command.

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Verifying the Cisco TrustSec Interface Configuration

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<tr>
<td>authc success: 0</td>
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</tbody>
</table>
Feature Information for Identities, Connections, and SGTs

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>
<thead>
<tr>
<th>Feature Name</th>
<th>Release</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identities, Connections, and SGTs</td>
<td>Cisco IOS XE Everest 16.6.1</td>
<td>This feature was introduced.</td>
</tr>
</tbody>
</table>
CHAPTER 3

Configuring Security Group ACL Policies

Using security group access control lists (SGACLs), you can control the operations that users can perform based on the security group assignments of users and destination resources. Policy enforcement within the Cisco TrustSec domain is represented by a permissions matrix, with source security group numbers on one axis and destination security group numbers on the other axis. Each cell in the body of the matrix can contain an ordered list of SGACLs which specifies the permissions that should be applied to packets originating from the source security group and destined for the destination security group.

- Restrictions for Configuring SGACL Policies, on page 31
- How to Configure SGACL Policies, on page 32
- Configuration Examples for SGACL Policies, on page 42
- Feature Information for Security Group ACL Policies, on page 43

Restrictions for Configuring SGACL Policies

- Due to hardware limitations, Cisco TrustSec SGACLs cannot be enforced for punt (CPU bound) traffic in hardware. SGACL enforcement in software is bypassed for CPU bound traffic for SVI and loopback interfaces.

- When configuring SGACL policies, if you change the IP version dynamically from IPv4 or IPv6 to Agnostic (applies to both IPv4 and IPv6) and vice-versa, the corresponding SGACL policies for IPv4 and IPv6 are not downloaded completely via the management VRF interface.

- When using an SGT white list model with default action as deny all, in some cases, Cisco TrustSec policies are partially downloaded from the ISE server after a device reload. To prevent this, define a static policy on the device. Even if the deny all option is applied, the static policy permits traffic which allows the device to download policies from the ISE server and overwrite the defined static policies. For device SGT, configure the following commands in global configuration mode:

  - cts role-based permissions from <sgt_num> to unknown
  - cts role-based permissions from unknown to <sgt_num>
How to Configure SGACL Policies

The following sections provide information on various SGACL policy configurations.

SGACL Policy Configuration Process

Follow these steps to configure and enable Cisco TrustSec Security Group ACL (SGACL) policies:

1. Configuration of SGACL policies should be done primarily through the Policy Management function of the Cisco Secure Access Control Server (ACS) or the Cisco Identity Services Engine (ISE).

   If you are not using AAA on a Cisco Secure ACS or a Cisco ISE to download the SGACL policy configuration, you can manually configure the SGACL mapping and policies.

   Note

   An SGACL policy downloaded dynamically from the Cisco Secure ACS or a Cisco ISE will override any conflicting locally-defined policy.

2. To enable SGACL policy enforcement on egress traffic on routed ports, enable SGACL policy enforcement globally as described in the Enabling SGACL Policy Enforcement Globally section.

3. To enable SGACL policy enforcement on switched traffic within a VLAN, or on traffic that is forwarded to an SVI associated with a VLAN, enable SGACL policy enforcement for specific VLANs as described in the Enabling SGACL Policy Enforcement on VLANs section.

Enabling SGACL Policy Enforcement Globally

You must enable SGACL policy enforcement globally for Cisco TrustSec-enabled routed interfaces.

To enable SGACL policy enforcement on routed interfaces, perform this task:

SUMMARY STEPS

1. enable
2. configure terminal
3. cts role-based enforcement

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td></td>
</tr>
<tr>
<td>enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example: enable</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>Device# enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td></td>
</tr>
<tr>
<td>configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example: configure terminal</td>
<td></td>
</tr>
<tr>
<td>Device# configure terminal</td>
<td></td>
</tr>
</tbody>
</table>
Enabling SGACL Policy Enforcement Per Interface

You must first enable SGACL policy enforcement globally for Cisco TrustSec-enabled routed interfaces. This feature is not supported on Port Channel interfaces.

To enable SGACL policy enforcement on Layer 3 interfaces, perform this task:

**SUMMARY STEPS**

1. enable
2. configure terminal
3. interface type slot/port
4. cts role-based enforcement
5. end
6. show cts interface

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example: Device# enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example: Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> interface type slot/port</td>
<td>Configures an interface and enters interface configuration mode.</td>
</tr>
<tr>
<td>Example: Device(config)# interface gigabitethernet 6/2</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> cts role-based enforcement</td>
<td>Enables Cisco TrustSec SGACL policy enforcement on routed interfaces.</td>
</tr>
<tr>
<td>Example: Device(config-if)# cts role-based enforcement</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> end</td>
<td>Exits to privileged EXEC mode.</td>
</tr>
<tr>
<td>Example: Device(config-if)# end</td>
<td></td>
</tr>
</tbody>
</table>
Enabling SGACL Policy Enforcement on VLANs

You must enable SGACL policy enforcement on specific VLANs to apply access control to switched traffic within a VLAN, or to traffic that is forwarded to an SVI associated with a VLAN.

To enable SGACL policy enforcement on a VLAN or a VLAN list, perform this task:

SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `cts role-based enforcement vlan-list vlan-list`

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
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<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td></td>
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<tr>
<td><code>enable</code></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device# enable</code></td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td></td>
</tr>
<tr>
<td><code>configure terminal</code></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device# configure terminal</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td></td>
</tr>
<tr>
<td><code>cts role-based enforcement vlan-list vlan-list</code></td>
<td>Enables Cisco TrustSec SGACL policy enforcement on the VLAN or VLAN list.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device(config)# cts role-based enforcement vlan-list 31-35,41</code></td>
<td></td>
</tr>
</tbody>
</table>

Configuring SGACL Monitor Mode

Before configuring SGACL monitor mode, ensure the following:

- Cisco TrustSec is enabled
- Counters are enabled

SUMMARY STEPS

1. `enable`
2. `configure terminal`
### 3. cts role-based monitor enable

### 4. cts role-based monitor permissions from \{\textit{sgt}\_\textit{num}\} to \{\textit{dgt}\_\textit{num}\} [\textit{ipv4} | \textit{ipv6}]

### 5. end

### 6. show cts role-based monitor permissions from \{\textit{sgt}\_\textit{num}\} to \{\textit{dgt}\_\textit{num}\} [\textit{ipv4} | \textit{ipv6}] [details]

### 7. show cts role-based counters [\textit{ipv4} | \textit{ipv6}]

---

#### Detailed Steps

<table>
<thead>
<tr>
<th>Command or Action</th>
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<tr>
<td><strong>Step 1</strong></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>enable</td>
<td>Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device# enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong> Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>Enables device level monitor mode.</td>
</tr>
<tr>
<td>cts role-based monitor enable</td>
<td>• By default device level monitor mode is enabled. If device monitor mode is disabled, monitor mode information is still downloaded from ISE but not applied on device until this configuration is turned on.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config)# cts role-based monitor enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>Enables monitor mode for IPv4/IPv6 Role Based Access Control List (RBACL) (Security Group Tag (SGT)-Destination Group Tag (DGT) pair).</td>
</tr>
<tr>
<td>cts role-based monitor permissions from {\textit{sgt}_\textit{num}} to {\textit{dgt}_\textit{num}} [\textit{ipv4}</td>
<td>\textit{ipv6}]</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config)# cts role-based permissions from 2 to 3 ipv4</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td>Exits to privileged EXEC mode.</td>
</tr>
<tr>
<td>end</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config)# end</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td>Displays the SGACL policies and details about the monitor mode feature for each pair. The command output displays monitored if per cell monitor mode is enabled for the &lt;SGT-DGT&gt; pair</td>
</tr>
<tr>
<td>show cts role-based monitor permissions from {\textit{sgt}_\textit{num}} to {\textit{dgt}_\textit{num}} [\textit{ipv4}</td>
<td>\textit{ipv6}] [details]</td>
</tr>
<tr>
<td><strong>Example:</strong> Device# show cts role-based permissions from 2 to 3 ipv4 details</td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong></td>
<td>Displays all SGACL enforcement statistics for IPv4 and IPv6 events.</td>
</tr>
<tr>
<td>show cts role-based counters [\textit{ipv4}</td>
<td>\textit{ipv6}]</td>
</tr>
<tr>
<td><strong>Example:</strong> Device# show cts role-based counters ipv4</td>
<td></td>
</tr>
</tbody>
</table>
Manually Configuring SGACL Policies

A role-based access control list bound to a range of SGTs and DGTs forms an SGACL, a Cisco TrustSec policy enforced on egress traffic. Configuration of SGACL policies are best done through the policy management functions of the Cisco ISE or the Cisco Secure ACS. To manually (that is, locally) configure SGACL policies, do the following:

1. Configure a role-based ACL.
2. Bind the role-based ACL to a range of SGTs.

**Note**
An SGACL policy downloaded dynamically from the Cisco ISE or Cisco ACS overrides any conflicting manually configured policy.

Manually Configuring and Applying IPv4 SGACL Policies

**Note**
When configuring SGACLs and Role-Based access control lists (RBACLs), the named access control lists (ACLs) must start with an alphabet.

### SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `ip access-list role-based rbacl-name`
4. `{ [ sequence-number] | default | permit | deny | remark }
5. `exit`
6. `cts role-based permissions {default | [from {sgt_num | unknown} to {dgt_num | unknown }] | rbacls | ipv4 rbacls}`
7. `end`
8. `show cts role-based permissions`
9. `show ip access-lists {rbacls | ipv4 rbacls}`

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1** enable | Enables privileged EXEC mode.  
  Example:  
  `Device# enable`  
  • Enter your password if prompted. |
| **Step 2** configure terminal | Enters global configuration mode.  
  Example:  
  `Device# configure terminal` |
<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>ip access-list role-based <em>rbacl-name</em></td>
<td>Creates a Role-based ACL and enters Role-based ACL configuration mode.</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device(config)# ip access-list role-based allow_webtraff</td>
<td></td>
</tr>
</tbody>
</table>
| 4    | { [ sequence-number] | default | permit | deny | remark } | Specifies the access control entries (ACEs) for the RBACL. You can use most of the commands and options allowed in extended named access list configuration mode, with the source and destination fields omitted. Press Enter to complete an ACE and begin the next. The following ACE commands or keywords are not supported:  
  * reflect  
  * evaluate  
  * time-range |
|      | **Example:**      |         |
|      | Device(config-rb-acl)# 10 permit tcp dst eq 80 dst eq 20 |         |
| 5    | **exit**          | Exits role-based ACL configuration mode and returns to global configuration mode. |
|      | **Example:**      |         |
|      | Device(config-rb-acl)# exit |         |
| 6    | cts role-based permissions {default | [from | {sgt_num | unknown} to | {dgt_num | unknown } | {rbacls | ipv4 rbacls} | Binds SGTs and DGTs to the RBACL. The configuration is analogous to populating the permission matrix configured on the Cisco ISE or the Cisco Secure ACS.  
  * Default—Default permissions list  
  * sgt_num—0 to 65,519. Source Group Tag.  
  * dgt_num—0 to 65,519. Destination Group Tag  
  * unknown—SGACL applies to packets where the security group (source or destination) cannot be determined.  
  * ipv4—Indicates the following RBACL is IPv4.  
  * rbacls —Name of RBACLs |
|      | **Example:**      |         |
|      | Device(config)# cts role-based permissions from 55 to 66 allow_webtraff |         |
| 7    | **end**           | Exits global configuration mode and returns to privileged EXEC mode. |
|      | **Example:**      |         |
|      | Device(config)# end |         |
| 8    | show cts role-based permissions | Displays permission to RBACL configurations. |
|      | **Example:**      |         |
|      | Device# show cts role-based permissions |         |
### Configuring IPv6 Policies

To manually configure IPv6 SGACL policies, perform this task:

#### SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ipv6 access-list role-based sgacl-name**
4. `{permit | deny} protocol [dest-option | dest-option-type {doh-number | doh-type}] [dscp cp-value] [flow-label fl-value] [mobility | mobility-type {mh-number | mh-type}] [routing | routing-type routing-number] [fragments] [log | log-input] [sequence seqno]`
5. **end**

#### DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>enable</td>
<td>Enables privileged EXEC mode. Enter your password if prompted.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device# enable</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>ipv6 access-list role-based sgacl-name</td>
<td>Creates a named IPv6 SGACL and enters IPv6 role-based ACL configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device(config)# ipv6 access-list role-based sgacl-name</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>`{permit</td>
<td>deny} protocol [dest-option</td>
</tr>
</tbody>
</table>

---

**Note**

IPv6 SGACL is not supported on Cisco IOS XE Everest 16.8.1.
### Purpose

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>• reflect</td>
<td></td>
</tr>
<tr>
<td>• evaluate</td>
<td></td>
</tr>
<tr>
<td>• time-range</td>
<td></td>
</tr>
</tbody>
</table>

### Step 5

**Example:**

```
Device(config-ipv6rb-acl)# end
```

Exits IPv6 role-based ACL configuration mode and returns to privileged EXEC mode.

---

## Manually Applying SGACL Policies

To manually apply SGACL policies, perform this task:

### SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **cts role-based permissions default [ipv4 | ipv6] sgacl-name1 [sgacl-name2 [sgacl-name3 ...]]**
4. **cts role-based permissions from {source-sgt | unknown} to {dest-sgt | unknown} [ipv4 | ipv6] sgacl-name1 [sgacl-name2 [sgacl-name3 ...]]**

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1**
  Example: Device# enable
| Enables privileged EXEC mode.
  • Enter your password if prompted. |
| **Step 2**
  Example: Device# configure terminal
| Enters global configuration mode. |
| **Step 3**
  Example: Device(config)# cts role-based permissions default MYDEFAULTSGACL
| Specifies the default SGACLs. The default policies are applied when no explicit policy exists between the source and destination security groups. |
| **Step 4**
  Example: Device(config)# cts role-based permissions from 3 to 5 SRB3 SRB5
| Specifies the SGACLs to be applied for a source security group (SGT) and destination security group (DGT). Values for source-sgt and dest-sgt range from 1 to 65533. By default, SGACLs are considered to be IPv4.
  • from — Specifies the source SGT.
  • to — Specifies the destination security group. |
Displaying SGACL Policies

After configuring the Cisco TrustSec device credentials and AAA, you can verify the Cisco TrustSec SGACL policies downloaded from the authentication server or configured manually. Cisco TrustSec downloads the SGACL policies when it learns of a new SGT through authentication and authorization on an interface, from SXP, or from manual IP address to SGT mapping.

Using the keywords, you can display all or part of the permissions matrix:

- If the `from` keyword is omitted, a column from the permissions matrix is displayed.
- If the `to` keyword is omitted, a row from the permissions matrix is displayed.
- If the `from` and `to` keywords are omitted, the entire permissions matrix is displayed.
- If the `from` and `to` keywords are specified, a single cell from the permissions matrix is displayed and the `details` keyword is available. When `details` is entered, the ACEs of the SGACL of the single cell are displayed.

To display the contents of the SGACL policies permissions matrix, perform this task:

**SUMMARY STEPS**

1. `enable`
2. `show cts role-based permissions default [ipv4 | ipv6 | details]`
3. `show cts role-based permissions from {source-sgt | unknown} to {dest-sgt | unknown} [ipv4 | ipv6 | details]`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> <code>enable</code></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example: <code>Device# enable</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> `show cts role-based permissions default [ipv4</td>
<td>ipv6</td>
</tr>
<tr>
<td>Example: <code>Device(config)# show cts role-based permissions default MYDEFAULTSGACL</code></td>
<td></td>
</tr>
</tbody>
</table>
### Purpose

Command or Action | Purpose
---|---
**Step 3** | Specifies the SGACLs to be applied for a source security group (SGT) and destination security group (DGT). Values for source-sgt and dest-sgt range from 1 to 65533. By default, SGACLs are considered to be IPv4.

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| show cts role-based permissions from \{source-sgt | unknown\} to \{dest-sgt | unknown\] [ipv4 | ipv6 | details] | \* from—Specifies the source SGT. 
\* to—Specifies the destination security group. 
\* unknown—SGACL applies to packets where the security group (source or destination) cannot be determined.

**Note** | An SGACL policy downloaded dynamically from the ACS will override any conflicting manual policy.

### Refreshing the Downloaded SGACL Policies

**SUMMARY STEPS**

1. enable
2. configure terminal
3. cts refresh policy \{peer [peer-id] | sgt [sgt_number | default | unknown]\}

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1** | Enables privileged EXEC mode. 
Enter your password if prompted. |
| enable | Enables privileged EXEC mode. |
| Example: | Enter your password if prompted. |
| Device# enable | |

| **Step 2** | Enters global configuration mode. |
| configure terminal | Enters global configuration mode. |
| Example: | Enters global configuration mode. |
| Device# configure terminal | |

| **Step 3** | Performs an immediate refresh of the SGACL policies from the authentication server. |
| cts refresh policy \{peer [peer-id] | sgt [sgt_number | default | unknown]\} | Performs an immediate refresh of the SGACL policies from the authentication server. |
| Example: | Performs an immediate refresh of the SGACL policies from the authentication server. |
| Device(config)# cts refresh policy peer my_cisco_ise | Performs an immediate refresh of the SGACL policies from the authentication server. |

- If a peer-id is specified, only the policies related to the specified peer connection are refreshed. To refresh all peer policies, press Enter without specifying an ID.
- If an SGT number is specified, only the policies related to that SGT are refreshed. To refresh all security group tag policies, press Enter without specifying an SGT number. Select default to refresh the default policy. Select unknown to refresh unknown policy.
Configuration Examples for SGACL Policies

The following sections provide information on various SGACL policy configuration examples.

Example: Displaying SGACL Policies

This example shows how to display the content of the SGACL policies permissions matrix for traffic sourced from security group 3:

Device# show cts role-based permissions from 3

Role-based permissions from group 3 to group 5:
  SRB3
  SRB5
Role-based permissions from group 3 to group 7:
  SRB4

Example: Manually Applying SGACLs

Device# configure terminal
Device(config)# cts role-based permissions default MYDEFAULTSGACL
Device(config)# cts role-based permissions from 3 to 5 SRB3 SRB5
Device(config)# exit

Example: Manually Configuring SGACL Policies

Device# configure terminal
Device(config)# ip access role allow_webtraff
Device(config-rb-acl)# 10 permit tcp dst eq 80
Device(config-rb-acl)# 20 permit tcp dst eq 443
Device(config-rb-acl)# 30 permit icmp
Device(config-rb-acl)# 40 deny ip
Device(config-rb-acl)# exit
Device(config)# cts role-based permissions from 55 to 66 allow_webtraff
Device# show ip access allow_webtraff
  10 permit tcp dst eq www
  20 permit tcp dst eq 443
  30 permit icmp
  40 deny ip
Device# show show cts role-based permissions from 50 to 70

Example: Configuring SGACL Monitor Mode

Device# configure terminal
Device(config)# cts role-based monitor enable
Device(config)# cts role-based permissions from 2 to 3 ipv4
Device# show cts role-based permissions from 2 to 3 ipv4
Example: Enabling SGACL Policy Enforcement on VLANs

```
Device# configure terminal
Device(config)# cts role-based enforcement vlan-list 31-35,41
Device(config)# exit
```

Example: Enabling SGACL Policy Enforcement Per Interface

```
Device# configure terminal
Device(config)# interface gigabitethernet 1/0/2
Device(config-if)# cts role-based enforcement
Device(config-if)# end
```

Example: Enabling SGACL Policy Enforcement Globally

```
Device# configure terminal
Device(config)# cts role-based enforcement
```

Feature Information for Security Group ACL Policies

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](http://www.cisco.com/go/cfn). An account on Cisco.com is not required.
Table 3: Feature Information for Security Group ACL Policies

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Release</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Security Group ACL Policies</td>
<td>Cisco IOS XE Everest 16.6.1</td>
<td>Using security group access control lists (SGACLs), you can control the operations that users can perform based on the security group assignments of users and destination resources.</td>
</tr>
</tbody>
</table>
Cisco TrustSec SGACL High Availability

Cisco TrustSec Security Group access control lists (SGACLs) support the high availability functionality in switches that support the Cisco StackWise technology. This technology provides stateful redundancy and allows a switch stack to enforce and process access control entries.

• Prerequisites for Cisco TrustSec SGACL High Availability, on page 45
• Restrictions for Cisco TrustSec SGACL High Availability, on page 45
• Information About Cisco TrustSec SGACL High Availability, on page 45
• Verifying Cisco TrustSec SGACL High Availability, on page 46
• Additional References for Configuring Cisco TrustSec SGACL High Availability, on page 48

Prerequisites for Cisco TrustSec SGACL High Availability

This document assumes the following:

• An understanding of Cisco TrustSec and the Security Group access control lists (SGACL) configuration.
• Switches are configured to function as a stack.
• All the switches in the stack are running an identical version of Cisco IOS XE software.

Restrictions for Cisco TrustSec SGACL High Availability

• When both active and standby switches fail simultaneously, stateful switchover of SGACL does not occur.

Information About Cisco TrustSec SGACL High Availability

Cisco TrustSec Security Group access control lists (SGACLs) support the high availability functionality in switches that support the Cisco StackWise technology. This technology provides stateful redundancy and allows a switch stack to enforce and process access control entries.

There is no Cisco TrustSec-specific configuration to enable this functionality, which is supported in Cisco IOS XE Denali 16.2.1 and later releases.
High Availability Overview

In a switch stack, the stack manager assigns the switch with the highest priority as the active switch, and the switch with the next highest priority as the standby switch. During an automatic or a CLI-based stateful switchover, the standby switch becomes the active switch and the switch with the next highest priority becomes the standby switch and so on.

Operation data is synchronized from the active switch to the standby switch, during initial system bootup, changes in the operational data (also called Change of Authorization [CoA]), or operational data refresh.

During a stateful switchover, the newly active switch, requests and downloads the operation data. The environment data (ENV-data) and the Role-Based access control lists (RBACLs) are not updated until the refresh time is complete.

The following operation data is downloaded to the active switch:

- Environment Data (ENV-data)—A variable length field that consists of the preferred server list to get the RBACL information at the time of refresh or initialization.
- Protected Access Credential (PAC)—A shared secret that is mutually and uniquely shared between the switch and the authenticator to secure an Extensible Authentication Protocol Flexible Authentication via the Secure Tunneling (EAP-FAST) tunnel.
- Role-Based Policy (RBACL or SGACL)—A variable-length role-based policy list that consists of policy definitions for all the Security Group Tag (SGT) mappings on the switch.

Note

Cisco TrustSec credential that consists of the device ID and password details is run as a command on the active switch.

Verifying Cisco TrustSec SGACL High Availability

To verify the Cisco TrustSec SGACL high availability configuration, run the `show cts role-based permissions` command on both the active and standby switches. The output from the command must be the same on both switches.

The following is sample output from the `show cts role-based permissions` command on the active switch:

```
Device# show cts role-based permissions
IPv4 Role-based permissions default (monitored):
    default_sgacl-01
    Deny IP-00
IPv4 Role-based permissions from group 10:SGT_10 to group 15:SGT_15:
    SGACL_3-01
IPv4 Role-based permissions from group 14:SGT_14 to group 15:SGT_15:
    multiple_ace-14
RBACL Monitor All for Dynamic Policies : FALSE
RBACL Monitor All for Configured Policies : FALSE
```

The following is sample output from the show cts role-based permissions command on the standby switch:

```
Device-stby# show cts role-based permissions
IPv4 Role-based permissions default (monitored):
```
default_sgacl-01
Deny IP=00
IPv4 Role-based permissions from group 10:SGT_10 to group 15:SGT_15: SGAACL_3-01
IPv4 Role-based permissions from group 14:SGT_14 to group 15:SGT_15: multiple_ace-14
RBACL Monitor All for Dynamic Policies : FALSE
RBACL Monitor All for Configured Policies : FALSE

After a stateful switchover, run the following commands on the active switch to verify the feature:

The following is sample output from the show cts pacs command:

Device# show cts pacs
AID: A3B6D4D8353F102346786CF220FF151C
PAC-Type: Cisco Trustsec
    AID: A3B6D4D8353F102346786CF220FF151C
    I-ID: CTS_ED_21
    A-ID-Info: Identity Services Engine
PAC-Opaque:
    000200B80003000100040010A3B6D4D8353F102346786CF220FF151C0006009C00030100E44B2650D8351FD06F23623C470511E80000991535DEA86C09099A90538898D4D06F3636388B053232D49222A7FEB4837EA9BBB89D1E51DA4EB71384E663DF2839C11E5F9386936BB85250C051C051E00052083184C6E96533CEAEF5C9BE08140ABBB194EE701A0056600CF5F5B152000022A46C31E39199830F79467842ADEEBB
    Refresh timer is set for 01:00:05

The following is sample output from the show cts environment-data command:

Device# show cts environment-data
CTS Environment Data
------------------------------------------
Current state = COMPLETE
Last status = Successful
Local Device SGT:
    SGT Tag = 0:Unknown
Server List Info:
    Installed list: CTSServerList1-000D, 1 server(s):
        *Server: 10.78.105.47, port 1812, A-ID A3B6D4D8353F102346786CF220FF151C
        Status = ALIVE
        auto-test = FALSE, keywrap-enable = FALSE, idle-time = 60 mins, deadtime = 20 secs
Multicast Group SGT Table:
    Security Group Name Table:
        0001-45 :
            0-00:Unknown
            2-ba:SGT_2
            3-00:SGT_3
            4-00:SGT_4
            5-00:SGT_5
            6-00:SGT_6
            7-00:SGT_7
            8-00:SGT_8
            9-00:SGT_9
            10-16:SGT_10

Environment Data Lifetime = 3600 secs
Last update time = 14:32:53 IST Mon Mar 14 2016
Env-data expires in 0:00:10:04 (dd:hr:mm:sec)
Env-data refreshes in 0:00:10:04 (dd:hr:mm:sec)
Cache data applied = NONE
State Machine is running

The following is sample output from the `show cts role-based permissions` command after a stateful switchover:

```
Device# show cts role-based permissions

IPv4 Role-based permissions default:
   default_sgacl-01
   Deny IP-00
IPv4 Role-based permissions from group 10:SGT_10 to group 15:SGT_15:
   SGACL_3-01
IPv4 Role-based permissions from group 14:SGT_14 to group 15:SGT_15:
   multiple_ace-14
RBACL Monitor All for Dynamic Policies : FALSE
RBACL Monitor All for Configured Policies : FALSE
```

**Additional References for Configuring Cisco TrustSec SGACL High Availability**

**Related Documents**

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Commands List, All Releases</td>
</tr>
</tbody>
</table>

**Technical Assistance**

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies.</td>
<td><a href="http://www.cisco.com/support">http://www.cisco.com/support</a></td>
</tr>
<tr>
<td>To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds.</td>
<td></td>
</tr>
<tr>
<td>Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.</td>
<td></td>
</tr>
</tbody>
</table>
Configuring SGT Exchange Protocol

You can use the SGT Exchange Protocol (SXP) to propagate the Security Group Tags (SGTs) across network devices that do not have hardware support for Cisco TrustSec. This module describes how to configure Cisco TrustSec SXP on switches in your network.

Cisco TrustSec builds secure networks by establishing domains of trusted network devices. Each device in the domain is authenticated by its peers. Communication on the links between devices in the domain is secured with a combination of encryption, message integrity check, and data-path replay protection mechanisms.

The Security Group Tag (SGT) Exchange Protocol (SXP) is one of several protocols that supports CTS and is referred to in this document as Cisco TrustSec-SXP. Cisco TrustSec-SXP is a control protocol for propagating IP-to-SGT binding information across network devices that do not have the capability to tag packets. Cisco TrustSec-SXP passes IP to SGT bindings from authentication points to upstream devices in the network. This process allows security services on switches, routers, or firewalls to learn identity information from access devices.

- Prerequisites for SGT Exchange Protocol, on page 49
- Restrictions for SGT Exchange Protocol, on page 50
- Information About SGT Exchange Protocol, on page 50
- How to Configure SGT Exchange Protocol, on page 51
- Configuration Examples for SGT Exchange Protocol, on page 57
- Verifying SGT Exchange Protocol Connections, on page 58

Prerequisites for SGT Exchange Protocol

The Cisco TrustSec-SGT Over Exchange Protocol (SXP) network needs to be established before implementing SXP. This network has the following prerequisites:

- 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 pre-installed on your router before it is shipped to you.
- Cisco TrustSec SXP software must run on all network devices.
- Connectivity should exist between all network devices.
- 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 Cisco TrustSec. ACS 5.1 operates with a Cisco TrustSec-SXP license.
• Configure the retry open timer command to a different value on different routers

Restrictions for SGT Exchange Protocol

• Cisco TrustSec Exchange Protocol is not supported on logical interfaces; supported only on physical interfaces.

• In Cisco IOS XE Everest 16.6.4 and later releases, when the Dynamic Host Control Protocol (DHCP) snooping is enabled, Cisco TrustSec enforcement for DHCP packets are bypassed by enforcement polices.

Information About SGT Exchange Protocol

SGT Exchange Protocol Overview

Cisco TrustSec builds secure networks by establishing domains of trusted network devices. Each device in the domain is authenticated by its peers. Communication on the links between devices in the domain is secured with a combination of encryption, message integrity check, and data-path replay protection mechanisms.

The Security Group Tag (SGT) Exchange Protocol (SXP) is one of several protocols that supports Cisco TrustSec. SXP is a control protocol for propagating IP-to-SGT binding information across network devices that do not have the capability to tag packets. Cisco TrustSec filters packets at the egress interface. During endpoint authentication, a host accessing the Cisco TrustSec domain (the endpoint IP address) is associated with an SGT at the access device through Dynamic Host Control Protocol (DHCP) snooping and IP device tracking. The access device transmits that association or binding through SXP to Cisco TrustSec hardware-capable egress devices. These devices maintain a table of source IP-to-SGT bindings. Packets are filtered on the egress interface by Cisco TrustSec hardware-capable devices by applying security group access control lists (SGACLs). SXP passes IP-to-SGT bindings from authentication points to upstream devices in the network. This process allows security services on switches, routers, or firewalls to learn identity information from access devices.

SGTs can be assigned through any of the following Endpoint Admission Control (EAC) access methods:

• 802.1X port-based authentication

• MAC Authentication Bypass (MAB)

• Web Authentication

SXP uses TCP as the transport protocol, and the TCP port 64999 for connection initiation. SXP uses Message Digest 5 (MD5) for authentication and integrity check. It has two defined roles—speaker (initiator) and listener (receiver).

Security Group Tagging

Security Group Tag is a unique 16 bit tag that is assigned to a unique role. It represents the privilege of the source user, device, or entity and is tagged at the ingress of the Cisco TrustSec domain. SXP uses the device and user credentials acquired during authentication for classifying packets by security groups (SGs) as they enter a network. This packet classification is maintained by tagging packets on the ingress to the Cisco TrustSec
network so that they can be identified for the purpose of applying security and other policy criteria along the data path. The Security Group Tag (SGT) allows the network to enforce the access control policy by enabling the endpoint device to act upon the SGT to filter traffic. Static port Identification is used to lookup the SGT value for a particular endpoint connected to a port.

**SGT Assignment**

The Security Group Tag (SGT) of a packet can be assigned at the port level when the packet comes tagged on a Cisco TrustSec link, or when a single endpoint authenticates on a port. SGT of an incoming packet is determined in the following ways:

- When a packet that is tagged with an SGT comes on a trust port, the tag of the packet is considered as the SGT of the packet.
- When a packet is tagged with an SGT, but comes on an untrusted port, the SGT of the packet is ignored and the peer SGT is configured for the port.
- When a packet does not have an SGT, the peer SGT is configured for a port.

The following methods of assigning SGTs are supported:

- IPM (dot1x, MAB, and Web Authentication)
- VLAN-to-SGT mapping Established when an authentication method provides an SGT for an authenticated entry already has an assigned IP address. A switch process monitors endpoint sessions and detects changes or removal of IP-to-SGT binding.
- SXP (SGT Exchange Protocol) Listener

**How to Configure SGT Exchange Protocol**

**Configuring a Device SGT Manually**

In normal Cisco TrustSec operation, the authentication server assigns an SGT to the device for packets originating from the device. You can manually configure an SGT to be used if the authentication server is not accessible, but an authentication server-assigned SGT will take precedence over a manually-assigned SGT.

To manually configure an SGT on the device, perform this task:

**SUMMARY STEPS**

1. `configure terminal`
2. `cts sgt tag`
3. `exit`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 <code>configure terminal</code></td>
<td>Enters global configuration mode.</td>
</tr>
</tbody>
</table>
### Purpose

**Command or Action**

**Example:**

Device# configure terminal

**Step 2**

**cts sgt tag**

**Example:**

Device(config)# cts sgt tag

**Step 3**

**exit**

**Example:**

Device(config)# exit

### Configuring an SXP Peer Connection

You must configure the SXP peer connection on both of the devices. One device is the speaker and the other is the listener. When using password protection, make sure to use the same password on both ends.

**Note**

If a default SXP source IP address is not configured and you do not configure an SXP source address in the connection, the Cisco TrustSec software derives the SXP source IP address from existing local IP addresses. The SXP source address might be different for each TCP connection initiated from the switch.

To configure an SXP peer connection, perform this task:

**SUMMARY STEPS**

1. enable
2. configure terminal
3. cts sxp connection peer peer-ipv4-addr [source src-ipv4-addr] password {default | none} mode {local | peer} {speaker | listener} {vrf vrf-name}
4. exit
5. show cts sxp connections

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1**
| enable
| **Example:**
| Device# enable |
| **Step 2**
| configure terminal
| **Example:**
| Device# configure terminal | Enables privileged EXEC mode.
| • Enter your password if prompted. |
| Enters global configuration mode. |
### Purpose Command or Action

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>cts sxp connection peer peer-ipv4-addr[source src-ipv4-addr] password {default</td>
<td>Configures the SXP address connection. The optional source keyword specifies the IPv4 address of the source device. If no address is specified, the connection will use the default source address, if configured, or the address of the port. The password keyword specifies the password that SXP will use for the connection using the following options:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>default</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong> Device(config)# cts sxp connection peer 10.10.1.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>password default mode local listener</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>exit</td>
<td>Exits global configuration mode and returns to privileged EXEC mode</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong> Device(config)# exit</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>show cts sxp connections</td>
<td>(Optional) Displays the SXP connection information.</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong> Device# show cts sxp connections</td>
<td></td>
</tr>
</tbody>
</table>

### Configuring the Default SXP Password

By default, SXP uses no password when setting up connections.

To configure a default SXP password, perform this task:

**SUMMARY STEPS**

1. enable
2. configure terminal
3. cts sxp default password [0 | 6 | 7] password
4. exit

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>Device# enable</td>
<td></td>
</tr>
<tr>
<td>Step 2 configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td>Step 3 cts sxp default password [0</td>
<td>6</td>
</tr>
<tr>
<td>Example:</td>
<td>a clear text password (using the 0 or no option) or an</td>
</tr>
<tr>
<td>Device(config)# cts sxp default password 0 hello</td>
<td>encrypted password (using the 6 or 7 option). The maximum</td>
</tr>
<tr>
<td></td>
<td>password length is 32 characters.</td>
</tr>
<tr>
<td>Step 4 exit</td>
<td>Exits global configuration mode and returns to privileged EXEC mode</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device(config)# exit</td>
<td></td>
</tr>
</tbody>
</table>

Configuring the Default SXP Source IP Address

SXP uses the default source IP address for all new TCP connections where a source IP address is not specified. There is no effect on existing TCP connections when you configure the default SXP source IP address.

To configure a default SXP source IP address, perform this task:

SUMMARY STEPS

1. enable
2. configure terminal
3. cts sxp default source-ip src-ip-addr
4. exit

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>Device# enable</td>
<td></td>
</tr>
<tr>
<td>Step 2 configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device# configure terminal</td>
<td></td>
</tr>
</tbody>
</table>
| Step 3 cts sxp default source-ip src-ip-addr | Con...
### Configuring SGT Exchange Protocol

#### Changing the SXP Reconciliation Period

After a peer terminates an SXP connection, an internal hold-down timer starts. If the peer reconnects before the internal hold-down timer expires, the SXP reconciliation period timer starts. While the SXP reconciliation period timer is active, the Cisco TrustSec software retains the SGT mapping entries learned from the previous connection and removes invalid entries. The default value is 120 seconds (2 minutes). Setting the SXP reconciliation period to 0 seconds disables the timer and causes all entries from the previous connection to be removed.

To change the SXP reconciliation period, perform this task:

**SUMMARY STEPS**

1. **enable**
2. **configure terminal**
3. **cts sxp reconciliation period** `seconds`
4. **exit**

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| 1    | **enable**        | Enables privileged EXEC mode.  
            | Example:          | • Enter your password if prompted. |
|      | Device# enable    |         |
| 2    | **configure terminal** | Enters global configuration mode. |
|      | Example:          |         |
|      | Device# configure terminal | |
| 3    | **cts sxp reconciliation period** `seconds` | Changes the SXP reconciliation timer. The default value is 120 seconds (2 minutes). The range is from 0 to 64000. |
|      | Example:          |         |
|      | Device(config)# cts sxp reconciliation period 360 | |
| 4    | **exit**          | Exits global configuration mode and returns to privileged EXEC mode. |
|      | Example:          |         |
|      | Device(config)# exit | |
Changing the SXP Retry Period

The SXP retry period determines how often the Cisco TrustSec software retries an SXP connection. When an SXP connection is not successfully set up, the Cisco TrustSec software makes a new attempt to set up the connection after the SXP retry period timer expires. The default value is 120 seconds. Setting the SXP retry period to 0 seconds disables the timer and retries are not attempted.

To change the SXP retry period, perform this task:

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `cts sxp retry period seconds`
4. `exit`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device# <code>enable</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> <code>configure terminal</code></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device# <code>configure terminal</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> <code>cts sxp retry period seconds</code></td>
<td>Changes the SXP retry timer. The default value is 120 seconds (2 minutes). The range is from 0 to 64000.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device(config)# <code>cts sxp retry period 360</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> <code>exit</code></td>
<td>Exits global configuration mode and returns to privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device(config)# <code>exit</code></td>
<td></td>
</tr>
</tbody>
</table>

Creating Syslogs to Capture Changes of IP Address-to-SGT Mapping Learned Through SXP

When the `cts sxp log binding-changes` command is configured in global configuration mode, SXP syslogs (sev 5 syslog) are generated whenever a change to IP address to SGT binding occurs (add, delete, change). These changes are learned and propagated on the SXP connection. The default is `no cts sxp log binding-changes`.

To enable logging of binding changes, perform the following task:

**SUMMARY STEPS**

1. `enable`
### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td></td>
</tr>
<tr>
<td>enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>Device# enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td></td>
</tr>
<tr>
<td>configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td></td>
</tr>
<tr>
<td>cts sxp log binding-changes</td>
<td>Enables logging for IP to SGT binding changes.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device(config)# cts sxp log binding-changes</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td></td>
</tr>
<tr>
<td>exit</td>
<td>Exits global configuration mode and returns to privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device(config)# exit</td>
<td></td>
</tr>
</tbody>
</table>

### Configuration Examples for SGT Exchange Protocol

#### Example: Enabling Cisco TrustSec SXP and an SXP Peer Connection

The following example shows how to enable SXP and configure an SXP peer connection between Switch A, the speaker, and Switch B, the listener:

```
Device# configure terminal
Device(config)# cts sxp enable
Device(config)# cts sxp default password Cisco123
Device(config)# cts sxp default source-ip 10.10.1.1
Device(config)# cts sxp connection peer 10.20.2.2 password default mode local speaker
```

The following example shows how to configure the SXP peer connection between Switch B, the listener, and Switch A, the speaker:

```
Device# configure terminal
Device(config)# cts sxp enable
Device(config)# cts sxp default password Cisco123
Device(config)# cts sxp default source-ip 10.20.2.2
Device(config)# cts sxp connection peer 10.10.1.1 password default mode local listener
```
Example: Configuring the Default SXP Password and Source IP Address

The following example shows how to configure a default SXP password and source IP address:

```
Device# configure terminal
Device(config)# cts sxp default password Cisco123
Device(config)# cts sxp default source-ip 10.20.2.2
Device(config)# end
```

Verifying SGT Exchange Protocol Connections

To view SXP connections, perform this task:

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>show cts sxp connections</td>
<td>Displays detailed information about the SXP status and connections.</td>
</tr>
<tr>
<td>show cts sxp connections [brief]</td>
<td>Displays brief information about the SXP status and connections.</td>
</tr>
</tbody>
</table>

The following is sample output from the `show cts sxp connections` command:

```
Switch# show cts sxp connections
SXP : Enabled
Default Password : Set
Default Source IP : 10.10.1.1
Connection retry open period: 10 secs
Reconcile period : 120 secs
Retry open timer is not running
----------------------------------------------
Peer IP : 10.20.2.2
Source IP : 10.10.1.1
Conn status : On
Conn Version : 2
Connection mode : SXP Listener
Connection inst# : 1
TCP conn fd : 1
TCP conn password : default SXP password
Duration since last state change: 0:00:21:25 (dd:hr:mm:sec)
Total num of SXP Connections = 1
```

The following is sample output from the `show cts sxp connections brief` command:

```
Switch# show cts sxp connections brief
SXP : Enabled
Default Password : Set
Default Source IP : Not Set
Connection retry open period: 120 secs
Reconcile period : 120 secs
Retry open timer is not running
-------------------------------------------------------------------------------
Peer_IP | Source_IP | Conn Status | Duration
-------------------------------------------------------------------------------
10.1.3.1 | 10.1.3.2 | On | 6:00:09:13 (dd:hr:mm:sec)
```
Total num of SXP Connections = 1
Verifying SGT Exchange Protocol Connections
CHAPTER 6

Configuring Security Group Tag Mapping

Subnet to security group tag (SGT) mapping binds an SGT to all host addresses of a specified subnet. Once this mapping is implemented, Cisco TrustSec imposes the SGT on any incoming packet that has a source IP address which belongs to the specified subnet.

- Restrictions for SGT Mapping, on page 61
- Information About SGT Mapping Manually, on page 61
- How to Configure SGT Mapping, on page 63
- Verifying SGT Mapping, on page 70
- Configuration Examples for SGT Mapping, on page 70
- Feature Information for SGT Mapping, on page 74

Restrictions for SGT Mapping

Restrictions for Subnet-to-SGT Mapping

- An IPv4 subnetwork with a /31 prefix cannot be expanded.

- Subnet host addresses cannot be bound to Security Group Tags (SGT)s when the network-map bindings bindings parameter is less than the total number of subnet hosts in the specified subnets, or when bindings is 0.

- IPv6 expansions and propagation only occurs when Security Exchange Protocol (SXP) speaker and listener are running SXPv3, or more recent versions.

Information About SGT Mapping Manually

Overview of Subnet-to-SGT Mapping

Subnet-to-SGT mapping binds an SGT to all host addresses of a specified subnet. Cisco TrustSec imposes the SGT on an incoming packet when the packet’s source IP address belongs to the specified subnet. The subnet and SGT are specified in the CLI with the cts role-based sgt-map net_address/prefix sgt sgt_number global configuration command. A single host may also be mapped with this command.
Overview of VLAN-to-SGT Mapping

The VLAN-to-SGT mapping feature binds an SGT to packets from a specified VLAN. This simplifies the migration from legacy to Cisco TrustSec-capable networks as follows:

- Supports devices that are not Cisco TrustSec-capable but are VLAN-capable, such as, legacy switches, wireless controllers, access points, VPNs, etc.
- Provides backward compatibility for topologies where VLANs and VLAN ACLs segment the network, such as, server segmentation in data centers.

The VLAN-to-SGT binding is configured with the `cts role-based sgt-map vlan-list` global configuration command.

When a VLAN is assigned a gateway that is a switched virtual interface (SVI) on a Cisco TrustSec-capable switch, and IP Device Tracking is enabled on that switch, then Cisco TrustSec can create an IP-to-SGT binding for any active host on that VLAN mapped to the SVI subnet.

IP-SGT bindings for the active VLAN hosts are exported to SXP listeners. The bindings for each mapped VLAN are inserted into the IP-to-SGT table associated with the VRF the VLAN is mapped to by either its SVI or by the `cts role-based l2-vrf` command.

VLAN-to-SGT bindings have the lowest priority of all binding methods and are ignored when bindings from other sources are received, such as from SXP or CLI host configurations. Binding priorities are listing in the Binding Source Priorities section.

Overview of Layer 3 Logical Interface-to-SGT Mapping (L3IF–SGT Mapping)

L3IF-SGT mapping can directly map SGTs to traffic of any of the following Layer 3 interfaces regardless of the underlying physical interface:

- Routed port
- SVI (VLAN interface)
- Layer 3 subinterface of a Layer 2 port
• Tunnel interface

Use the **cts role-based sgt-map interface** global configuration command to specify either a specific SGT number, or a Security Group Name (whose SGT association is dynamically acquired from a Cisco ISE or a Cisco ACS access server).

In cases where Identity Port Mapping (cts interface manual sub mode configuration) and L3IF-SGT require different IP to SGT bindings, IPM takes precedence. All other conflicts among IP to SGT binding are resolved according to the priorities listing in the Binding Source Priorities section.

**Binding Source Priorities**

Cisco TrustSec resolves conflicts among IP-SGT binding sources with a strict priority scheme. For example, an SGT may be applied to an interface with the `policy {dynamic identity peer-name | static sgt tag}` Cisco TrustSec Manual interface mode command (Identity Port Mapping). The current priority enforcement order, from lowest (1) to highest (7), is as follows:

1. VLAN—Bindings learned from snooped ARP packets on a VLAN that has VLAN-SGT mapping configured.
2. CLI—Address bindings configured using the IP-SGT form of the cts role-based sgt-map global configuration command.
3. Layer 3 Interface—(L3IF) Bindings added due to FIB forwarding entries that have paths through one or more interfaces with consistent L3IF-SGT mapping or Identity Port Mapping on routed ports.
4. SXP—Bindings learned from SXP peers.
5. IP_ARP—Bindings learned when tagged ARP packets are received on a CTS capable link.
6. LOCAL—Bindings of authenticated hosts which are learned via EPM and device tracking. This type of binding also include individual hosts that are learned via ARP snooping on L2 [I]PM configured ports.
7. INTERNAL—Bindings between locally configured IP addresses and the device own SGT.

**How to Configure SGT Mapping**

**Configuring a Device SGT Manually**

In normal Cisco TrustSec operation, the authentication server assigns an SGT to the device for packets originating from the device. You can manually configure an SGT to be used if the authentication server is not accessible, but an authentication server-assigned SGT will take precedence over a manually-assigned SGT.

To manually configure an SGT on the device, perform this task:

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `cts sgt tag`
4. `exit`
### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><code>enable</code></td>
<td>- Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device# enable</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><code>configure terminal</code></td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device# configure terminal</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>Enables SXP for Cisco TrustSec.</td>
</tr>
<tr>
<td><code>cts sgt tag</code></td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device(config)# cts sgt 1234</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>Exits global configuration mode and returns to privileged EXEC mode</td>
</tr>
<tr>
<td><code>exit</code></td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device(config)# exit</code></td>
<td></td>
</tr>
</tbody>
</table>

### Configuring Subnet-to-SGT Mapping

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `cts sxp mapping network-map bindings`
4. `cts role-based sgt-map ipv4_address/prefix sgt number`
5. `cts role-based sgt-map ipv6_address::prefix sgt number`
6. `exit`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><code>enable</code></td>
<td>- Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device# enable</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><code>configure terminal</code></td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device# configure terminal</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>Configures the Subnet to SGT Mapping host count constraint. The bindings argument specifies the maximum number of subnet IP hosts that can be bound to SGTs and exported to the SXP listener.</td>
</tr>
<tr>
<td><code>cts sxp mapping network-map bindings</code></td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device(config)# cts sxp mapping network-map 10000</code></td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
</tr>
<tr>
<td><strong>Step 4</strong> cts role-based sgt-map ipv4_address/prefix sgt number</td>
<td>• bindings—(0 to 65,535) default is 0 (no expansions performed)</td>
</tr>
</tbody>
</table>
| Example: Device(config)# cts role-based sgt-map 10.10.10.10/29 sgt 1234 | (IPv4) Specifies a subnet in CIDR notation.  
• Use the no form of the command to unconfigure the Subnet to SGT mapping. The number of bindings specified in Step 2 should match or exceed the number of host addresses in the subnet (excluding network and broadcast addresses). The sgt number keyword specifies the Security Group Tag to be bound to every host address in the specified subnet.  
• ipv4_address—Specifies the IPv4 network address in dotted decimal notation.  
• prefix—(0 to 30) Specifies the number of bits in the network address.  
• sgt number—(0–65,535) Specifies the Security Group Tag (SGT) number. |

| Step 5 | cts role-based sgt-map ipv6_address::prefix sgt number | (IPv6) Specifies a subnet in colon hexadecimal notation. Use the no form of the command to unconfigure the Subnet to SGT mapping.  
The number of bindings specified in Step 2 should match or exceed the number of host addresses in the subnet (excluding network and broadcast addresses). The sgt number keyword specifies the Security Group Tag to be bound to every host address in the specified subnet.  
• ipv6_address—Specifies IPv6 network address in colon hexadecimal notation.  
• prefix—(0 to 128) Specifies the number of bits in the network address.  
• sgt number—(0–65,535) Specifies the Security Group Tag (SGT) number. |
| Example: Device(config)# cts role-based sgt-map 2020::/64 sgt 1234 |  |

| Step 6 | exit | Exits global configuration mode and returns to privileged EXEC mode. |
| Example: Device(config)# exit |  |

### Configuring VLAN-to-SGT Mapping

**Task Flow for Configuring VLAN-SGT Mapping**

- Create a VLAN on the TrustSec device with the same VLAN_ID of the incoming VLAN.
• Create an SVI for the VLAN on the TrustSec device to be the default gateway for the endpoint clients.
• Configure the TrustSec device to apply an SGT to the VLAN traffic.
• Enable IP Device tracking on the TrustSec device.
• Verify that VLAN-to-SGT mapping occurs on the TrustSec device.

### SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vlan vlan_id**
4. **[no] shutdown**
5. **exit**
6. **interface type slot/port**
7. **ip address slot/port**
8. **[no ] shutdown**
9. **exit**
10. **cts role-based sgt-map vlan-list vlan_id sgt sgt_number**
11. **ip device tracking probe [count count |delay seconds |interval length ]**
12. **exit**
13. **show cts role-based sgt-map {ipv4_netaddr|ipv4_netaddr/prefix|ipv6_netaddr|ipv6_netaddr/prefix all [ipv4 |ipv6] |host {ipv4__addr|ipv6_addr} |summary [ipv4 |ipv6 ]**
14. **show ip device tracking {all |interface |ip |mac}**

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device# enable</td>
<td>Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> vlan vlan_id</td>
<td>Creates VLAN 100 on the TrustSec-capable gateway device and enters VLAN configuration submode.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config)# vlan 100</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> [no] shutdown</td>
<td>Provisions VLAN 100.</td>
</tr>
<tr>
<td><strong>Example:</strong> Device(config-vlan)# no shutdown</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> exit</td>
<td>Exits VLAN configuration mode and returns to global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
</tbody>
</table>
### Configuring Security Group Tag Mapping

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device(config-vlan)# exit</td>
<td>Enters interface configuration mode.</td>
</tr>
</tbody>
</table>

#### Step 6
- **Command:** `interface type slot/port`  
  **Example:**  
  Device(config)# interface vlan 100  
- **Purpose:** Configures Switched Virtual Interface (SVI) for VLAN 100.

#### Step 7
- **Command:** `ip address slot/port`  
  **Example:**  
  Device(config-if)# ip address 10.1.1.2 255.0.0.0  
- **Purpose:** Enables the SVI.

#### Step 8
- **Command:** `[no ] shutdown`  
  **Example:**  
  Device(config-if)# no shutdown  
- **Purpose:** Exits VLAN interface configuration mode and returns to global configuration mode.

#### Step 9
- **Command:** `exit`  
  **Example:**  
  Device(config-if)# exit  
- **Purpose:** Enables IP device tracking. When active hosts are detected, the device adds the following entries to an IP Device tracking table:
  - IP address of host
  - MAC address of host
  - VLAN of the host
  - The interface on which the device detected the host
  - The state of the host (active or inactive)
  
The host added to the IP Device tracking table is monitored with periodic ARP probes. Hosts that fail to respond are removed from the table.

#### Step 10
- **Command:** `cts role-based sgt-map vlan-list vlan_id sgt sgt_number`  
  **Example:**  
  Device(config)# cts role-based sgt-map vlan-list 100 sgt 10  
- **Purpose:** Assigns the specified SGT to the specified VLAN.

#### Step 11
- **Command:** `ip device tracking probe [count count | delay seconds | interval length ]`  
  **Example:**  
  Device(config)# ip device tracking  
- **Purpose:** (Optional) Displays the VLAN-to-SGT mappings.

#### Step 12
- **Command:** `exit`  
  **Example:**  
  Device(config)# exit  
- **Purpose:** Exits global configuration mode.

#### Step 13
- **Command:** `show cts role-based sgt-map {ipv4 netaddr | ipv4 netaddr/prefix | ipv6 netaddr | ipv6 netaddr/prefix | all [ipv4 | ipv6] | host {ipv4__addr |ipv6_addr} | summary [ipv4 | ipv6 ]`  
- **Purpose:** (Optional) Displays the VLAN-to-SGT mappings.
### Configuring L3IF-to-SGT Mapping

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `cts role-based sgt-map interface type slot/port [security-group name | sgt number]`
4. `exit`
5. `show cts role-based sgt-map all`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1** | `enable`
| **Example:** | `Device# enable`
| | Enables privileged EXEC mode.
| | • Enter your password if prompted. |
| **Step 2** | `configure terminal`
| **Example:** | `Device# configure terminal`
| | Enters global configuration mode. |
| **Step 3** | `cts role-based sgt-map interface type slot/port [security-group name | sgt number]`
| **Example:** | `Device(config)# cts role-based sgt-map interface gigabitEthernet 1/1 sgt 77`
| | An SGT is imposed on ingress traffic to the specified interface.
| | • `interface type slot/port` — Displays list of available interfaces.
| | • `security-group name` — Security Group name to SGT pairings are configured on the Cisco ISE or Cisco ACS.
| | • `sgt number` — (0 to 65,535). Specifies the Security Group Tag (SGT) number. |
| **Step 4** | `exit`
| **Example:** | `Device(config)# exit`
| | Exits configuration mode. |
| **Step 5** | `show cts role-based sgt-map all`
| **Example:** | Verify that ingressing traffic is tagged with the specified SGT. |
Emulating the Hardware Keystore

In cases where a hardware keystore is not present or is unusable, you can configure the switch to use a software emulation of the keystore. To configure the use of a software keystore, perform this task:

SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `cts keystore emulate`
4. `exit`
5. `show keystore`

DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td><code>enable</code></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td></td>
<td>Example: <code>enable</code></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device# <code>enable</code></td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>Step 2</td>
<td><code>configure terminal</code></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example: <code>configure terminal</code></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device# <code>configure terminal</code></td>
<td></td>
</tr>
<tr>
<td>Step 3</td>
<td><code>cts keystore emulate</code></td>
<td>Configures the switch to use a software emulation of the keystore instead of the hardware keystore.</td>
</tr>
<tr>
<td></td>
<td>Example: <code>cts keystore emulate</code></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device(config)# <code>cts keystore emulate</code></td>
<td></td>
</tr>
<tr>
<td>Step 4</td>
<td><code>exit</code></td>
<td>Exits configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example: <code>exit</code></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device(config)# <code>exit</code></td>
<td></td>
</tr>
<tr>
<td>Step 5</td>
<td><code>show keystore</code></td>
<td>Displays the status and contents of the keystore. The stored secrets are not displayed.</td>
</tr>
<tr>
<td></td>
<td>Example: <code>show keystore</code></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device# <code>show keystore</code></td>
<td></td>
</tr>
</tbody>
</table>
Verifying SGT Mapping

Verifying Subnet-to-SGT Mapping Configuration

To display Subnet-to-SGT Mapping configuration information, use one of the following show commands:

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>show cts sxp connections</td>
<td>Displays the SXP speaker and listener connections with their operational status.</td>
</tr>
<tr>
<td>show cts sxp sgt-map</td>
<td>Displays the IP to SGT bindings exported to the SXP listeners.</td>
</tr>
<tr>
<td>show running-config</td>
<td>Verifies that the subnet-to-SGT configurations commands are in the running configuration file.</td>
</tr>
</tbody>
</table>

Verifying VLAN-to-SGT Mapping

To display VLAN-to-SGT configuration information, use the following show commands:

Table 4:

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>show ip device tracking</td>
<td>Displays the status of IP Device Tracking which identifies the IP addresses of active hosts on a VLAN.</td>
</tr>
<tr>
<td>show cts role-based sgt-map</td>
<td>Displays IP address-to-SGT bindings.</td>
</tr>
</tbody>
</table>

Verifying L3IF-to-SGT Mapping

To display L3IF-to-SGT configuration information, use the following show command:

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>show cts role-based sgt-map all</td>
<td>Displays all IP address-to-SGT bindings.</td>
</tr>
</tbody>
</table>

Configuration Examples for SGT Mapping

Example: Configurating a Device SGT Manually

Device# configure terminal
Device(config)# cts sgt 1234
Device(config)# exit
Example: Configuration for Subnet-to-SGT Mapping

The following example shows how to configure IPv4 Subnet-to-SGT Mapping between devices running SXPv3 (Device1 and Device2):

1. Configure SXP speaker/listener peering between devices.

   Device1# configure terminal  
   Device1(config)# cts sxp enable  
   Device1(config)# cts sxp default source-ip 1.1.1.1  
   Device1(config)# cts sxp default password 1syzygy1  
   Device1(config)# cts sxp connection peer 2.2.2.2 password default mode local speaker

2. Configure Device2 as SXP listener of Device1.

   Device2(config)# cts sxp enable  
   Device2(config)# cts sxp default source-ip 2.2.2.2  
   Device2(config)# cts sxp default password 1syzygy1  
   Device2(config)# cts sxp connection peer 1.1.1.1 password default mode local listener

3. On Device2, verify that the SXP connection is operating:

   Device2# show cts sxp connections brief | include 1.1.1.1  
   1.1.1.1 2.2.2.2 On 3:22:23:18

4. Configure the subnetworks to be expanded on Device1.

   Device1(config)# cts sxp mapping network-map 10000  
   Device1(config)# cts role-based sgt-map 10.10.10.0/30 sgt 101  
   Device1(config)# cts role-based sgt-map 11.11.11.0/29 sgt 11111  
   Device1(config)# cts role-based sgt-map 192.168.1.0/28 sgt 65000

5. On Device2, verify the subnet-to-SGT expansion from Device1. There should be two expansions for the 10.10.10.0/30 subnetwork, six expansions for the 11.11.10.0/29 subnetwork, and 14 expansions for the 192.168.1.0/28 subnetwork.

   Device2# show cts sxp sgt-map brief | include 101|11111|65000  
   IPv4,SGT: <10.10.10.1 , 101>  
   IPv4,SGT: <10.10.10.2 , 101>  
   IPv4,SGT: <11.11.11.1 , 11111>  
   IPv4,SGT: <11.11.11.2 , 11111>  
   IPv4,SGT: <11.11.11.3 , 11111>  
   IPv4,SGT: <11.11.11.4 , 11111>  
   IPv4,SGT: <11.11.11.5 , 11111>  
   IPv4,SGT: <11.11.11.6 , 11111>  
   IPv4,SGT: <192.168.1.1 , 65000>  
   IPv4,SGT: <192.168.1.2 , 65000>  
   IPv4,SGT: <192.168.1.3 , 65000>  
   IPv4,SGT: <192.168.1.4 , 65000>  
   IPv4,SGT: <192.168.1.5 , 65000>  
   IPv4,SGT: <192.168.1.6 , 65000>  
   IPv4,SGT: <192.168.1.7 , 65000>  
   IPv4,SGT: <192.168.1.8 , 65000>  
   IPv4,SGT: <192.168.1.9 , 65000>  
   IPv4,SGT: <192.168.1.10 , 65000>  
   IPv4,SGT: <192.168.1.11 , 65000>  
   IPv4,SGT: <192.168.1.12 , 65000>  
   IPv4,SGT: <192.168.1.13 , 65000>  
   IPv4,SGT: <192.168.1.14 , 65000>

6. Verify the expansion count on Device1:
Example: Configuration for VLAN-to-SGT Mapping for a Single Host Over an Access Link

In the following example, a single host connects to VLAN 100 on an access device. A switched virtual interface on the TrustSec device is the default gateway for the VLAN 100 endpoint (IP Address 10.1.1.1). The TrustSec device imposes Security Group Tag (SGT) 10 on packets from VLAN 100.

1. Create VLAN 100 on an access device.
   ```
   access_device# configure terminal
   access_device(config)# vlan 100
   access_device(config-vlan)# no shutdown
   access_device(config-vlan)# exit
   access_device(config)#
   ```

2. Configure the interface to the TrustSec device as an access link. Configurations for the endpoint access port are omitted in this example.
   ```
   access_device(config)# interface gigabitEthernet 6/3
   access_device(config-if)# switchport
   access_device(config-if)# switchport mode access
   access_device(config-if)# switchport access vlan 100
   ```

3. Create VLAN 100 on the TrustSec device.
   ```
   TS_device(config)# vlan 100
   TS_device(config-vlan)# no shutdown
   TS_device(config-vlan)# end
   TS_device#
   ```

4. Create an SVI as the gateway for incoming VLAN 100.
   ```
   TS_device(config)# interface vlan 100
   TS_device(config-if)# ip address 10.1.1.2 255.0.0.0
   TS_device(config-if)# no shutdown
   TS_device(config-if)# end
   TS_device(config)#
   ```

5. Assign Security Group Tag (SGT) 10 to hosts on VLAN 100.
   ```
   TS_device(config)# cts role-based sgt-map vlan 100 sgt 10
   ```

6. Enable IP Device Tracking on the TrustSec device. Verify that it is operating.
   ```
   TS_device(config)# ip device tracking
   TS_device# show ip device tracking all
   IP Device Tracking - Enabled
   ```
IP Device Tracking Probe Count = 3
IP Device Tracking Probe Interval = 100

---

<table>
<thead>
<tr>
<th>IP Address</th>
<th>MAC Address</th>
<th>Vlan</th>
<th>Interface</th>
<th>STATE</th>
</tr>
</thead>
</table>

Total number interfaces enabled: 1
Vlan100

7. (Optional) PING the default gateway from an endpoint (in this example, host IP Address 10.1.1.1). Verify that SGT 10 is being mapped to VLAN 100 hosts.

```
TS_device# show cts role-based sgt-map all
```

Active IP-SGT Bindings Information

<table>
<thead>
<tr>
<th>IP Address</th>
<th>SGT</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.1.1.1</td>
<td>10</td>
<td>VLAN</td>
</tr>
</tbody>
</table>

IP-SGT Active Bindings Summary

Total number of VLAN bindings = 1
Total number of CLI bindings = 0
Total number of active bindings = 1

---

**Example: Configuration for L3IF-to-SGT Mapping on an Ingress Port**

In the following example a Layer 3 interface of a device linecard is configured to tag all ingressing traffic with SGT 3. Prefixes of attached subnets are already known.

1. Configure the interface.

```
Device# configure terminal
Device(config)# interface gigabitEthernet 6/3 sgt 3
Device(config)# exit
```

2. Verify that the ingressing traffic to the interface is tagged appropriately.

```
Device# show cts role-based sgt-map all
```

<table>
<thead>
<tr>
<th>IP Address</th>
<th>SGT</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.1.1.15</td>
<td>4</td>
<td>INTERNAL</td>
</tr>
<tr>
<td>17.1.1.0/24</td>
<td>3</td>
<td>L3IF</td>
</tr>
<tr>
<td>21.1.1.2</td>
<td>4</td>
<td>INTERNAL</td>
</tr>
<tr>
<td>31.1.1.0/24</td>
<td>3</td>
<td>L3IF</td>
</tr>
<tr>
<td>31.1.1.2</td>
<td>4</td>
<td>INTERNAL</td>
</tr>
<tr>
<td>43.1.1.0/24</td>
<td>3</td>
<td>L3IF</td>
</tr>
<tr>
<td>49.1.1.0/24</td>
<td>3</td>
<td>L3IF</td>
</tr>
<tr>
<td>50.1.1.0/24</td>
<td>3</td>
<td>L3IF</td>
</tr>
<tr>
<td>50.1.1.2</td>
<td>4</td>
<td>INTERNAL</td>
</tr>
<tr>
<td>51.1.1.1</td>
<td>4</td>
<td>INTERNAL</td>
</tr>
<tr>
<td>52.1.1.0/24</td>
<td>3</td>
<td>L3IF</td>
</tr>
<tr>
<td>81.1.1.1</td>
<td>5</td>
<td>CLI</td>
</tr>
<tr>
<td>102.1.1.1</td>
<td>4</td>
<td>INTERNAL</td>
</tr>
<tr>
<td>105.1.1.1</td>
<td>3</td>
<td>L3IF</td>
</tr>
<tr>
<td>111.1.1.1</td>
<td>4</td>
<td>INTERNAL</td>
</tr>
</tbody>
</table>

IP-SGT Active Bindings Summary

Total number of CLI bindings = 1
Total number of L3IF bindings = 7
Example: Emulating the Hardware Keystore

This example shows how to configure and verify the use of a software keystore:

```
Device# configure terminal
Device(config)# cts keystore emulate
Device(config)# exit
Device# show keystore
No hardware keystore present, using software emulation.
Keystore contains the following records (S=Simple Secret, P=PAC, R=RSA):
Index Type Name
----- ---- ----
0 S CTS-password
1 P ECF05BB8DFAD854E8376DEA4EF6171CF
```

Feature Information for SGT Mapping

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 5: Feature Information for SGT Mapping
```
CHAPTER 7

Cisco TrustSec VRF-Aware SGT

The Cisco TrustSec VRF-Aware SGT feature binds a Security Group Tag (SGT) Exchange Protocol (SXP) connection with a specific virtual routing and forwarding (VRF) instance.

- Information About Cisco TrustSec VRF-Aware SGT, on page 75
- How to Configure VRF-Aware SGT, on page 76
- Configuration Examples for Cisco TrustSec VRF-Aware SGT, on page 78
- Additional References for Configuring Cisco TrustSec VRF-Aware SGT, on page 78
- Feature Information for Cisco TrustSec VRF-Aware SGT, on page 79

Information About Cisco TrustSec VRF-Aware SGT

VRF-Aware SXP

The SXP implementation of Virtual Routing and Forwarding (VRF) binds an SXP connection with a specific VRF. It is assumed that the network topology is correctly configured for Layer 2 or Layer 3 VPNs, with all VRFs configured before enabling Cisco TrustSec.

SXP VRF support can be summarized as follows:

- Only one SXP connection can be bound to one VRF.
- Different VRFs may have overlapping SXP peer or source IP addresses.
- IP–SGT mappings learned (added or deleted) in one VRF can be updated only in the same VRF domain. The SXP connection cannot update a mapping bound to a different VRF. If no SXP connection exits for a VRF, IP–SGT mappings for that VRF won’t be updated by SXP.
- Multiple address families per VRF is supported. Therefore, one SXP connection in a VRF domain can forward both IPV4 and IPV6 IP-SGT mappings.
- SXP has no limitation on the number of connections and number of IP-SGT mappings per VRF.
# How to Configure VRF-Aware SGT

## Configuring VRF-to-Layer-2-VLAN Assignments

### SUMMARY STEPS
1. `enable`
2. `configure terminal`
3. `interface type number`
4. `vrf forwarding vrf-name`
5. `exit`
6. `cts role-based l2-vrf vrf1 vlan-list 20`
7. `end`

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1** | Command: `enable`
| Example: Device> enable | Enables privileged EXEC mode. |
| | • Enter your password if prompted. |
| **Step 2** | Command: `configure terminal`
| Example: Device# configure terminal | Enters global configuration mode. |
| **Step 3** | Command: `interface type number`
| Example: Device(config)# interface vlan 101 | Enables an interface and enters interface configuration mode. |
| **Step 4** | Command: `vrf forwarding vrf-name`
| Example: Device(config-if)# vrf forwarding vrf1 interface | Associates a VRF instance or a virtual network with an interface or subinterface. |
| | **Note** Do not configure VRFs on the management interface. |
| **Step 5** | Command: `exit`
| Example: Device(config-if)# end | Exits interface configuration mode and returns to global configuration mode. |
| **Step 6** | Command: `cts role-based l2-vrf vrf1 vlan-list 20`
| Example: | Selects a VRF instance for Layer 2 VLANs. |
Purpose

Command or Action

Device(config)# cts role-based l2-vrf vrf1 vlan-list 20

Step 7

end

Example:

Device(config)# end

Exits global configuration mode and returns to privileged EXEC mode.

Configuring VRF-to-SGT Mapping

SUMMARY STEPS

1. enable
2. configure terminal
3. cts role-based sgt-map vrf vrf-name {ip4_netaddress | ipv6_netaddress | host {ip4_address | ip6_address}} | sgt sgt_number
4. end

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>Device&gt; enable</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device# configure terminal</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>cts role-based sgt-map vrf vrf-name {ip4_netaddress</td>
<td>ipv6_netaddress</td>
</tr>
<tr>
<td>Example:</td>
<td>The IP-SGT binding is entered into the IP-SGT table associated with the specified VRF and the IP protocol version implied by the type of IP address.</td>
</tr>
<tr>
<td>Device(config)# cts role-based sgt-map vrf red 10.0.0.3 sgt 23</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>end</td>
<td>Exits global configuration mode and returns to privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device(config)# end</td>
<td></td>
</tr>
</tbody>
</table>
Configuration Examples for Cisco TrustSec VRF-Aware SGT

Example: Configuring VRF-to-Layer2-VLAN Assignments

```
Device> enable
Device# configure terminal
Device(config)# interface vlan 101
Device(config-if)# vrf forwarding vrf-intf
Device(config-if)# exit
Device(config)# cts role-based l2-vrf vrf1 vlan-list 20
Device(config)# end
```

Example: Configuring VRF-to-Layer2-VLAN Assignments

```
Device> enable
Device# configure terminal
Device(config)# cts role-based sgt-map vrf red 23.1.1.2 sgt 23
Device(config)# end
```

Additional References for Configuring Cisco TrustSec VRF-Aware SGT

**Related Documents**

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Commands List, All Releases</td>
</tr>
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</table>

**MIBs**

<table>
<thead>
<tr>
<th>MIB</th>
<th>MIBs Link</th>
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</thead>
<tbody>
<tr>
<td>All the supported MIBs for this release.</td>
<td>To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use the Cisco MIB Locator found at: <a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a>.</td>
</tr>
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</table>
Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support website provides extensive online resources, including</td>
<td><a href="https://www.cisco.com/c/en/us/support/index.html">https://www.cisco.com/c/en/us/support/index.html</a></td>
</tr>
<tr>
<td>documentation and tools for troubleshooting and resolving technical issues</td>
<td></td>
</tr>
<tr>
<td>with Cisco products and technologies.</td>
<td></td>
</tr>
<tr>
<td>To receive security and technical information about your products, you can</td>
<td></td>
</tr>
<tr>
<td>subscribe to various services, such as the Product Alert Tool (accessed from</td>
<td></td>
</tr>
<tr>
<td>Field Notices), the Cisco Technical Services Newsletter, and Really Simple</td>
<td></td>
</tr>
<tr>
<td>Syndication (RSS) Feeds.</td>
<td></td>
</tr>
<tr>
<td>Access to most tools on the Cisco Support website requires a Cisco.com user</td>
<td></td>
</tr>
<tr>
<td>ID and password.</td>
<td></td>
</tr>
</tbody>
</table>

Feature Information for Cisco TrustSec VRF-Aware SGT

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.

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**Table 6: Feature Information for Cisco TrustSec VRF-Aware SGT**

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Release</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco TrustSec VRF-Aware SGT</td>
<td>Cisco IOS XE Everest 16.6.1</td>
<td>The Cisco TrustSec VRF-Aware SGT feature binds a Security Group Tag (SGT) Exchange Protocol (SXP) connection with a specific virtual routing and forwarding (VRF) instance.</td>
</tr>
</tbody>
</table>
Cisco TrustSec SGT Caching

The Cisco TrustSec SGT Caching feature enhances the ability of Cisco TrustSec to make Security Group Tag (SGT) transportability flexible. This feature identifies IP-SGT bindings, and caches the corresponding SGTs so that network packets are forwarded through all the network services for normal deep-packet inspection processing, and at the service egress point the packets are re-tagged with the appropriate SGT.

Only IPv4 SGT caching is supported. High availability is supported for SGT caching.

• Restrictions for Cisco TrustSec SGT Caching, on page 81
• Information About Cisco TrustSec SGT Caching, on page 82
• How to Configure Cisco TrustSec SGT Caching, on page 83
• Verifying Cisco TrustSec SGT Caching, on page 85
• Configuration Examples for Cisco TrustSec Caching, on page 88
• Additional References for Cisco TrustSec SGT Caching, on page 89
• Feature Information for Cisco TrustSec SGT Caching, on page 90

Restrictions for Cisco TrustSec SGT Caching

The global SGT caching configuration and the interface-specific ingress configuration are mutually exclusive. In the following scenarios, a warning message is displayed if you attempt to configure SGT caching both globally and on an interface:

• If an interface has ingress SGT caching enabled using the **cts role-based sgt-cache ingress** command in interface configuration mode, and a global configuration is attempted using the **cts role-based sgt-caching** command, a warning message is displayed, as shown in this example:

```
Device> enable
Device# configure terminal
Device(config)# interface gigabitEthernet 1/0/1
Device(config-if)# cts role-based sgt-cache ingress
Device(config-if)# exit
Device(config)# cts role-based sgt-caching
```

There is at least one interface that has ingress sgt caching configured. Please remove all interface ingress sgt caching configuration(s) before attempting global enable.

This restriction specifically applies only to Layer 3-routed port interfaces. Also, the port must be a trusted port for SGT caching to work.
Because SGT caching internally uses the NetFlow ternary content-addressable memory (TCAM) space, at any time on an interface, you can enable only either Flexible NetFlow or SGT caching in a given direction.

If global configuration is enabled using the `cts role-based sgt-caching` command, and an interface configuration is attempted using the `cts role-based sgt-cache ingress` command in interface configuration mode, a warning message is displayed, as shown in this example:

```
Device> enable
Device# configure terminal
Device(config)# cts role-based sgt-caching
Device(config)# interface gigabitEthernet 1/0/1
Device(config-if)# cts role-based sgt-cache ingress
```

Note that ingress sgt caching is already active on this interface due to global sgt-caching enable.

IPv6 SGT caching is not supported.

SGT caching cannot be performed for the link-local IPv6 source address.

A link-local address is a network address that is valid only for communications within the network segment (link) or the broadcast domain that the host is connected to. Link-local addresses are not guaranteed to be unique beyond a single network segment. Therefore, devices do not forward packets with link-local addresses. Because they are not unique, SGT tags are not assigned for packets with source as link-local IPv6 address.

SGT caching cannot coexist on the same port interface that has Application Visibility and Control (AVC), Wired Device AVC (WDAVC), Encrypted Traffic Analysis (ETTA,) or NetFlow/Flexible NetFlow features configured. An error message is displayed on the console if both SGT caching and one of these features are configured on the same interface.

When SGT caching is enabled along with any of the above mentioned features, the following error message is displayed on the console: `SGT Caching cannot be configured. Remove the configuration.` However; the SGT Caching feature is displayed in the output of the `show running-config` command. You need to manually remove SGT caching and reconfigure it, after removing the feature that cannot co-exist with it.

### Information About Cisco TrustSec SGT Caching

#### Identifying and Reapplying SGT Using SGT Caching

Cisco TrustSec uses Security Group Tag (SGT) caching to ensure that traffic that is tagged with SGT can also pass through services that are not aware of SGTs. Examples of services that cannot propagate SGTs are WAN acceleration or optimization, Intrusion Prevention Systems (IPSs), and upstream firewalls.

To configure SGACL caching on a VLAN, SGT caching must be enabled on the corresponding port and VLAN.

In one-arm mode (See the below figure), a packet tagged with SGT enters a device (where the tags are cached), and is redirected to a service. After that service is completed, the packet either returns to the device, or is redirected to another device. In such a scenario:
1. The Cisco TrustSec SGT Caching feature enables the device to identify the IP-SGT binding information from the incoming packet and caches this information.

2. The device redirects the packet to services that cannot propagate SG Ts.

3. After the completion of the service, the packet returns to the device.

4. The appropriate SGT is reapplied to the packet at the service egress point.

5. Role-based enforcements are applied to the packet that has returned to the device from the service or services.

6. The packet with SG Ts is forwarded to other Cisco TrustSec-capable devices downstream.

**Figure 8: SGT Caching in One-Arm Mode**

In certain instances, some services are deployed in a bump-in-the-wire topology (See the above figure). In such a scenario:

1. Packets that go through a service or services do not come back to the device.

2. Single-hop SGT Exchange Protocol (SXP) is used to identify and export the identified IP-SGT bindings.

3. The upstream device in the network identifies the IP-SGT bindings through SXP and reapplies the appropriate tags or uses them for SGT-based enforcement. During egress caching, the original pre-Network Address Translation (NAT) source IP address is cached as part of the identified IP-SGT binding information.

4. IP-SGT bindings that do not receive traffic for 300 seconds are removed from the cache.

**Figure 9: SGT Caching in Bump-in-the-wire Topology**

### How to Configure Cisco TrustSec SGT Caching

This section describes how to configure SGT caching globally and on interfaces.
Configuring SGT Caching Globally

Before you begin

Before SGT caching is enabled, Security Exchange Protocol (SXP) must be established for information exchange.

SUMMARY STEPS

1. enable
2. configure terminal
3. cts role-based sgt-caching
4. end

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Device&gt; enable</td>
<td></td>
</tr>
</tbody>
</table>

| **Step 2** configure terminal      | Enters global configuration mode.                                       |
| Example:                           |                                                                         |
| Device# configure terminal         |                                                                         |

| **Step 3** cts role-based sgt-caching | Enables SGT caching in ingress direction for all interfaces.                     |
| Example:                           |                                                                         |
| Device(config)# cts role-based sgt-caching |                                                                         |

| **Step 4** end                     | Exits global configuration mode and returns to privileged EXEC mode.          |
| Example:                           |                                                                         |
| Device(config)# end                |                                                                         |

Configuring SGT Caching on an Interface

When an interface is configured to be on a Virtual Routing and Forwarding (VRF) network, the IP-SGT bindings identified on that interface are added under the specific VRF. (To view the bindings identified on a corresponding VRF, use the `show cts role-based sgt-map vrf vrf-name all` command.) SGT caching can also be configured per VRF.

SUMMARY STEPS

1. enable
2. configure terminal
3. `interface type slot/port`
4. `cts role-based sgt-cache [ingress | egress]`
5. `end`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> <code>enable</code></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example: <code>Device&gt; enable</code></td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong> <code>configure terminal</code></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example: <code>Device# configure terminal</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> <code>interface type slot/port</code></td>
<td>Configures an interface and enters interface configuration mode.</td>
</tr>
<tr>
<td>Example: <code>Device(config)# interface gigabitethernet 1/0/1</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> `cts role-based sgt-cache [ingress</td>
<td>egress]`</td>
</tr>
<tr>
<td>Example: <code>Device(config-if)# cts role-based sgt-cache ingress</code></td>
<td>• <strong>ingress</strong>: Enables SGT caching for traffic entering the specific interface (inbound traffic).</td>
</tr>
<tr>
<td></td>
<td>• <strong>ingress</strong>: Enables SGT caching for traffic exiting the specific interface (outbound traffic).</td>
</tr>
<tr>
<td><strong>Step 5</strong> <code>end</code></td>
<td>Exits interface configuration mode and returns to privileged EXEC mode.</td>
</tr>
<tr>
<td>Example: <code>Device(config-if)# end</code></td>
<td></td>
</tr>
</tbody>
</table>

**Verifying Cisco TrustSec SGT Caching**

**SUMMARY STEPS**

1. `enable`
2. `show cts`
3. `show cts interface`
4. `show cts interface brief`
5. `show cts role-based sgt-map all ipv4`
6. `show cts role-based sgt-map vrf vrf-name all ipv4`
7. The SGT cache entry is removed after a port shutdown or SGT cache timeout.
DETAILED STEPS

Step 1  
**enable**

Enables privileged EXEC mode. Enter your password if prompted.

**Example:**

Device> enable

Step 2  
**show cts**

Displays the Cisco TrustSec connections and the status of global SGT caching.

**Example:**

Device# show cts

Global Dot1x feature: Disabled
CTS device identity: ""
CTS caching support: disabled
**CTS sgt-caching global: Enabled**
Number of CTS interfaces in DOT1X mode: 0, MANUAL mode: 0
Number of CTS interfaces in LAYER3 TrustSec mode: 0
Number of CTS interfaces in corresponding IFC state
  INIT state: 0
  AUTHENTICATING state: 0
  AUTHORIZING state: 0
  SAP_NEGOTIATING state: 0
  OPEN state: 0
  HELD state: 0
  DISCONNECTING state: 0
  INVALID state: 0

CTS events statistics:
  authentication success: 0
  authentication reject : 0
  authentication failure: 0
  authentication logoff : 0
  authentication no resp: 0
  authorization success : 0
  authorization failure : 0
  sap success : 0
  sap failure : 0
  port auth failure : 0

Step 3  
**show cts interface**

Displays the Cisco TrustSec configuration statistics for an interface and SGT caching information with mode details (ingress or egress).

**Example:**

Device# show cts interface GigabitEthernet 1/0/1

Interface GigabitEthernet1/0/1
  CTS sgt-caching Ingress: Enabled
  CTS sgt-caching Egress : Disabled
  CTS is enabled, mode: MANUAL
  Propagate SGT: Enabled
Step 4  show cts interface brief

Displays SGT caching information with mode details (ingress or egress) for all interfaces.

Example:

Device# show cts interface brief

Interface GigabitEthernet1/0/1
  CTS sgt-caching Ingress: Enabled
  CTS sgt-caching Egress : Disabled
  CTS is enabled

Interface GigabitEthernet1/0/2
  CTS sgt-caching Ingress: Enabled
  CTS sgt-caching Egress : Disabled
  CTS is enabled, mode: MANUAL
  Propagate SGT: Enabled
  Static Ingress SGT Policy:
    Peer SGT: 200
    Peer SGT assignment: Trusted

Interface GigabitEthernet1/0/3
  CTS sgt-caching Ingress: Enabled
  CTS sgt-caching Egress : Disabled
  CTS is enabled, mode: MANUAL
  Propagate SGT: Enabled
  Static Ingress SGT Policy:
    Peer SGT: 0
    Peer SGT assignment: Untrusted

Step 5  show cts role-based sgt-map all ipv4

Displays all the SGT-IPv4 bindings.

Example:
Device# show cts role-based sgt-map all ipv4

Active IPv4-SGT Bindings Information

<table>
<thead>
<tr>
<th>IP Address</th>
<th>SGT</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>192.0.2.1</td>
<td>50</td>
<td>CACHED</td>
</tr>
<tr>
<td>192.0.2.2</td>
<td>50</td>
<td>CACHED</td>
</tr>
<tr>
<td>192.0.2.3</td>
<td>50</td>
<td>CACHED</td>
</tr>
<tr>
<td>192.0.2.4</td>
<td>50</td>
<td>CACHED</td>
</tr>
<tr>
<td>192.0.2.5</td>
<td>3900</td>
<td>INTERNAL</td>
</tr>
<tr>
<td>192.0.2.6</td>
<td>3900</td>
<td>INTERNAL</td>
</tr>
<tr>
<td>192.0.2.7</td>
<td>3900</td>
<td>INTERNAL</td>
</tr>
</tbody>
</table>

IP-SGT Active Bindings Summary

| Total number of CACHED bindings = | 20 |
| Total number of INTERNAL bindings = | 3 |
| Total number of active bindings = | 23 |

Step 6  

show cts role-based sgt-map vrf vrf-name all ipv4

Displays all the SGT-IP bindings for a specific Virtual Routing and Forwarding (VRF) interface.

Example:

Device# show cts role-based sgt-map vrf vrf1 all ipv4

%IPv6 protocol is not enabled in VRF vrf1

Active IPv4-SGT Bindings Information

<table>
<thead>
<tr>
<th>IP Address</th>
<th>SGT</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>192.0.2.1</td>
<td>50</td>
<td>CACHED</td>
</tr>
<tr>
<td>192.0.2.2</td>
<td>2007</td>
<td>CACHED</td>
</tr>
<tr>
<td>192.0.2.3</td>
<td>50</td>
<td>CACHED</td>
</tr>
<tr>
<td>192.0.2.4</td>
<td>50</td>
<td>CACHED</td>
</tr>
</tbody>
</table>

Step 7  

The SGT cache entry is removed after a port shutdown or SGT cache timeout.

Configuration Examples for Cisco TrustSec Caching

Example: Configuring SGT Caching Globally

The following example shows how to configure SGT caching globally:

Device> enable
Device# configure terminal
Device(config)# cts role-based sgt-caching
Device(config)# end
Example: Configuring SGT Caching for an Interface

The following example shows how to configure SGT caching for an interface:

Device> enable
Device# configure terminal
Device(config)# interface gigabitEthernet 1/0/1
Device(config-if)# cts role-based sgt-cache ingress
Device(config-if)# end

Example: Disabling SGT Caching on an Interface

The following example shows how to disable SGT caching on an interface and displays the status of SGT caching on the interface when caching is enabled globally, but disabled on the interface.

Device> enable
Device# configure terminal
Device(config)# cts role-based sgt-caching
Device(config)# interface gigabitEthernet 1/0/1
Device(config-if)# no cts role-based sgt-cache ingress
Device(config-if)# end
Device# show cts interface GigabitEthernet 1/0/1

Interface GigabitEthernet1/0/1
  CTS sgt-caching Ingress: Disabled
  CTS sgt-caching Egress: Disabled
  CTS is enabled, mode: MANUAL
  Propagate SGT: Enabled
  Static Ingress SGT Policy:
    Peer SGT: 200
    Peer SGT assignment: Trusted

L2-SGT Statistics
  Pkts In: 200890684
  Pkts (policy SGT assigned): 0
  Pkts Out: 14
  Pkts Drop (malformed packet): 0
  Pkts Drop (invalid SGT): 0

Additional References for Cisco TrustSec SGT Caching

Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
</tbody>
</table>
Technical Assistance

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</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
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</tbody>
</table>

Feature Information for Cisco TrustSec SGT Caching

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Table 7: Feature Information for Cisco TrustSec SGT Caching

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco TrustSec SGT Caching</td>
<td>Cisco IOS XE Everest 16.9.1</td>
<td>The Cisco TrustSec SGT Caching feature enhances the ability of Cisco TrustSec to make SGT transportability flexible. In Cisco IOS XE Fuji 16.9.1, this feature was implemented on Cisco Catalyst 9400 Series Switches.</td>
</tr>
</tbody>
</table>
CHAPTER 9

IP-Prefix and SGT-Based SXP Filtering

The Security Group Tag (SGT) Exchange Protocol (SXP) is one of the several protocols that supports Cisco TrustSec. SXP is a control protocol for propagating IP-to-SGT binding information across network devices that do not have the capability to tag packets. SXP passes IP-to-SGT bindings from authentication points to upstream devices in a network. This process allows security services on switches, routers, or firewalls to learn user identity information from access devices.

The IP-Prefix and SGT-Based SXP Filtering feature allows IP-to-SGT bindings to be filtered, when they are exported or imported. This filtering can be done based on the IP prefix, SGT, or a combination of both.

- Restrictions for IP-Prefix and Security Group Tag (SGT)-Based Security Exchange Protocol (SXP) Filtering, on page 91
- Information About IP-Prefix and SGT-Based SXP Filtering, on page 92
- How to Configure IP-Prefix and SGT-Based SXP Filtering, on page 93
- Configuration Examples for IP-Prefix and SGT-Based SXP Filtering, on page 97
- Verifying IP-Prefix and SGT-Based SXP Filtering, on page 98
- Syslog Messages for SXP Filtering, on page 100

Restrictions for IP-Prefix and Security Group Tag (SGT)-Based Security Exchange Protocol (SXP) Filtering

- No high availability support for the stateful synchronization of IP-Security Group Tag (SGT) bindings in an Security Exchange Protocol (SXP) database between active and standby devices.

- Filters applied to an existing connection will take effect only on the subsequent bindings that are exported or imported. The filters do not apply to any bindings that have been exported or imported prior to applying the filters.

- Virtual Routing and Forwarding (VRF)-specific filtering is not supported, and a filter specified for a peer IP is applicable across all VRFs on the device.

- SGT values in filter rules will be a list of single SGT numbers. SGT ranges are not supported.
Information About IP-Prefix and SGT-Based SXP Filtering

Overview
The IP-Prefix and SGT-Based SXP Filtering feature allows IP-to-SGT bindings to be filtered, when they are exported or imported. This filtering can be done based on the IP prefix, SGT, or a combination of both.

The Security Group Tag (SGT) Exchange Protocol (SXP) is one of the several protocols that supports Cisco TrustSec. SXP is a control protocol for propagating IP-to-SGT binding information across network devices that do not have the capability to tag packets. SXP passes IP-to-SGT bindings from authentication points to upstream devices in a network. This process allows security services on switches, routers, or firewalls to learn user identity information from access devices.

The IP-to-SGT filtering allow systems to selectively import or export only bindings of interest. In an SXP connection, a filter can be configured on a device that acts either as a speaker or a listener, based on the filtering that happens during the export or import of bindings.

In the case of bidirectional SXP connections, filters are applied in either of the directions, based on whether a speaker or listener filter is configured. If a peer is a part of both the speaker and the listener filter groups, then filtering is applied in both directions.

Filters can be applied either on a peer-to-peer basis or globally (applicable to all SXP connections). In both cases, the filter can be applied on the speaker or the listener.

Filter Rules
A filter that needs to be applied on a device is created with a set of filter rules. Each filter rule specifies the action or actions to be taken for bindings with specific SGT values and/or IP-prefix values. Each binding is matched against the values specified in the filter rules; if a match is found, the corresponding action specified in the filter rule is applied. An action that can be applied on a selected binding is either a permit or a deny action. When a filter is enabled on the speaker or listener during the export or import of IP-SGT bindings, the bindings are filtered based on the filter rules.

If a rule is not specified for a binding in a filter list, the catch-all rule that is configured in the filter-list is executed. In the absence of a catch-all rule, the corresponding binding is implicitly denied.

Types of SXP Filtering
IP-SGT bindings are filtered in one of the following ways:

- SGT-based filtering: Filters IP-SGT bindings in an SXP connection based on the SGT value.
- IP-prefix based filtering: Filters IP-SGT bindings in an SXP connection based on the IP-prefix value.
- SGT and IP-prefix based filtering: Filter IP-SGT bindings in an SXP connection based on the SGT value and IP-prefix value.

A filter rule is applied on each of the IP-SGT binding.
How to Configure IP-Prefix and SGT-Based SXP Filtering

Configuring an SXP Filter List

In this step, a filter list is created to hold a set of rules. These rules filter the IP-SGT bindings by allowing bindings that are permitted, and blocking bindings that are denied. Each rule can be based on an SGT, IP prefix, or a combination of both the SGT and IP prefix.

If a filter list does not have a rule that matches a specific IP-SGT binding, the binding is implicitly denied unless a default or catch-all ruled is defined.

SUMMARY STEPS

1. enable
2. configure terminal
3. cts sxp filter-list filter-name
4. sequence-number permit ipv4 ip-address/prefix deny sgt sgt-value
5. exit
6. cts sxp filter-list filter-name
7. [sequence-number] deny sgt sgt-value permit ipv6 ipv6-address/prefix
8. exit
9. cts sxp filter-list filter-name
10. [sequence-number] permit ipv6 ipv6-address/prefix permit sgt-value permit
11. end

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Step 2 configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Step 3 cts sxp filter-list filter-name</td>
<td>Configures a Cisco TrustSec filter list and enters filter-list configuration mode.</td>
</tr>
<tr>
<td>Step 4 sequence-number permit ipv4 ip-address/prefix deny sgt sgt-value</td>
<td>Configures a filter list rule.</td>
</tr>
<tr>
<td>Step 5 exit</td>
<td>Exits filter-list configuration mode and returns to global configuration mode.</td>
</tr>
<tr>
<td>Step 6 cts sxp filter-list filter-name</td>
<td>Configures a Cisco TrustSec filter list and enters filter list configuration mode.</td>
</tr>
<tr>
<td>Step 7 [sequence-number] deny sgt sgt-value permit ipv6 ipv6-address/prefix</td>
<td>Configures a filter list rule.</td>
</tr>
</tbody>
</table>
### Configuring an SXP Filter Group

In this step, a set of peers are combined into a group, and a filter list is applied to the group. A filter-group can either be defined as a speaker group or listener group. To apply the same filter list to all speakers or all listeners, you can create a global speaker filter group or a global listener filter group.

**Note**
Only one filter list can be attached to a filter group.

#### SUMMARY STEPS

1. enable
2. configure terminal
3. cts sxp filter-group listener listener-name
4. filter filter-list-name
5. peer ipv4-address
6. exit
7. cts sxp filter-group speaker speaker-name
8. filter filter-list-name
9. peer ipv4-address
10. end

#### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Step 2 configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Step 3 cts sxp filter-group listener listener-name</td>
<td>Configures an SXP filter-group listener, and enters filter-group configuration mode.</td>
</tr>
<tr>
<td>Step 4 filter filter-list-name</td>
<td>Configures a filter list rule.</td>
</tr>
</tbody>
</table>
### Configuring a Global Listener or Speaker Filter Group

When configuring a global listener and global speaker filter group, the filter is applied to across the box for all SXP connections that are in listener or speaker mode.

When adding a filter-list to a filter group the currently configured set of filter lists on the box is displayed as a help string.

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 5 peer ipv4-address</td>
<td>Configures the IP address of a peer.</td>
</tr>
<tr>
<td>Step 6 exit</td>
<td>Exits filter-group configuration mode and returns to global configuration mode.</td>
</tr>
<tr>
<td>Step 7 cts sxp filter-group speaker speaker-name</td>
<td>Configures a voice VLAN on a multiple VLAN access port.</td>
</tr>
<tr>
<td>Step 8 filter filter-list-name</td>
<td>Configures a filter list name.</td>
</tr>
<tr>
<td>Step 9 peer ipv4-address</td>
<td>Configures the IP address of a peer.</td>
</tr>
<tr>
<td>Step 10 end</td>
<td>Exits filter-group configuration mode and returns to privileged EXEC mode.</td>
</tr>
</tbody>
</table>

#### SUMMARY STEPS

1. enable
2. configure terminal
3. cts sxp filter-group listener global filter-list-name
4. cts sxp filter-group speaker global filter-list-name
5. end

#### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td></td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td>Step 2 configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Step 3 cts sxp filter-group listener global filter-list-name</td>
<td>Configures a global listener filter group.</td>
</tr>
<tr>
<td>Step 4 cts sxp filter-group speaker global filter-list-name</td>
<td>Configures a global speaker filter group.</td>
</tr>
</tbody>
</table>
### Command or Action

<table>
<thead>
<tr>
<th>Step 5</th>
<th>end</th>
</tr>
</thead>
</table>

Exits global configuration mode and returns to privileged EXEC mode.

---

## Enabling SXP Filtering

After the SXP filter list and filter groups are configured, you must enable filtering.

### SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `cts sxp filter enable`
4. `exit`
5. `show cts sxp filter-list filter_name`

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td><code>enable</code>&lt;br&gt;Enables privileged EXEC mode.&lt;br&gt;• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td><code>configure terminal</code>&lt;br&gt;Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td><code>cts sxp filter enable</code>&lt;br&gt;Configures a source template for the interface.</td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td><code>exit</code>&lt;br&gt;Exits global configuration mode and returns to privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td><code>show cts sxp filter-list filter_name</code>&lt;br&gt;Displays the filter lists configured on the device along with the filter rules in each of the filter list.</td>
</tr>
</tbody>
</table>

---

## Configuring the Default or Catch-All Rule

The default or catch-all rule is applied on IP-SGT bindings for which there was no match with any of the rules in the filter list. If a default rule is not specified, these IP-SGT bindings are denied.

Define the default or catch-all rule in the filter-list configuration mode of the corresponding filter list.

### SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `cts sxp filter-list filter-name`
4. `permit ipv4 ip-address/prefix`
5. `deny ipv6 ipv6-address/prefix`
6. `permit sgt all`
7. end

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1** enable | Enables privileged EXEC mode.  
  - Enter your password if prompted. |
| **Step 2** configure terminal | Enters global configuration mode. |
| **Step 3** cts sxp filter-list filter-name | Configures a Cisco TrustSec filter list and enters filter-list configuration mode. |
| **Step 4** permit ipv4 ip-address/prefix | Permits access if the conditions are matched. |
| **Step 5** deny ipv6 ipv6-address/prefix | Denies access if the conditions are matched. |
| **Step 6** permit sgt all | Permits bindings corresponding to all SGTs. |
| **Step 7** end | Exits filter-list configuration mode and returns to privileged EXEC mode. |

### Configuration Examples for IP-Prefix and SGT-Based SXP Filtering

#### Example: Configuring an SXP Filter List

```
Device> enable
Device# configure terminal
Device(config)# cts sxp filter-list filter1
Device(config-filter-list)# permit ipv4 10.1.1.0/24 deny sgt 3 4
Device(config-filter-list)# exit
Device(config)# cts sxp filter-list filter2
Device(config-filter-list)# permit sgt all
Device(config-filter-list)# exit
Device(config)# cts sxp filter-list filter3
Device(config-filter-list)# deny ipv6 2001:db8::1/64 permit sgt 67
Device(config-filter-list)# end
```

#### Example: Configuring an SXP Filter Group

```
Device> enable
Device# configure terminal
Device(config)# cts sxp filter-group listener group1
Device(config-filter-group)# filter filter1
Device(config-filter-group)# peer 172.16.0.1 192.168.0.1
Device(config-filter-group)# exit
```
Example: Enabling SXP Filtering

Device(config)# cts sxp filter-group listener global group2
Device(config)# end

Example: Configuring the Default or Catch-All Rule

The following example shows how to create a default prefix rule that permits bindings corresponding to all IPv4 and IPv6 addresses:

Device(config)# cts sxp filter-list filter1
Device(config-filter-list)# permit ipv4 10.0.0.0/0
Device(config-filter-list)# deny ipv6 2001:db8::1/0

Verifying IP-Prefix and SGT-Based SXP Filtering

To verify the configuration, use the following commands:

The **debug cts sxp filter events** command is used to log events related to the creation, removal, and update of filter-lists and filter-groups. This command is also used to capture events related to the matching actions in a filtering process.

Device# debug cts sxp filter events

The following sample output from the **show cts sxp filter-group speaker** command displays SXP speaker filter groups:

Device# show cts sxp filter-group speaker group1
  Filter-group: group1
  Filter-name: filter1
  Peer-list: 172.16.0.1 192.168.0.1

The following sample output from the **show cts sxp filter-group listener** command displays SXP speaker listener groups:

Device# show cts sxp filter-group listener
  Global Listener Filter: Not configured
  Filter-group: group1
Filter-name: filter1
Peer-list: 172.16.0.1 192.168.0.1
Filter-group: group2
Filter-name: filter1
Peer-list: 192.0.2.1, 198.51.100.1, 203.0.113.1

The following sample output from the `show cts sxp filter-group speaker detailed` command displays detailed information about SXP speaker filter groups:

```
Device# show cts sxp filter-group speaker group1 detailed

Filter-group: group1
Filter-name: filter1
Filter-rules:
  10 deny sgt 30
  20 deny prefix 10.1.0.0/16
  30 permit sgt 60-100
Peer-list: 172.16.0.1 192.168.0.1
```

The following sample output from the `show cts sxp filter-group` command displays information about all configured filter groups:

```
Device# show cts sxp filter-group

Global Listener Filter: Not configured
Global Speaker Filter: Not configured

Listener Group:
  Filter-group: group1
  Filter-name: filter1
  Peer-list: 172.16.0.1 192.168.0.1
  Filter-group: group2
  Filter-name: filter1
  Peer-list: 192.0.2.1, 198.51.100.1, 203.0.113.1

Speaker Group:
  Filter-group: group3
  Filter-name: filter1
  Peer-list: 172.16.0.1 192.168.0.13
  Filter-group: group2
  Filter-name: filter1
  Peer-list: 192.0.2.1, 198.51.100.1, 203.0.113.1
```

The following sample output from the `show sxp filter-group detailed` command displays detailed information about all configured SXP filter groups:

```
Device# show cts sxp filter-group detailed

Global Listener Filter: Configured
  Filter-name: global1
  Filter-rules:
    10 deny 192.168.0.13/32
    20 deny sgt 100-200

Global Speaker Filter: Configured
  Filter-name: global2
  Filter-rules:
    10 deny 192.168.0.13/32
```
Syslog Messages for SXP Filtering

Syslog messages for SXP filtering are generated to indicate the various events related to filtering.

**Syslog Messages for Filter Rules**

The maximum number of rules that can be configured in a single filter is 128. The following message is generated every time the number of filter rules that is configured in a single filter increases by 20% of the limit:


The following message is generated when the number of rules configured in a single filter reaches 95% of the maximum number of rules allowed for a filter list:


The following message is generated when the number of rules configured in a single filter reaches the maximum number of allowed rules, and no more rules can be added:

`Reached maximum filter rules. Could not add new rule in filter [filter-name]`
Syslog Messages for Filter Lists

The maximum number of filter lists that can be configured is 256. The following message is generated every time the number of filter lists that is configured increases by 20% of this limit:


The following message is generated when the number of filter lists that is configured reaches 95% of the maximum number of allowed filter lists:

CTS SXP filter rules exceed %[ ] threshold. Reached count of [count] out of [max]

The following message is generated when the number of filter lists that is configured reaches the maximum number of allowed filter lists, and no more filter lists can be added:

Reached maximum filter count. Could not add new filter
Syslog Messages for SXP Filtering
CHAPTER 10

Configuring SGT Inline Tagging

- Information About SGT Inline Tagging, on page 103
- SGT Inline Tagging on a NAT Enabled Device, on page 104
- Configuring SGT Inline Tagging, on page 105
- Example: Configuring SGT Static Inline Tagging, on page 106
- Feature Information for SGT Inline Tagging, on page 106

Information About SGT Inline Tagging

Each security group in a Cisco TrustSec domain is assigned a unique 16 bit tag called the Security Group Tag (SGT). The SGT is a single label indicating the privileges of the source within the entire network. It is in turn propagated between network hops allowing any intermediary devices (switches, routers) to enforce polices based on the identity tag.

Cisco TrustSec-capable devices have built-in hardware capabilities than can send and receive packets with SGT embedded in the MAC (L2) layer. This feature is called Layer 2 (L2)-SGT Imposition. It allows ethernet interfaces on the device to be enabled for L2-SGT imposition so that the device can insert an SGT in the packet to be carried to its next hop ethernet neighbor. SGT-over-Ethernet is a method of hop-by-hop propagation of SGT embedded in clear-text (unencrypted) ethernet packets. The inline identity propagation is scalable, provides near line-rate performance and avoids control plane overhead.

The Cisco TrustSec with SGT Exchange Protocol V4 (SXPv4) feature supports Cisco TrustSec metadata-based L2-SGT. When a packet enters a Cisco TrustSec-enabled interface, the IP-SGT mapping database (with dynamic entries built by SXP and/or static entries built by configuration commands) is analyzed to learn the SGT corresponding to the source IP address of the packet, which is then inserted into the packet and carried throughout the network within the Cisco TrustSec header.

As the tag represents the group of the source, the tag is also referred to as the Source Group Tag (SGT). At the egress edge of the network, the group assigned to the packet's destination becomes known. At this point, access control can be applied. With Cisco TrustSec, access control policies are defined between the security groups and are referred to as Security Group Access Control Lists (SGACL). From the view of any given packet, SGACL is simply being sourced from a security group and destined for another security group.

The SGT tag received in a packet from a trusted interface is propagated to the network, and is also be used for Identity firewall classification. When IPsec support is added, the received SGT tag is shared with IPsec for SGT tagging.
A network device at the ingress of Cisco TrustSec cloud needs to determine the SGT of the packet entering the Cisco TrustSec cloud so that it can tag the packet with that SGT when it forwards it into the Cisco TrustSec cloud. The SGT of a packet can be determined with these methods:

- SGT field on Cisco TrustSec header: If a packet is coming from a trusted peer device, it is assumed that the Cisco TrustSec header carries the correct SGT field. This situation applies to a network that is not the first network device in the Cisco TrustSec cloud for the packet.

- SGT lookup based on source IP address: In some cases, the administrator may manually configure a policy to decide the SGT of a packet based upon the source IP address. An IP address to SGT table can also be populated by the SXP protocol.

L2 Inline Tagging is supported for IPv6 multicast traffic with unicast source IPv6 addresses.

### SGT Inline Tagging on a NAT Enabled Device

The following scenarios explain how SGT is determined for a packet that flows from a primary device, which has Network Address Translation (NAT) enabled on both ingress and egress ports, to a secondary device:

---

**Note**

All ports that are used for the flow must have [CTS manual](#) and trusted configured on both devices.

- **If inline tagging is enabled between both devices and SGT tag is not changed with CLI:**

  In this case, on the primary device Cisco TrustSec is enforced on the SGT tag corresponding to the packet's source IP. The same SGT tag is tagged to the NAT IP. On the secondary device, Cisco TrustSec is enforced on the SGT tag corresponding to the packet's source IP also.

  For example, a packet is received on the primary device with a source IP 192.0.2.5 and SGT tag 133. Cisco TrustSec is enforced for the SGT tag 133 on the primary device. After NAT translation the packet's IP changes to 198.51.100.10 and tagged to the SGT tag 133. On the secondary device, the packet is received with IP address 198.51.100.10 and SGT tag 133. Cisco TrustSec is enforced with SGT tag 133 on the secondary device.

- **If inline tagging is enabled between both devices and SGT tag is changed with CLI:**

  In this case, on the primary device Cisco TrustSec is enforced on the SGT tag corresponding to the packet's source IP. The SGT tag is changed by CLI but the SGT tag corresponding to the packets's source IP is tagged to the packet's NAT IP. On the secondary device, Cisco TrustSec is enforced on the SGT tag corresponding to the packet's source IP also.

  For example, a packet is received on the primary device with a source IP 192.0.2.5 and SGT tag 133. Cisco TrustSec is enforced for the SGT tag 133 on the primary device. The SGT tag is changed to 200 with CLI. After NAT translation the packet’s IP changes to 198.51.100.10 but tagged to the SGT tag 133. On the secondary device, the packet is received with IP address 198.51.100.10 and SGT tag 133. Cisco TrustSec is enforced on the SGT tag 133 on the secondary device.

- **If inline tagging is disabled (SGT is populated through SXP protocol on the secondary device) and SGT tag is changed with CLI:**

  In this case, on the primary device Cisco TrustSec is enforced on the SGT tag corresponding to the packet's source IP. The SGT to Post Nat IP is defined through CLI and is learnt on the primary device. On the secondary device, Cisco TrustSec is enforced on the SGT tag corresponding to the NAT IP, if
there is no direct Cisco TrustSec link between primary and secondary device and IP to SGT bindings are learnt through SXP in secondary device.

For example, a packet is received on the primary device with a source IP 192.0.2.5 and SGT tag 133. After NAT translation the source IP changes to 198.51.100.10, for which the SGT is defined through CLI as 200. Cisco TrustSec is enforced for the SGT tag 133 on the primary device. On the secondary device, IP to SGT binding is received through SXP and Cisco TrustSec is enforced on the SGT tag 200 on the secondary device.

### Configuring SGT Inline Tagging

**Procedure**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td></td>
</tr>
<tr>
<td><code>enable</code></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device&gt; enable</code></td>
<td>Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td></td>
</tr>
<tr>
<td><code>configure terminal</code></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device# configure terminal</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td></td>
</tr>
<tr>
<td>`interface {gigabitethernet port</td>
<td>vlan number}`</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device(config)# interface gigabitethernet 1/0/1</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td></td>
</tr>
<tr>
<td><code>cts manual</code></td>
<td>Enables Cisco TrustSec SGT authorization and forwarding on the interface, and enters Cisco TrustSec manual interface configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device(config-if)# cts manual</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td></td>
</tr>
<tr>
<td><code>propagate sgt</code></td>
<td>Enables Cisco TrustSec SGT propagation on an interface.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Device(config-if-cts-manual)# propagate sgt</code></td>
<td></td>
</tr>
</tbody>
</table>

**Note**

Use this command in situations where the peer device is not capable of receiving SGT over Ethernet packets (that is, when a peer device does not support Cisco Ethertype CMD 0x8909 frame format).
### Purpose

**Command or Action**

**Step 6**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>policy static sgt tag [trusted]</code></td>
<td>Configures a static SGT ingress policy on the interface and defines the trustworthiness of an SGT received on the interface. <strong>Note</strong> The <code>trusted</code> keyword indicates that the interface is trustworthy for Cisco TrustSec. The SGT value received in the Ethernet packet on this interface is trusted and will be used by the device for any SG-aware policy enforcement or for the purpose of egress-tagging.</td>
</tr>
</tbody>
</table>

**Example:**

Device(config-if-cts-manual)# `policy static sgt 77 trusted`

<table>
<thead>
<tr>
<th>Step 7</th>
<th>Example:</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>end</code></td>
<td>Exits Cisco TrustSec manual interface configuration mode and enters privileged EXEC mode.</td>
</tr>
</tbody>
</table>

### Example: Configuring SGT Static Inline Tagging

This example shows how to enable an interface on the device for L2-SGT tagging or imposition and defines whether the interface is trusted for Cisco TrustSec.

Device# `configure terminal`
Device(config)# `interface gigabitethernet 1/0/1`
Device(config-if)# `cts manual`
Device(config-if-cts-manual)# `propagate sgt`
Device(config-if-cts-manual)# `policy static sgt 77 trusted`

### Feature Information for SGT Inline Tagging

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](http://www.cisco.com/go/cfn). An account on Cisco.com is not required.

**Table 8: Feature Information for SGT Inline Tagging**

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Release</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>SGT Inline Tagging</td>
<td>Cisco IOS XE Everest 16.6.1</td>
<td>Each security group in a Cisco TrustSec domain is assigned a unique 16 bit tag called the Security Group Tag (SGT). The SGT is a single label indicating the privileges of the source within the entire network.</td>
</tr>
</tbody>
</table>
Flexible NetFlow Export of Cisco TrustSec Fields

The Flexible NetFlow Export of Cisco TrustSec Fields feature supports the Cisco TrustSec fields in the Flexible NetFlow (FNF) flow record and helps to monitor, troubleshoot, and identify nonstandard behavior for Cisco TrustSec deployments.

This module describes the interaction between Cisco TrustSec and FNF and how to configure and export Cisco TrustSec fields in the NetFlow Version 9 flow records.

Restrictions for Flexible NetFlow Export of Cisco TrustSec Fields

- The security group tag (SGT) value that is exported in FNF records is zero in the following scenarios:
  - The corresponding packet is received with an SGT value of zero from a trusted interface.
  - The corresponding packet is received without an SGT.
  - The SGT is not found during the IP-SGT lookup. (The SGT is not found in the same packet because the packet is received without an SGT.)
  - When a flow record has SGT and Destination Group Tag (DGT) fields (or only either of the two), and if both these values are not applicable, a flow will still be created with zero values for SGT and DGT. The flow records are expected to include source and destination IP addresses, along with SGT and DGT fields.

Information About Flexible NetFlow Export of Cisco TrustSec Fields

Cisco TrustSec Fields in Flexible NetFlow

The Cisco TrustSec fields, source SGT and destination sSGT, in FNF flow records help administrators correlate the flow with identity information. It enables network engineers to gain a detailed understanding how customers use the network and application resources. This information can then be used to efficiently plan and allocate access and application resources, and to detect and resolve potential security and policy violations.
Cisco TrustSec fields are supported for ingress and egress FNF and for unicast and multicast traffic.

The following table lists NetFlow Version 9 enterprise-specific field types for Cisco TrustSec, which are used in FNF templates for the Cisco TrustSec source and destination SGTs.

<table>
<thead>
<tr>
<th>Flow Field Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTS_SRC_GROUP_TAG</td>
<td>Cisco TrustSec source SGT</td>
</tr>
<tr>
<td>CTS_DST_GROUP_TAG</td>
<td>Cisco TrustSec destination SGT</td>
</tr>
</tbody>
</table>

Cisco TrustSec fields are configured in addition to the existing match fields under the FNF flow record. The following configurations are used to add Cisco TrustSec flow objects to the FNF flow record as key or nonkey fields and to configure source and destination SGTs for a packet.

The `match flow cts {source | destination} group-tag` command is configured under the corresponding flow record to specify Cisco TrustSec fields as key fields. The key fields differentiate flows, with each flow having a unique set of values. A flow record requires at least one key field, before it can be used in a flow monitor. You can configure the `match` command to a source SGT, destination SGT or both, at the same time.

The flow record is then configured under the flow monitor, and the flow monitor is applied to an interface. To export the FNF data, a flow exporter needs to be configured and then added under the flow monitor.

### How to Configure Flexible NetFlow Export of Cisco TrustSec Fields

The following sections provide information about the various tasks that comprise FNF export of Cisco TrustSec fields.

### Configuring Cisco TrustSec Fields as Key Fields in the Flow Record

#### SUMMARY STEPS

1. enable
2. configure terminal
3. flow record record-name
4. match ipv4 protocol
5. match ipv4 source address
6. match ipv4 destination address
7. match transport source-port
8. match transport destination-port
9. match flow direction
10. match flow cts {source | destination} group-tag
11. end

#### DETAILED STEPS

<table>
<thead>
<tr>
<th>Step 1</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Command or Action</strong></td>
<td><strong>Purpose</strong></td>
<td></td>
</tr>
<tr>
<td>----------------------</td>
<td>-------------</td>
<td></td>
</tr>
<tr>
<td>Device&gt; enable</td>
<td>Enters global configuration mode.</td>
<td></td>
</tr>
</tbody>
</table>

**Step 2**

```configure terminal``

**Example:**

```
Device# configure terminal
```

**Step 3**

```flow record record-name```

**Example:**

```
Device(config)# flow record cts-record-ipv4
```

- This command also allows you to modify an existing flow record.

**Step 4**

```match ipv4 protocol```

**Example:**

```
Device(config-flow-record)# match ipv4 protocol
```

(Optional) Configures the IPv4 protocol as a key field for a flow record.

**Step 5**

```match ipv4 source address```

**Example:**

```
Device(config-flow-record)# match ipv4 source address
```

(Optional) Configures the IPv4 source address as a key field for a flow record.

**Step 6**

```match ipv4 destination address```

**Example:**

```
Device(config-flow-record)# match ipv4 destination address
```

(Optional) Configures the IPv4 destination address as a key field for a flow record.

**Step 7**

```match transport source-port```

**Example:**

```
Device(config-flow-record)# match transport source-port
```

(Optional) Configures the transport source port as a key field for a flow record.

**Step 8**

```match transport destination-port```

**Example:**

```
Device(config-flow-record)# match transport destination-port
```

(Optional) Configures the transport destination port as a key field for a flow record.

**Step 9**

```match flow direction```

**Example:**

```
Device(config-flow-record)# match flow direction
```

(Optional) Configures the direction in which the flow is monitored as a key field.
### Configuring SGT Name Export in NetFlow

Each flow exporter supports only one destination. If you want to export the data to multiple destinations, you must configure multiple flow exporters and assign them to the flow monitor.

#### SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `flow exporter exporter-name`
4. `destination {ip-address | hostname} [vrf vrf-name]`
5. `option cts-sgt-table [timeout seconds]`
6. `end`
### DETAILED STEPS

<table>
<thead>
<tr>
<th>Step 1</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>enable</td>
<td>Enables privileged EXEC mode.</td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td>- Enter your password if prompted.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 2</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>configure terminal</td>
<td>Enters global configuration mode.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 3</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>flow exporter exporter-name</td>
<td>Creates a flow exporter or modifies an existing flow exporter, and enters Flexible NetFlow flow exporter configuration mode.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 4</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>destination {ip-address</td>
<td>hostname} [vrf vrf-name]</td>
<td>Specifies the IP address or hostname of the destination system for the exporter.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 5</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>option cts-sgt-table [timeout seconds]</td>
<td>Selects the SGT ID-to-name table option for the exporter.</td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td>- This option allows FNF to export Cisco TrustSec environmental data tables that map SGTs to Security Group Names.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 6</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>end</td>
<td>Exits Flexible NetFlow flow exporter configuration mode and returns to privileged EXEC mode.</td>
<td></td>
</tr>
</tbody>
</table>

### Configuration Examples for Flexible NetFlow Export of Cisco TrustSec Fields

The following sections provide examples relating to the configuration of FNF export of Cisco TrustSec fields.

**Example: Configuring Cisco TrustSec Fields as Key Fields in the Flow Record**

The following example shows how to configure the Cisco TrustSec flow objects as key fields in an IPv4 Flexible NetFlow flow record:

```bash
Device> enable
Device# configure terminal
Device(config)# flow record cts-record-ipv4
Device(config-flow-record)# match ipv4 protocol
Device(config-flow-record)# match ipv4 source address
```
Example: Configuring SGT Name Export in NetFlow

The following example shows how to configure SGT name export in NetFlow:

```
Device> enable
Device# configure terminal
Device(config)# flow exporter EXPORTER-1
Device(config-flow-exporter)# destination 172.16.10.2
Device(config-flow-exporter)# option cts-sgt-table timeout 1200
Device(config-flow-exporter)# end
```

Additional References for Flexible NetFlow Export of Cisco TrustSec Fields

### Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
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</thead>
<tbody>
<tr>
<td>Cisco IOS commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
</tbody>
</table>

### Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
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</thead>
</table>

The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.
Feature Information for Flexible NetFlow Export of Cisco TrustSec Fields

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 9: Feature Information for Flexible NetFlow Export of Cisco TrustSec Fields

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexible NetFlow Export of Cisco TrustSec Fields</td>
<td>Cisco IOS XE</td>
<td>The Flexible NetFlow Export of Cisco TrustSec Fields feature supports the Cisco TrustSec fields in the FNF flow record and helps to monitor, troubleshoot, and identify nonstandard behavior for Cisco TrustSec deployments.</td>
</tr>
<tr>
<td></td>
<td>Everesst 16.6.1</td>
<td>The following command was introduced: `match flow cts {source</td>
</tr>
</tbody>
</table>


CHAPTER 12

Configuring Endpoint Admission Control

This module describes the Endpoint Admission Control (EAC) access methods for authentication and authorization in TrustSec networks.

- Information About Endpoint Admission Control, on page 115
- Example: 802.1X Authentication Configuration, on page 116
- Example: MAC Authentication Bypass Configuration, on page 116
- Example: Web Authentication Proxy Configuration, on page 116
- Example: Flexible Authentication Sequence and Failover Configuration, on page 117
- 802.1X Host Modes, on page 117
- Pre-Authentication Open Access, on page 117
- Example: DHCP Snooping and SGT Assignment, on page 117
- Feature Information for Endpoint Admission Control, on page 118

Information About Endpoint Admission Control

In TrustSec networks, packets are filtered at the egress, not the ingress to the network. In TrustSec endpoint authentication, a host accessing the TrustSec domain (endpoint IP address) is associated with a Security Group Tag (SGT) at the access device through DHCP snooping and IP device tracking. The access device transmits that association (binding) through SXP-to-TrustSec hardware-capable egress devices, which maintain a continually updated table of Source IP to SGT bindings. Packets are filtered on egress by the TrustSec hardware-capable devices by applying security group ACLs (SGACLs).

Endpoint Admission Control (EAC) access methods for authentication and authorization can include the following:

- 802.1X port-based Authentication
- MAC Authentication Bypass (MAB)
- Web Authentication (WebAuth)

All port-based authentication can be enabled with the authentication command. Each access method must be configured individually per port. The flexible authentication sequence and failover features permit the administrator to specify the failover and fallback sequence when multiple authentication modes are configured and the active method fails. The 802.1X host mode determines how many endpoint hosts can be attached per 802.1X port.
Example: 802.1X Authentication Configuration

The following example shows the basic 802.1x configuration on a Gigabit Ethernet port:

```
Device> enable
Device# configure terminal
Device(config)# dot1x system-auth-control
Device(config)# interface GigabitEthernet2/1
Device(config-if)# authentication port-control auto
Device(config-if)# dot1x pae authenticator
```

Example: MAC Authentication Bypass Configuration

MAC Authentication Bypass (MAB) enables hosts or clients that are not 802.1X capable to join 802.1X-enabled networks. It is not required to enable 802.1X authentication prior to enabling MAB.

The following example is of a basic MAB configuration:

```
Device> enable
Device# configure terminal
Device(config)# interface GigabitEthernet2/1
Device(config-if)# authentication port-control auto
Device(config-if)# mab
```

For additional information on configuring MAB authentication, see the configuration guide for your access device.

Example: Web Authentication Proxy Configuration

Web Authentication Proxy (WebAuth) allows the user to use a web browser to transmit their login credentials to the Cisco Secure ACS though a Cisco IOS web server on the access device. WebAuth can be enabled independently. It does not require 802.1X or MAB to be configured.

The following example shows a basic WebAuth configuration on a Gigabit Ethernet port:

```
Device(config)# ip http server
Device(config)# ip access-list extended POLICY
Device(config-ext-nacl)# permit udp any any eq bootps
Device(config-ext-nacl)# permit udp any any eq domain
Device(config)# ip admission name HTTP proxy http
Device(config)# fallback profile FALLBACK_PROFILE
Device(config-fallback-profile)# ip access-group POLICY in
Device(config-fallback-profile)# ip admission HTTP
Device(config)# interface GigabitEthernet2/1
Device(config-if)# authentication port-control auto
Device(config-if)# authentication fallback FALLBACK_PROFILE6500(config-if)#ip access-group POLICY in
```
Example: Flexible Authentication Sequence and Failover Configuration

Flexible Authentication Sequence (FAS) allows the access port to be configured for 802.1X, MAB, and WebAuth authentication methods, specifying the fallback sequence if one or more of the authentication methods are not available. The default failover sequence is as follows:

- 802.1X port-based Authentication
- MAC Authentication Bypass
- Web Authentication

Layer 2 authentications always occur before Layer 3 authentications. That is, 802.1X and MAB must occur before WebAuth.

The following example specifies the authentication sequence as MAB, dot1X, and then WebAuth:

```
Device> enable
Device# configure terminal
Device(config)# interface gigabitEthernet 2/1
Device(config-if)# authentication order mab dot1x webauth
Device(config-if)# ^Z
```

For additional information on FAS, see Flexible Authentication Order, Priority, and Failed Authentication.

802.1X Host Modes

Four host classification modes can be configured per port:

- Single Host — Interface-based session with one MAC address
- Multi Host — Interface-based session with multiple MAC addresses per port
- Multi Domain — MAC + Domain (VLAN) session
- Multi Auth — MAC-based session with multiple MAC address per port

Pre-Authentication Open Access

The Pre-Authentication Open Access feature allows clients and devices to gain network access before port authentication is performed. This process is primarily required for the PXE boot scenario, where a device needs to access the network before PXE times out and download a bootable image that may contain a supplicant.

Example: DHCP Snooping and SGT Assignment

After the authentication process, authorization of the device occurs (for example, dynamic VLAN assignment, ACL programming, etc.). For TrustSec networks, a Security Group Tag (SGT) is assigned per the user...
configuration in the Cisco ACS. The SGT is bound to traffic sent from that endpoint through DHCP snooping and the IP device tracking infrastructure.

The following example enables DHCP snooping and IP device tracking on an access device:

```
Device> enable
Device# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Device(config)# ip dhcp snooping
Device(config)# ip dhcp snooping vlan 10
Device(config)# no ip dhcp snooping information option
Device(config)# ip device tracking
```

## Feature Information for Endpoint Admission Control

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<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Endpoint Admission Control</td>
<td>Cisco IOS XE Everest 16.6.1</td>
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