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.

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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.

Restriction for Default Route SGT Mapping

- Default route configuration is accepted only with the subnet **/0**. Entering only the host-ip without the subnet /0 displays the following message:

```
Device(config)#cts role-based sgt-map 0.0.0.0 sgt 1000
Default route configuration is not supported for host ip
```

Information About SGT Mapping

This section provides information about SGT mapping.

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.

In IPv4 networks, Security Exchange Protocol (SXP)v3, and more recent versions, can receive and parse subnet *net_address/prefix* strings from SXPv3 peers. Earlier SXP versions convert the subnet prefix into its set of host bindings before exporting them to an SXP listener peer.

For example, the IPv4 subnet 192.0.2.0/24 is expanded as follows (only 3 bits for host addresses):

- Host addresses 198.0.2.1 to 198.0.2.7—tagged and propagated to SXP peer.
- Network and broadcast addresses 198.0.2.0 and 198.0.2.8—not tagged and not propagated.

To limit the number of subnet bindings SXPv3 can export, use the **cts sxp mapping network-map** global configuration command.

Subnet bindings are static, there is no learning of active hosts. They can be used locally for SGT imposition and SGACL enforcement. Packets tagged by subnet-to-SGT mapping can be propagated on Layer 2 or Layer 3 Cisco TrustSec links.

For IPv6 networks, SXPv3 cannot export subnet bindings to SXPv2 or SXPv1 peers.

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.

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. SXP: Bindings learned from SXP peers.
4. IP_ARP: Bindings learned when tagged ARP packets are received on a CTS capable link.
5. 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.
6. INTERNAL: Bindings between locally configured IP addresses and the device own SGT.

Note If the source IP address matches multiple subnet prefixes with different assigned SGTs, then the longest prefix SGT takes precedence unless priority differs.

Default Route SGT

Default Route Security Group Tag (SGT) assigns an SGT number to default routes.

Default Route is that route which does not match a specified route and therefore is the route to the last resort destination. Default routes are used to direct packets addressed to networks not explicitly listed in the routing table.

How to Configure SGT Mapping

This section describes 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:

Procedure

	Command or Action	Purpose
Step 1	**enable**	Enables privileged EXEC mode.

	Command or Action	Purpose
	Example: `Device# enable`	• Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**cts sgt** *tag* **Example:** `Device(config)# cts sgt 1234`	Enables SXP for Cisco TrustSec.
Step 4	**exit** **Example:** `Device(config)# exit`	Exits global configuration mode and returns to privileged EXEC mode

Configuring Subnet-to-SGT Mapping

Procedure

	Command or Action	Purpose
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 sxp mapping network-map** *bindings* **Example:** `Device(config)# cts sxp mapping network-map 10000`	• 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. • *bindings*—(0 to 65,535) default is 0 (no expansions performed)
Step 4	**cts role-based sgt-map** *ipv4_address/prefix* **sgt** *number* **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

	Command or Action	Purpose
		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* **Example:** `Device(config)# cts role-based sgt-map 2020::/64 sgt 1234`	(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 to128) Specifies the number of bits in the network address. • **sgt** *number*—(0–65,535) Specifies the Security Group Tag (SGT) number.
Step 6	**exit** **Example:** `Device(config)# exit`	Exits global configuration mode and returns to privileged EXEC mode..

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.

Procedure

	Command or Action	Purpose
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	**vlan** *vlan_id* **Example:** `Device(config)# vlan 100`	Creates VLAN 100 on the TrustSec-capable gateway device and enters VLAN configuration submode.
Step 4	[**no**] **shutdown** **Example:** `Device(config-vlan)# no shutdown`	Provisions VLAN 100.
Step 5	**exit** **Example:** `Device(config-vlan)# exit`	Exits VLAN configuration mode and returns to global configuration mode.
Step 6	**interface** *type slot/port* **Example:** `Device(config)# interface vlan 100`	Enters interface configuration mode.
Step 7	**ip address** *slot/port* **Example:** `Device(config-if)# ip address 10.1.1.2 255.0.0.0`	Configures Switched Virtual Interface (SVI) for VLAN 100.
Step 8	[**no**] **shutdown** **Example:** `Device(config-if)# no shutdown`	Enables the SVI.
Step 9	**exit** **Example:** `Device(config-if)# exit`	Exits VLAN interface configuration mode and returns to global configuration mode.
Step 10	**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`	Assigns the specified SGT to the specified VLAN.

	Command or Action	Purpose
Step 11	**ip device tracking probe** [**count** *count* |**delay** *seconds* |**interval** *length*] **Example:** `Device(config)# ip device tracking`	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 12	**exit** **Example:** `Device(config)# exit`	Exits global configuration mode.
Step 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**] **Example:** `Device(config)# show cts role-based sgt-map all`	(Optional) Displays the VLAN-to-SGT mappings.
Step 14	**show ip device tracking** {**all** | **interface** | **ip** | **mac**} **Example:** `Device(config)# show ip device tracking all`	(Optional) Verifies the operational status of IP Device tracking.

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:

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:**	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
	`Device# enable`	
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**cts keystore emulate** **Example:** `Device(config)# cts keystore emulate`	Configures the switch to use a software emulation of the keystore instead of the hardware keystore.
Step 4	**exit** **Example:** `Device(config)# exit`	Exits configuration mode.
Step 5	**show keystore** **Example:** `Device# show keystore`	Displays the status and contents of the keystore. The stored secrets are not displayed.

Configuring Default Route SGT

Before you begin

Ensure that you have already created a default route on the device using the **ip route 0.0.0.0** command. Otherwise, the default route (which comes with the Default Route SGT) gets an unknown destination and therefore the last resort destination will point to CPU.

Procedure

	Command or Action	Purpose
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 0.0.0.0/0 sgt** *number* **Example:** `Device(config)# cts role-based sgt-map 0.0.0.0/0 sgt 3`	Specifies the SGT number for the default route. Valid values are from 0 to 65,519. **Note** • The **host_address/subnet** can be either IPv4 address (0.0.0.0/0) or IPv6 address (0:0::/0)

	Command or Action	Purpose

		• The default route configuration is accepted only with the subnet **/0**. Entering only the host-ip without the subnet /0 displays the following message:
		`Device(config)#cts role-based sgt-map 0.0.0.0 sgt 1000`
		`Default route configuration is not supported for host ip`

Step 4	**exit** **Example:** `Device(config)# exit`	Exits global configuration mode.

Verifying SGT Mapping

The following sections show how to verify SGT mapping:

Verifying Subnet-to-SGT Mapping Configuration

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

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

Verifying VLAN-to-SGT Mapping

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

Table 1:

Command	Purpose
show ip device tracking	Displays the status of IP Device Tracking which identifies the IP addresses of active hosts on a VLAN.
show cts role-based sgt-map	Displays IP address-to-SGT bindings.

Verifying Default Route SGT Configuration

Verify the Default Route SGT configuration:

```
device# show role-based sgt-map all
Active IPv4-SGT Bindings Information

IP Address              SGT     Source
============================================
0.0.0.0/0               3       CLI
11.0.0.0/8              11      CLI
11.0.0.10               1110    CLI
11.1.1.1                1111    CLI
21.0.0.2                212     CLI

IP-SGT Active Bindings Summary
============================================
Total number of CLI      bindings = 5
Total number of active   bindings = 5
```

Configuration Examples for SGT Mapping

The following sections show configuration examples of SGT mapping:

Example: Configuring 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
   (dd:hr:mm:sec)
   ```

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 11.11.11.0/29 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:

```
Device1# show cts sxp sgt-map
            IP-SGT Mappings expanded:22
            There are no IP-SGT Mappings
```

7. Save the configurations on Device1 and Device2 and exit global configuration mode.

```
Device1(config)# copy running-config startup-config
Device1(config)# exit
Device2(config)# copy running-config startup-config
Device2(config)# exit
```

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.

```
TS_device(config)# device-tracking policy policy1
```

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

IP Address         SGT         Source
============================================

10.1.1.1           10           VLAN

IP-SGT Active Bindings Summary
============================================
Total number of VLAN bindings = 1
Total number of CLI bindings = 0
Total number of active bindings = 1
```

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
```

Example: Configuring Device Route SGT

```
Device# configure terminal
Device(config)# cts role-based sgt-map 0.0.0.0/0 sgt 3
Device(config)# exit
```

Feature History for Security Group Tag Mapping

This table provides release and related information for features explained in this module.

These features are available on all releases subsequent to the one they were introduced in, unless noted otherwise.

Release	Feature	Feature Information
Cisco IOS XE Everest 16.5.1a	Security Group Tag Mapping	Subnet to 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. Support for this feature was introduced only on the C9500-12Q, C9500-16X, C9500-24Q, C9500-40X models of the Cisco Catalyst 9500 Series Switches.
Cisco IOS XE Fuji 16.8.1a	Security Group Tag Mapping	Support for this feature was introduced on the C9500-32C, C9500-32QC, C9500-48Y4C, and C9500-24Y4C models of the Cisco Catalyst 9500 Series Switches.
Cisco IOS XE Gibraltar 16.11.1	Default Route SGT Classification	Default Route SGT assigns an SGT tag number to those routes that do not match a specified route. Support for this feature was introduced on all the models of the Cisco Catalyst 9500 Series Switches.

Use Cisco Feature Navigator to find information about platform and software image support. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn.